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# *Annexes*

## **MATERIEL**

Ariel dynamics Inc., Trabuco Canyon, CA, USA (<http://www.arielnet.com>).

Motion Analysis Limited, Santa Rosa, California, USA (<http://www.motionanalysis.com>).

Peak Performance Technologies, Inc., Castle Donington, UK  
(<http://www.motioncapture.co.uk>).

Qualisis Inc., Glastonbury, CT, USA (<http://qualysis.com>).

Oxford Metrics Limited, Oxford, England (<http://www.vicon.com>).

Northern Digital Inc., Waterloo, Ontario, Canada (<http://www.ndigital.com>).

Charnwood Dynamics Limited, Barrow-upon-Soar, England (<http://www.charndyn.com>).

Skill Technologie Inc.

Advanced Mechanical Technology Inc., Newton, MA, USA (<http://www.amtiweb.com>).

## **LES ACCIDENTS VASCULAIRES CEREBRAUX**

Les AVC peuvent être classés en trois groupes principaux (Bariety et al., 1990 : tableau III.1.) : les ramollissements cérébraux, l'hémorragie cérébrale et l'hémorragie méningée.

**Les ramollissements cérébraux** ont pour principales étiologies : 1) la *thrombose* essentiellement par *athérome* artériel, 2) l'*embolie* cérébrale (moins fréquente que la thrombose) principalement par rétrécissement *mitral*, 3) l'association à l'*infarctus du myocarde* (caillot, *ischémie* dans le territoire d'une artère athéromateuse...), 4) les embolies gazeuses (accident de décompression, introduction d'air dans le système veineux...). **L'hémorragie cérébrale** est due à la rupture d'une artère dans le *parenchyme cérébral* et a pour étiologie une hypertension artérielle (cause la plus fréquente) ou une malformation vasculaire congénitale (*anévrisme*, *angiome*). **L'hémorragie méningée** est caractérisée par un épanchement de sang dans l'espace *sous-arachnoïdien* ayant pour étiologie la plus fréquente le traumatisme, l'hypertension artérielle et la malformation vasculaire congénitale (les deux dernières étant les plus fréquentes) ou encore des cas plus rares (*maladie d'Osler*, *méningite*, *encéphalite*, tumeur, intoxication au plomb...).

**Le mode d'installation de l'atteinte** est très variable. Il peut être progressif (trouble de la marche, gêne de certains mouvements, paralysie faciale, troubles de la parole), brusque (apparition nette de l'atteinte) ou d'une brutalité extrême (coma). **Les différents aspects cliniques** typiques sont : 1) l'hémiplégie flasque en dehors du coma, 2) l'hémiplégie *spasmodique* (évolution habituelle de l'hémiplégie flasque), 3) l'hémiplégie *frustre* (légère), 4) l'hémiplégie dans le coma. **Les facteurs de risque des AVC** sont : l'âge, l'hypertension artérielle, le diabète sucré, l'*hyperlipidémie*, le tabagisme, l'obésité, les contraceptifs oraux fortement dosée en œstrogènes, certaines anomalies hématologiques tels que l'hyperagrégation plaquettaire, l'alcoolisme mais aussi certains facteurs migraineux, génétiques, familiaux, infectieux... (Mazaux et al., 1995).

**Les troubles associés** peuvent être divers. Les séquelles sont rarement purement motrices (Albert, 1980). En effet, au niveau du Système Nerveux Central des structures aux fonctions très variées se trouvent à proximité immédiate des voies motrices. Dans le cas d'un AVC, il est peu probable que les effets destructeurs des troubles circulatoires suivent les frontières anatomiques des voies motrices. Ainsi, les conséquences de l'atteinte sont le plus souvent très variées et ont en commun des troubles sensitivo-moteurs. Ces troubles peuvent également être sensoriels, centraux ou périphériques, psychologiques, neurovégétatifs... (Mazaux et al., 1995). **Les troubles sensoriels** sont essentiellement des troubles de la discrimination tactile par déficit ou par exagération (chaleur, douleur...), troubles de reconnaissance de la position, du sens ou du mouvement articulaire en absence de contrôle visuel, d'une manière plus générale des *troubles gnosiques*. Ces troubles peuvent atteindre chacun des sens. Par exemple, pour la vision, l'*hémianopsie* est un trouble relativement courant... **Les troubles**

**périphériques** ou de l'appareil locomoteur sont essentiellement : amyotrophie, rétraction musculaire, rétraction capsulo-articulaire, paralysie ou *parésie*, *troubles trophiques*, *spasticité*, fatigabilité, tremblement, *clonie*, *réflexes polycinétiques*, réactivité à l'effort (augmentation de la spasticité par exemple), *synergies*, *syncinésies*, diminution des capacités physiques (force, endurance, vitesse...). **Les troubles "supérieurs"** sont essentiellement : *aphasie*, *héminégligence*, trouble de l'identité, de la personnalité, renfermement, état de confusion, phobies (surtout d'un nouvel accident), ignorance ou refus de la pathologie, d'une manière plus générale des troubles psychoaffectifs et émotionnels variés, *hypochondrie*, *schizophrénie*, hystérie, anxiété, dépression... **Les troubles neurovégétatifs** sont essentiellement : vesico-sphinctérien, déglutition...

Les **complications** possibles sont également nombreuses : *phlébite*, escarre, *ostéoporose*, *ankylose*, névrose, dépression... **Le côté de l'hémiplégie** (droite ou gauche) a son importance. Des études telles que celles de Rode et al. (1997) ou Hess et al. (1994) montrent que les sujets atteints d'une hémiplégie gauche présentent des troubles de l'équilibre plus importants que ceux atteints d'une lésion droite. Plusieurs autres constatations ont également été faites : une moins bonne récupération de la posture, des troubles d'orientation et de perception spatiale plus importants... De même, la rééducation de ces sujets semble présenter de moins bons résultats (Mazaux et al., 1995).

## **GLOSSAIRE**

Réalisé à partir du Larousse médical (1990) et du dictionnaire des termes de médecine (Garnier Delamare, 1992).

- Anastomose* : Communication entre deux vaisseaux ou deux conduits de même nature.
- Anévrisme* : Distension localisée de la paroi d'un vaisseau d'origine artériel, artério-veineux...
- Angiome* : Malformation du système vasculaire, prolifération et agglomération de vaisseaux sanguin ou lymphatique. Ils peuvent être superficiels, cérébraux...
- Ankylose* : Limitation plus ou moins grande de mobilité.
- Aphasie* : Perte ou troubles de la compréhension et de l'usage des symboles parlés ou écrits du langage.
- Athérome* : Dépôt de corps gras sur les artères.
- Atrophie* : Volume anormalement petit.
- Clonie* : Contraction musculaire successive et involontaire spontanée ou provoquée.
- Embolie* : Oblitération d'un segment de canal, habituellement un vaisseau, par un corps anormal en migration.
- Encéphalite* : Inflammation de l'encéphale.
- Equin* : Hyperextension du pied sur la jambe c'est-à-dire exagération de la flexion plantaire de cheville
- Focal* : Localisé.
- Hémianopsie* : Affaiblissement localisé ou perte de la vue d'un ou des deux côtés du champ visuel.
- Héminégligence* : Négligence d'un héli-corps.
- Hémiplégie flasque* : Paralysie d'un héli-corps, (paralysie faciale, abolition force musculaire, hypotonie, abolition réflexes tendineux, signe de Babinski unilatéral).
- Hémiplégie frustre* : Hémiplégie discrète.
- Hémiplégie spasmodique* : Evolution habituelle de l'hémiplégie flasque caractérisée par une hyper-activité réflexe (contracture musculaire, réapparition voire exagération des réflexes tendineux, diminution sans abolition de la force musculaire, exagération du réflexe myotatique, signe de Babinski...).
- Hyperlipidémie* : Présence trop importante de lipides dans le sang.
- Hypochondrie* : Etat de perpétuelle inquiétude pour son état de santé.
- Incidence* : Fréquence de cas nouveaux.
- Infarctus du myocarde* : Nécrose d'une partie du muscle cardiaque privé d'apport sanguin presque toujours à la suite de la thrombose d'une artère coronaire.
- Ischémie* : Arrêt ou altération plus ou moins localisée de la circulation sanguine.
- Maladie d'Osler* : Angiomatose hémorragique familiale.
- Méninges* : Ensemble de trois membranes enveloppant le système nerveux central.
- Méningites* : inflammation des méninges.
- Mésencéphale* : Portion de l'encéphale.
- Morbidité* : Etat de maladie ou somme des maladies d'une population.
- Néof ormation* : formation d'un nouveau tissu.
- Ostéoporose* : Déminéralisation squelettique généralisée par raréfaction de la trame protéique de l'os.
- Parenchyme cérébral* : Tissus dont les cellules ont une activité physiologique par opposition au tissu conjonctif.

*Parésie* : Paralysie légère.

*Phlébites* : Inflammation veineuse avec formation le plus souvent d'un caillot qui entraîne son oblitération avec douleur, œdème, colonisation... plus ou moins localisé.

*Polycinétique (réflexe)* : Plusieurs réponses réflexes à un même stimulus.

*Prévalence* : Nombre de cas d'une maladie dans une population donnée sans distinction.

*Ramollissement cérébral* : lésion cérébrale entraînant secondairement la nécrose et le ramollissement du territoire cérébral considéré.

*Récurvatum* : Hyper-extension du genou.

*Rétrécissement mitral* : Diminution du calibre de l'orifice de sortie de l'oreillette gauche du cœur.

*Schizophrénie* : Etat mental qui présente comme principale caractéristique la dissociation et la discordance des fonctions psychiques avec perte de l'unité de la personnalité, rupture du contact avec la réalité...

*Sous-arachnoïdien* : Sous la troisième membrane des méninges.

*Spasticité* : Disposition plus ou moins marquée à se contracturer par exagération du réflexe myotatique.

*Syncinésie* : Contractions coordonnées et involontaires apparaissant dans un groupe de muscle à l'occasion de mouvements volontaires ou réflexes.

*Syndrome méningé* : Groupe de symptômes fonctionnels (céphalée, vomissement, constipation...) et de signes physiques (raideur de la nuque, contracture du membre inférieur...) qui peuvent laisser penser à une atteinte des méninges.

*Synergies* : Association de plusieurs mouvements. Les synergies fonctionnelles sont une catégorie particulière de syncinésie. Exemple synergie de flexion du membre inférieur = hanche: flexion, abduction rotation externe, genou: flexion et cheville: flexion dorsale, inflexion.

*Syncinésie* : Contraction musculaire involontaire, n'ayant aucun rôle dans la réalisation d'un mouvement volontaire. Par exemple l'écartement des doigts d'un patient hémiplegique à qui on demande de soulever son bras paralysé.

*Thrombose* : Formation d'un caillot sanguin dans un vaisseau sanguin ou dans des cavités du cœur.

*Tronc basilaire* : Vaisseau situé dans l'encéphale, né de la fusion des deux artères vertébrales.

*Troubles gnosiques* : Troubles de la reconnaissance des propriétés d'un élément par l'un des sens.

*Troubles trophiques* : Troubles concernant la nutrition des tissus.

*Varus* : Se dit d'un membre ou d'un segment de membre dévié en dedans.

*Vaulting* : Exagération de la flexion plantaire de cheville afin d'éviter que le pied opposée ne traîne par terre lors du passage du pas.

### Annexe III.1.

Revue de bibliographie des indicateurs de marche. Suite à la liste des abréviations utilisées (page suivante), les indicateurs sont regroupés en quatre catégories :

- Tableau III.1.1. :** Indicateurs relatifs à la phase oscillante du cycle de marche,  
**Tableau III.1.2. :** Indicateurs relatifs à la phase d'appui du cycle de marche,  
**Tableau III.1.3. :** Indicateurs relatifs aux paramètres spatio-temporels du cycle de marche,  
**Tableau III.1.4. :** Indicateurs généraux.

Les références citées sont identifiées de 1 à 39 dans la liste suivante :

- |                               |                                    |
|-------------------------------|------------------------------------|
| (1) Asencio et al. (1993)     | (21) Winter (1985)                 |
| (2) Yngve & Chambers (1996)   | (22) "what people said" on CGA sur |
| (3) Lavigne (1974)            | Biomech-L (1997)                   |
| (4) Colaso & Josephi (1971)   | (23) Lehmann (1982)                |
| (5) Brunnstrom (1964)         | (24) Landen et al. (1963)          |
| (6) Moore et al. (1993)       | (25) Gage (1991)                   |
| (7) Moseley et al. (1993)     | (26) Caillet et al. (1994)         |
| (8) Whittle (1996)            | (27) Daniels & Wortingham (1979)   |
| (9) Goodkin & Diller (1973)   | (28) Wolfson et al. (1990)         |
| (10) Holden et al. (1986)     | (29) Mazaux et al. (1995)          |
| (11) Hughes & Bell (1994)     | (30) Reimers (1972)                |
| (12) Krebs et al. (1985)      | (31) Saleh & Murdoch (1985)        |
| (13) Miyazaki & Kubota (1984) | (32) Lord et al. (1998)            |
| (14) Eastlack et al. (1991)   | (33) Albert (1980)                 |
| (15) Patla et al. (1987)      | (34) Pierron et al. (1989)         |
| (16) Perry (1995)             | (35) Cunha (1988)                  |
| (17) Viel (1998)              | (36) Debelleix (1997)              |
| (18) Rodriquez (1996)         | (37) Caillet et al. (1997)         |
| (19) Saunders et al. (1953)   | (38) Olney & Richard (1996)        |
| (20) Perry (1992)             | (39) Richards & Olney (1996)       |

|                                   |                                 |                                  |
|-----------------------------------|---------------------------------|----------------------------------|
| ☛=Indicateur utilisé par l'auteur | du = durée                      | péri= périmètre                  |
| ↗ = augmentation                  | dy = dysfonctionnement          | PF = pend flacidement            |
| ↘ = diminution                    | dyn = dynamique                 | PhA = phase d'appui              |
| + = plus                          | E = extension                   | PhO = phase oscillante           |
| A = Appui                         | ég = égalité                    | pi = pied                        |
| A/R = anté-retroversion           | El = Elévation                  | pl = placement                   |
| AA = Amplitude articulaire        | EP = égalité à la phase de      | pla = plastronnement             |
| ab = abaissement                  | propulsion                      | PN = position neutre             |
| abd = abduction                   | eq = équilibre                  | PO = par orteils                 |
| abs = Absence                     | es = esquive                    | Pos = position                   |
| acc = accélération                | ev = éversion                   | PP = pied à plat                 |
| AD = Allure décidée               | ev = évitement                  | pr = précautionneuse             |
| add = adduction                   | ex = Exagération                | pro = propulsion                 |
| ag = angle                        | ext = externe                   | proj = projection                |
| am = amortissement                | F = Fin                         | PT = pattern de marche           |
| AMP = appui monopodale            | Fe = flexion                    | pt = petit                       |
| an = Anormale                     | fles = flessum                  | PV = passage à la verticale      |
| ant = antépulsion                 | flu = fluidité                  | QAP = que l'avant pied           |
| anté = antépulsion                | G = genou                       | ql = qualité                     |
| ante = antéversion                | ge = général                    | qsp = quand se produit           |
| AP = Appui plantigrade            | GM = gêne ressentie à la marche | R = réduit                       |
| AR = à reculons                   | gr = griffe                     | R/P = Redressent/ pointent       |
| art = articulation                | H = hémiplegique                | latéralement                     |
| asy = Asymétrie                   | han = hanche                    | ra = rapide                      |
| AT = Appui Talonnier              | he = hésitante                  | rai = raide                      |
| att = attitude                    | HO = Heel Off                   | ré = rétraction                  |
| B = ballant                       | HS = attaque du sol             | RE = Rotation Externe            |
| bas = bascule                     | I = Inclinaison                 | ret = retropulsion               |
| BE = Bord externe                 | I/E = inversion/éverson         | retr = rétroversion              |
| br = brusque                      | IL = Inclinaison latérale       | RI = Rotation Interne            |
| bra = bras                        | im = immobile                   | ro = rotation                    |
| C = côté                          | imp = important                 | rot = rotation                   |
| cei = ceintures                   | in = invalidantes               | RPAP= rapide passage en avant du |
| CG = centre de gravité            | ina = inadéquate                | pied                             |
| ch = cheville                     | inc = inconfort                 | S = sain                         |
| chu = chute                       | inf = inférieur                 | S/P = salutation/plastronnement  |
| co = conservation                 | int = interne                   | sal = salutation                 |
| co = controlatéral                | inv = inversion                 | ScE = Schéma d'extension         |
| con = contrôle                    | IZ = indiquer la zone           | ss = sans                        |
| CP = Claquement du pied           | jb = jambe                      | sta = stabilité                  |
| D = Début                         | JPN = jusqu'au point neutre     | sup. = supérieur                 |
| dan = dandinante                  | L = latéral                     | T = tronc                        |
| dé = déficit                      | li = limite                     | Tal = talon                      |
| de basc = de bascule              | lor = lordose                   | tb = troubles                    |
| dec = décollement                 | lt = lent                       | TC = troubles de la commande     |
| def = défauts                     | M = Milieu                      | TL = Transfert latéral           |
| dep = déplacement                 | max = maximale                  | TO = Décollage du pied           |
| dép = dépression                  | mbr. = membre                   | ton = tonicité                   |
| der = déroberement                | min = minimale                  | Tre = Trendelenberg              |
| des = décélération                | MJ = Majorité du cycle          | unip = unipodale                 |
| désa = désaxation                 | mob = mobilité                  | uti = utilisation                |
| diff = difficulté                 | MS = Milieu phase oscillante    | V = verticale                    |
| DP = décollement de la plante     | mv = mouvement                  | v = vitesse                      |
| DPF = dans le plan frontal        | O = oscillante                  | V/V = valgus / Varus             |
| DPS = Dans le Plan Sagittal       | OAT = occupé par l'aide         | va = varus                       |
| DPT = Dans le Plan Transversal    | technique                       | val = valgus                     |
| DREP = depressed ou retracted ou  | op = opposé                     | var = variabilité                |
| elevated ou protacted             | P = pic                         | VE = varus équin                 |
| DSA = durée du simple appui       | pd = Pendant                    |                                  |
| DT = démarche talonnante          | PDC = poids de corps            |                                  |

**Tableau III.1.1. :** Indicateur relatif à la phase oscillante du cycle

| <i>Référence</i><br><i>Indicateur</i>  | 1                      | 2                       | 3*                  | 4                               | 5                               | 6 | 7                       | 8 | 9                                | 10*            | 11*                                                                             | 12 | 13 | 14 | 15 | 16 | 17                   | 18*                                                                             | 19 | 20*                                                                             |
|----------------------------------------|------------------------|-------------------------|---------------------|---------------------------------|---------------------------------|---|-------------------------|---|----------------------------------|----------------|---------------------------------------------------------------------------------|----|----|----|----|----|----------------------|---------------------------------------------------------------------------------|----|---------------------------------------------------------------------------------|
| Steppage ou pseudo-steppage            | ✓                      |                         |                     |                                 |                                 |   |                         | ✓ |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Membre inférieur                       |                        |                         |                     |                                 | ✓ <sup>add</sup>                |   |                         |   | ✓ <sup>add</sup> ✓ <sup>bd</sup> |                |                                                                                 |    |    |    |    |    |                      | ✓ <sup>ai</sup> ✓ <sup>ED</sup>                                                 |    |                                                                                 |
| Rythme                                 |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Synergie de flexion                    |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Evolution angulaire                    |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Phase oscillante                       | ✓ <sup>durée C H</sup> |                         |                     |                                 | ✓ <sup>durée C H</sup>          |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Bras                                   | ✓ <sup>Ballant</sup>   |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Varus / valgus du pied                 |                        | ✓ <sup>ur Imp</sup>     |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Supinatus                              |                        | ✓ <sup>Importance</sup> |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Orteils                                | ✓ <sup>ur</sup>        |                         |                     |                                 | ✓ <sup>D/P</sup>                |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>P, ex E, gr</sup>                                                        |
| Dorsiflexion                           |                        |                         | ✓ <sup>x</sup>      | ✓ <sup>é</sup> ✓ <sup>x</sup>   | ✓ <sup>x</sup>                  |   | ✓ <sup>x</sup>          |   |                                  |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>x</sup>                                                                  |
| Flexion plantaire                      | ✓                      | ✓                       |                     |                                 |                                 |   |                         |   |                                  |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>x</sup>                                                                  |
| Pieds ou orteils traînent au sol       |                        | ✓                       | ✓                   | ✓                               | ✓                               |   |                         |   | ✓                                |                |                                                                                 |    |    |    |    |    |                      | ✓ <sup>pd MJ</sup>                                                              |    | ✓                                                                               |
| "Curling" des orteils ?                |                        |                         |                     | ✓                               |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Egalité des add. de pied               |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      | ✓                                                                               |    |                                                                                 |
| Equinisme                              | ✓                      |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Décollage des orteils (foot clearance) |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                | ✓                                                                               |    |    |    |    |    | ✓ <sup>du pied</sup> | ✓ <sup>ret</sup>                                                                |    |                                                                                 |
| Pied                                   |                        |                         | ✓ <sup>nv</sup>     | ✓ <sup>nv</sup> ✓ <sup>v</sup>  | ✓ <sup>nv</sup> ✓ <sup>v</sup>  |   |                         |   |                                  |                | ✓ <sup>nv</sup> ✓ <sup>v</sup>                                                  |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>E</sup>                                                                  |
| Flexion de genou                       | ✓                      |                         | ✓ <sup>x</sup>      | ✓ <sup>é</sup> ✓ <sup>x</sup>   | ✓ <sup>x</sup>                  |   | ✓ <sup>du P de Fe</sup> |   |                                  | ✓ <sup>x</sup> | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      | ✓ <sup>ur</sup> ✓ <sup>FO à MS</sup>                                            | ✓  | ✓ <sup>é, ex</sup>                                                              |
| Extension de genou                     |                        |                         |                     |                                 |                                 |   | ✓ <sup>E au HS</sup>    |   |                                  |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>na, ex co</sup>                                                          |
| Raideur du genou                       |                        |                         | ✓                   | ✓                               | ✓                               |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| "Whipe " fouette du genou              |                        |                         |                     | ✓                               | ✓                               |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| "Buckles" du genou                     |                        |                         |                     |                                 | ✓ <sup>ou F</sup>               |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Amplitude                              |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                | ✓ <sup>é</sup>                                                                  |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Flexion de hanche                      |                        |                         | ✓ <sup>é en F</sup> |                                 | ✓ <sup>x</sup>                  |   | ✓ <sup>du P en F</sup>  |   |                                  |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Extension de hanche                    |                        |                         |                     |                                 |                                 |   | ✓ <sup>du P en F</sup>  |   |                                  |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      | ✓ <sup>g des F</sup>                                                            |    | ✓ <sup>é, ex, ina</sup>                                                         |
| Circumduction de hanche/fauchage       | ✓                      |                         | ✓                   | ✓                               | ✓                               |   |                         | ✓ | ✓                                |                | ✓ <sup>x</sup>                                                                  |    |    |    |    |    |                      | ✓ <sup>m M</sup>                                                                |    |                                                                                 |
| Hanche                                 |                        |                         | ✓ <sup>RE</sup>     | ✓ <sup>ai</sup> ✓ <sup>RI</sup> | ✓ <sup>ai</sup> ✓ <sup>RE</sup> |   |                         |   | ✓ <sup>RI</sup> ✓ <sup>RE</sup>  |                | ✓ <sup>ai</sup> ✓ <sup>RE</sup> ✓ <sup>ai</sup> ✓ <sup>RE</sup>                 |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>E, RI</sup><br>✓ <sup>Abd, Add</sup>                                     |
| "Hitching" roue denté de hanche        |                        |                         |                     | ✓                               |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| "Hiking" de la hanche                  |                        |                         |                     |                                 |                                 |   |                         | ✓ | ✓                                |                |                                                                                 |    |    |    |    |    |                      | ✓ <sup>A MS</sup>                                                               |    | ✓                                                                               |
| Bassin                                 |                        |                         | ✓ <sup>ai</sup>     | ✓ <sup>ai</sup>                 | ✓ <sup>ai</sup>                 |   |                         |   |                                  |                | ✓ <sup>ai</sup> ✓ <sup>RI</sup> ✓ <sup>ai</sup> ✓ <sup>RE</sup> ✓ <sup>ai</sup> |    |    |    |    |    |                      | ✓ <sup>ai</sup> ✓ <sup>RI</sup> ✓ <sup>ai</sup> ✓ <sup>RE</sup> ✓ <sup>ai</sup> |    | ✓ <sup>ai</sup> ✓ <sup>RI</sup> ✓ <sup>ai</sup> ✓ <sup>RE</sup> ✓ <sup>ai</sup> |
| Raideur du bassin                      |                        |                         |                     | ✓ <sup>é base</sup>             | ✓ <sup>é base</sup>             |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>ai</sup> ✓ <sup>RI</sup> ✓ <sup>ai</sup> ✓ <sup>RE</sup> ✓ <sup>ai</sup> |
| "Hitching" roue dentée du bassin       |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                | ✓                                                                               |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Lombaire                               |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                | ✓                                                                               |    |    |    |    |    |                      |                                                                                 |    |                                                                                 |
| Tronc                                  |                        |                         |                     |                                 |                                 |   |                         |   |                                  |                |                                                                                 |    |    |    |    |    |                      |                                                                                 |    | ✓ <sup>P, IL, rot</sup>                                                         |

\* confère annexe 3 pour plus de détails

| <i>Référence</i><br><i>Indicateur</i>             | 21                                  | 22                                      | 23                                 | 24                              | 25                                                                | 26              | 27 | 28*                | 29                  | 30* | 31 | 32                                              | 33*             | 34              | 35 | 36 | 37                  | 38 | 39 | Nombre |
|---------------------------------------------------|-------------------------------------|-----------------------------------------|------------------------------------|---------------------------------|-------------------------------------------------------------------|-----------------|----|--------------------|---------------------|-----|----|-------------------------------------------------|-----------------|-----------------|----|----|---------------------|----|----|--------|
| Steppage ou pseudo-steppage                       |                                     |                                         |                                    |                                 |                                                                   |                 |    | ✓                  |                     |     |    |                                                 | ✓               | ✓               |    | ✓  |                     |    |    | 6      |
| Membre inférieur                                  |                                     |                                         | ✓ <sup>RE</sup> rai                | ✓ <sup>ai</sup>                 |                                                                   |                 |    |                    | ✓ <sup>RI</sup>     |     |    |                                                 |                 |                 |    |    |                     |    |    | 6      |
| Rythme                                            | ✓ <sup>tes</sup> ex F               |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Synergie de flexion                               | ✓                                   |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Evolution angulaire                               |                                     |                                         |                                    |                                 | ✓ <sup>6</sup>                                                    |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Phase oscillante                                  |                                     |                                         |                                    |                                 | ✓ <sup>asp V/V</sup> ✓ <sup>ant F</sup>                           |                 |    |                    | ✓ <sup>fl</sup> gen |     |    |                                                 |                 |                 |    |    | ✓                   |    |    | 5      |
| Bras                                              |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Varus / valgus du pied                            |                                     |                                         |                                    | ✓ <sup>ol</sup> ✓ <sup>ai</sup> | ✓ <sup>ol</sup> ✓ <sup>ai</sup>                                   | ✓ <sup>ai</sup> |    |                    |                     |     |    |                                                 |                 |                 |    |    | ✓                   |    |    | 5      |
| Supinatus                                         |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 | ✓               |    |    |                     |    |    | 2      |
| Orteils                                           |                                     |                                         |                                    |                                 |                                                                   | ✓ <sup>tr</sup> |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 4      |
| Dorsiflexion                                      | ✓ <sup>o</sup> , F                  | ✓ <sup>é</sup>                          | ✓ <sup>x</sup> CS                  |                                 | ✓ <sup>x</sup> en F                                               |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 10     |
| Flexion plantaire                                 | ✓ <sup>ai</sup>                     |                                         |                                    |                                 | ✓ <sup>ol</sup> ✓ <sup>ai</sup>                                   |                 |    |                    |                     |     |    | ✓ <sup>x</sup>                                  |                 | ✓ <sup>ai</sup> |    |    |                     |    |    | 8      |
| Pieds ou orteils traînent au sol                  |                                     |                                         |                                    |                                 |                                                                   |                 |    | ✓                  | ✓                   |     |    |                                                 |                 |                 | ✓  |    |                     |    |    | 10     |
| "Curling" des orteils                             |                                     |                                         |                                    | ✓                               |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 2      |
| Egalité des add. de pied                          |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Equinisme                                         |                                     |                                         |                                    |                                 | ✓                                                                 | ✓               |    |                    | ✓                   |     |    |                                                 |                 |                 |    | ✓  | ✓                   | ✓  |    | 7      |
| Décollage des orteils (foot clearance, foot drop) |                                     | ✓                                       | ✓                                  | ✓                               | ✓                                                                 |                 |    | ✓                  | ✓                   |     | ✓  |                                                 | ✓               |                 |    |    |                     | ✓  |    | 12     |
| Pied                                              |                                     |                                         |                                    |                                 |                                                                   | ✓ <sup>RI</sup> |    |                    |                     |     |    |                                                 |                 | ✓ <sup>EI</sup> |    |    | ✓ <sup>ombant</sup> |    |    | 8      |
| Flexion de genou                                  | ✓ <sup>o</sup> , F, ✓ <sup>ai</sup> | ✓ <sup>é</sup> av HS, ✓ <sup>AP</sup> D | ✓ <sup>x</sup> CS                  | ✓ <sup>x</sup>                  | ✓ <sup>ol</sup> ✓ <sup>ai</sup> ✓ <sup>ai</sup> ✓ <sup>en</sup> F | ✓               |    | ✓ <sup>max</sup> M |                     |     |    | ✓ <sup>ai</sup>                                 | ✓ <sup>ai</sup> |                 |    |    |                     |    |    | 19     |
| Extension de genou                                |                                     |                                         |                                    |                                 | ✓ <sup>ai</sup>                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 3      |
| Raideur du genou                                  |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 | ✓               |    |    |                     |    |    | 4      |
| "Whipe " fouette du genou                         |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 2      |
| "Buckles" du genou                                |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Amplitude                                         |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     | ✓  |    | 2      |
| Flexion de hanche                                 | ✓ <sup>o</sup> ✓ <sup>ai</sup>      | ✓ <sup>ai</sup> P                       | ✓ <sup>ex</sup> CS ✓ <sup>ex</sup> |                                 | ✓ <sup>x</sup> ✓ <sup>ai</sup>                                    |                 |    |                    |                     |     |    | ✓ <sup>ai</sup>                                 |                 | ✓ <sup>ex</sup> |    |    | ✓ <sup>ai</sup>     |    |    | 11     |
| Extension de hanche                               | ✓ <sup>ai</sup>                     |                                         |                                    |                                 | ✓ <sup>ai</sup>                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 6      |
| Circumduction de hanche/fauchage                  | ✓                                   |                                         | ✓                                  |                                 | ✓                                                                 | ✓               |    |                    | ✓                   |     |    |                                                 | ✓               | ✓               |    | ✓  |                     | ✓  |    | 17     |
| Hanche                                            |                                     |                                         |                                    | ✓ <sup>sys</sup>                | ✓ <sup>ai</sup> abd ✓ <sup>ai</sup> add                           | ✓ <sup>RI</sup> |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 9      |
| "Hitching" roue denté de hanche                   |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| "Hiking" de la hanche                             | ✓                                   |                                         | ✓                                  |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     | ✓  |    | 7      |
| Bassin                                            |                                     |                                         | ✓ <sup>ai</sup>                    |                                 |                                                                   |                 |    |                    |                     |     |    | ✓ <sup>tr</sup>                                 |                 |                 |    |    |                     |    |    | 8      |
| Raideur du bassin                                 |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 2      |
| "Hitching" roue dentée du bassin                  |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 1      |
| Lombaire                                          |                                     |                                         |                                    |                                 | ✓ <sup>or</sup> F                                                 |                 |    |                    |                     |     |    |                                                 |                 |                 |    |    |                     |    |    | 2      |
| Tronc                                             |                                     |                                         |                                    |                                 |                                                                   |                 |    |                    |                     |     |    | ✓ <sup>ol</sup> ✓ <sup>ai</sup> ✓ <sup>ai</sup> |                 |                 |    |    |                     |    |    | 2      |

**Tableau III.1.2. :** Indicateurs relatifs à la phase d'appui du cycle de marche,

| <i>Référence</i><br><i>Indicateur</i> | 1                                     | 2                       | 3                  | 4                   | 5                                            | 6 | 7                                   | 8                                | 9                  | 10 | 11                                                                                                                | 12                                                                                                                | 13              | 14                       | 15                            | 16 | 17                        | 18                           | 19                     | 20                                             |
|---------------------------------------|---------------------------------------|-------------------------|--------------------|---------------------|----------------------------------------------|---|-------------------------------------|----------------------------------|--------------------|----|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------|-------------------------------|----|---------------------------|------------------------------|------------------------|------------------------------------------------|
| Qualité générale                      |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   | ✓               |                          |                               |    |                           |                              |                        |                                                |
| Verticalité des cuisses               |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           | ✓                            |                        |                                                |
| Mise en charge                        |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Phase d'appui                         |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Evolution angulaire                   |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Projection du CG en avant             |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    | ✓ <sub>u</sub> HO         |                              |                        |                                                |
| Position globale du mbr inf           | ✓                                     |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Mbr inf                               | ✓ <sub>ce</sub>                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Inversion du pied                     | ✓ <sub>pas ant</sub>                  |                         | ✓ <sub>ant D</sub> | ✓ <sub>ant D</sub>  | ✓ <sub>ant D</sub>                           |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓ <sub>E</sub>                                 |
| Esquive                               | ✓ <sub>au pas post</sub>              | ✓ <sub>de l'appui</sub> |                    |                     | ✓ <sub>de l'appui</sub>                      |   |                                     |                                  |                    |    | ✓ <sub>de l'appui</sub>                                                                                           |                                                                                                                   |                 |                          |                               |    |                           | ✓ <sub>de l'appui</sub>      |                        |                                                |
| Pied totalement plat                  |                                       |                         | ✓                  | ✓                   | ✓                                            |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Instabilité du pied                   | ✓                                     |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Double appuis                         | ✓ <sub>durée</sub>                    |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Equinisme                             | ✓ <sub>persiste</sub>                 |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Attaque du sol                        |                                       | ✓                       | ✓ <sub>PO</sub>    | ✓ <sub>PO</sub>     | ✓ <sub>PO PP</sub>                           |   |                                     |                                  | ✓ <sub>n</sub>     |    | ✓ <sub>2</sub> ✓ <sub>BE</sub> ✓ <sub>A</sub>                                                                     |                                                                                                                   |                 |                          |                               |    | ✓ <sub>PO PP, nette</sub> | ✓ <sub>PO PP, bord ext</sub> |                        | ✓ <sub>P, PO, CP</sub>                         |
| Dorsiflexion                          |                                       | ✓                       |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    | ✓ <sub>g marqué</sub>     |                              | ✓ <sub>IS</sub>        | ✓ <sub>x</sub>                                 |
| Flexion plantaire                     |                                       | ✓                       |                    |                     |                                              |   | ✓ <sub>é en F</sub>                 |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓ <sub>x</sub>                                 |
| Contact avec le sol                   |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓ <sub>en M, F</sub>                                                                                              |                                                                                                                   |                 |                          | ✓ <sub>2</sub> ✓ <sub>3</sub> |    |                           |                              |                        |                                                |
| Valgus / varus du pied                |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   | ✓ <sub>au DMF</sub> ✓ <sub>al DMF</sub>                                                                           |                 |                          |                               |    |                           |                              |                        |                                                |
| Appuis                                | ✓ <sub>Co AP</sub> ✓ <sub>Es AT</sub> |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓ <sub>CS</sub>                                                                                                   |                                                                                                                   | ✓ <sub>M</sub>  |                          |                               |    |                           | ✓ <sub>durée</sub>           |                        |                                                |
| Propulsion                            |                                       |                         |                    |                     | ✓ <sub>Dé</sub> ✓ <sub>Abs</sub>             |   |                                     | ✓ <sub>Dé</sub> ✓ <sub>Abs</sub> |                    |    |                                                                                                                   |                                                                                                                   | ✓ <sub>on</sub> |                          | ✓                             |    |                           |                              |                        |                                                |
| Pied                                  |                                       |                         |                    |                     |                                              |   |                                     | ✓ <sub>ot</sub>                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓ <sub>ec tal en M</sub>                       |
| Cheville                              |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Orteils                               |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓ <sub>c, gr</sub>                             |
| Foot upward                           |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Supination du pied                    |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Maintien de l'arche plantaire         |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| "Foot rockers"                        |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| "Foot leads"                          |                                       |                         | ✓ <sub>H</sub>     | ✓ <sub>H</sub>      | ✓ <sub>H</sub>                               |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Flexion de genou                      |                                       |                         |                    |                     | ✓ <sub>2</sub> ✓ <sub>3</sub> ✓ <sub>D</sub> |   | ✓ <sub>en D</sub>                   |                                  |                    |    | ✓ <sub>M, F</sub> ✓ <sub>D</sub>                                                                                  | ✓ <sub>2</sub> , M, F                                                                                             |                 | ✓ <sub>0, M, H, TO</sub> |                               |    |                           |                              |                        | ✓ <sub>é, ex</sub>                             |
| Extension de genou                    |                                       |                         |                    |                     | ✓ <sub>é en F</sub>                          |   | ✓ <sub>é F</sub> ✓ <sub>ex DM</sub> | ✓ <sub>x D, M</sub>              |                    |    | ✓ <sub>x en M, F</sub>                                                                                            | ✓ <sub>2</sub> , M, F                                                                                             |                 |                          |                               |    |                           | ✓ <sub>M PA, HS</sub>        |                        | ✓ <sub>na</sub>                                |
| Recurvatum/hyperextension du G        | ✓                                     |                         | ✓                  | ✓                   | ✓ <sub>n D, M</sub>                          |   | ✓                                   |                                  | ✓                  |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓                                              |
| Instabilité du genou                  |                                       |                         |                    | ✓                   |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Genou                                 |                                       |                         | ✓ <sub>al M</sub>  |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   | ✓ <sub>al DMF</sub><br>✓ <sub>a DMF</sub>                                                                         |                 |                          |                               |    |                           |                              |                        | ✓ <sub>ro de l'E</sub><br>✓ <sub>v</sub>       |
| "Buckles" du genou                    |                                       |                         | ✓                  | ✓                   | ✓                                            |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Accélération du tibia                 |                                       | ✓ <sub>CPAP</sub>       |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Stabilité du genou en légère F        |                                       |                         | ✓                  | ✓                   | ✓                                            |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Flexion de hanche                     |                                       |                         |                    | ✓ <sub>é en F</sub> | ✓ <sub>é en F</sub>                          |   |                                     |                                  |                    |    | ✓ <sub>x D, M, F</sub>                                                                                            | ✓ <sub>2</sub> , M, F                                                                                             |                 |                          |                               |    |                           | ✓ <sub>A, HS, EP, TO</sub>   |                        | ✓ <sub>é, ex</sub>                             |
| Extension de hanche                   | ✓ <sub>yper</sub>                     |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓ <sub>x en F</sub>                                                                                               | ✓ <sub>2</sub> , M, F                                                                                             |                 |                          |                               |    |                           | ✓ <sub>ip</sub>              | ✓ <sub>max au HS</sub> | ✓ <sub>na</sub>                                |
| Add. Abd de hanche                    |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓ <sub>add DMF</sub><br>✓ <sub>abd DMF</sub><br>✓ <sub>RE DMF</sub><br>✓ <sub>RE DMF</sub><br>✓ <sub>RE DMF</sub> | ✓ <sub>add DMF</sub><br>✓ <sub>abd DMF</sub><br>✓ <sub>RE DMF</sub><br>✓ <sub>RE DMF</sub><br>✓ <sub>RE DMF</sub> |                 |                          |                               |    |                           |                              |                        |                                                |
| Rot. int. ext. de hanche              |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Hanche                                |                                       |                         | ✓ <sub>na</sub>    | ✓ <sub>na</sub>     | ✓ <sub>na</sub>                              |   |                                     |                                  |                    |    | ✓ <sub>na DMF</sub>                                                                                               |                                                                                                                   |                 |                          |                               |    |                           | ✓ <sub>nd add en F</sub>     |                        | ✓ <sub>RE, RI</sub><br>✓ <sub>Abd, Add</sub>   |
| Bassin                                |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓ <sub>na DMF</sub>                                                                                               |                                                                                                                   |                 |                          |                               |    |                           |                              |                        | ✓ <sub>ec RE, RI</sub><br>✓ <sub>AR, chu</sub> |
| Déplacement latéral du bassin         |                                       |                         |                    |                     |                                              |   | ✓ <sub>ou 2 du P</sub>              |                                  |                    |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Retraction du bassin (antepulsion ?)  |                                       |                         |                    |                     |                                              |   |                                     |                                  |                    |    | ✓                                                                                                                 |                                                                                                                   |                 |                          |                               |    |                           |                              |                        |                                                |
| Tronc                                 |                                       |                         | ✓ <sub>P</sub>     | ✓ <sub>P</sub>      | ✓ <sub>P</sub>                               |   |                                     | ✓ <sub>u, Pla</sub>              | ✓ <sub>P, IL</sub> |    |                                                                                                                   |                                                                                                                   |                 |                          |                               |    |                           | ✓ <sub>la pro, Sal</sub>     |                        | ✓ <sub>P, IL, rot</sub>                        |

| <i>Référence</i><br><i>Indicateur</i> | 21                  | 22         | 23           | 24         | 25                          | 26          | 27 | 28             | 29                | 30      | 31                     | 32         | 33           | 34                | 35                | 36          | 37             | 38           | 39       | Nombre |
|---------------------------------------|---------------------|------------|--------------|------------|-----------------------------|-------------|----|----------------|-------------------|---------|------------------------|------------|--------------|-------------------|-------------------|-------------|----------------|--------------|----------|--------|
| Qualité générale                      |                     |            |              |            |                             |             |    |                |                   |         | ✓                      |            |              |                   |                   |             |                |              |          | 1      |
| Verticalité des cuisses               |                     |            |              |            |                             |             |    |                |                   |         | ✓                      |            |              |                   |                   |             |                |              |          | 2      |
| Mise en charge                        |                     | ✓          |              |            | ✓                           |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 2      |
| Phase d'appui                         |                     |            |              |            | ✓<br>app E max G<br>app v/v |             |    |                | ✓<br>E, de ge, ev |         |                        |            |              |                   |                   |             | ✓              | ✓            |          | 1      |
| Evolution angulaire                   |                     |            |              |            | ✓                           |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| Projection du CG en avant             |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| Position globale du mbr inf           |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| Mbr inf                               |                     |            |              |            |                             |             |    |                | ✓<br>er           | ✓<br>I  |                        |            |              |                   |                   |             |                |              |          | 3      |
| Inversion du pied                     |                     |            |              |            |                             |             |    |                |                   |         |                        | ✓<br>t     |              |                   |                   |             |                |              |          | 6      |
| Esquive                               |                     |            | ✓<br>e appui |            |                             |             |    | ✓<br>e appui   |                   |         |                        |            | ✓<br>e appui | ✓<br>e appui      | ✓<br>e appui      |             |                | ✓<br>e appui |          | 11     |
| Pied totalement plat                  |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 3      |
| Instabilité du pied                   |                     |            |              |            | ✓                           |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 2      |
| Double appuis                         |                     |            |              |            |                             | ✓           |    |                |                   |         |                        |            |              |                   |                   | ✓           | ✓              | ✓            |          | 5      |
| Equinisme                             |                     |            | ✓            | ✓          |                             | ✓           |    |                | ✓                 | ✓       |                        |            |              |                   |                   | ✓           |                | ✓            |          | 8      |
| Attaque du sol                        | ✓<br>P, PO          | ✓<br>P, PO | ✓<br>P, PO   |            |                             |             |    | ✓<br>PO, P     |                   |         | ✓<br>os pi             |            | ✓<br>al, E   | ✓<br>al RE, Si am |                   | ✓<br>E, def |                | ✓<br>P       |          | 18     |
| Dorsiflexion                          | ✓<br>IS, TO, DMF    | ✓<br>P     | ✓<br>c       |            | ✓<br>c                      |             |    |                |                   |         |                        | ✓<br>t     |              |                   |                   |             |                | ✓            |          | 10     |
| Flexion plantaire                     | ✓<br>P, P           | ✓<br>P, P  |              |            | ✓<br>c                      |             |    |                |                   |         |                        | ✓<br>TO, P |              |                   |                   |             |                | ✓<br>HS, M   |          | 8      |
| Contact avec le sol                   | ✓<br>AP             | ✓<br>l ch  |              |            | ✓<br>P, P                   | ✓<br>PO, P  |    |                |                   |         |                        |            |              | ✓<br>E            |                   |             |                |              |          | 7      |
| Valgus / varus du pied                |                     |            |              | ✓<br>a, al |                             | ✓<br>a D, F |    |                |                   | ✓       |                        |            |              |                   |                   |             |                |              |          | 4      |
| Appuis                                |                     | ✓<br>AMP   | ✓<br>P, T    |            | ✓<br>E, P                   | ✓<br>E, P   |    |                |                   | ✓<br>er | ✓<br>SA,<br>nos pi DMF |            | ✓<br>P, P    | ✓<br>thme         | ✓<br>ex CS, de CH | ✓<br>E      | ✓<br>E, as Tal |              |          | 10     |
| Propulsion                            | ✓<br>P, P           | ✓<br>P, P  | ✓<br>c       | ✓<br>c     |                             |             |    | ✓<br>c         |                   |         |                        |            | ✓<br>c en av |                   |                   | ✓<br>P      |                | ✓            | ✓        | 14     |
| Pied                                  | ✓<br>P              |            |              |            |                             |             |    |                | ✓<br>I, der       |         |                        |            | ✓<br>P       |                   |                   |             |                |              |          | 5      |
| Chevilles                             | ✓<br>AA             |            |              |            |                             |             |    |                |                   |         |                        |            | ✓<br>gée     |                   |                   |             |                |              |          | 2      |
| Orteils                               | ✓<br>c              |            | ✓<br>c       |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             | ✓<br>i         |              |          | 4      |
| Foot upward                           |                     | ✓          |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| Supination du pied                    |                     | ✓          |              |            |                             |             |    |                |                   |         |                        |            |              | ✓                 |                   |             |                |              |          | 2      |
| Maintien de l'arche plantaire         |                     |            |              |            | ✓<br>c                      |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| "Foot rockers"                        |                     |            |              |            | ✓<br>c                      |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 1      |
| "Foot leads"                          |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 3      |
| Flexion de genou                      | ✓<br>IS, TO, DMF    | ✓<br>P, P  | ✓<br>c       |            | ✓<br>P, P                   | ✓<br>P, P   |    |                |                   | ✓       | ✓                      | ✓<br>P, P  |              |                   |                   |             |                | ✓<br>P, P    |          | 15     |
| Extension de genou                    | ✓<br>D, M           |            |              | ✓<br>c     | ✓<br>P, P                   |             |    | ✓<br>max au HS |                   |         |                        | ✓<br>P, P  |              |                   |                   |             |                |              |          | 12     |
| Recurvatum/hyperextension du G        |                     | ✓          |              | ✓          | ✓                           | ✓<br>P, P   |    |                | ✓                 | ✓       |                        |            | ✓            |                   |                   | ✓           | ✓              | ✓            | ✓<br>DMF | 18     |
| Instabilité du genou                  |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             | ✓              |              |          | 3      |
| Genou                                 | ✓<br>P              |            |              |            | ✓<br>I                      | ✓<br>P, P   |    | ✓              | ✓<br>er           |         |                        |            | ✓<br>passif  |                   |                   |             |                |              |          | 8      |
| "Buckles" du genou                    |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 3      |
| Accélération du tibia                 |                     | ✓<br>ost   |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 2      |
| Stabilité du genou en légère F        |                     |            |              |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                |              |          | 3      |
| Flexion de hanche                     | ✓<br>P, TO          |            |              |            | ✓<br>x                      |             |    |                |                   | ✓       |                        |            |              |                   | ✓<br>x            |             |                | ✓<br>P, P    |          | 11     |
| Extension de hanche                   | ✓<br>P, M           | ✓<br>P, P  | ✓<br>P, M, F |            | ✓<br>a                      |             |    |                |                   |         |                        | ✓<br>P     |              |                   |                   |             |                |              |          | 10     |
| Add. Abd de hanche                    | ✓<br>add, P         |            |              |            | ✓<br>c abd                  |             |    |                | ✓<br>d            |         |                        |            |              |                   |                   |             |                |              |          | 4      |
| Rot. int. ext. de hanche              |                     |            |              |            |                             |             |    |                | ✓<br>I            |         |                        |            |              |                   |                   |             |                |              |          | 2      |
| Hanche                                |                     |            | ✓<br>P, P    |            |                             |             |    |                |                   |         |                        | ✓<br>c     |              |                   |                   |             |                |              |          | 6      |
| Bassin                                |                     | ✓<br>hu    | ✓<br>P       |            |                             |             |    |                |                   |         |                        | ✓<br>hu    | ✓<br>hu      | ✓<br>as           |                   |             |                |              |          | 7      |
| Déplacement latéral du bassin         |                     | ✓<br>P, P  |              |            |                             |             |    |                |                   |         |                        | ✓          |              |                   |                   |             |                |              |          | 3      |
| Retraction du bassin (antepulsion ?)  |                     |            | ✓            |            |                             |             |    |                |                   |         |                        |            |              |                   |                   |             |                | ✓            |          | 3      |
| Tronc                                 | ✓<br>IS, TO, DMF, P | ✓<br>P, P  | ✓<br>P, P    | ✓<br>P, P  | ✓<br>P, P                   | ✓<br>P, P   |    |                |                   |         |                        | ✓<br>P, P  | ✓<br>P, P    |                   |                   |             |                |              |          | 14     |

**Tableau III.1.3. :** Indicateurs relatifs aux paramètres spatio-temporelles du cycle de marche,

| <i>Référence</i><br><i>Indicateur</i> | 1    | 2 | 3       | 4 | 5    | 6 | 7 | 8 | 9    | 10 | 11              | 12           | 13  | 14       | 15 | 16 | 17            | 18             | 19 | 20 |
|---------------------------------------|------|---|---------|---|------|---|---|---|------|----|-----------------|--------------|-----|----------|----|----|---------------|----------------|----|----|
| Pas                                   |      |   | ✓H pt   |   |      |   |   |   |      |    | ✓CS pt✓CH pt✓pt | ✓CH pt✓CS pt | ✓ar | ✓e✓durée | ✓e |    | ✓e✓résistant  | ✓S pt          | ✓  |    |
| Polygone sustentation (Walking base)  |      |   |         |   |      |   |   | ✓ |      |    |                 |              |     |          | ✓  |    |               |                |    |    |
| Largeur du pas, attaque sur la côté   |      |   |         |   |      |   |   |   | ✓    |    |                 |              |     | ✓        | ✓  |    | ✓             | ✓              |    |    |
| ½ pas                                 | ✓asy |   | ✓S + pt |   | ✓asy |   |   |   | ✓asy |    |                 |              |     | ✓e       |    |    |               | ✓e CS ✓e durée |    |    |
| Vitesse de marche                     | ✓    |   | ✓       |   |      |   | ✓ |   |      |    | ✓               |              |     |          |    |    | ✓✓fluctuation |                |    |    |
| Cadence                               |      |   | ✓       |   |      |   |   |   |      |    |                 |              |     | ✓        | ✓  |    | ✓             |                | ✓  |    |
| Pas postérieur                        |      |   |         |   | ✓CS  |   |   |   |      |    |                 |              |     |          |    |    |               |                |    |    |
| pas antérieur                         |      |   |         |   | ✓CS  |   |   |   |      |    |                 |              |     |          |    |    |               |                |    |    |
| Rectitude de la marche                |      |   |         |   |      |   |   |   |      |    |                 |              |     |          | ✓  |    |               |                |    |    |
| Angle du pas                          |      |   |         |   |      |   |   |   |      |    |                 |              |     |          |    |    |               |                | ✓  |    |

| <i>Référence</i><br><i>Indicateur</i>     | 21    | 22       | 23  | 24  | 25        | 26 | 27 | 28     | 29     | 30 | 31     | 32     | 33     | 34     | 35               | 36       | 37    | 38   | 39    | Nombre |
|-------------------------------------------|-------|----------|-----|-----|-----------|----|----|--------|--------|----|--------|--------|--------|--------|------------------|----------|-------|------|-------|--------|
| Pas                                       | ✓u ✓e | ✓sy ✓e   | ✓e  | ✓ar |           |    |    | ✓ar lg | ✓sy ✓e |    | ✓sy ✓e | ✓sy ✓e | ✓sy ✓e | ✓ar ✓e | ✓ar ✓h<br>✓sy ✓e | ✓sy ✓alg | ✓u ✓e | ✓alg | ✓u ✓e | 24     |
| Polygone sustentation (Walking base)      |       | ✓        | ✓   |     | ✓         |    |    | ✓      |        |    |        |        |        |        | ✓                |          |       |      |       | 7      |
| Largeur du pas, attaque sur la côté       | ✓     | ✓        | ✓   |     |           |    |    |        | ✓      |    |        |        |        | ✓      |                  |          |       |      |       | 10     |
| ½ pas                                     | ✓e    | ✓u ✓u lg | ✓pt |     |           |    |    |        |        |    |        |        |        |        |                  |          |       |      |       | 9      |
| Vitesse de marche                         | ✓     | ✓        | ✓   |     | ✓u        | ✓  |    | ✓      |        |    | ✓      | ✓      | ✓      | ✓      | ✓u               | ✓u       | ✓     | ✓u   | ✓u    | 20     |
| Cadence                                   | ✓     | ✓        | ✓   |     |           |    |    |        |        |    |        |        |        |        |                  | ✓u       | ✓     | ✓u   | ✓     | 12     |
| Pas postérieur                            |       |          |     |     |           |    |    |        |        |    |        |        |        |        |                  |          |       |      |       | 1      |
| pas antérieur                             |       |          |     |     |           |    |    |        |        |    |        |        |        |        |                  |          |       |      |       | 0      |
| Rectitude de la marche/ ligne progression |       |          |     |     | ✓         |    |    | ✓      |        |    |        |        |        | ✓      |                  |          |       |      |       | 4      |
| Angle du pas                              |       | ✓MS      |     |     | ✓PhO ✓PhA |    |    |        |        |    |        |        |        | ✓      | ✓                |          |       |      |       | 4      |

**Tableau III.1.4. :** Indicateur généraux.

| <i>Référence</i><br><i>Indicateur</i>           | 1                 | 2               | 3                   | 4 | 5 | 6 | 7 | 8                      | 9               | 10             | 11                            | 12 | 13                    | 14 | 15                             | 16                                | 17                                               | 18                                  | 19                            | 20* |
|-------------------------------------------------|-------------------|-----------------|---------------------|---|---|---|---|------------------------|-----------------|----------------|-------------------------------|----|-----------------------|----|--------------------------------|-----------------------------------|--------------------------------------------------|-------------------------------------|-------------------------------|-----|
| Arrêt du mouvement ou pause                     |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  | ✓ <sub>av</sub> TO                  |                               |     |
| Fatigue avec les passages                       | ✓                 |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Marche                                          | ✓ <sub>étri</sub> |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    | ✓ <sub>R</sub> ✓ <sub>tu</sub> |                                   | ✓ <sub>lu</sub> ✓ <sub>end</sub> ✓ <sub>ar</sub> |                                     |                               |     |
| Troubles de l'équilibre                         | ✓                 |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  | ✓                                   |                               |     |
| Troubles de la sensibilité                      | ✓                 |                 |                     | ✓ |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Trouble du rythme de la marche                  |                   |                 |                     |   | ✓ |   |   | ✓                      |                 |                | ✓                             |    |                       |    |                                |                                   |                                                  | ✓                                   |                               |     |
| Déficit de force musculaire                     |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Autonomie                                       | ✓                 |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Contrôle volontaire                             |                   |                 | ✓ <sub>CH</sub>     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Symétrie                                        |                   |                 | ✓ <sub>es</sub> pas |   |   |   |   |                        |                 |                | ✓ <sub>iv</sub> asy CG        |    | ✓ <sub>PT</sub>       |    | ✓ <sub>PT</sub>                |                                   |                                                  | ✓ <sub>es</sub> pas                 |                               |     |
| Appréhension, peur de marcher                   |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   | ✓ <sub>DO</sub>                                  |                                     |                               |     |
| Coordination                                    |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   | ✓ <sub>jb</sub>                                  |                                     |                               |     |
| "Consistency of gait"                           |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  | ✓                                   |                               |     |
| Motricité générale du mbr inf                   |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Boiterie                                        |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Marche précautionneuse, prudente, "Guardedness" |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  | ✓                                   |                               |     |
| Dépendance                                      |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    | ✓ <sub>te</sub> canne |    | ✓ <sub>te</sub> canne          |                                   |                                                  |                                     |                               |     |
| Douleur                                         |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Spasticité                                      |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Amplitude articulaire                           |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Raideur                                         |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Hémicorps                                       |                   |                 |                     |   |   |   |   |                        |                 |                | ✓ <sub>R</sub> ✓ <sub>R</sub> |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Flexion générale                                |                   |                 |                     |   |   |   |   |                        |                 |                | ✓ <sub>x</sub>                |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Evaluation sur des sols irréguliers             |                   |                 |                     |   | ✓ |   |   |                        |                 | ✓              | ✓                             |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Evaluation en pente, escalier...                |                   |                 |                     |   | ✓ |   |   |                        |                 |                | ✓                             |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Variation de la vitesse de marche               |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Marche av/ss orthèse attelle                    |                   |                 | ✓                   |   | ✓ |   |   |                        |                 | ✓              |                               | ✓  |                       |    |                                |                                   |                                                  | ✓                                   |                               |     |
| Marche barre//, canne, aide/seul                |                   |                 | ✓                   |   | ✓ |   |   |                        |                 | ✓              |                               | ✓  |                       |    |                                | ✓ <sub>OPS</sub> ✓ <sub>OPT</sub> |                                                  | ✓                                   |                               |     |
| Orteils                                         |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Cheville                                        |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     | ✓ <sub>rot</sub>              |     |
| Pied                                            |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓ <sub>l</sub>                    |                                                  |                                     |                               |     |
| Flexion/Extension de cheville                   |                   |                 |                     |   |   |   |   | ✓ <sub>bs</sub> cont E |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     | ✓                             |     |
| Valgus / varus che/pied                         |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Abd. /Add. de cheville                          |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Inv / eversion du pied/                         |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Genou                                           |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    | ✓ <sub>algus</sub>             | ✓ <sub>e</sub> /E                 |                                                  |                                     | ✓ <sub>e</sub> E, V/V         |     |
| Flexion / extension du genou                    |                   | ✓ <sub>ex</sub> |                     |   |   |   |   | ✓ <sub>ex</sub>        | ✓ <sub>ex</sub> |                |                               |    |                       |    |                                |                                   |                                                  |                                     | ✓                             |     |
| Abd/Add de genou                                |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Flexion / extension de hanche                   |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     | ✓                             |     |
| Abd/Add de hanche                               |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| Hanche                                          |                   |                 |                     |   |   |   |   | ✓ <sub>rot</sub> An    |                 |                |                               |    |                       |    |                                | ✓ <sub>e</sub> /E                 |                                                  |                                     | ✓ <sub>rot</sub>              |     |
| "hiking"                                        |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                | ✓                                 |                                                  |                                     |                               |     |
| "droping"                                       |                   |                 |                     |   |   |   |   |                        |                 |                |                               |    |                       |    |                                |                                   |                                                  |                                     |                               |     |
| Bassin                                          |                   |                 |                     |   |   |   |   |                        |                 | ✓ <sub>c</sub> |                               |    |                       |    |                                |                                   |                                                  | ✓ <sub>rot</sub> ✓ <sub>dep</sub> L | ✓ <sub>ante</sub> retr, dep L |     |

| <i>Référence</i><br><i>Indicateur</i>           | 21  | 22     | 23     | 24  | 25          | 26    | 27 | 28                | 29           | 30   | 31  | 32   | 33 | 34     | 35                  | 36            | 37       | 38   | 39  | Nombre |
|-------------------------------------------------|-----|--------|--------|-----|-------------|-------|----|-------------------|--------------|------|-----|------|----|--------|---------------------|---------------|----------|------|-----|--------|
| Arrêt du mouvement ou pause                     |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Fatigue avec les passages                       |     |        |        |     |             |       |    |                   | ✓            |      |     |      |    |        |                     |               | ✓équin   |      |     | 3      |
| Marche                                          | ✓ur |        | ✓u     |     |             |       |    | ✓u, he            |              | ✓éri |     | ✓éri |    | ✓u     | ✓lan, Fc, ✓inc, sta | ✓u, ✓/C, ✓éri | ✓M, ✓éri |      |     | 12     |
| Troubles de l'équilibre                         |     |        | ✓      | ✓   | ✓           |       |    | ✓                 | ✓            |      |     | ✓    |    |        | ✓                   | ✓             |          | ✓    | ✓   | 12     |
| Troubles de la sensibilité                      |     |        | ✓      |     | ✓           |       |    |                   | ✓            |      |     |      |    |        | ✓                   | ✓             |          | ✓    |     | 8      |
| Trouble du rythme de la marche                  |     |        | ✓      |     |             |       |    | ✓                 |              |      |     |      | ✓  | ✓      | ✓                   | ✓             |          |      |     | 10     |
| Déficit de force musculaire                     |     | ✓      |        |     |             |       |    |                   |              |      |     |      |    |        | ✓                   | ✓             |          | ✓    | ✓   | 5      |
| Autonomie                                       |     |        |        |     |             |       |    |                   |              | ✓    |     |      |    |        | ✓                   | ✓             |          |      |     | 4      |
| Contrôle volontaire                             |     |        |        |     | ✓rt han     |       |    |                   |              |      |     |      |    |        |                     | ✓mip          | ✓        | ✓    | ✓   | 5      |
| Symétrie                                        | ✓   |        | ✓      |     |             | ✓A CH |    |                   |              |      |     |      |    |        | ✓                   | ✓             |          |      | ✓   | 11     |
| Appréhension, peur de marcher                   |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Coordination/commande                           |     |        | ✓      | ✓   |             |       |    | ✓na jb            |              |      |     |      |    |        |                     |               |          | ✓    | ✓   | 6      |
| "Consistency of gait"                           |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 2      |
| Motricité générale du mbr inf                   |     |        | ✓ai    | ✓LI |             |       |    | ✓RE, tb add, 3 Fe |              |      |     |      |    |        |                     | ✓é            |          |      |     | 5      |
| Boiterie                                        |     |        | ✓      |     |             |       |    |                   |              |      |     |      |    |        | ✓                   |               |          |      |     | 3      |
| Marche précautionneuse, prudente, "Guardedness" |     |        | ✓      |     |             |       |    | ✓                 |              |      |     |      |    | ✓      | ✓                   |               |          |      |     | 5      |
| Dépendance                                      |     | ✓      |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 3      |
| Douleur                                         |     |        |        |     |             |       |    |                   |              |      |     |      |    | ✓rt    | ✓                   |               | ✓phA     |      |     | 3      |
| Spasticité                                      |     |        |        |     |             |       |    |                   |              |      |     |      |    |        | ✓                   | ✓             | ✓        | ✓    | ✓   | 5      |
| Amplitude articulaire                           |     |        |        |     |             |       |    |                   |              |      |     |      |    |        | ✓✓han               |               |          | ✓✓PA |     | 2      |
| Raideur                                         |     |        |        |     |             |       |    |                   |              |      |     |      |    | ✓assin | ✓                   |               |          | ✓    |     | 3      |
| Hémicorps                                       |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Flexion générale                                |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Evaluation sur des sols irréguliers             |     |        |        |     |             |       |    |                   |              |      |     |      |    | ✓      |                     |               |          |      |     | 4      |
| Evaluation en pente, escalier...                |     |        |        |     |             |       |    |                   | ✓            |      |     |      | ✓  | ✓      |                     |               |          |      |     | 5      |
| Varier la vitesse de marche                     |     |        | ✓      |     |             |       |    |                   |              |      |     |      | ✓  | ✓      | ✓                   |               |          |      |     | 5      |
| Marche av/ss orthèse attelle                    |     |        |        | ✓   | ✓           |       |    |                   |              |      |     |      |    | ✓      | ✓                   | ✓             | ✓        |      |     | 11     |
| Marche barre//, canne, aide/seul                |     |        |        | ✓   |             | ✓     |    |                   | ✓            | ✓    |     | ✓    | ✓  |        |                     | ✓             | ✓        |      |     | 14     |
| Orteils                                         |     |        |        |     |             |       |    | ✓er               |              |      |     |      |    |        | ✓er                 |               |          |      |     | 2      |
| Cheville                                        |     |        |        |     |             |       |    |                   |              |      | ✓iv |      |    |        |                     |               | ✓iv      |      |     | 3      |
| Pied                                            |     |        |        |     |             |       |    | ✓V/V, VE          |              |      | ✓iv |      |    |        |                     | ✓b dyn        |          |      |     | 4      |
| Flexion/Extension de cheville                   |     | ✓      | ✓      |     | ✓A Fe       |       |    | ✓é                |              |      |     |      |    |        |                     |               | ✓        |      |     | 8      |
| Valgus / varus che/pied                         |     |        |        |     |             |       |    |                   |              | ✓    |     |      |    | ✓      |                     | ✓             | ✓        |      |     | 4      |
| Abd. /Add. de cheville                          |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Inv / eversion du pied/                         |     |        |        |     |             |       |    |                   |              | ✓    |     |      |    |        |                     | ✓             |          |      |     | 2      |
| Genou                                           |     |        | ✓✓th   |     |             |       |    | ✓A                | ✓on          |      | ✓iv |      |    | ✓✓on   |                     | ✓on           |          |      |     | 9      |
| Flexion / extension du genou                    |     |        |        |     |             |       |    | ✓é                | ✓é           | ✓é   | ✓é  |      |    | ✓é     |                     |               |          |      |     | 8      |
| Abd/Add de genou                                |     |        |        |     |             |       |    |                   |              |      |     |      |    |        |                     |               |          |      |     | 1      |
| Flexion / extension de hanche                   |     |        | ✓      |     |             |       |    |                   |              |      |     |      |    |        |                     |               | ✓        | ✓    |     | 4      |
| Abd/Add de hanche                               |     |        | ✓pasme |     | ✓           |       |    |                   |              |      |     |      |    | ✓ndeur |                     |               |          |      |     | 4      |
| Hanche                                          |     |        | ✓LI    |     | ✓ai Fe, ✓LI |       |    | ✓A                | ✓e con, ex E |      | ✓iv |      |    |        |                     |               |          |      |     | 8      |
| "hiking"                                        |     |        |        |     |             |       |    |                   |              |      | ✓   |      |    |        |                     |               |          | ✓    | ✓   | 4      |
| "dropping"                                      |     |        |        |     |             |       |    |                   | ✓            |      |     |      |    |        |                     |               |          |      |     | 1      |
| Bassin                                          |     | ✓dep L | ✓dep L |     |             |       |    | ✓dep L, ✓R        | ✓R           |      | ✓iv |      |    | ✓      | ✓ct                 | ✓ta           | ✓nte     |      | ✓ot | 12     |

## Général (suite)

| <i>Référence</i><br><i>Indicateur</i>                           | 1 | 2 | 3       | 4              | 5   | 6                  | 7 | 8 | 9    | 10    | 11            | 12 | 13      | 14 | 15         | 16 | 17                | 18           | 19        | 20 |
|-----------------------------------------------------------------|---|---|---------|----------------|-----|--------------------|---|---|------|-------|---------------|----|---------|----|------------|----|-------------------|--------------|-----------|----|
| Torsion tibiale                                                 |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              | ✓         |    |
| "Scissoring of leg"                                             |   |   |         |                |     |                    |   |   |      | ✓     |               |    |         |    |            |    |                   |              |           |    |
| Vaulting                                                        |   |   |         |                |     |                    |   | ✓ | ✓    |       |               |    |         |    |            |    |                   | ✓            |           | ✓  |
| Hyperlordose                                                    |   |   |         |                |     |                    |   | ✓ |      |       |               |    |         |    |            |    |                   |              |           |    |
| Tronc                                                           |   |   |         |                |     |                    |   |   |      |       |               |    |         |    | ✓ Position |    | ✓ n Fe            | ✓ os ✓ mob L |           |    |
| Epaule                                                          |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    | ✓ e               |              |           |    |
| Le bras                                                         |   |   | ✓ F ✓ e |                | ✓ F |                    |   |   | ✓    | ✓ é B | ✓ é ✓ B br op |    |         |    |            |    |                   |              |           |    |
| Coude                                                           |   |   | ✓ e     |                | ✓ e |                    |   |   |      |       | ✓ e ✓ DREP    |    |         |    |            |    |                   |              |           |    |
| Membre supérieur                                                |   |   |         |                |     |                    |   |   |      |       | ✓ AT          |    | ✓ ar mv |    |            |    | ✓ en av tr ✓ vert |              |           |    |
| Doigts et poignets                                              |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Tête                                                            |   |   |         |                |     |                    |   |   | ✓ on |       | ✓ CH, CS ✓ e  |    |         |    |            |    |                   |              | ✓ O V & L |    |
| Stabilité articulaire                                           |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Transfert du poids                                              |   |   |         | ✓ H → CS       |     | ✓ CS → CH, CH → CS |   |   |      |       |               |    |         |    | ✓          |    |                   | ✓ CS → CH    | ✓         |    |
| Synergie                                                        |   |   |         | ✓ de Fe ✓ al'E |     | ✓ de Fe ✓ al'E     |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Suportabilité du PDC                                            |   |   |         |                |     |                    |   |   |      |       |               |    | ✓ u PDC |    |            |    |                   |              |           |    |
| Distance canne/appui                                            |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   | ✓            |           |    |
| La canne améliore la marche                                     |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Qualité générale de la marche                                   |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Demande attentionnelle, automaticité                            |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Alignement des segments                                         |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Les phases acti/pass st elle bien A/P ?                         |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Comment est le rapport amp. art. dispo sur amp. art. utilisée ? |   |   |         |                | ✓   |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Evite d'amplifier ses défauts et optimise son potentiel moteur  |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Inégalité de longueur des                                       |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Marche sur la pointe des pieds                                  |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| S'aide de la vision                                             |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Fluidité des déplacements du CG                                 |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              | ✓         |    |
| Accentuation des défauts                                        |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Passage du pas                                                  |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| syncinésie/tremblements                                         |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Synchronisme                                                    |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| esthetisme de la marche                                         |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Projection des segments                                         |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Risque de chute                                                 |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |
| Initiation de la marche/tourner                                 |   |   |         |                |     |                    |   |   |      |       |               |    |         |    |            |    |                   |              |           |    |

| <i>Référence</i><br><i>Indicateur</i>                           | 21       | 22       | 23                    | 24             | 25           | 26      | 27 | 28*        | 29          | 30      | 31      | 32              | 33            | 34       | 35 | 36         | 37 | 38      | 39     | Nombre |
|-----------------------------------------------------------------|----------|----------|-----------------------|----------------|--------------|---------|----|------------|-------------|---------|---------|-----------------|---------------|----------|----|------------|----|---------|--------|--------|
| Torsion tibiale                                                 |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| "Scissoring of leg"                                             |          |          | ✓                     |                | ✓            |         |    |            |             | ✓       |         |                 |               |          |    |            |    |         |        | 4      |
| Vaulting                                                        | ✓        |          |                       |                | ✓            |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 6      |
| Lombaire                                                        |          |          | ✓<br>Alor             |                | ✓<br>or      |         |    |            |             | ✓<br>or |         |                 |               |          |    |            |    |         |        | 4      |
| Tronc                                                           |          |          | ✓<br>Alor             | ✓<br>upport de | ✓<br>os      | ✓<br>la |    | ✓<br>PA    | ✓<br>CH     |         | ✓<br>iv |                 |               | ✓<br>Al  |    | ✓<br>ésa   |    | ✓<br>P  | ✓<br>q | 12     |
| Epaule                                                          |          |          | ✓<br>Al, rot, ext ant |                | ✓<br>RI      |         |    | ✓<br>A     | ✓<br>dd, RI |         |         | ✓<br>I, dé, dép | ✓<br>oiterie? | ✓<br>las |    |            |    | ✓<br>ot |        | 9      |
| Le bras                                                         | ✓<br>til | ✓<br>B   | ✓<br>charpe           | ✓<br>mbre      |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 9      |
| Coude                                                           |          |          | ✓<br>e                | ✓<br>e         | ✓<br>e       |         |    | ✓<br>I     |             |         | ✓<br>iv | ✓<br>e          |               |          |    |            |    |         |        | 9      |
| Membre supérieur                                                |          |          |                       |                |              |         |    | ✓<br>A     | ✓<br>Fe     |         |         |                 |               |          |    |            |    |         |        | 5      |
| Doigts et poignets                                              |          |          |                       | ✓              |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Tête                                                            |          | ✓        | ✓                     | ✓<br>upport de |              |         |    | ✓<br>e     |             |         |         |                 |               | ✓<br>Ei  |    |            |    | ✓<br>q  |        | 9      |
| Stabilité articulaire                                           |          |          |                       |                | ✓<br>S       | ✓<br>H  |    |            |             |         |         |                 |               |          |    |            |    |         |        | 2      |
| Transfert du poids                                              | ✓<br>iff | ✓<br>TS  | ✓<br>pas              | ✓              | ✓            |         |    |            | ✓           |         |         |                 |               |          |    |            |    |         | ✓      | 11     |
| Synergie                                                        |          | ✓<br>e F | ✓<br>E                |                | ✓<br>imitive |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 5      |
| Supportabilité du PDC                                           |          |          | ✓                     |                |              |         |    |            |             |         |         |                 |               |          |    |            |    | ✓       |        | 3      |
| Distance canne/appui                                            |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| La canne améliore la marche                                     |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Qualité générale de la marche                                   |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    | ✓          | ✓  |         |        | 2      |
| Demande attentionnelle, automaticité                            |          |          |                       |                |              |         |    |            | ✓           |         |         |                 |               |          | ✓  |            |    |         |        | 2      |
| Alignement des segments                                         |          |          |                       |                |              |         |    |            | ✓           |         |         |                 |               |          |    |            |    |         |        | 1      |
| Les phases acti/pass st elle bien A/P ?                         |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Comment est le rapport amp. art. dispo sur amp. art. utilisée ? |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Evite d'amplifier ses défauts et optimise sont potentiel moteur |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Inégalité de longueur des jambes                                |          |          |                       |                |              |         |    |            |             |         |         |                 |               | ✓        |    |            |    |         |        | 1      |
| Marche sur la pointe des pieds                                  |          |          |                       |                |              |         |    |            |             | ✓       |         |                 |               | ✓        |    |            | ✓  |         |        | 3      |
| S'aide de la vision                                             |          |          | ✓                     |                |              |         |    |            |             |         |         |                 |               |          | ✓  |            |    |         |        | 2      |
| Accentuation des défauts                                        |          |          |                       |                |              |         |    |            | ✓<br>v acc  |         |         |                 |               |          |    |            |    |         |        | 2      |
| Passage du pas                                                  |          |          |                       |                |              |         |    |            | ✓<br>iff    |         |         |                 |               |          |    |            |    |         |        | 1      |
| Syncinésie/tremblements                                         |          |          |                       |                |              |         |    |            | ✓           |         |         |                 |               |          | ✓  |            |    |         |        | 2      |
| Esthétisme de la marche                                         |          |          |                       |                |              |         |    |            | ✓           |         |         |                 |               |          |    | ✓          |    | ✓       | ✓      | 4      |
| Synchronisme                                                    |          |          |                       |                |              |         |    | ✓<br>S bra | ✓<br>ei     |         |         |                 |               | ✓<br>ei  |    | ✓<br>é cei |    | ✓<br>ei |        | 5      |
| Projection des segments                                         |          |          |                       |                |              |         |    | ✓          |             |         |         |                 |               |          |    |            |    |         |        | 1      |
| Oscillation                                                     |          |          |                       |                |              |         |    |            |             |         |         |                 | ✓<br>il, post | ✓        |    | ✓<br>sy v  |    |         |        | 3      |
| Risque de chute                                                 |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          | ✓  | ✓          |    |         |        | 2      |
| Initiation de la marche/tourner                                 |          |          |                       |                |              |         |    |            |             |         |         |                 |               |          | ✓  |            |    |         |        | 1      |

## **Annexe III.2.**

Cette annexe comprend les tableaux 1 à 5 dans lesquels les indicateurs de marche issue de l'extraction de connaissances sont regroupés selon 5 catégories :

**Tableau III.2.1. :** Indicateurs de type "localisé" à une articulation ou un segment corporel,

**Tableau III.2.2. :** Indicateurs de type "régional" situé au niveau d'un membre,

**Tableau III.2.3. :** Indicateurs de type "général",

**Tableau III.2.4. :** Indicateurs de la "qualité de la marche",

**Tableau III.2.5. :** Indicateurs de type "interprétatif".

|            |        |                                                                      | SUJETS                           |                                    |                                    |                                  |                                    |                            | Nb Citation<br>ET<br>Nb de spé |
|------------|--------|----------------------------------------------------------------------|----------------------------------|------------------------------------|------------------------------------|----------------------------------|------------------------------------|----------------------------|--------------------------------|
| Catégories |        | Indicateurs qualifiés                                                | S1                               | S2                                 | S3                                 | S4                               | S5                                 | S6                         |                                |
| Localisé   | Pied   | Qualité de la flexion/extension, fixité de la cheville, pied tombant | N4<br>R1R3R5<br>K3               | N1N2<br>R2R3R4<br>K1K2K4           | R1R2R3R4R5<br>K3K4K5               | N1N3N4<br>R1R3R4R5<br>K1K2K3K4   | N5<br>R2R3R4<br>K1K2K3K4           | R2R3R4R5<br>K1K2K3K4K5     | 7 / 5<br>25 / 5<br>20 / 5      |
|            |        | Equinisme                                                            | N1N2N3<br>K1K2                   | N1N2N4N5<br>R2R3R4R5<br>K3         |                                    | R4<br>K3                         | N1N2<br>R1R2R3R4R5<br>K3           | N1N3N5<br>R1R3R4<br>K1K2   | 12 / 5<br>13 / 5<br>7 / 3      |
|            |        | Stabilité de la cheville                                             | N1<br>R1R2R3R5                   |                                    | R1R2<br>K5                         | N1<br>R1R4R5<br>K1K2             |                                    | R3R4R5<br>K1K2             | 2 / 1<br>12 / 5<br>5 / 3       |
|            |        | Varus                                                                | N1N2<br>K2K4K5                   | N1N2N3N4N5<br>R1R2R5<br>K3K4K5     |                                    | K4K5                             | N1N2N3N5<br>R1R2R3R4R5<br>K4       | N1N5<br>R3R5               | 13 / 5<br>10 / 5<br>7 / 3      |
|            |        | Attaque du sol et déroulement du pas                                 | N1N4<br>R1R4R5<br>K1K2K3K5       | N1N2N5<br>R1R2R4R5<br>K3           | N3N5<br>R1R2R3R4R5<br>K1K2         | N3<br>R1R4R5<br>K1K2K3K4         | N2N3<br>R2R3R4R5<br>K1K2K3K5       | N4N5<br>R1R3R5<br>K1K2K3K4 | 12 / 5<br>22 / 5<br>19 / 5     |
|            | Genou  | Qualité de la flexion/extension, manque de mobilité, raideur...      | N1N2N3<br>R1R2R3R4R5<br>K1K2K3K4 | N1N2N3N4<br>R1R2R3R4R5<br>K1K2K3K4 | N1N2N3<br>R1R2R3R4R5<br>K1K2K3K4K5 | N1N2N4<br>R1R2R3R4R5<br>K1K2K3K5 | N1N2N3N4<br>R1R2R3R4R5<br>K1K2K3   | N4<br>R1R5<br>K3           | 18 / 4<br>27 / 5<br>21 / 5     |
|            |        | Verrouillage du genou                                                | N1N4<br>R1<br>K3K4K5             | N2N4<br>R4<br>K3K5                 | N4<br>K3K5                         | N1N4<br>K1K2K5                   |                                    | N4<br>R1R5<br>K1K2K4K5     | 8 / 3<br>4 / 3<br>15 / 5       |
|            |        | Recurvatum/flessum                                                   | N1N2N3<br>R1<br>K1K2K3K4K5       | N2N3N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N3<br>R1<br>K3K4K5                 | N3<br>R1R4<br>K1K2K3K4K5         | N1<br>R2R4R5<br>K1K2K3             | N4<br>R1R2R5<br>K1K2K4K5   | 7 / 4<br>16 / 5<br>25 / 5      |
|            |        | Stabilité du genou                                                   | R2                               | N4                                 | R2                                 | N3<br>R1<br>K1K2                 | R1                                 |                            | 2 / 2<br>4 / 2<br>2 / 2        |
|            |        | Valgus/Varus                                                         |                                  |                                    |                                    |                                  |                                    | N2N3<br>R3R5<br>K1K2       | 2 / 2<br>2 / 2<br>2 / 2        |
|            | Han/Ba | Bascule du bassin                                                    | N3<br>R1R3<br>K1K2               | N3N5<br>R1R2                       | N3<br>R2R3                         | N3<br>R1R2R3                     | R1R2R3<br>K1K2                     | N5<br>K1K2                 | 6 / 2<br>12 / 3<br>6 / 2       |
|            |        | Qualité de la flexion/extension, manque de mobilité, raideur...      | R1R3R5<br>K1K2K3                 | N1N2<br>R1R2R3R4R5<br>K1K2K3K4     | N1<br>R1R3R4R5<br>K1K2K3           | N1N2N4<br>R1R2R3R4R5<br>K1K2K3K4 | N1N2N3<br>R1R2R3R4R5<br>K1K2K3K4K5 | R1R2R3R4<br>K1K2K3         | 9 / 4<br>26 / 4<br>22 / 5      |
|            |        | Stabilité du bassin et/ou de la hanche                               | K1K2K3K5                         | R2R3R4<br>K3                       |                                    | R4                               | K1K2                               |                            | 4 / 3<br>7 / 4                 |
|            |        | Rotation du bassin et de la hanche                                   | K4K5                             | N1N3N4<br>R1R2R3R5<br>K1K3K2K4K5   | R1R3<br>K4K5                       | R3R4<br>K5                       | R1R2R3R4R5<br>K5                   | R3R5<br>K5                 | 3 / 3<br>16 / 5<br>12 / 5      |
|            |        | Qualité du pas pelvien                                               |                                  | R2R3<br>K5                         | K5                                 | K5                               | R4                                 | K5                         | 3 / 3<br>4 / 1                 |
|            |        | Surélévation du bassin pour passer le pas                            | R1R3<br>K1K2K5                   | N3<br>R1R2R5<br>K1K2K5             | R1R3                               | N5<br>R1R4                       | R1                                 | R1R2<br>K1K2               | 2 / 1<br>12 / 5<br>8 / 3       |
|            | Epaule | Pli de peau ou de flexion                                            |                                  | K1K2                               | K1K2                               |                                  |                                    |                            | 4 / 2                          |
|            |        | Mobilité de la ceinture Scapulaire                                   | N2<br>K4                         | N2<br>R4                           | R1R4<br>K4K5                       | R1                               | R1                                 |                            | 2 / 1<br>5 / 2<br>3 / 2        |
|            |        | Symétrie des épaules                                                 | N2N3<br>R1R2<br>K4K5             | R1<br>K4                           | R1R2R3R4R5                         | R4R5<br>K1K2                     | N1<br>R4R5<br>K1K2                 | R1R2R5                     | 3 / 2<br>15 / 5<br>7 / 4       |
|            | Main   | Motricité de la main                                                 | N1N2N3                           | N1N2N3N4<br>R1<br>K1K2             | N2N3N4N5<br>R1                     | N2N3N4                           | N1N2N3<br>R4                       | N1N2N3N4<br>R4             | 21 / 5<br>4 / 3<br>2 / 2       |
|            | Tête   | Flexion, inclinaison ou fixité de la tête                            |                                  |                                    | R1R3R4                             | R1R4                             | R4                                 | R4                         | 7 / 3                          |
|            |        |                                                                      | 21<br>31<br>39                   | 37<br>52<br>37                     | 13<br>41<br>26                     | 19<br>39<br>34                   | 21<br>55<br>26                     | 17<br>38<br>33             | 128<br>256<br>195              |

**Tableau III.2.1. :** Indicateurs de marche de la catégorie "localisé" utilisés par les différents spécialistes et pour chacun des sujets (N = neurologue, R = médecin rééducateur, K = cadres kinésithérapeutes, S = sujet), Les numéros correspondent aux codes spécialistes et sujets, Nb = nombre, spé = spécialiste.



|            |                  |                                                                                           | SUJETS                             |                                        |                                        |                                        |                                        |                            |                                |
|------------|------------------|-------------------------------------------------------------------------------------------|------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------|--------------------------------|
| Catégories |                  | Indicateurs qualifiés                                                                     | S1                                 | S2                                     | S3                                     | S4                                     | S5                                     | S6                         | Nb Citation<br>ET<br>Nb de spé |
| Régional   | Mbr.<br><br>Inf. | Fauchage                                                                                  | N1N2N3N4N5<br>R4<br>K3             | N1N4N5<br>R1R2R3R4R5<br>K5             | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N5<br>R1R5<br>K1K2                     | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N5<br>R2R3R4R5<br>K2       | 20 / 5<br>22 / 5<br>15 / 5     |
|            |                  | Steppage                                                                                  | N3N4                               | N4                                     | N4                                     | N2N4                                   | N4N5                                   | N4N5                       | 10 / 3                         |
|            |                  | Rotation externe globale                                                                  |                                    | N1<br>R1<br>K4                         | R1                                     | R3                                     | R4                                     | R1R4R5                     | 3 / 2<br>1<br>7 / 3            |
|            |                  | Stabilité                                                                                 | R3                                 | N2<br>R2R5                             | N3<br>R2R3R5                           | N3<br>R1R2R3R4R5                       | R3R4                                   | R3R5                       | 3 / 2<br>15 / 5                |
|            |                  | Qualité de la flexion et/ou d'extension du membre inférieur                               | N3<br>R3<br>K4                     | N1N4N5<br>R1R2R3R4R5<br>K5             | R3R5                                   | N2N3<br>R1R3                           | N1<br>R1<br>K5                         |                            | 7 / 5<br>11 / 5<br>3 / 2       |
|            |                  | Rigidité OU hyper-extension du membre inférieur                                           |                                    | N3N4<br>R2R4R5                         |                                        | N4N5                                   | N3<br>K5                               | N4                         | 6 / 3<br>3 / 3<br>1            |
|            | Mbr.<br><br>Sup. | Ballant, mobilité, fonctionnalité du bras                                                 | N1N2N4<br>R1R2R3R4R5<br>K1K2K3K4K5 | N1N2<br>R1R2R4R5<br>K1K2K4             | N1N3N4<br>R1R2R3R4R5<br>K3K4           | K4                                     | N1N3<br>R1R4R5<br>K3K4                 | N1N4<br>R1R5<br>K3         | 12 / 4<br>19 / 5<br>37 / 5     |
|            |                  | Posture du membre supérieur (flexion, position indifférenciée, rétropulsion, dystonie...) | N1N2N3N4N5<br>R1R5                 | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N1N2N3N4N5<br>R1R2R3R4R5<br>K1K2K3K4K5 | N2N3N5<br>R1R3R5<br>K2K3K5 | 28 / 5<br>25 / 5<br>18 / 5     |
|            |                  | Abduction du bras pour se rééquilibrer                                                    |                                    | N1N2                                   |                                        | N2                                     |                                        | N4                         | 4 / 3                          |
|            | Tronc            | Plastronnement ou salutation                                                              | R3<br>K3K4                         | N1N2<br>R1<br>K1K2K3                   | R1                                     | R1R2<br>K1K2K3K4                       | R1R2R4<br>K1K2K5                       |                            | 2 / 2<br>8 / 4<br>12 / 5       |
|            |                  | Mobilité du tronc                                                                         |                                    | R1R4                                   |                                        |                                        | R1R4                                   |                            | 4 / 2                          |
|            |                  | Inclinaison latérale, rotation, retroposition...                                          | N1N2N3N4N5<br>K1K2K3               | N1N2N3<br>R1R5<br>K1K2                 | N5<br>R1                               | N3<br>R2<br>K1K2                       | N1N2N5<br>R2                           | N3<br>R1                   | 14 / 5<br>6 / 3<br>7 / 3       |
|            |                  |                                                                                           | 21<br>12<br>12                     | 25<br>34<br>16                         | 15<br>27<br>12                         | 15<br>20<br>15                         | 18<br>27<br>16                         | 10<br>18<br>2              | 105<br>138<br>76               |

**Tableau III.2.2. :** Indicateurs de marche de la catégorie « Régional » utilisés par les différents spécialistes et pour chacun des sujets (N = neurologue, R = médecin rééducateur, K = cadres kinésithérapeutes, S = sujet). Les numéros correspondent aux codes spécialistes et sujets, Nb = nombre, spé = spécialiste.

| Catégories     | Indicateurs qualifiés                                                                                             | SUJETS                 |                          |                              |                                  |                    |                          | Nb Citation<br>ET<br>Nb de spé |
|----------------|-------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------|------------------------------|----------------------------------|--------------------|--------------------------|--------------------------------|
|                |                                                                                                                   | S1                     | S2                       | S3                           | S4                               | S5                 | S6                       |                                |
| <b>Général</b> | Claudication ou boiterie                                                                                          | N1                     | R4                       | N1N5                         |                                  |                    |                          | 3/2<br>1                       |
|                | Syncinésies                                                                                                       | N4<br>R3R4             | N4<br>R3R4<br>K5         | N4                           | N4<br>K5                         | N4<br>R4           | N4N5<br>R4<br>K5         | 7/2<br>6/2<br>3/1              |
|                | Type de marche : « Précautionneuse », « Instable », « Ataxique », « cérébelleuse », « précaire », « coûteuse »... | R1R4<br>K1K2K4K5       | N1<br>R1R4<br>K5         | N2N3N4N5<br>R1R4R5<br>K1K2K5 | N2N3N4N5<br>R1R3R4               | N1N2N3N5<br>R1R2R3 | N2N3N5<br>R2R3R4         | 16/5<br>16/5<br>8/4            |
|                | Type d'hémiplégie ou d'hémi-parésie : « ataxo-spasmodique », « flasco-spastique », bracio-fasciale »...           | N2N3N4N5               | N3N4                     | N3N4<br>R5                   | R3R4                             | N3N4N5<br>R3R5     | N3N4<br>R3               | 13/4<br>6/3                    |
|                | Tremblement ou clonies                                                                                            |                        | N5                       |                              |                                  | K3                 |                          | 1<br>1                         |
|                | Synchronisme des flexions, des rotations, du ballant du bras, dissociation des ceintures.                         | R4<br>K4               | N1<br>R1R2R4R5           | K3<br>R3R4                   | N5<br>R1R4R5<br>K1K2             | R4R5               | R4<br>K1K2               | 3/3<br>13/5<br>4/2             |
|                | Equilibre                                                                                                         | R1R2                   | N3<br>R2                 | N2N3N4N5<br>R1R2R3R5<br>K4   | N2N3N4N5<br>R1R2R4R5<br>K1K2K3K4 | N3N5<br>R1R4       | N2N4<br>R3               | 13/4<br>14/5<br>5/4            |
|                | Posture OU symétrie générale                                                                                      | N1N2<br>R1R3R5<br>K4   | N1N2N4<br>R1R3           | N4<br>R1R3R5                 | N2N4N5<br>R1R3                   | N2N3N4<br>R1R3R4R5 | N2<br>R3                 | 13/5<br>15/4<br>1              |
|                | Regarde ses appuis                                                                                                |                        | N3N5                     | N5<br>R3R4                   | R1R4                             |                    |                          | 3/2<br>4/3<br>1                |
|                | Déficit particulièrement localisé (proximal, distal, fascio-brachiale, brachiale...)                              | N2N3N4<br>R1R3R5<br>K4 | N2N4<br>R1R2R3R5<br>K1K2 | N2N4<br>R3R4                 | N2N4<br>R2R3R5<br>K1K2           | N1N4<br>R3R4       | N2N4<br>R3<br>K1K2       | 13/4<br>15/5<br>7/3            |
|                | Un hémi-corps est totalement effacé, uniquement ramené au niveau de l'autre lors de la marche...                  |                        | N2<br>R1R3R5<br>K1K2     |                              | R1R2R3R5<br>K1K2                 |                    |                          | 1<br>7/4<br>4/2                |
|                | Vitesse de marche                                                                                                 | R1R3                   | N1<br>R1R5               | N1<br>R1R5<br>K1K2           | R1R3R4R5                         | N3<br>R1R2<br>K5   | N1N3N5<br>R5<br>K1K2K4K5 | 6/3<br>13/5<br>7/4             |
|                | Instabilité : appuis, cheville, genou, hanche, bassin, membre inférieur                                           | N1<br>R1R2R3R5         | N2<br>R2R4R5             | N3<br>R1R2R5<br>K5           | N1N3<br>R1R2R3R4R5               | R3R4<br>K1K2       | R1R3R4R5                 | 5/3<br>21/5<br>3/2             |
|                | Contrôle : appuis, cheville, genou, hanche, bassin, membre inférieur, distal, proximal                            | N4<br>R3<br>K4         | N2N4<br>R2<br>K3K4       | N4<br>R2<br>K4K5             | N1<br>R1R2R4<br>K1K2             | R4                 | N4<br>R1<br>K5           | 6/3<br>7/4<br>8/5              |
|                | Mobilité passive                                                                                                  | R4                     | R1R3R5<br>K1K2           | R1                           | R5                               | R1                 | R1R5<br>K1K2             | 9/4<br>4/2                     |
|                | Le ½ tour, se lever de sa chaise...                                                                               | N3N4                   | N3N5<br>R2R4R5           | N1N3                         | N2N3N4N5<br>R1R4R5<br>K4         | R4                 | N2N5<br>R4<br>K4         | 12/4<br>8/4<br>2/2             |
|                | Apparition de synergies d'extensions                                                                              | R1                     | R1R4                     |                              |                                  |                    |                          | 3/2                            |
|                | Avec la fatigue ou les passages : augmentation du steppage ou fauchage ou de la spasticité...                     | N4<br>R1R3R4R5<br>K4K5 | N4<br>R1<br>K5           | N4<br>K5                     | N3<br>R5<br>K3K4                 | R4<br>K5           | N4                       | 5/2<br>6/4<br>7/3              |
|                | Manque de fluidité de la marche, marche saccadée, petit temps d'arrêt                                             | R4<br>K1K2             |                          | N3<br>R4                     |                                  | N2N3<br>R3R4       | N3<br>R2R3R4R5<br>K1K2K4 | 4/2<br>8/4<br>5/3              |
|                |                                                                                                                   | 12<br>27<br>12         | 22<br>37<br>12           | 25<br>37<br>12               | 33<br>41<br>16                   | 17<br>27<br>5      | 20<br>23<br>16           | 150<br>190<br>70               |

**Tableau III.2.3. :** Indicateurs de marche de la catégorie « Général » utilisés par les différents spécialistes et pour chacun des sujets (N = neurologue, R = médecin rééducateur, K = cadres kinésithérapeutes, S = sujet). Les numéros correspondent aux codes spécialistes et sujets, Nb = nombre, spé = spécialiste.

|                      |                 |                                                                                                       | SUJETS                       |                                |                                  |                                    |                            |                                  |                                |
|----------------------|-----------------|-------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------|----------------------------------|------------------------------------|----------------------------|----------------------------------|--------------------------------|
| Catégories           |                 | Indicateurs qualifiés                                                                                 | S1                           | S2                             | S3                               | S4                                 | S5                         | S6                               | Nb Citation<br>ET<br>Nb de spé |
| Qualité<br>du<br>pas | Pas             | Rythme du pas, durée du pas                                                                           | R4<br>K1K2                   | R4<br>K4                       | R4                               | K1K2K3K4                           | N2N3<br>R4<br>K1K2         | R2R4<br>K1K2                     | 2 / 2<br>6 / 2<br>11 / 4       |
|                      |                 | Angle du pas, largeur du pas                                                                          | N3N5<br>K5                   | R1R2R3R5<br>K1K2               | R1<br>K3                         | N5                                 | N3<br>R4R5                 | N2N3N4N5<br>R2R3R4R5<br>K2K3K4K5 | 8 / 5<br>11 / 5<br>8 / 5       |
|                      |                 | Longueur, symétrie/dissymétrie, prédominance du pas antérieur ou postérieur, petit pas...             | N1N3<br>R1R2R3R4R5<br>K3K4K5 | N2<br>R1R2R3R4R5<br>K1K2K3K4K5 | N3N4N5<br>R1R2R3R4<br>K1K2K3K4K5 | N1N2N3N5<br>R1R2R3R4R5<br>K1K2K3K5 | R1R2R3R4R5<br>K4K5         | R1R4R5<br>K4K5                   | 10 / 5<br>27 / 5<br>21 / 5     |
|                      | Appuis          | Dominance unilatérale des appuis                                                                      | N1N3<br>R2R3<br>K3           | N2<br>R1R2R3R4<br>K1K2K3K4K5   | N5<br>R3<br>K1K2K4K5             | N3N4<br>R1R2R3<br>K3               | R1R4<br>K5                 | N3<br>R1<br>K4                   | 7 / 4<br>13 / 5<br>13 / 5      |
|                      |                 | Qualité des propulsions                                                                               | R1R3R4R5<br>K3               | R1R3<br>K3                     | R2R4<br>K3                       | R1R3<br>K3K5                       | R1R2                       |                                  | 12 / 5<br>5 / 2                |
|                      |                 | Qualité générale de l'appui                                                                           | N2<br>R1R3R4<br>K1K2K3K4K5   | R3R4                           | N2<br>R1R3<br>K1K2K3K5           | N4<br>R1<br>K1K2K4K5               | R1R3                       | K2K3K4                           | 3 / 2<br>10 / 3<br>16 / 4      |
|                      | Ph.<br>Osci.    | Hauteur du pied, décollement du pied, le pied traîne par terre, frotte sur le sol...                  | N3N4<br>R1R3<br>K5           | N2N4<br>R1R2R3<br>K1K2         | N1<br>R1                         | N1N3N5<br>R1<br>K1K2K4             | N5<br>R1<br>K5             | N3<br>R1<br>K2K4                 | 10 / 5<br>9 / 3<br>9 / 4       |
|                      |                 | La jambe est lancée en avant ou traînée                                                               | N2N3<br>R2<br>K1K2           | N1N2N3N5<br>R1<br>K1K2         | N1N2N5<br>K3K5                   | N2N3<br>R1R4                       | N4N5<br>R1R2<br>K5         | N2<br>K1K2K5                     | 14 / 5<br>7 / 4<br>10 / 4      |
|                      |                 | Laisse tomber sa jambe, membre pilon marche talonnante, ne contrôle pas la fin de la phase oscillante | N2N5<br>K1K2K3K5             | R1R4                           | N4                               | N2<br>R3R4<br>K1K2                 | R4                         | N2<br>R1R3R4                     | 5 / 3<br>8 / 3<br>6 / 4        |
|                      |                 | Harmonie, durée de la phase...                                                                        | R4<br>K1K2                   | R1                             |                                  | R3                                 | R4                         |                                  | 4 / 3<br>2 / 2                 |
|                      | Db.<br>App.     | Double appuis                                                                                         | R4                           | R1R3R4                         |                                  | R1R2R3R5<br>K1K2                   |                            | R1R3                             | 10 / 5<br>2 / 2                |
|                      | T. du<br>Pd     | Qualité du transfert du poids                                                                         | R1R3                         | R3R5                           | R1R2R5<br>K3K4                   | R1R2R3R4<br>K1K2                   |                            |                                  | 11 / 5<br>4 / 4                |
|                      | Trajectoir<br>e | Trajectoire du pied, du genou, du bassin, oscillation de la jambe                                     | R1<br>K1K2                   | R1R2R5<br>K1K2                 | R1R2R3<br>K4                     | N5<br>R1R4R5<br>K1K2               | N4N5<br>R1R2R3R4R5<br>K1K2 | R1R2R3<br>K1K2                   | 3 / 2<br>18 / 5<br>11 / 3      |
|                      | Autre           | Utilise sa jambe comme une canne                                                                      |                              | N3N5                           |                                  |                                    | N5<br>R5                   |                                  | 3 / 2<br>1                     |
|                      |                 | Mode d'utilisation de l'appareillage                                                                  |                              | N3N5<br>R4<br>K1K2             |                                  |                                    |                            |                                  | 2 / 2<br>1<br>2 / 2            |
|                      |                 |                                                                                                       | 13<br>25<br>22               | 10<br>39<br>22                 | 9<br>17<br>19                    | 15<br>30<br>26                     | 15<br>30<br>9              | 8<br>21<br>19                    | 64<br>162<br>118               |

**Tableau III.2.4. :** Utilisation des indicateurs de marche de la catégorie « Qualité de marche » utilisés par les différents spécialistes et pour chacun des sujets (N = neurologue, R = médecin rééducateur, K = cadres kinésithérapeutes, S = sujet, les numéros correspondent aux codes spécialistes et sujets, Nb = nombre, spé = spécialiste.

|               |                                                                                  | SUJETS                 |                                  |                            |                    |                          |                        | Nb Citation<br>ET<br>Nb de spé |
|---------------|----------------------------------------------------------------------------------|------------------------|----------------------------------|----------------------------|--------------------|--------------------------|------------------------|--------------------------------|
| Catégories    | Indicateurs qualifié                                                             | S1                     | S2                               | S3                         | S4                 | S5                       | S6                     |                                |
| Interprétatif | Déficits ou troubles moteurs                                                     | N2                     | N2N4N5<br>R3                     | N2N4N5<br>R3               | N2N4<br>R1R3       | N1N5<br>R3R4             | N2N4<br>R3<br>K1K2     | 13 / 4<br>7 / 3<br>2 / 2       |
|               | Effcience d'un muscle en particulier                                             | N4N5<br>K1K2K3K4       | R1R2R4R5<br>K1K2K3K4             | R3R4<br>K4                 | R2R3<br>K3K4       | N5<br>R2R4R5<br>K3K4     | K4                     | 3 / 3<br>11 / 5<br>14 / 5      |
|               | Déficit de force musculaire                                                      | N3N4<br>R3             | N2                               | R4                         | N5                 |                          |                        | 4 / 4<br>2 / 2                 |
|               | Avec les passages certains paramètres s'améliorent                               | R1R4                   | R1                               |                            | N5<br>R3R4R5       |                          |                        | 1<br>6 / 4                     |
|               | Possibilité d'atteinte autre que cette hémiplegie dominante                      | N1                     | N2N5                             |                            | N1N2               | N2N3<br>K3               | N2                     | 8 / 4<br>1                     |
|               | Note dystonique                                                                  | N1                     |                                  |                            | N2<br>R2           |                          | N1<br>R2               | 3 / 2<br>2 / 1                 |
|               | Spasticité                                                                       | N2N3N4<br>R1R2R3<br>K4 | N2N3N4<br>R1R2R3R5<br>K1K2K3K4K5 | N1N3N4<br>R1R2R3R5<br>K4K5 | R3R4<br>K4         | N1N4<br>R1R2R3R4R5<br>K3 | N4<br>R3<br>K1K2K4     | 12 / 4<br>19 / 5<br>13 / 5     |
|               | Problèmes de sensibilité, de proprioception, de schéma corporel...               | N2N4<br>R3R4<br>K4     | N3N4<br>R3R4                     | N2N4N5<br>K3K4K5           | N5<br>R1R3R4<br>K4 | R1R3<br>K4               | N2N4N5<br>R3R4<br>K4K5 | 11 / 4<br>11 / 3<br>8 / 3      |
|               | Phobie de marcher                                                                |                        |                                  |                            | N5<br>R5           |                          |                        | 1<br>1                         |
|               | Ancienneté de l'hémiplegie                                                       |                        |                                  |                            |                    | N5                       | N5<br>R1               | 2 / 1<br>1                     |
|               | Risque de chute                                                                  |                        | R1R5                             |                            | N3<br>R1R5         |                          |                        | 1<br>4 / 2                     |
|               | Attention nécessaire ou portée à la marche                                       | N1N2<br>R3R4R5         | R3                               | R3R4                       | N3<br>R3R4         | R4                       | R4<br>K4               | 3 / 3<br>10 / 3<br>1           |
|               | Longue rééducation, bonne rééducation ...                                        | N1N2N3<br>R4R5         |                                  | R4R5                       | R4R5               | R3                       |                        | 3 / 3<br>7 / 3                 |
|               | Impression de douleur à la marche                                                |                        |                                  | N2<br>R5                   | N3                 |                          |                        | 2 / 2<br>1                     |
|               | Appareillage : canne, releveur, alcoolisation... améliorerait beaucoup la marche |                        | N1N3N5<br>R1R2R4R5<br>K4         |                            | N3<br>R1R3R5       | R3R5<br>K4               | R3                     | 4 / 3<br>10 / 5<br>2 / 1       |
|               | Hyper et/ou hypotonie                                                            | N1N2N3N5<br>K1K2       | N1N2N3N4N5<br>R4                 | N1N2N4N5<br>R1R3           | N1N2N3N5           | N1N2N3N4N5<br>R4         | N5<br>R4<br>K1K2       | 23 / 5<br>5 / 3<br>4 / 2       |
|               |                                                                                  | 23<br>14<br>8          | 20<br>19<br>10                   | 13<br>16<br>6              | 27<br>24<br>4      | 13<br>17<br>5            | 9<br>9<br>10           | 105<br>99<br>43                |

**Tableau III.2.5. :** Indicateurs de marche de la catégorie « Interprétatif » utilisés par les différents spécialistes et pour chacun des sujets (N = neurologue, R = médecin rééducateur, K = cadres kinésithérapeutes, S = sujet). Les numéros correspondent aux codes spécialistes et sujets, Nb = nombre, spé = spécialiste.

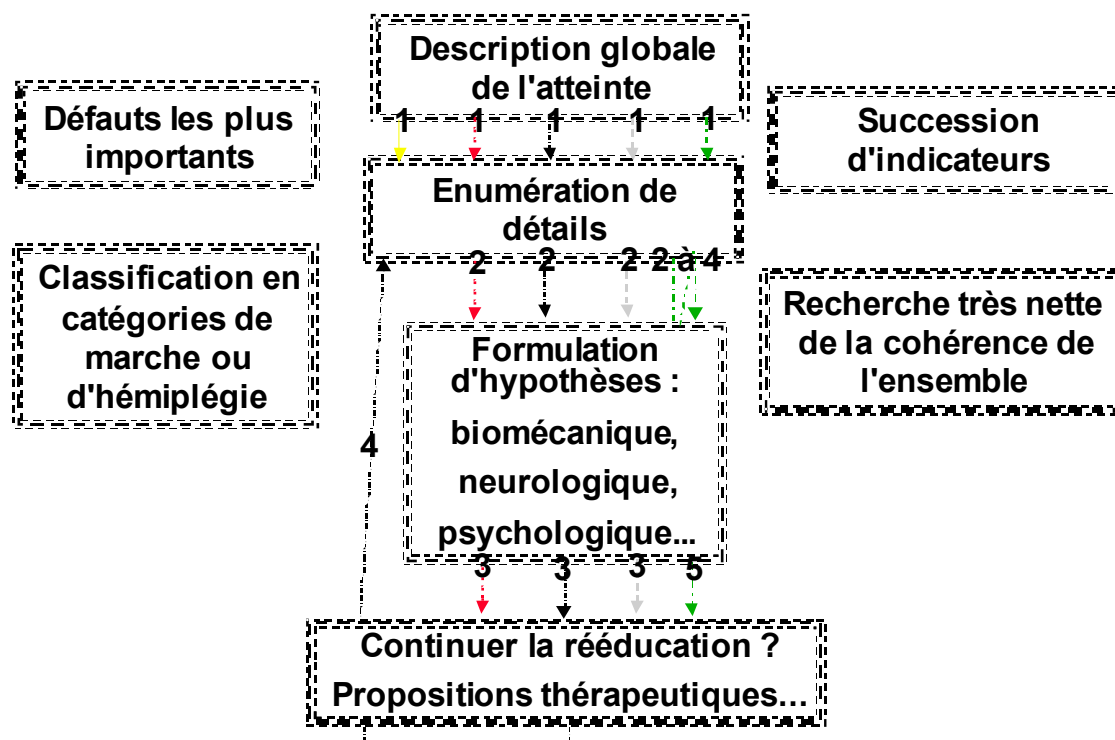
### ANNEXE III.3.

Organigrammes des différentes étapes de l'évaluation fonctionnelle de la marche pour les différents spécialistes :

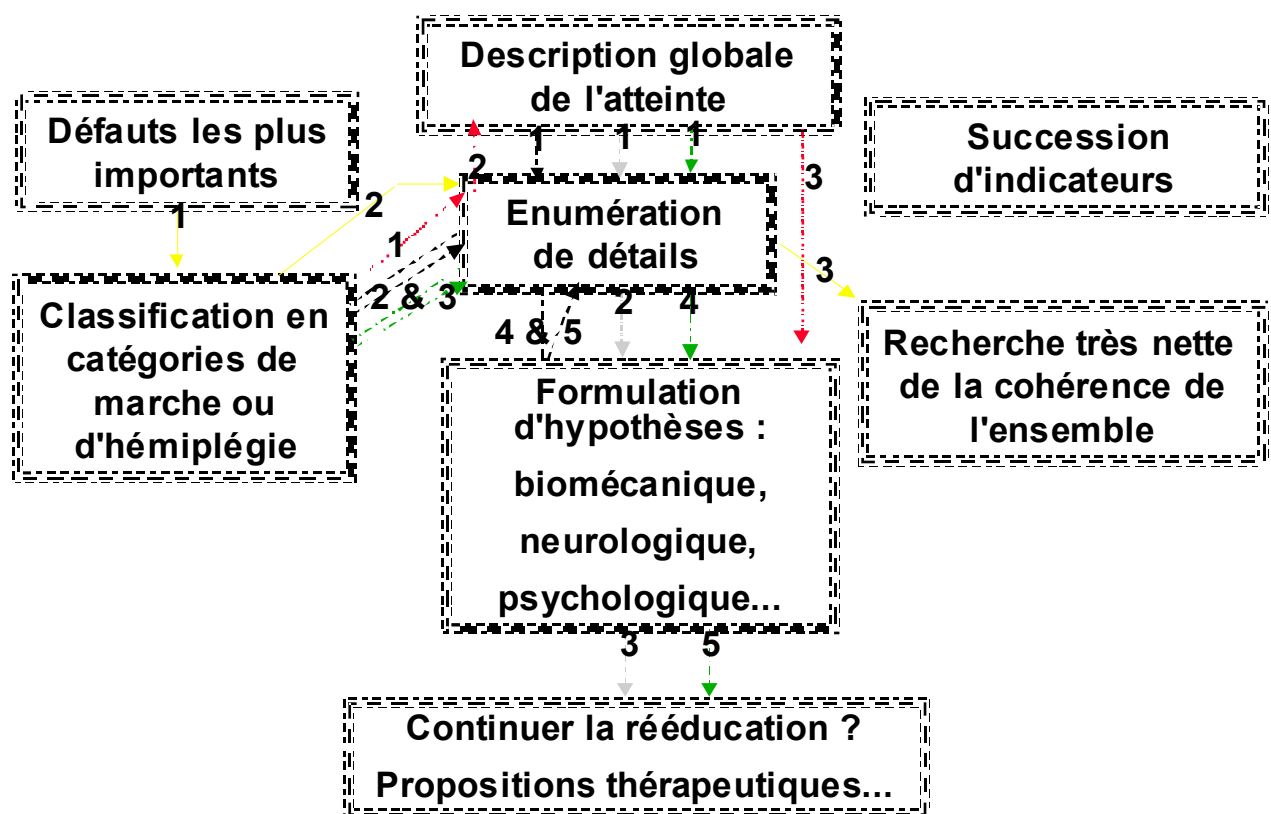
**Figure III.3.1. :** Organigramme des médecins rééducateurs,

**Figure III.3.2. :** Organigramme des neurologues,

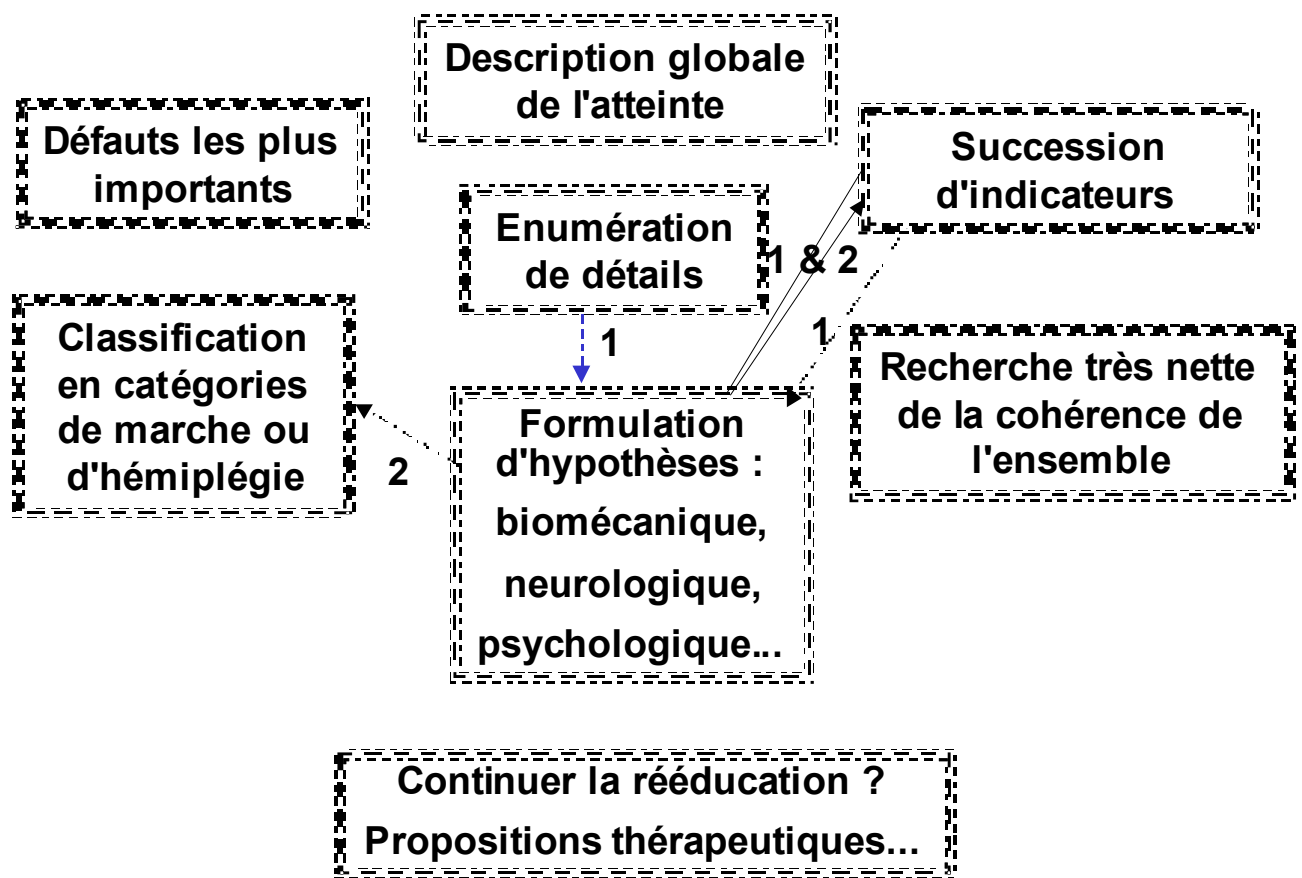
**Figure III.3.3. :** Organigramme des cadres kinésithérapeutes,



**Figure III.3.1. :** Organigramme des différentes étapes (identifiées par des chiffres) de l'évaluation fonctionnelle de la marche (EFM). Celui-ci a été réalisé à partir des 6 EFM effectués par chacun des cinq médecins rééducateurs (spécialistes identifiés par les différents types de traits).

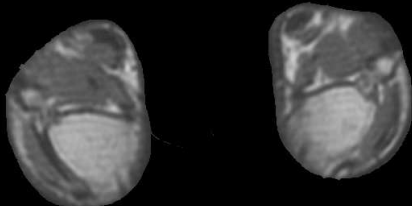
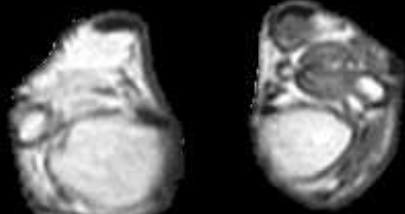
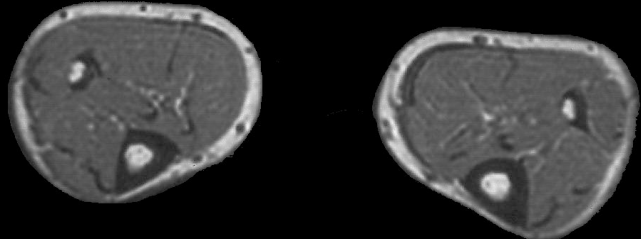
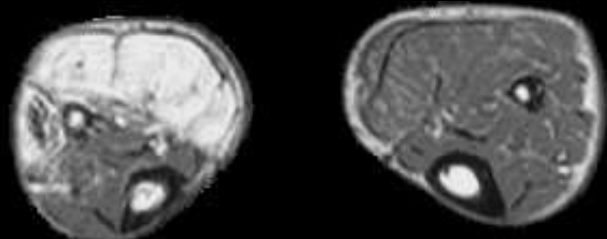
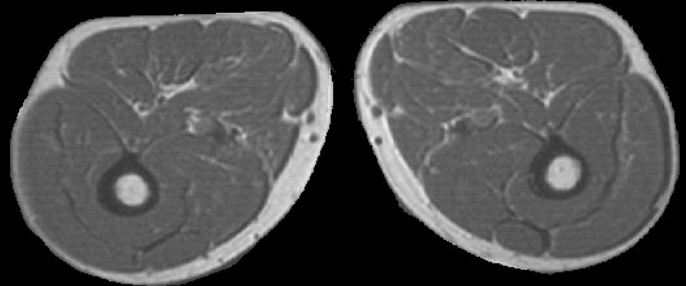
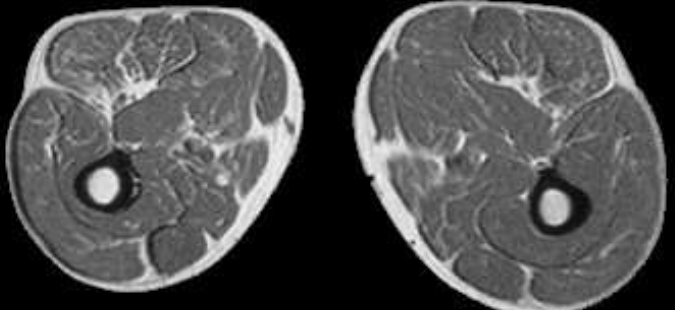


**Figure III.3.2. :** Organigramme des différentes étapes (identifiées par des chiffres) de l'évaluation fonctionnelle de la marche (EFM). Celui-ci a été réalisé à partir des 6 EFM effectués par chacun des cinq neurologues (spécialistes identifiés par les différents types de traits).



**Figure III.3.3. :** Organigramme des différentes étapes (identifiées par des chiffres) de l'évaluation fonctionnelle de la marche (EFM). Celui-ci a été réalisé à partir des 6 EFM effectués par chacun des cinq cadres kinésithérapeutes (spécialistes identifiés par les différents types de traits).

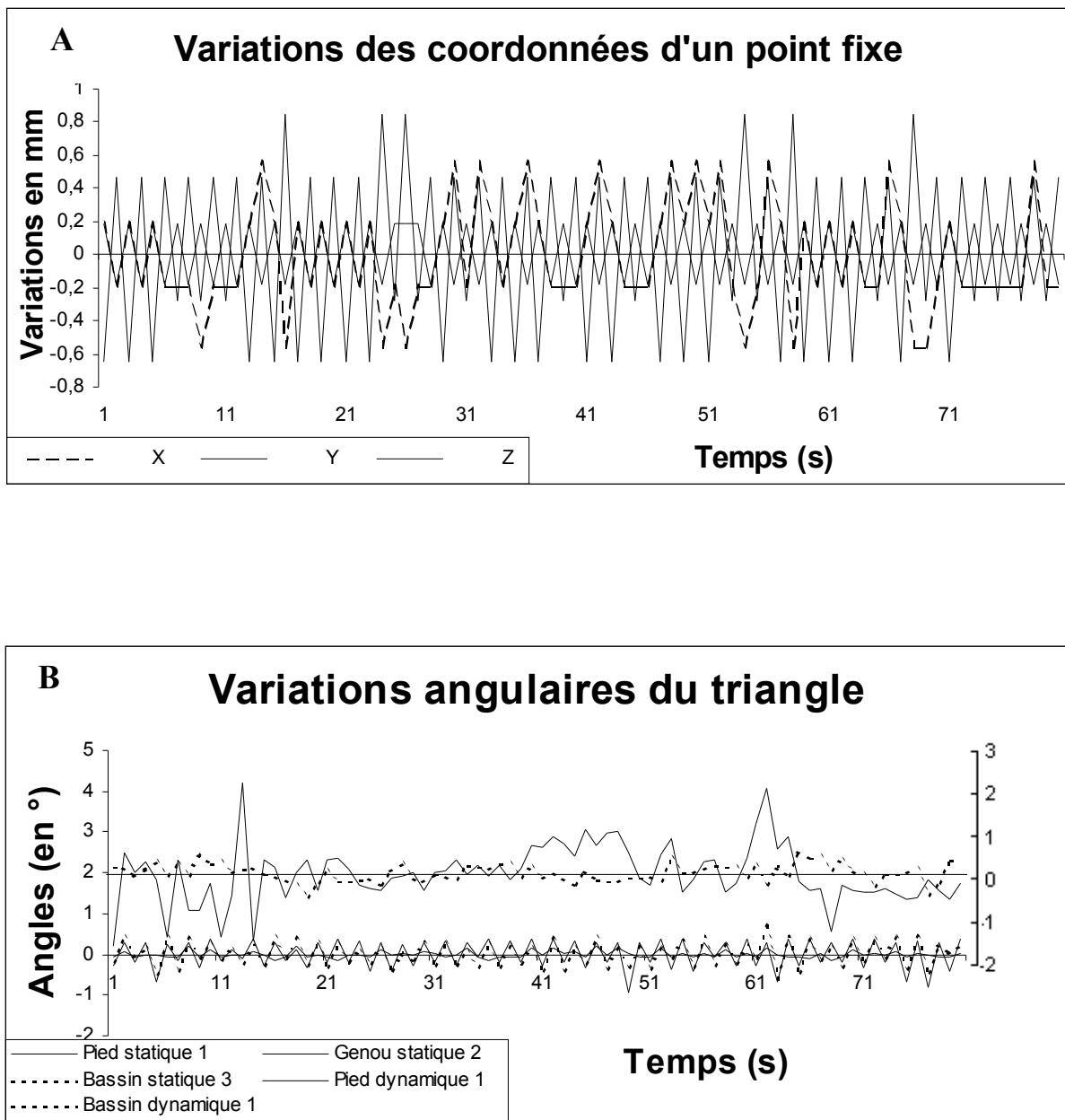
### ANNEXES III.4.

| Exemples de coupes à même hauteur   |                                                                                     |                                                                                      |
|-------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Hauteur de coupe                    | Photos d'un <b>sujet sain**</b>                                                     | Images IRM du sujet <b>hémiplégique*</b>                                             |
| <b>Au-dessus<br/>de la cheville</b> |   |   |
| <b>Aux 2/3 sup.<br/>de la jambe</b> |   |   |
| <b>A mi-cuisse</b>                  |  |  |

\* Le sujet hémiplégique étudié est un patient masculin de 60 ans, 1m70, 71 kg, longueur des jambes identique, proche de l'ictus (AVC sylvien) et ayant récupéré une marche avec canne anglaise autonome sur 60 m (Indice de Barthel de 80, M.I.F. de 95, S.I.A.S. de 56 et Fugl Meyer de 166, Time up and go 23s). L'enregistrement des IRM axiales de la cheville au sommet de l'iliaque ont été réalisées à droite et à gauche : TR 500 et 560 ms ; TE 13 ms ; épaisseur 10 mm ; 1 mm d'intervalle ; champ d'analyse de 48\*36 cm et une matrice de 512\*320, codée en 16 bits.

\*\* Le sujet sain étudié est âgé de 60 ans, mesure 1m72 et pèse 73kg. Les IRM ont été réalisées avec les mêmes paramètres.

### ANNEXE III.5.



**Figure III.5.1. :** Exemple de la variations des coordonnées (en x, y et z) d'un point fixe situé dans l'espace de calibration (A). Variations d'angles formés par 3 points pour trois triangles indéformables (B) de la taille des segments corporels fixés sur un marcheur (partie supérieure du graphique) et lorsqu'ils sont en position statique à différents endroits du volume de calibration (aucun pré-traitement des données).

|                                           |     | D1 | X1    | SD1 | Min1  | Max1  | Dif1 | D2 | X2    | SD2 | Min2  | Max2  | Dif2 | Ang | X3   | SD3 | Min3 | Max3 | Dif3 |
|-------------------------------------------|-----|----|-------|-----|-------|-------|------|----|-------|-----|-------|-------|------|-----|------|-----|------|------|------|
| S<br>T<br>A<br>T<br>I<br>Q<br>U<br>E      | C1a |    | 450.7 | 1.2 | 448.8 | 452.4 | 3.7  |    | 164.3 | 0.6 | 162.9 | 165.9 | 3    |     | 90.2 | 0.3 | 89.3 | 90.6 | 1.3  |
|                                           | C1b |    | 450.6 | 1.1 | 448.6 | 452.1 | 3.5  |    | 164.2 | 0.6 | 162.8 | 166   | 3.2  |     | 90.1 | 0.3 | 89.2 | 90.5 | 1.3  |
|                                           | C2a | 4  | 450.5 | 0.7 | 449.4 | 452.1 | 2.7  | 1  | 164.5 | 1   | 162.9 | 166.6 | 3.7  |     | 89.9 | 0.1 | 89.7 | 90.1 | 0.4  |
|                                           | C2b | 5  | 450.7 | 0.8 | 449.5 | 452.3 | 2.8  | 6  | 164.6 | 0.9 | 163   | 166.3 | 3.3  | 9   | 90   | 0.2 | 89.6 | 90.2 | 0.6  |
|                                           | C3a | 0  | 453.5 | 0.4 | 452.2 | 453.8 | 1.6  | 4  | 165.3 | 0.8 | 164   | 167.7 | 3.7  | 0   | 91   | 0.2 | 90.6 | 91.5 | 0.9  |
|                                           | C3b |    | 453.2 | 0.4 | 452   | 454   | 2    |    | 165   | 0.8 | 163.9 | 166.9 | 3    |     | 91   | 0.2 | 90.5 | 91.6 | 1.1  |
| D<br>Y<br>N<br>A<br>M<br>I<br>Q<br>U<br>E | C4a |    | 450.5 | 1   | 446.9 | 454   | 7.1  |    | 165.7 | 1.3 | 162.8 | 168.9 | 6.1  |     | 90.1 | 0.6 | 88.7 | 92.6 | 3.9  |
|                                           | C4b | 4  | 449.5 | 1.1 | 445.8 | 452.7 | 6.9  | 1  | 165   | 1.4 | 161.7 | 168   | 6.3  |     | 90.1 | 1   | 87.2 | 95.1 | 7.9  |
|                                           | C5a | 5  | 450.5 | 1.2 | 445.6 | 453.5 | 8.3  | 6  | 165.4 | 1.3 | 161.6 | 168.9 | 7.3  | 9   | 90.1 | 0.9 | 87.8 | 93.6 | 5.7  |
|                                           | C5b | 0  | 450.9 | 1.3 | 445.9 | 453.8 | 7.9  | 4  | 165.1 | 1.2 | 161.1 | 168.7 | 7.6  | 0   | 90   | 0.9 | 87.2 | 95.2 | 8    |

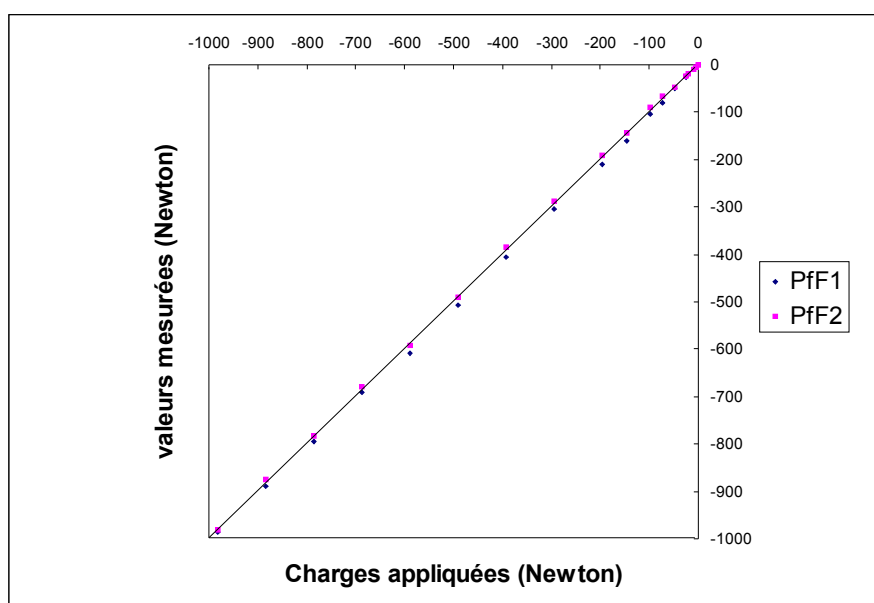
**Tableau III.5.1. :** Présentation des résultats de précision « globale » du système d'analyse du mouvement à partir de calculs de distances et d'angles fixes dans différentes conditions statiques et dynamiques pour un triangle simulant la cheville, dimensions présentées dans le tableau III.3 ; les valeurs sont présentées en millimètres et en degrés à un chiffre après la virgule. D=distance, C=cheville, 1=approche de la première PfF, 2=sur la deuxième PfF, 3=proche de la sortie du volume de calibration, 4=triangle fixé sur la jambe droite, 5= triangle fixé sur la jambe gauche, a=première série de mesures, b=deuxième série de mesures distante d'une semaine de la première, X=moyenne, SD=écart type, Min=Minimum, Max=Maximum, Dif=Différence.

|                                      |     | D1 | X1    | SD1 | Min1  | Max1  | Dif1 | D2 | X2    | SD2 | Min2  | Max2  | Dif2 | Ang | X3    | SD3 | Min3  | Max3  | Dif3 |
|--------------------------------------|-----|----|-------|-----|-------|-------|------|----|-------|-----|-------|-------|------|-----|-------|-----|-------|-------|------|
| S<br>T<br>A<br>T<br>I<br>Q<br>U<br>E | G1a |    | 479.6 | 0.5 | 479.3 | 481.2 | 1.9  |    | 454.3 | 0.5 | 453.1 | 455.3 | 2.2  |     | 139.6 | 0.1 | 139.5 | 139.9 | 0.4  |
|                                      | G1b |    | 480   | 0.6 | 479.2 | 480.9 | 1.7  |    | 452.2 | 0.6 | 451   | 453.4 | 2.4  |     | 139.8 | 0.2 | 139.5 | 141.1 | 0.6  |
|                                      | G2a | 4  | 479.1 | 0.3 | 478.5 | 480   | 1.5  | 4  | 451.3 | 0.7 | 450   | 452.3 | 2.3  | 1   | 140   | 0.1 | 139.8 | 140.2 | 0.4  |
|                                      | G2b | 8  | 480.3 | 0.6 | 479   | 481.1 | 1.4  | 5  | 450   | 0.6 | 449   | 451.1 | 2.1  | 4   | 139.7 | 0.1 | 139.5 | 139.9 | 0.4  |
|                                      | G3a | 0  | 480   | 0.2 | 479.6 | 480.4 | 0.8  | 4  | 451.7 | 1.5 | 449.1 | 454.1 | 5    | 0   | 139.5 | 0.2 | 139.1 | 139.9 | 0.8  |
|                                      | G3b |    | 479.3 | 0.3 | 478.8 | 478.8 | 1    |    | 452   | 1.3 | 450.4 | 453.6 | 3.2  |     | 140.1 | 0.2 | 139.7 | 140.4 | 0.7  |

**Tableau III.5.2. :** Présentation des résultats de précision « globale » du système d'analyse du mouvement à partir du calcul de distances et d'angles fixes dans différentes conditions statiques pour un triangle simulant le genou, dimensions présentées dans le tableau III.3 ; les valeurs sont présentées en millimètres et en degrés à un chiffre après la virgule. G=genou, 1=approche de la première PfF, 2=sur la deuxième PfF, 3=proche de la sortie du volume de calibration, a=première série de mesures, b=deuxième série de mesure distante d'une semaine de la première, X=moyenne, SD=écart type, Min=Minimum, Max=Maximum, Dif=Différence.

|                                           |     | D1          | X1    | SD1 | Min1  | Max1  | Dif1 | D2          | X2    | SD2 | Min2  | Max2  | Dif2 | Ang         | X3    | SD3 | Min3  | Max3  | Dif3 |
|-------------------------------------------|-----|-------------|-------|-----|-------|-------|------|-------------|-------|-----|-------|-------|------|-------------|-------|-----|-------|-------|------|
| S<br>T<br>A<br>T<br>I<br>Q<br>U<br>E      | B1a | 1<br>6<br>0 | 161.3 | 0.8 | 159.4 | 162.8 | 3.4  | 2<br>4<br>0 | 240.4 | 1   | 239   | 241.9 | 2.9  | 1<br>2<br>0 | 122.1 | 0.4 | 113.3 | 112.8 | 1.6  |
|                                           | B1b |             | 160.8 | 0.7 | 159.3 | 162.3 | 3    |             | 240.6 | 0.8 | 239.4 | 242   | 2.5  |             | 119.9 | 0.4 | 118.1 | 119.9 | 1.8  |
|                                           | B2a |             | 160.1 | 0.7 | 161.5 | 162.7 | 2.6  |             | 240.8 | 0.7 | 239.7 | 241.9 | 2.3  |             | 122.1 | 0.4 | 121.5 | 122.7 | 1.2  |
|                                           | B2b |             | 160.3 | 0.7 | 158.9 | 161.7 | 2.8  |             | 240.1 | 0.6 | 238.8 | 241.4 | 2.6  |             | 121   | 0.3 | 120.3 | 121.7 | 1.3  |
|                                           | B3a |             | 159.6 | 0.6 | 158.1 | 160.8 | 2.7  |             | 240.7 | 0.6 | 238.9 | 241.9 | 3    |             | 121.5 | 0.3 | 120.9 | 122.2 | 1.3  |
|                                           | B3b |             | 159.9 | 0.6 | 158.6 | 161.2 | 2.6  |             | 240.3 | 0.7 | 239.9 | 241.7 | 2.8  |             | 120.8 | 0.4 | 120.1 | 121.5 | 1.4  |
| D<br>Y<br>N<br>A<br>M<br>I<br>Q<br>U<br>E | B4a | 1<br>6<br>0 | 160.5 | 1   | 158.3 | 162.7 | 4.4  | 2<br>4<br>0 | 241   | 1.1 | 237.9 | 243.9 | 6    | 1<br>2<br>0 | 121   | 0.3 | 119.9 | 122.1 | 2.2  |
|                                           | B4b |             | 160.2 | 0.8 | 158.5 | 162   | 3.5  |             | 240.8 | 0.9 | 238.9 | 235.2 | 3.7  |             | 119.8 | 0.5 | 118.7 | 120.8 | 2.1  |
|                                           | B5a |             | 160.3 | 0.6 | 158.5 | 161.4 | 3    |             | 241.3 | 0.8 | 239.4 | 243.2 | 3.8  |             | 121.1 | 0.2 | 120.5 | 121.6 | 1.1  |
|                                           | B5b |             | 160.1 | 0.9 | 158.6 | 161.7 | 3.1  |             | 241.1 | 0.8 | 239.3 | 242.9 | 3.5  |             | 121.3 | 0.3 | 120.4 | 122.3 | 1.9  |

**Tableau III.5.3. :** Présentation des résultats de précision « globale » du système d'analyse du mouvement à partir du calcul de distances et d'angles fixes dans différentes conditions statiques et dynamiques simulant le bassin. B=bassin, 1=approche de la première PfF, 2=sur la deuxième PfF, 3=proche de la sortie du volume de calibration, 4=triangle fixé sur le bassin de face, 5= triangle fixé sur le bassin de dos, a=première série de mesures, b=deuxième série de mesure distante d'une semaine de la première, X=moyenne, SD=écart type, Min=Minimum, Max=Maximum, Dif=Différence ; les valeurs sont présentées en millimètres et en degrés à un chiffre après la virgule.



**Figure III.5.2. :** Etalonnage de la composante de force Fz (verticale) à l'aide de masses de 0.5 à 100 kg placées dans un ordre aléatoire.

| <b>A) Forces mesurés par la Pff 1, avant le passage des sujets</b> |        |       |       |       |        |       |        |       |        |       |       |        |
|--------------------------------------------------------------------|--------|-------|-------|-------|--------|-------|--------|-------|--------|-------|-------|--------|
|                                                                    | FY (N) |       |       |       | FX (N) |       |        |       | FZ (N) |       |       |        |
|                                                                    | Moy    | SD    | Min   | Max   | Moy    | SD    | Min    | Max   | Moy    | SD    | Min   | Max    |
| T1                                                                 | 1,386  | 0,618 | 0,183 | 2,928 | 1,084  | 0,650 | -0,549 | 2,379 | 7,284  | 1,113 | 5,061 | 9,399  |
| T2                                                                 | 2,571  | 0,687 | 1,647 | 4,026 | 1,084  | 0,650 | -0,549 | 2,379 | 8,043  | 1,315 | 2,892 | 10,122 |
| T3                                                                 | 1,876  | 0,394 | 1,098 | 2,745 | 2,223  | 0,310 | 1,464  | 2,928 | 5,495  | 1,129 | 3,615 | 9,399  |
| T4                                                                 | 2,782  | 0,515 | 2,013 | 3,843 | 2,269  | 0,347 | 1,464  | 3,111 | 9,688  | 0,805 | 7,953 | 10,845 |
| T5                                                                 | 1,373  | 0,589 | 0,183 | 2,379 | 1,093  | 0,637 | -0,549 | 2,379 | 7,302  | 1,129 | 5,061 | 9,399  |

| <b>B) Moments mesurés par la Pff 1, avant le passage des sujets</b> |           |        |        |        |           |        |        |        |           |        |        |        |
|---------------------------------------------------------------------|-----------|--------|--------|--------|-----------|--------|--------|--------|-----------|--------|--------|--------|
|                                                                     | MY (N.mm) |        |        |        | MX (N.mm) |        |        |        | MZ (N.mm) |        |        |        |
|                                                                     | Moy       | SD     | Min    | Max    | Moy       | SD     | Min    | Max    | Moy       | SD     | Min    | Max    |
| T1                                                                  | 454,51    | 120,48 | 180,9  | 723,6  | 393,15    | 102,15 | 180,76 | 632,66 | 583,58    | 164,39 | 233,9  | 935,6  |
| T2                                                                  | 1517,3    | 155,9  | 1266,3 | 1809   | 2132,9    | 94,3   | 1897,9 | 2349,8 | 652,58    | 63,585 | 514,58 | 748,48 |
| T3                                                                  | 773,34    | 104,99 | 633,15 | 994,95 | 535,50    | 91,251 | 361,52 | 723,04 | 387,10    | 82,356 | 233,9  | 608,14 |
| T4                                                                  | 1639,4    | 118,2  | 1356,7 | 1809   | 2650,3    | 76,6   | 2530,6 | 2801,7 | 947,2     | 49,8   | 842,1  | 1075,9 |
| T5                                                                  | 449,99    | 117,04 | 180,9  | 723,6  | 397,67    | 100,64 | 180,76 | 632,66 | 577,73    | 159,17 | 233,9  | 935,6  |

| <b>C) Pour les six composantes, différence entre avant et après le passage sur la Pff (hystérésis)</b> |        |        |        |          |          |          |
|--------------------------------------------------------------------------------------------------------|--------|--------|--------|----------|----------|----------|
| <b>T1</b>                                                                                              | FY (N) | FX (N) | FZ (N) | MY (Nmm) | MX (Nmm) | MZ (Nmm) |
| Moy                                                                                                    | 12,21  | 8,86   | -15,38 | -13,43   | -36,21   | -1,40    |
| SD                                                                                                     | 0,51   | 27,46  | 7,34   | 12,45    | 8,51     | 74,11    |
| <b>T2</b>                                                                                              |        |        |        |          |          |          |
| Moy                                                                                                    | -30,07 | -43,94 | -16,40 | -22,35   | -12,39   | -8,78    |
| SD                                                                                                     | -23,92 | -11,60 | -9,22  | 2,12     | -30,26   | -22,98   |
| <b>T3</b>                                                                                              |        |        |        |          |          |          |
| Moy                                                                                                    | 2,44   | 9,05   | -29,28 | -10,23   | -18,14   | 12,39    |
| SD                                                                                                     | -87,77 | -62,49 | -8,91  | -56,36   | -21,30   | 27,31    |
| <b>T4</b>                                                                                              |        |        |        |          |          |          |
| Moy                                                                                                    | 4,61   | 17,34  | -6,72  | 2,21     | 1,11     | 6,79     |
| SD                                                                                                     | 29,78  | 5,77   | -20,82 | -8,15    | -8,70    | -13,27   |
| <b>T5</b>                                                                                              |        |        |        |          |          |          |
| Moy                                                                                                    | 11,33  | 9,62   | -15,10 | -14,57   | -34,66   | -2,43    |
| SD                                                                                                     | -4,38  | 26,00  | 8,69   | 9,88     | 7,13     | 73,27    |

**Tableaux III.5.4. :** Valeurs moyennes, écarts types et amplitudes de la ligne de base des six composantes de la Pff 1 dans les secondes qui précèdent le passage sur la Pff (en A les forces et en B les moments) ; les différences entre avant et après le passage sur celles-ci sont également présentées (en C) pour 5 sujets à 5 dates différentes (sujet marchant à vitesse spontanée). Pff = plate forme de forces, FY = forces en Y, FX = forces en X, FZ = forces en Z, MY = moment en Y, MX = moment en X, MZ = moment en Z, Moy = moyenne, SD = écart type, Min = minimum, Max = maximum, N= Newton, N.mm = Newton par millimètre. T1 à T5 = Passage d'un sujet à une date donnée.

| <b>A) Forces mesurés par la Pff 1, avant le passage des sujets</b> |        |       |        |        |        |       |        |       |        |       |       |       |
|--------------------------------------------------------------------|--------|-------|--------|--------|--------|-------|--------|-------|--------|-------|-------|-------|
|                                                                    | FY (N) |       |        |        | FX (N) |       |        |       | FZ (N) |       |       |       |
|                                                                    | Moy    | SD    | Min    | Max    | Moy    | SD    | Min    | Max   | Moy    | SD    | Min   | Max   |
| T1                                                                 | 1,540  | 0,208 | 1,11   | 2,035  | 1,841  | 0,352 | 0,93   | 2,604 | 9,229  | 0,875 | 8,041 | 12,42 |
| T2                                                                 | -1,822 | 0,423 | -2,59  | -0,925 | 1,841  | 0,352 | 0,93   | 2,604 | 8,059  | 0,503 | 7,31  | 9,503 |
| T3                                                                 | -2,687 | 1,338 | -4,255 | 1,48   | 1,846  | 0,746 | 0      | 2,976 | 13,99  | 0,602 | 12,42 | 15,35 |
| T4                                                                 | 0,005  | 0,270 | -0,555 | 0,74   | 3,167  | 0,985 | -0,558 | 3,906 | 14,43  | 1,549 | 11,69 | 18,27 |
| T5                                                                 | 1,499  | 0,277 | 0,74   | 2,035  | 1,525  | 1,170 | -3,534 | 2,604 | 9,667  | 1,622 | 8,041 | 14,62 |

| <b>B) Moments mesurés par la Pff 1, avant le passage des sujets</b> |           |        |        |        |           |        |        |        |           |        |        |        |
|---------------------------------------------------------------------|-----------|--------|--------|--------|-----------|--------|--------|--------|-----------|--------|--------|--------|
|                                                                     | MY (N.mm) |        |        |        | MX (N.mm) |        |        |        | MZ (N.mm) |        |        |        |
|                                                                     | Moy       | SD     | Min    | Max    | Moy       | SD     | Min    | Max    | Moy       | SD     | Min    | Max    |
| T1                                                                  | 1257,5    | 169,51 | 1097,5 | 1920,6 | 442,38    | 40,41  | 275,01 | 458,35 | 646,61    | 32,39  | 614,77 | 709,35 |
| T2                                                                  | 1136,3    | 57,43  | 1006,6 | 1280,4 | 1290,5    | 55,7   | 1191,7 | 1466,7 | 1294,5    | 55,61  | 1134,9 | 1371,1 |
| T3                                                                  | 521,32    | 68,442 | 457,3  | 640,22 | 912,17    | 115,84 | 550,02 | 1008,7 | 396,05    | 179,66 | 189,16 | 803,93 |
| T4                                                                  | 2073,8    | 212,95 | 1920,6 | 2652,3 | 1931,9    | 47,57  | 1833,4 | 2108,1 | 1223,9    | 77,11  | 898,51 | 1324,1 |
| T5                                                                  | 1326,1    | 248,78 | 1097,5 | 1920,6 | 417,5     | 89,21  | 91,67  | 458,35 | 627,75    | 60,74  | 378,32 | 709,35 |

| <b>C) Pour les 6 composantes, différence entre avant et après le passage sur la Pff</b> |         |         |        |          |          |          |
|-----------------------------------------------------------------------------------------|---------|---------|--------|----------|----------|----------|
| <b>T1</b>                                                                               | FY (N)  | FX (N)  | FZ (N) | MY (Nmm) | MX (Nmm) | MZ (Nmm) |
| Moy                                                                                     | 29,73   | 10,61   | -3,76  | 4,36     | -1,04    | 0,91     |
| SD                                                                                      | 16,86   | 46,50   | 63,60  | 71,59    | 9,45     | -52,91   |
| <b>T2</b>                                                                               |         |         |        |          |          |          |
| Moy                                                                                     | 70,56   | -191,76 | -6,58  | -3,82    | 6,57     | 21,92    |
| SD                                                                                      | 86,88   | 44,71   | -6,45  | 30,59    | -1,09    | 40,85    |
| <b>T3</b>                                                                               |         |         |        |          |          |          |
| Moy                                                                                     | 105,68  | -9,07   | 3,52   | 9,65     | 23,62    | 57,31    |
| SD                                                                                      | 79,28   | 56,47   | 23,22  | 36,26    | 50,59    | 51,87    |
| <b>T4</b>                                                                               |         |         |        |          |          |          |
| Moy                                                                                     | 8600,00 | -8,22   | 3,42   | 4,85     | 0,47     | -0,48    |
| SD                                                                                      | 56,10   | 88,91   | 77,89  | 74,79    | 8,73     | 56,64    |
| <b>T5</b>                                                                               |         |         |        |          |          |          |
| Moy                                                                                     | 27,78   | -7,93   | 0,95   | 9,31     | -7,14    | -2,07    |
| SD                                                                                      | 37,41   | 83,88   | 80,36  | 80,64    | 58,99    | 18,43    |

**Tableaux III.5.5. :** Valeurs moyennes, écarts types et amplitudes de la ligne de base des 6 composantes de la Pff 2 dans les secondes qui précèdent le passage sur la Pff (en A les forces et en B les moments) ; les différences entre avant et après le passage sur celles-ci sont également présentées (en C) pour 5 sujets à 5 dates différentes (sujets marchant à vitesse spontanée). Pff = plate forme de forces, FY = forces en Y, FX = forces en X, FZ = forces en Z, MY = moment en Y, MX = moment en X, MZ = moment en Z, Moy = moyenne, SD = écart type, Min = minimum, Max = maximum, N= Newton, N.mm = Newton par millimètre. T1 à T5 = Passage d'un sujet à une date donnée.

## Annexe III.6.

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### **Gait pattern classification of healthy elderly men based on biomechanical data**

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#### INTRODUCTION

Maintaining walking abilities is important to elderly people since it is instrumental in activities of daily living and required in many tasks for independent living<sup>1</sup>. Since locomotion is recognized as a risk factor associated with falls<sup>2</sup>, gait patterns in elderly able-bodied subjects were documented to establish relationships with walking speeds<sup>3</sup>, to compare them to those obtained from young adults<sup>4</sup> or with those of known fallers<sup>5</sup>. The recruitment strategy in all these studies and in many others was to divide the population based on age alone, usually above 60 years.

Documented changes in some gait parameters, such as shorter stride length, reduced walking speed and lower ankle push-off muscle power, may be more indicative of gait adaptations selected by elderly men rather than the results of age specific impairments. Grouping populations by age has the inconvenience of masking these gait-related adaptations attributed to aging. We hypothesize that the walking patterns in elderly subjects are different from those of the young adults and that they can be distinguished according to the biomechanical gait parameters of each individual rather than using age as a grouping factor.

An activity such as walking can be an overall result of several movement parameters, which can vary within the gait of the individual while the activity itself, can be fairly representative of the person's performance<sup>6</sup>. Classifying gait patterns has the advantage of taking into account several parameters at the same time rather than a single one for each individual<sup>7</sup>.

Using peak muscle powers developed at the hip, knee and ankle, Vardaxis and collaborators<sup>6</sup> have identified five gait families in 19 young adults using cluster analysis. A gait family was formed by subjects which displayed a strong affinity based on several parameters obtained from each individual gait trial and which were significantly different from the other clusters of subjects having their own gait similarities. The subjects in the first family displayed a strong hip pull and ankle push to propel themselves forward. For families 2 to 5, forward progression was ensured by an increasing action of the sagittal hip power shortly after heel-strike. These results highlight the multiple normal dynamic strategies selected by able-bodied subjects in walking. We further speculate gait patterns for elderly subjects differ even within that age category.

Muscle power which is the product of the net muscle moment and the joint angular velocity has been recognized as a valuable gait descriptor since it combines both kinematic and kinetic information<sup>8</sup>. It is widely used to characterize able-bodied gait<sup>9,10</sup>, cerebral palsy locomotion<sup>11</sup>, and the gait of subjects with various foot prostheses<sup>12,13</sup> or total hip implants<sup>14</sup>. In healthy elderly gait<sup>1,15,16</sup>, phasic and temporal-distance parameters must also be considered since walking speed has been found to influence the mechanical work developed in the lower limb<sup>9</sup> and reduced walking speed has been reported in this population<sup>3,17</sup>.

Most gait studies involving elderly subjects have been carried out using a control group consisting of healthy young adults. These studies have examined one gait parameter (e.g. locomotion speed, stance time, joint peak muscle power) at a time; to our knowledge, none have grouped several parameters together to describe the global locomotion pattern as has been done for healthy young adults<sup>6</sup>, patients with an anterior cruciate ligament deficiency<sup>7</sup> or in hemiplegic patients<sup>18</sup>. While muscle powers were used to characterize gait in elderly<sup>1,15,16</sup> subjects, these were either limited to a planar analysis or, when a three-dimensional (3D) analysis was reported, only sagittal plane information was

given. The primary objectives of this study were twofold. Using a single but mixed group of able-bodied young and elderly men we hoped to distinguish the gait patterns of these populations based on one phasic and temporal parameters as well as three-dimensional peak muscle powers rather than age alone, and b) to determine whether or not elderly subjects displayed different gait patterns. We also hoped to identify from the parameters determined above those which best describe elderly gaits.

## METHODS

A single mixed group of 16 able-bodied young and elderly men (32 subjects in all) participated in this study which was reviewed and approved by the local Institutional Review Ethics Board. The demographic information pertaining to the young men and the elderly subjects are respectively given in Table 1. The subjects were later classified into different groups according to their gait characteristics.

The sixteen young male volunteers who participated in this study had an average age of 28.0 years, and none were over 35 years old. None had a limb length discrepancy larger than 1.5 cm, and all were in good health. The exclusion criteria were musculo-skeletal ailments, scoliosis, joint replacement, recent surgery, use of medication and/or a history of neurological pulmonary, cardiac or locomotor disorders. Half of the young men participated in some sport activities, though not on a regular basis, while the others were essentially sedentary.

Sixteen healthy elderly men also took part in this study. Their mean age was 61.7 years. The youngest subject was 56 years old while the eldest was 71 years. The inclusion criteria were the same as for the young men, but with the following additional requirements: the subjects had to be capable of independent walking and be over 55 years old (due to recruitment difficulties). The exclusion criteria for this group added the following conditions -- vertigo, stroke or other heart problems, diabetes, eyesight problems and pulmonary diseases -- to those of the young men group. Seven of the elderly subjects were sedentary and five were active but did not participate in any organized sport-related activities while the remaining four were active in occasional sport activities (tennis). This demographic information concerning both the healthy young adults and the elderly subjects was not included in the subsequent analysis.

The gait analyses were performed in the Human Movement Laboratory of the Service d'Exploration Neurophysiologique at the Centre Hospitalier Régional Universitaire of Lille. The kinematic data were collected by a Vicon 360 system<sup>a</sup>. Two 50 Hz cameras were located at 3.5m from the center of a 10m walkway to cover the volume required for at least one complete gait cycle of the right lower limb. A third camera was placed in front of the subject and aligned along the axis of progression. Reflective markers were located on the subject prior to the gait analysis according to the Vicon Clinical Manager<sup>a</sup> protocol. An AMTI<sup>b</sup> force plate (250 Hz) located in the middle of the walkway was synchronized to the cameras of the Vicon system.

Prior to data collection, the cameras were calibrated using 20 markers located within a calibration volume of 2.8m long by a 1.0m wide and 1.80m high. The subject was asked to walk at his natural speed and step with his right leg on the force plate before coming to a full stop five meters further on. A few practice trials were permitted before the gait data were collected. The subject performed at least five successful trials where both kinematic and kinetic informations were available. Since there were some variations in the walking speed of the elderly subjects, two trials were selected<sup>6</sup> for further analysis. Counting the trials of two population's (young and elderly) totaling 64 gait trials.

The three-dimensional coordinates were calculated and then filtered using the routines provided in the Vicon system software. The phasic and temporal gait parameters were obtained from video and force plate data. Speed, stride length, cadence and stance phase relative duration were selected because these parameters were reported to be modified in the gait of elderly men<sup>3,17</sup>. The three-dimensional joint reaction forces and net muscle moments were calculated by the Vicon Clinical Manager software. All the kinematic and kinetic data were normalized with respect to 100% of the gait cycle (GC) duration defined by two consecutive heel-strikes of the right lower limb.

The 3-D muscle powers were estimated by the product of the net muscle moment developed at each joint of the lower limb and for each plane, and the angular velocity calculated about each joint axis<sup>6,10,19</sup>. When the muscle moments and the corresponding angular velocities have the same polarity, the muscle power is positive and is considered to generate energy during a concentric contraction. When the polarities are different, then the muscle power is negative and it is assumed that energy is being absorbed in an eccentric contraction<sup>19</sup>. The muscle powers were normalized with respect to the individual body mass and labeled according to Eng and Winter<sup>10</sup>. For example, K3F corresponds to the third peak knee power developed in the frontal plane. In all, 27 3-D peak power values were identified for each subject and for each trial.

The principal objectives of this study were to determine if gait data are sufficient to distinguish the patterns observed in the young able-bodied subjects from those obtained in elderly healthy men, and if there was more than a single pattern in the elderly gait although neither the number nor the members of the family groups were known. To answer these objectives, a cluster analysis<sup>20</sup> was carried out using gait parameters only. Cluster analysis was successfully used by Vardaxis et al.<sup>6</sup> to classify gait patterns in healthy young adults and by Winters et al.<sup>21</sup> to categorize the diagnosis of patients with shoulder complaints.

A gait trial was defined by 31 discrete parameters consisting of the four phasic and temporal parameters and the 27 3-D peak power values. The hierarchical cluster method proposed by Ward<sup>20</sup> assigns the gait trials to clusters (families) in a step-wise fashion. It begins with as many clusters as there are trials, 64 in this study. Afterwards, these individual clusters are joined together to form new clusters and so on. The procedure ends by grouping all the trials in a single cluster, which forms a hierarchical tree called a dendrogram. The trials are first joined into clusters according to the degree of similarity among the 31 gait parameters of every trial. This is shown in Fig. 1 where trials are grouped by twos at different linkage distances. Though there are other methods available, the measurement of similarity was based on the Euclidean distance between the trials, which is the most commonly chosen type of distance calculation.

Clusters having different characteristics are distanced from each other. This distance was determined by the complete linkage method and is calculated using the greatest distance between any two trials in the different clusters. This method performs well in cases when the trials naturally form distinct families as was expected in this study. In Fig. 1, trial 1 and 2 (right side) are very much different from trials 59 and 60 (left side), always in terms of the effect of the combined 31 gait parameters. The optimum number of clusters can be determined in several ways. Winters et al.<sup>21</sup> calculated the criterion of Hartigan and the maximum value of the cubic clustering criterion while Vardaxis et al.<sup>6</sup> used the R ratio which is a measure of the reduction of the inner cluster variability. The R ratio was applied in this study to determine the number of meaningful gait families.

Once the number of optimal clusters or gait families was identified, univariate ANOVA tests were performed on each of the demographic parameters which were not considered in the cluster analysis and on the 31 dependent variables to determine which parameters best describe the gait patterns of the young and elderly subjects. This was followed by post hoc Tukey (HSD) for unequal N multiple comparison tests. The statistically significant differences ( $p < 0.05$ ) found were used to describe the patterns of the young and elderly gait families.

## RESULTS

The ascending hierarchical cluster method formed a tree-like structure (depicted in Fig. 1) outlining four main branches from bottom to top. The first division occurred at an Euclidean distance of 7.3 where 32 trials (33 to 64) formed a cluster. This first division separates those trials, which were much different from the single group. They represent a family of 16 young subjects, Y. This group could be subdivided into three groups, but the divisions within the family Y1 occurred too closely together to be able to distinguish them using the R ratio. Both trials of the same individual were

grouped together, with the exception of three subjects (trials 49-50, 51-52 and 53-54). Vardaxis et al.<sup>6</sup> reported a similar observation in their group of able-bodied subjects.

The second and third divisions occurred at an Euclidean distance of 8.7 and 13.7 respectively. They form one family of 10 trials, E1, and a smaller one, E2, of 6, all consisting of elderly men. Though all the trials of the E1 cluster were paired according to the subjects, this was not always observed in the E2 group. This reflects a variable pattern between the two trials of the same individual. The fourth family of 16 gait trials was made up exclusively of the eight elderly subjects, E3. All but two subjects did not have their trials grouped together (15-16 and 21-22).

The phasic and temporal gait parameters for the young and elderly groups and each family are given in Table 1. The data for the group of young able-bodied subjects fall within previously reported values<sup>6,22,23</sup>. Only the significant differences,  $p < 0.05$ , were reported. Generally, the group of elderly subjects were older ( $F = 401.74$ ), and slightly shorter (4.6% ;  $F = 15.82$ ) than the group of young men. Their walking speed was about 9.3% ( $F = 27.69$ ) slower due to a decrease in the stride length ( $F = 16.41$ ). The stance phase's relative duration was approximately 5% longer ( $F = 31.83$ ) in the healthy elderly men. The variability expressed by the standard deviation was always larger in the elderly group than in the young men. Similar observations have previously been reported elsewhere<sup>1,4,14,15,16</sup>.

The mean 3-D muscle power curves calculated for each joint of the healthy young men with their respective standard deviation are given in Fig. 2. The mean power curves for the three families of elderly subjects are also presented with the 27 peak powers used in this study. Sagittal plane data were within the values previously reported for able-bodied young and elderly subjects<sup>6,9,10,16</sup>. Out of 27 3-D peak muscle powers only eight were found to display significant differences between families. Though it was shown that limb length influenced muscle powers<sup>1</sup>, normalizing the peak power did not modify our findings. These findings are presented in Fig. 3 and 4. There are some slight discrepancies between the mean muscle power curves (Fig. 2) and the mean peak powers (Fig. 3 and 4). This stems from the fact that the individual peak values do not necessarily occur exactly at same the time in each individual trials and for each individual but rather within 1 to 3% time range. Thus, the values reported in figure 3 and 4 represent the peak power bursts taken from the individual trials and not from the mean curve. Half of the statistically significant peak muscle powers were related to the hip. Three peak powers were associated with the frontal plane and occurred at heel-strike (20% GC). In the transverse plane, the peak power (H3T) manifested itself in the midstance period (40% GC). The remaining four peak powers were related to the sagittal plane and happened between the push-off and the terminal swing periods.

Three gait patterns were found in the healthy elderly subjects. The first group of elderly subjects, E1, had the slowest walking speed (1.017 m/s) which was significantly different from all the other groups. This was attributed to a 16.7% decrease in stride length and a small but not significant decrease in cadence. This family had the most significant peak power differences with the other groups. This group of elderly subjects was the first to cluster itself with the healthy young men and displayed seven out of eight significant differences in the peak muscle powers as compared to the other three families. The E1 family usually had the lowest peak muscle power values. These lower values could be the result of the slower walking speed, as reported by Chen et al.<sup>8</sup> where speed influenced the sagittal plane hip and ankle muscle powers.

The second family of elderly men, E2, had a slow walking speed (1.260 m/s), but was not statistically different to that of the young men, due to a 6% reduction in cadence coupled with a slightly smaller stride length. The cluster analysis was able to differentiate this family from the others because of the temporal and phasic parameters, as well as for three peak powers higher than those of the E1 family.

The E3 was characterized by a walking speed, similar to the Y1 group. This was mainly achieved by a significant increase in cadence (6.5%) and a corresponding but not significant decrease in stride length. The E3 subjects usually had muscle powers values close to those of the Y1 subjects. These

differences were not found to be significant with the exception of the H2F peak power. However, the E3 family displayed six higher peak powers than those of the E1 family. In the dendrogram, this group was located at the opposite end from the young men's group and E1 family, and was the last to join the other clusters.

## DISCUSSION

The aim of this work was to distinguish the gait patterns of 16 able-bodied young and 16 elderly men from of a single group of 32 subjects. Phasic and temporal parameters and three-dimensional peak muscle powers were used in the classification process rather than age alone. The hierarchical cluster method proposed by Ward<sup>20</sup> was used successfully to this purpose. The young subjects were the first to form a cluster and dissociate themselves from the three elderly subjects' gait trials (Fig. 1).

The cluster analysis method is sensitive to variations in the gait trials, especially where reproducibility may be difficult to attain, particularly in the elderly subjects. The trials of a new subject may not be grouped together but rather located anywhere in the dendrogram, and at the same time adding new subjects can perturb the tree architecture making it totally useless. It is also possible that the trials of a young subject be located in one of the elderly subject's clusters. Inversely, the trials of an elderly individual could end up within the cluster of the young able-bodied subjects. This study was susceptible to this type of perturbation, even though our elderly subjects were relatively young and physically fit. Two additional subjects, one in each group, were not included in this study since they were unable to develop reproducible and consistent gait data between trials. This was mostly observed in the temporal gait parameters and in the sagittal peak muscle powers. The lack of reproducibility between these individual gait data was determined by the cluster analysis. This was based on the euclidean distances between these subject's own two trials. These trials were located far from each other. Including those two subjects with the present 32, led to a confused dendrogram where several young and elderly subjects were grouped indiscriminately.

As stated in the introduction, the second purpose of this study was to determine if elderly subjects displayed different gait patterns and identify among these gait parameters those, which best describe the gait of the young and elderly subjects. It was the combined effect of the 27 peak muscle powers and four phasic and temporal parameters that enabled the classification of the elderly gait families and allowed us to distinguish them from the young men. Three families of elderly men were identified by means of the R ratio<sup>6,24</sup> following cluster analysis.

The phasic and temporal gait parameters were recognized as important in this study as well as in others<sup>1,3,15,16,25</sup>. The variability expressed by the standard deviation in the temporal and phasic parameters was always larger in the elderly group than in the young men. This could emphasize the possibilities of different families of elderly gaits. Taken alone, these parameters can be misleading due to their interdependence. This explains, in part, the conflicting results reported in the literature on the walking patterns of the elderly. One of the major findings of this study was to explain the reported contradictory observations related to the phasic and temporal gait parameters according to the three families of elderly men.

The E1 family had the slowest speed because of a reduction in stride length. In fact, our whole group of 16 elderly subjects can be classified as having slow speed due to reduced stride length. Judge<sup>1</sup> and Kerrigan et al.<sup>15</sup> previously described elderly gait as such. Nonetheless, others<sup>26,27</sup> have attributed reduced walking speed to a decrease in cadence. The cluster analysis revealed that our E2 family displayed this characteristic. Finally, the E3 family developed the same walking speed as the young men by increasing their cadence. Blanke and Hageman<sup>4</sup> found a 6% increase in walking speed in a group of 12 elderly men aged between 60 and 74 years who had a short stride length. From these observations, one can only conclude that the cadence of the elderly men was much higher than that of the young men's group, as was the case in this study. Thus, we can not generalize that elderly subjects aged between 60 and 70 years have a slower walking speed and a shorter stride length. We need to associate the temporal and phasic gait parameters to their different able-bodied walking patterns.

In previous studies, muscle powers have been used to describe the dynamic walking pattern in healthy elderly men. Some of these performed a planar (2-D) analysis<sup>16</sup> while others followed a three-dimensional gait analysis protocol<sup>1,15</sup>. Nonetheless, only sagittal plane muscle powers were reported. In this study, four out of the eight significant peak powers occurred in the sagittal plane, and half of them at the hip, which supports in part the previous studies<sup>1,15,16</sup>. These peak powers were distributed throughout the whole gait cycle. It appears that the plane in which these eight statistically significant powers occurred was related to their occurrence in the gait cycle. Shortly after heel-strike, the frontal plane peak powers were associated with the control needed for body weight transfer. During midstance, a transverse plane peak power occurred which stabilized the support during single limb balance. From push-off to terminal swing, the sagittal plane peak powers were required for progression and control in the forward direction.

Generally, the A1F, K2F and H2F frontal peak powers reflect the energy generated between the 10% and 25% mark on the gait cycle. These three peak powers are respectively associated with a hip and knee abduction moment and an ankle eversion moment. They counterbalance the frontal plane displacement of the center of mass towards the supporting limb. These peak powers have not been well documented before in the literature.

In this study, at the hip, the H2F was higher for the elderly families, with the E3 group having the highest value ( $0.585 \pm 0.432$  W/kg). According to Eng and Winter<sup>10</sup> and MacKinnon and Winter<sup>28</sup>, H2F activity was attributed to the raising of the pelvis and trunk to its neutral position. We hypothesize that the elderly subjects were mostly concerned with achieving a stable base of support by a controlling hip action. This was less marked in the slowest E1 group ( $0.231 \pm 0.202$  W/kg). The knee K2F values were less than that of the young adults with the exception of the E2 group ( $0.581 \pm 0.565$  W/kg). The K2F power generation was associated with a knee abduction moment which can act with the pelvis H2F abduction. The highest K2F value could reflect a greater frontal stability in developing the largest stride length of the elderly groups. Only the E1 family displayed a higher absorption of the A1F ( $-0.107 \pm 0.109$  W/kg) due to an adduction ankle moment. The A1F power generation can be considered as a reaction to the knee abduction. It appeared that the subjects of E1 family were passively controlling the body-weight transfer, whereas the subjects in the E2 and E3 families were actively contributing by generating the A1F. The control subject had also a low A1F peak power absorption ( $-0.005 \pm 0.032$  W/kg).

During midstance, both young and elderly subjects developed a positive H3T peak power associated with an active thigh internal rotation moment which occurred late in midstance. The H3T was assumed to be related to body-weight transfer on the contralateral limb in preparation to the subsequent heel-strike by propelling the body forward. The E1 family had the highest, significantly different H3T ( $0.320 \pm 0.372$  W/kg). As a result, normal cadence could be maintained. The E3 family, which had the highest cadence, did not increase its H3T because other power strategies were available.

In late midstance, the H2S muscle power absorption peak is responsible for the deceleration of the thigh extension<sup>10</sup>. The H2S peak powers in the E1 ( $-0.525 \pm 0.519$  W/kg) and E2 ( $-0.818 \pm 0.278$  W/kg) families were less than that of the Y1 group. The subjects in the E3 family developed a higher ( $-1.288 \pm 0.700$  W/kg), but not significantly different H2S from that of the Y1 family ( $-1.01 \pm 0.308$  W/kg). Only the H3S of the E3 family was statistically different from that of the E1 group. We postulate that a reduction in the H2S can be associated with a shorter stride length, resulting in a slower walking speed as observed in the E1 and E2 families. A reduction in the H2S could also be attributed to trunk forward inclination as commonly observed in the elderly population<sup>29</sup>.

At push-off, the H3S activity was associated with propulsion in healthy young men<sup>6,30</sup>. It has been shown that the hip pulling action (H3S) contributes actively to push-off in the gait of elderly subjects<sup>1</sup>. We speculate that the subjects of the E3 family developed the highest H3S muscle power ( $1.930 \pm 0.811$  W/kg) to increase their cadence and maintain a walking speed similar to that of the

young men's group. Though lower H3S values were observed in other elderly subjects, there was only a significant difference between the E1 ( $0.962 \pm 0.598$  W/kg) family, which had the slowest walking speed, and the E3 group.

A lower ankle peak power has been observed in the gait of healthy elderly subjects during push-off<sup>1,15,16</sup>. The ankle peak power (A2S) responsible for push-off has been found to explain more than 52% of the step length variance<sup>1</sup>. A comparable value (64%) was found in this study. Interestingly, the E3 family compensated for a reduction in the A2S peak power ( $2.810 \pm 0.589$  W/kg) by an increase in the hip pulling action (H3S). The members of the other two elderly families were not able to compensate for a low A2S, which resulted in a slower walking speed. This was more pronounced in the E1 family where the slowest values were observed for the walking speed as well as for the A2S ( $1.869 \pm 0.867$  W/kg) and the H3S peak powers. Though the E2 family developed a slightly higher A2S ( $2.914 \pm 0.544$  W/kg) among the elderly families, it was insufficient to compensate for their low H3S value.

The last peak power that was observed to be lower in the gait of healthy elderly subjects was related to the knee (K4S). The K4S peak power controls the lower limb's forward projection in preparation for the following heel-strike. A higher knee generation at push-off (K3S) and a decrease in the knee absorption (K4S) has been reported during late swing in a group of elderly men<sup>16</sup>. A reduction in the K4S, also observed in this study, may help increase the stride length, but at the cost of a higher horizontal speed of the foot which causes stumbling. Though this could be applicable to all three elderly families, the E1 ( $-0.573 \pm 0.386$  W/kg) had the largest reduction (54%) compared to the young men group ( $-1.250 \pm 0.432$  W/kg).

Considering the major involvement of the hip muscle powers in the three families of the healthy elderly subjects, our findings support Kerrigan et al.<sup>15</sup> proposition that a stretching exercise program would improve walking performance. They<sup>15</sup> also proposed that reduced plantar flexion may not be representative of an impairment but rather of a strategy to preserve balance during walking. We postulate that this observation could be extended to the muscle power patterns in the elderly. This may explain why the elderly subjects, particularly the E1 family, had as a gait strategy a slow walking speed, a short stride length and a long stance phase duration. Low peak ankle power (A2S) and hip pulling action (H3S) at push-off may lessen forward propulsion and result in a short stride length and a slow walking speed. Having low muscle powers at push-off may require less knee control in the limb's forward projection as shown by the K4S power burst which can lead to a faster foot speed and increasing the risk of falling.

In summary, the muscle powers in elderly subjects are perturbed throughout the gait cycle and not only at push-off. These gait adaptations are important to recognize in assessing elderly subjects as they could falsely be attributed to age-related pathologies<sup>1,16</sup> and not to age alone. This paper highlights different healthy elderly gait families classified according to their own phasic and temporal parameters and muscle power characteristics. The E1 family was characterized by a slow walking speed due in greater part to a short stride length. These subjects needed more internal rotation (H3T), less hip extension deceleration (H2S) during midstance and less knee absorption (K4S) at the end of the swing phase to compensate for their small stride length. The E2 family had also a slow walking speed, though it resulted from a decrease in cadence. Stride length was possibly maintained by a large abduction activity (K2F). Though the strongest push-off (A2S) was reported in the elderly families, it was insufficient to compensate the weak hip pulling action (H3S). The E3 family was able to maintain a walking speed similar to the young subjects by an exaggerated cadence. This led to a greater need for frontal hip stability (H2F) shortly after heel-strike and a high ankle push-off (A2S) combined with an active hip pulling action (H3S). These families must not be confused or interpreted as part of some age-related pathology but rather as natural adaptations or compensations in the diversified evolution of able-bodied gait.

The walking patterns in elderly subjects were found to be different from those of the young adults by means of hierarchical cluster analysis based on biomechanical parameters rather than using age alone

as a grouping factor. Four phasic and temporal gait parameters as well as 27 three-dimensional peak powers for each individual trial were used in the classification process, rather than taking a single gait parameter at a time to determine the three families of elderly subjects. Cluster analysis enabled group comparison of young men and elderly subjects while allowing the characterization of individual performances. Significant differences between the three elderly families were found in the phasic and temporal gait parameters as well as in eight peak muscle powers. Five peak powers, namely H2S, and four frontal and transverse plane powers were identified for the first time due to the clustering of gait patterns, and complete in part the dynamic description of elderly gait. The muscle powers in elderly subjects were perturbed throughout the gait cycle and not only at push-off. It appears that the plane in which they occurred was related their occurrence in the gait cycle.

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## SUPPLIERS

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<sup>b</sup>AMTI, Newton, MA, USA

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- Fig. 2 Ankle, knee and hip muscle power curves developed in the a) sagittal, b) frontal and c) transverse planes by the Y1, E1, E2 and E3 families over which the standard deviation of the Y1 family is overlaid in bold.
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- Table 1: Mean values of the demographic information and of the phasic and temporal gait parameters of the young able-bodied subjects and healthy elderly men. The standard deviation is expressed in parenthesis.

Table 1: Mean values of the demographic information and of the phasic and temporal gait parameters of the young able-bodied subjects and healthy elderly men. The standard deviation is expressed in parenthesis.

|                    | Young Subjects (Y1)             | Elderly Subjects (all)        | Family E1                     | Family E2                     | Family E3                     |
|--------------------|---------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Number of subjects | 16                              | 16                            | 5                             | 3                             | 8                             |
| Number of trials   | 32                              | 32                            | 10                            | 6                             | 16                            |
| Age (years)        | 28.04 <sup>a,b</sup><br>(3.60)  | 61.73 <sup>a</sup><br>(3.81)  | 61.14 <sup>b</sup><br>(5.21)  | 64.33 <sup>b</sup><br>(1.86)  | 61.12 <sup>b</sup><br>(3.03)  |
| Height (m)         | 1.817 <sup>a,b</sup><br>(0.045) | 1.734 <sup>a</sup><br>(0.046) | 1.706 <sup>b</sup><br>(0.019) | 1.722 <sup>b</sup><br>(0.067) | 1.756 <sup>b</sup><br>(0.038) |
| Weight (kg)        | 80.23<br>(6.25)                 | 78.41<br>(8.36)               | 78.42<br>(11.13)              | 76.17<br>(3.17)               | 78.25<br>(7.92)               |
| Speed (m/s)        | 1.348 <sup>a,c</sup><br>(0.097) | 1.222 <sup>a</sup><br>(0.189) | 1.017 <sup>c</sup><br>(0.100) | 1.260 <sup>c</sup><br>(0.056) | 1.335 <sup>c</sup><br>(0.132) |
| Cadence (step/min) | 110.70 <sup>a,d</sup><br>(1.83) | 112.92 <sup>a</sup><br>(5.87) | 110.41 <sup>d</sup><br>(1.33) | 103.74 <sup>d</sup><br>(1.77) | 117.93 <sup>d</sup><br>(2.09) |
| Stride length (m)  | 1.458 <sup>a,c</sup><br>(0.099) | 1.334 <sup>a</sup><br>(0.131) | 1.214 <sup>c</sup><br>(0.037) | 1.453 <sup>c</sup><br>(0.054) | 1.364 <sup>c</sup><br>(0.133) |
| Stance phase (%)   | 59.90 <sup>a,b</sup><br>(0.87)  | 63.03 <sup>a</sup><br>(1.84)  | 64.15 <sup>b</sup><br>(0.90)  | 62.43 <sup>b</sup><br>(1.65)  | 62.56 <sup>b</sup><br>(2.09)  |

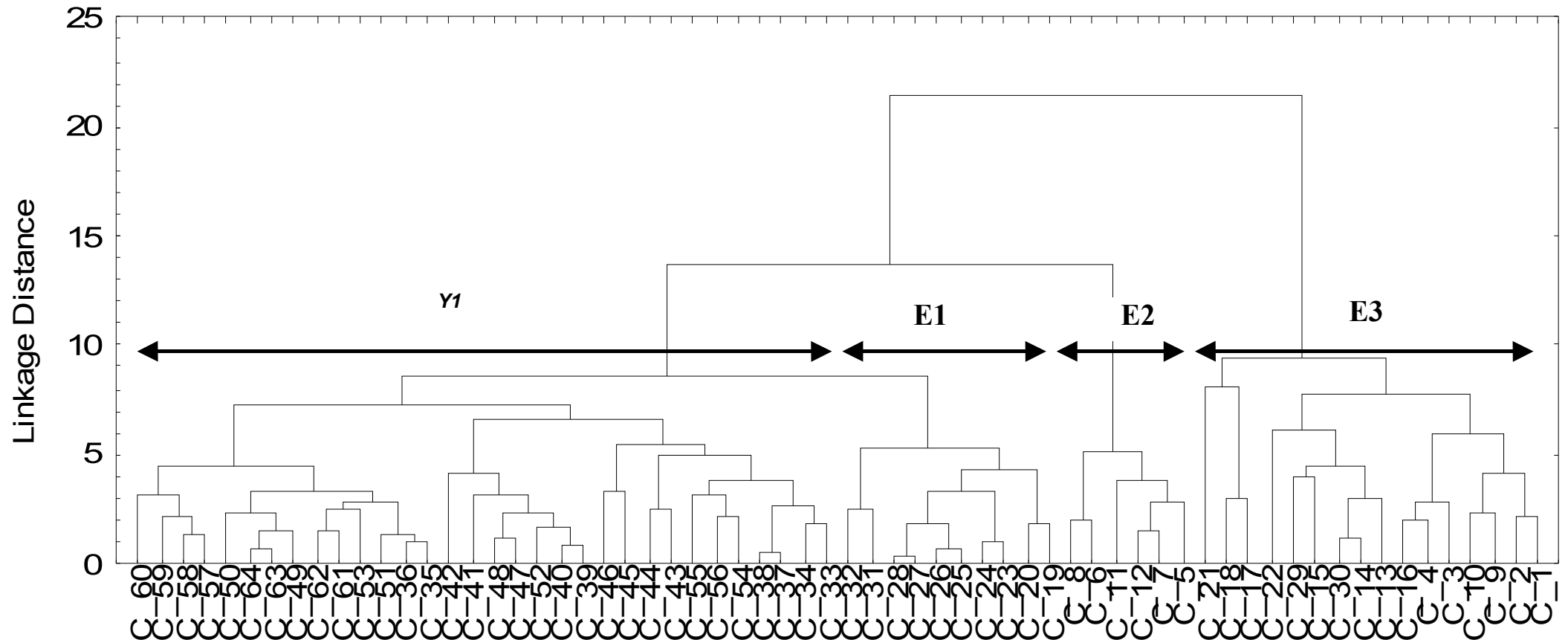
a,  $p < 0.05$ , between Y1 and all elderly subjects

b,  $p < 0.05$ , between Y1 and E1, E2 and E3

c,  $p < 0.05$ , between E1 and Y, E2 and E3

d,  $p < 0.05$ , between E1 and Y1, E2 and E3; between Y1 and E2; between E2 and E3

Fig. 1 Dendrogram representing the minimum variance hierarchical classification of the gait patterns of healthy young and elderly men. Four groups (families) are labeled Y1 for the young men's family, and E1 to E3 for the three elderly men families. The figure is read from the bottom where the individual trials are listed, in four families, to top where all the gait trials are grouped into a single family.





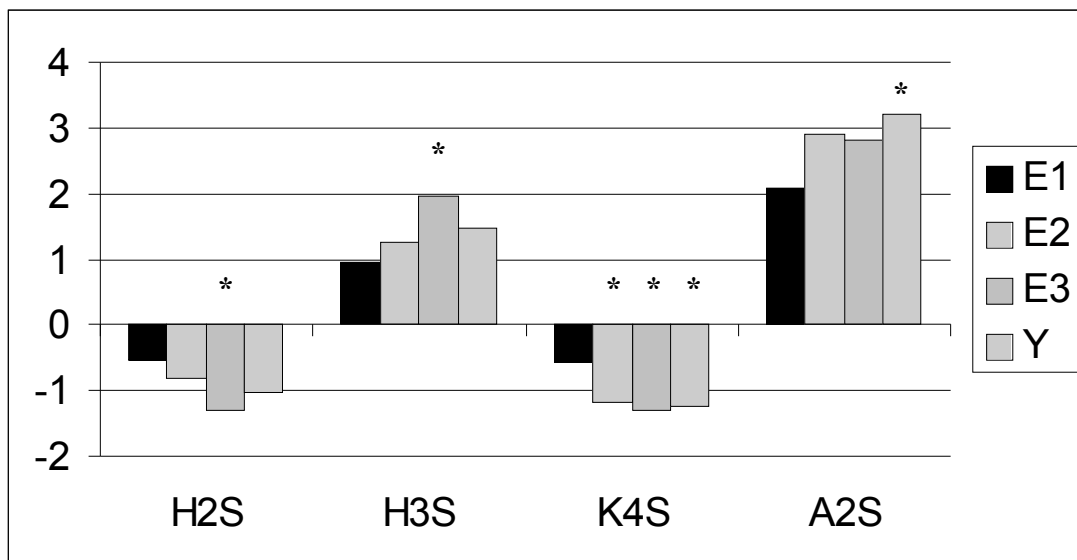


Fig. 3: Peak muscle powers found statistically different across all or some gait families by a one-way ANOVAs on the sagittal plane for the hip, knee and ankle and where \* denote a statistical difference ( $p < 0.05$ ) between E1 and other families.

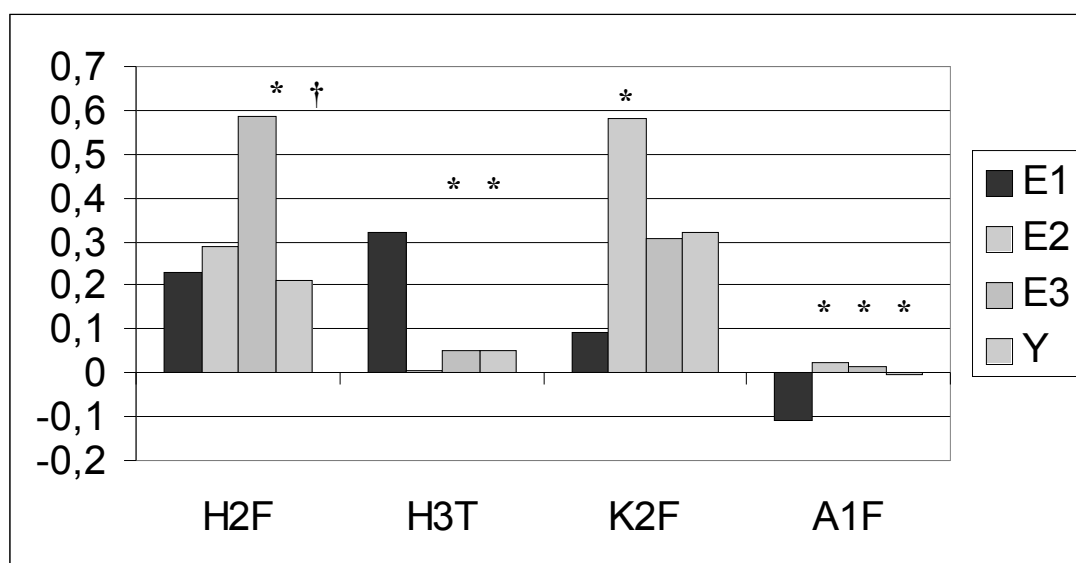


Fig. 4: Peak muscle powers found statistically different across all or some gait families by a one-way ANOVAs on the frontal and transverse planes for the hip, knee and ankle and where \* denote a statistical difference ( $p < 0.05$ ) between E1 and other families and † denote a statistical difference ( $p < 0.05$ ) between E3 and Y1.

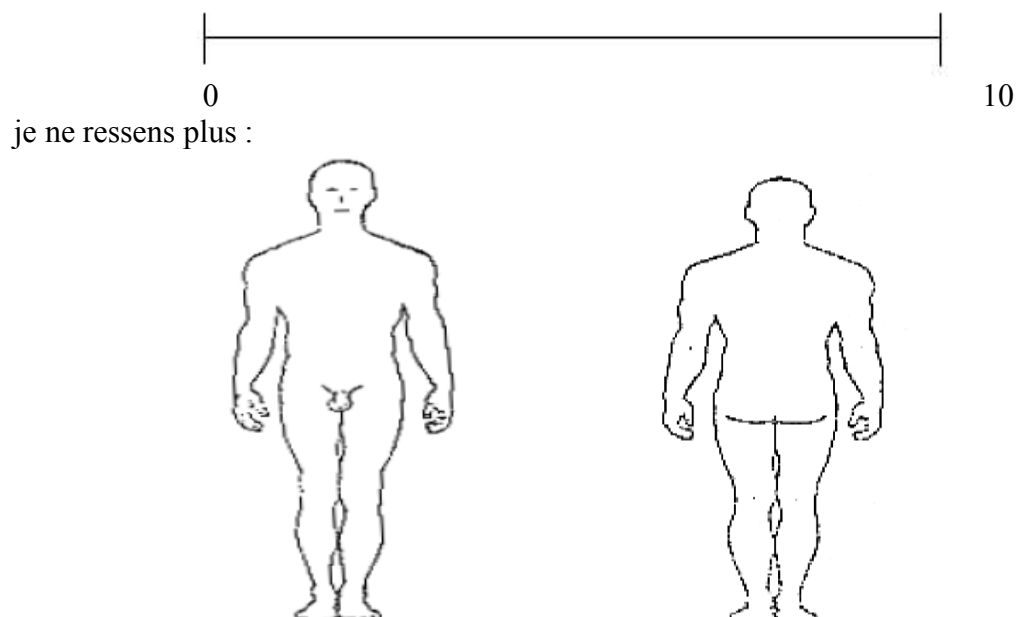


**Annexe IV.1.****Questionnaire d'Analyse du Ressenti de la marche**

1> Aujourd'hui, lorsque vous marchez ressentez-vous vos membres ? avez-vous des sensations, savez-vous où ils se trouvent ?  
(SENSIBILITE)

Je ressens parfaitement mes segments...  
Je sais exactement où ils sont sans les regarder...  
Je ressens de suite le sol lorsque mon pied le touche...

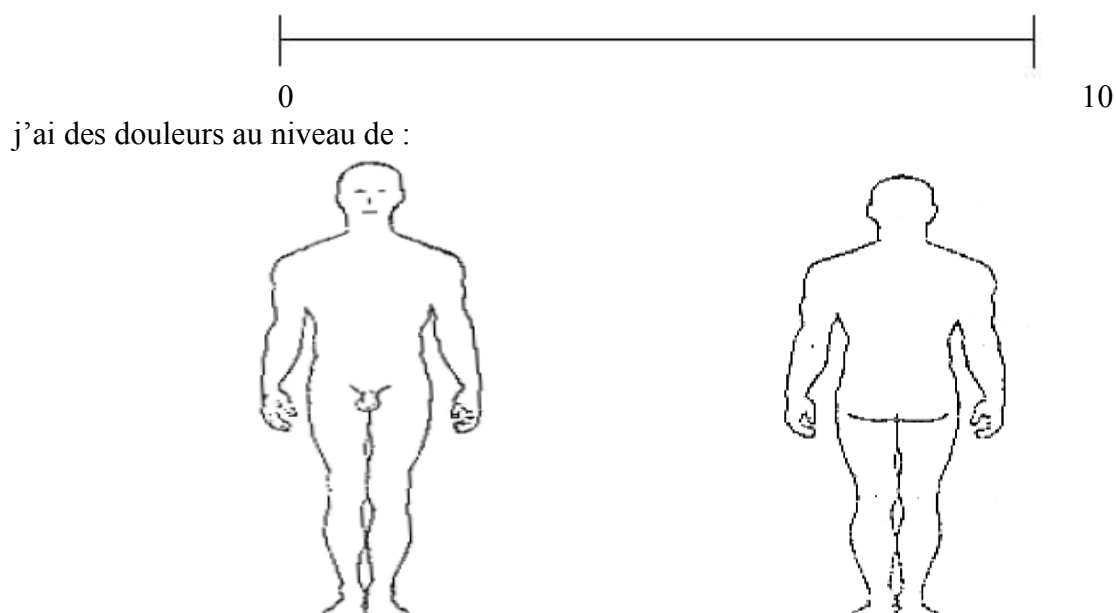
Je ne ressens plus du tout mes segments.  
Je ne sais pas du tout où ils se situent dans l'espace.  
Je ne ressens pas le sol lorsque mon pied le touche.



2> Aujourd'hui, lorsque vous marchez avez-vous ressenti des douleurs ? avez-vous mal quelque part ?  
(DOULEUR)

Je n'ai aucune douleur lorsque je marche  
Aucune souffrance localisée

La marche est très douloureuse.  
A cause de la douleur je marche le moins possible.



3> Aujourd'hui, lorsque vous avez marché quel a été votre sentiment : (PHOBIE)

|                                              |                            |
|----------------------------------------------|----------------------------|
| J'ai peur de marcher,                        | J'ai tout à fait confiance |
| La marche est angoissante,                   | Je suis totalement rassuré |
| J'appréhende toujours d'avoir à me déplacer. | Je n'ai aucune inquiétude. |



4> Marcher jusqu'à l'objet a été pour vous :

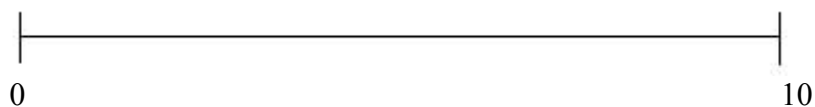
(FACILITE)

|                                     |                   |
|-------------------------------------|-------------------|
| Difficile, pénible, ardu,           | Très facile,      |
| Si contraignant que je n'aurais pas | Aucune difficulté |
| pu marcher plus longtemps.          | Très simple.      |



5> Aujourd'hui, votre marche vous demande-t-elle : (DEMANDE ATTENTIONNELLE)

|                                            |                                                   |
|--------------------------------------------|---------------------------------------------------|
| Enormément d'attention                     | La marche est automatique                         |
| Enormément de concentration                | Elle ne nécessite aucune attention                |
| De réflexion, cela fatigue nerveusement... | Je pourrais faire du calcul mental en marchant... |



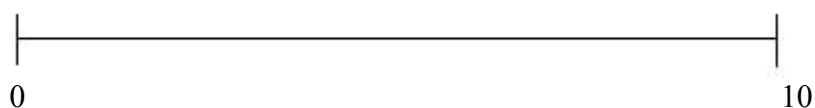
6> Aujourd'hui, lorsque vous avez marché avez vous l'impression d'avoir : (EQUILIBRE)

|                                                 |                                                |
|-------------------------------------------------|------------------------------------------------|
| Beaucoup d'équilibre                            | Des vertiges                                   |
| Aucune sensation de vertige                     | Des perturbations de l'équilibre qui sont à la |
| Jamais besoin de contrebalancer un déséquilibre | limite de vous empêcher de marcher             |
| En levant les bras sur les côtés par exemple.   | Une très mauvaise stabilité.                   |



7> Aller jusqu'à la table et revenir vous asseoir a été : (FATIGUE)

|                                          |                                           |
|------------------------------------------|-------------------------------------------|
| Fatigant, éreintant, épuisant            | C'était très facile                       |
| Très dur physiquement                    | J'aurais pu le faire 15 fois sans arrêter |
| Si fatigant que vous n'auriez pas pu     | Je ne suis absolument pas fatigué.        |
| marcher beaucoup plus sans vous arrêter. |                                           |



8> D'une manière générale la marche est pour vous quelque chose de : (PLAISIR)

Agréable, plaisant

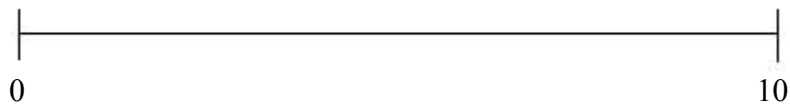
Désagréable, rebutant

Marcher est un plaisir

Ennuyeux, de suite lassant

Vous marchez parfois sans but précis.

Je ne marche que par nécessité absolue.



9> Selon vous qu'est ce qui pourrait améliorer votre marche ?

10> Selon vous qu'est ce qui limite le plus votre marche, qu'est ce qui vous empêche le plus de marcher comme avant ?

Nom :

Prénom :

Date :

Heure :

Age :