



HAL
open science

Weight-bearing asymmetry: recovery or not?

Ophélie Folmer

► **To cite this version:**

Ophélie Folmer. Weight-bearing asymmetry: recovery or not?. Human health and pathology. 2021. dumas-03629370

HAL Id: dumas-03629370

<https://dumas.ccsd.cnrs.fr/dumas-03629370v1>

Submitted on 4 Apr 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

AVERTISSEMENT

Ce document est le fruit d'un long travail approuvé par le jury de soutenance.

La propriété intellectuelle du document reste entièrement celle du ou des auteurs. Les utilisateurs doivent respecter le droit d'auteur selon la législation en vigueur, et sont soumis aux règles habituelles du bon usage, comme pour les publications sur papier : respect des travaux originaux, citation, interdiction du pillage intellectuel, etc.

Il est mis à disposition de toute personne intéressée par l'intermédiaire de [l'archive ouverte DUMAS](#) (Dépôt Universitaire de Mémoires Après Soutenance).

Si vous désirez contacter son ou ses auteurs, nous vous invitons à consulter en ligne les annuaires de l'ordre des médecins, des pharmaciens et des sages-femmes.

Contact à la Bibliothèque universitaire de Médecine Pharmacie de Grenoble :

bump-theses@univ-grenoble-alpes.fr

Année : 2021

WEIGHT-BEARING ASYMMETRY: RECOVERY OR NOT?

THÈSE
PRÉSENTÉE POUR L'OBTENTION DU TITRE DE DOCTEUR EN MÉDECINE
DIPLOME D'ÉTAT

Ophélie FOLMER

[Données caractère personnel]

THÈSE SOUTENUE PUBLIQUEMENT À LA FACULTÉ DE MÉDECINE DE GRENOBLE

Le : 02/04/2021

DEVANT LE JURY COMPOSÉ DE

Président du jury :

Monsieur le Professeur Dominic PERENNOU, PUPH Institut de Rééducation CHU Grenoble Alpes

Membres :

Madame le Professeur Monica BACIU

Monsieur le Professeur Marc HOMMEL

Monsieur le Maître de Conférence David GASQ

Madame le Docteur Anne CHRISPIN

L'UFR de Médecine de Grenoble n'entend donner aucune approbation ni improbation aux opinions émises dans les thèses ; ces opinions sont considérées comme propres à leurs auteurs.

RESUME

Objectifs. L'évolution de l'asymétrie d'appui après accident vasculaire cérébral (AVC) est peu décrite dans la littérature. Nos objectifs sont d'analyser l'évolution de la répartition des appuis à la phase subaiguë d'un AVC et d'explorer la relation entre la récupération des capacités d'équilibre, évaluées par l'échelle PASS (Postural Assessment Scale for Stroke) et l'amélioration de l'asymétrie d'appui.

Méthode. Cohorte de 31 patients admis en rééducation après un premier AVC hémisphérique. La répartition des appuis et l'instabilité ont été mesurées à deux reprises grâce à deux plateformes de force. L'asymétrie d'appui était diagnostiquée quand le côté parétique était chargé à moins de 41% ou plus de 59% du poids du corps. Les déficits cliniques et les scores fonctionnels de mobilité ont également été évalués. Une forte récupération de l'asymétrie d'appui a été définie comme une amélioration supérieure au changement minimal détectable (MDC) qui est de 5%. Nous avons comparé les caractéristiques entre les patients qui récupèrent fortement leur asymétrie d'appui, et ceux qui ne récupèrent pas ou peu.

Résultats. La première évaluation a été réalisée après une période post-AVC médiane de 41 (32;70) jours et la deuxième après 82 (59;95) jours. La répartition des appuis était significativement plus symétrique à la deuxième session (6.8 à 4.1% du poids du corps ; $p=0.040$). Selon notre critère de symétrie, 10/31 patients ont été considérés comme asymétriques (9 patients déchargent et 1 surcharge le côté parétique). Parmi eux, l'amélioration de l'asymétrie d'appui était significative ($p=0.004$) et hautement corrélée à la récupération des capacités d'équilibre ($R=-0.81$; $p=0.005$). Quel que soit le type d'asymétrie d'appui, 4/10 (40%) patients ont présenté une forte récupération de leur asymétrie (amélioration médiane de 11.3% du poids du corps). Ils présentaient des déficits initiaux plus sévères, notamment concernant la force motrice du membre inférieur parétique ($p=0.019$).

Conclusion. La répartition des appuis devient plus symétrique avec le temps parmi des patients hospitalisés en rééducation à la phase subaigüe d'un AVC. Une forte récupération de l'asymétrie d'appui est particulièrement retrouvée chez les patients qui présentent des déficits initiaux sévères, qui ont donc une plus grande marge de progression. Cette récupération de l'asymétrie d'appui est fortement associée à une amélioration des capacités d'équilibre, évaluées par l'échelle PASS. Cela suggère que la récupération d'une symétrie d'appui est nécessaire pour améliorer l'équilibre. Ces résultats renforcent l'importance d'une rééducation spécifique de l'asymétrie d'appui après AVC.

Mots clés : AVC, posturographie, équilibre, contrôle postural, asymétrie d'appui, récupération

ABSTRACT

Objectives. Little is known about the evolution of the weight-bearing asymmetry (WBA) after stroke. Our objectives were to describe and analyze the evolution of the weight bearing distribution in the subacute phase after stroke, and to explore the relationship between the recovery of balance ability in daily life, assessed by the Postural Assessment Scale for Stroke (PASS), and the recovery of WBA.

Methods. Cohort study of 31 individuals admitted to rehabilitation after a first hemispheric stroke. Weight-bearing distribution and instability were measured twice with a dual force platform, with vision. Clinical deficits and functional abilities were also assessed. WBA was diagnosed when the paretic leg was under-loaded less than 41% of body weight or over-loaded more than 59% of body weight. Strong WBA recovery was defined as an improvement greater than the Minimal Detectable Change (5%). We compared the characteristics between the individuals who showed a strong recovery of WBA and those who didn't.

Results. The first assessment was performed at a median time of 41 (32;70) days post-stroke and the second assessment 82 (59;95) days post-stroke. Weight-bearing distribution was more symmetric at the second assessment (from 6.8 to 4.1% of body weight; $p=0.040$). According to our threshold criteria, 10/31 (32%) patients were considered asymmetric (9 under-loading and 1 over-loading the paretic leg). Among them, the recovery of WBA was significant ($p=0.004$) and was highly correlated to balance recovery ($R=-0.81$; $p=0.005$). Whatever the WBA type, 4/10 (40%) showed a strong WBA recovery (median improvement of 11.3% of body weight). They presented more severe deficits at first assessment, especially regarding the lower limb motor command ($p=0.019$).

Conclusion. Weight-bearing distribution becomes more symmetric among patients in the subacute phase post stroke during their inpatient rehabilitation. A strong WBA recovery was found especially among individuals who had a more severe initial profile, so a wider potential for

improvement. The recovery of balance and WBA are closely associated. This suggests that a recovery of weight-bearing asymmetry is needed to improve balance in daily life. This finding strengthens the relevance of a specific WBA rehabilitation.

Key words: stroke, posturography, postural control, balance, weight-bearing asymmetry, recovery

Mes très sincères remerciements

Au Professeur Dominic Pérennou, pour son encadrement tout au long de cette thèse ainsi que pour son aide précieuse et son soutien dans mes projets.

Aux Professeurs Monica Baci, Marc Hommel, David Gasq et au Docteur Anne Chrispin, pour avoir très gentiment accepté d'être membres de mon jury de thèse.

A Louis, Céline, Adèle, Emmanuelle Clarac et à ceux que j'oublie et qui ont participé à l'élaboration de la base de données à l'origine de ce projet.

A tous les médecins qui m'ont formée pendant mon internat. Je pense particulièrement aux Docteurs Delphine Lamotte, Sylvie Cantalloube, Jean-François Grange, Stanislas Giroux, pour m'avoir donné goût à la rééducation neurologique ; au Dr Patrice Davoine pour m'avoir initiée aux injections de toxine ; à Karine et Victor pour ce joyeux semestre d'été en rééducation orthopédique ; à l'équipe médicale de l'unité neuro-vasculaire à Chambéry, pour m'avoir gentiment recueillie dans ce contexte si particulier ; aux Docteurs Françoise Laloua, Nathalie Guihard, Marie-Adeline Siegerth, Brahim Anajjar pour votre présence et vos encouragements pendant ce dernier semestre.

Aux infirmières, aides-soignantes, aux rééducateurs, kiné, ergo, APA, psychomot, ortho, neuropsych, aux secrétaires, aux assistantes sociales... qui m'ont beaucoup appris (et ont encore beaucoup à m'apprendre !) et avec qui c'est un plaisir de travailler tous les jours.

A mes co-internes et anciens co-internes. Je pense en particulier à Adélo pour sa présence rassurante et son énergie débordante, au Professeur Jean pour sa bonne humeur constante et son incroyable gentillesse. Rien ne s'est passé comme prévu mais on a tenu le choc ! Je remercie également Rémi pour son accueil si chaleureux dans le monde de la MPR, ainsi que David et sa force tranquille qui m'apaise.

Je ne cite pas le reste des internes de MPR, mais j'ai hâte que les MPbières reprennent !

A mes amis de plus ou moins longue date. A Manon, Jordan et Marie, qui ont ensoleillé mon adolescence. A Sarah et Camille, pour ces riches années d'études nancéennes remplies

d'aventures. A Cécile, pour son accueil chaleureux en plein master. A Lucie, Liza et Sushi, pour ces 6 mois de joyeuse colocation. A Jojo et Adélie, que je languis de revoir.

A ma belle-famille, pour leur générosité et leur soutien.

A ma mère, toujours là pour moi. A mon père, que j'espère rendre fier. A ma sœur, et ses multiples talents qui m'agaçaient autrefois, et qui m'inspirent aujourd'hui.

A Raphaël, pour m'avoir soutenue, écoutée, chouchoutée, divertie, ... pendant ces longs mois de travail. Le meilleur reste à venir !

A tous mes patients, pour leur sympathie et leur confiance, qui me confortent tous les jours dans ce choix de spécialité qu'est la médecine de rééducation.

Doyen de la Faculté : Pr. Patrice MORAND

Année 2020-2021

ENSEIGNANTS DE L'UFR DE MEDECINE

CORPS	NOM-PRENOM	Discipline universitaire
PU-PH	ALBALADEJO Pierre	Anesthésiologie-réanimation et médecine péri-opératoire
PU-PH	APTEL Florent	Ophthalmologie
PU-PH	ARVIEUX-BARTHELEMY Catherine	Chirurgie viscérale et digestive
PU-PH	BAILLET Athan	Rhumatologie
PU-PH	BARONE-ROCHETTE Gilles	Cardiologie
PU-PH	BAYAT Sam	Physiologie
MCF Ass.MG	BENDAMENE Farouk	Médecine Générale
PU-PH	BENHAMOU Pierre-Yves	Endocrinologie, diabète et maladies métaboliques
PU-PH	BERGER François	Biologie cellulaire
MCU-PH	BIDART-COUTTON Marie	Biologie cellulaire
PU-PH	BLAISE Sophie	Chirurgie vasculaire ; médecine vasculaire
PR Ass. Méd.	BOILLOT Bernard	
MCU-PH	BOISSET Sandrine	Bactériologie-virologie ; Hygiène hospitalière
PU-PH	BONAZ Bruno	Gastroentérologie ; hépatologie ; addictologie
PU-PH	BONNETERRE Vincent	Médecine et santé au travail
PU-PH	BOREL Anne-Laure	Nutrition
PU-PH	BOSSON Jean-Luc	Biostatistiques, informatique médicale et technologies de communication
MCU-PH	BOTTARI Serge	Biologie cellulaire
PR Ass.MG	BOUCHAUD Jacques	Médecine Générale
PU-PH	BOUGEROL Thierry	Psychiatrie d'adultes
PU-PH	BOUILLET Laurence	Médecine interne ; gériatrie et biologie du vieillissement ; addictologie
MCU-PH	BOUSSAT Bastien	Epidémiologie, économie de la santé et prévention
PU-PH	BOUZAT Pierre	Anesthésiologie-réanimation et médecine péri-opératoire
PU-PH émérite	BRAMBILLA Christian	Pneumologie
PU-PH émérite	BRAMBILLA Elisabeth	Anatomie et cytologie pathologiques
MCU-PH	BRENIER-PINCHART Marie Pierre	Parasitologie et mycologie
PU-PH	BRICAULT Ivan	Radiologie et imagerie médicale
PU-PH	BRICHON Pierre-Yves	Chirurgie thoracique et cardiovasculaire
MCU-PH	BRIOT Raphaël	Thérapeutique-médecine de la douleur ; Addictologie
PU-PH émérite	CAHN Jean-Yves	Hématologie
PU-PH émérite	CARPENTIER Patrick	Chirurgie vasculaire, médecine vasculaire
PR Ass.MG	CARRILLO Yannick	Médecine Générale
PU-PH	CESBRON Jean-Yves	Immunologie
PU-PH	CHABARDES Stephan	Neurochirurgie
PU-PH	CHABRE Olivier	Endocrinologie, diabète et maladies métaboliques
PU-PH	CHAFFANJON Philippe	Anatomie
MCF Ass.MG	CHAMBOREDON Benoît	Médecine Générale
PU-PH	CHARLES Julie	Dermato-vénérologie
MCF Ass.MG	CHAVUET Marion	Médecine Générale
PU-PH	CHAVANON Olivier	Chirurgie thoracique et cardiovasculaire

CORPS	NOM-PRENOM	Discipline universitaire
PU-PH	CHIQUET Christophe	Ophthalmologie
PU-PH	CHIRICA Mircea	Chirurgie viscérale et digestive
PU-PH	CINQUIN Philippe	Biostatistiques, informatique médicale et technologies de communication
MCU-PH	CLAVARINO Giovanna	Immunologie
PU-PH	COHEN Olivier	Histologie, embryologie et cytogénétique
PU-PH	COURVOISIER Aurélien	Chirurgie infantile
PU-PH	COUTTON Charles	Génétique
PU-PH	COUTURIER Pascal	Médecine interne ; gériatrie et biologie du vieillissement ; addictologie
PU-PH	CRACOWSKI Jean-Luc	Pharmacologie fondamentale ; pharmacologie clinique ; addictologie
PU-PH	DEBATY Guillaume	Médecine d'Urgence
PU-PH	DEBILLON Thierry	Pédiatrie
PU-PH	DECAENS Thomas	Gastroentérologie ; hépatologie ; addictologie
PR Ass. Méd.	DEFAYE Pascal	Cardiologie
PU-PH	DEGANO Bruno	Pneumologie ; addictologie
PU-PH	DEMATTEIS Maurice	Pharmacologie fondamentale ; pharmacologie clinique ; addictologie
PU-PH émérite	DEMONGEOT Jacques	Biostatistiques, informatique médicale et technologies de communication
MCU-PH	DERANSART Colin	Physiologie
PU-PH	DESCOTES Jean-Luc	Urologie
PU-PH	DETANTE Olivier	Neurologie
MCU-PH	DIETERICH Klaus	Génétique
MCU-PH	DOUTRELEAU Stéphane	Physiologie
MCU-PH	DUMESTRE-PERARD Chantal	Immunologie
PU-PH	EPAULARD Olivier	Maladies infectieuses ; Maladies tropicales
PU-PH	ESTEVE François	Biophysique et médecine nucléaire
MCU-PH	EYSSERIC Héléne	Médecine légale et droit de la santé
PU-PH	FAUCHERON Jean-Luc	Chirurgie viscérale et digestive
MCU-PH	FAURE Julien	Biochimie et biologie moléculaire
PU-PH	FERRETTI Gilbert	Radiologie et imagerie médicale
PU-PH	FEUERSTEIN Claude	Physiologie
PU-PH	FONTAINE Éric	Nutrition
PU-PH	FRANCOIS Patrice	Epidémiologie, économie de la santé et prévention
MCU-MG	GABOREAU Yoann	Médecine Générale
PU-PH	GARBAN Frédéric	Hématologie ; Transfusion
PU-PH	GAUDIN Philippe	Rhumatologie
PU-PH	GAVAZZI Gaétan	Médecine interne ; gériatrie et biologie du vieillissement ; addictologie
PU-PH	GAY Emmanuel	Neurochirurgie
MCU-PH	GILLOIS Pierre	Biostatistiques, informatique médicale et technologies de communication
PU-PH	GIOT Jean-Philippe	Chirurgie plastique, reconstructrice et esthétique ; Brûlologie
MCU-PH	GRAND Sylvie	Radiologie et imagerie médicale
PU-PH émérite	GRIFFET Jacques	Chirurgie infantile
MCU-PH	GUZUN Rita	Nutrition
PU-PH	HAINAUT Pierre	Biochimie et biologie moléculaire
PU-PH émérite	HALIMI Serge	Nutrition
PU-PH	HENNEBICQ Sylviane	Biologie et médecine du développement et de la reproduction ; gynécologie médicale
PU-PH	HOFFMANN Pascale	Gynécologie-obstétrique ; gynécologie médicale
PU-PH émérite	HOMMEL Marc	Neurologie
PU-MG	IMBERT Patrick	Médecine Générale

CORPS	NOM-PRENOM	Discipline universitaire
PU-PH émérite	JOUK Pierre-Simon	Génétique
PU-PH	KAHANE Philippe	Physiologie
MCU-PH	KASTLER Adrian	Radiologie et imagerie médicale
PU-PH	KRAINIK Alexandre	Radiologie et imagerie médicale
PU-PH	LABARERE José	Epidémiologie, économie de la santé et prévention
MCU-PH	LABLANCHE Sandrine	Endocrinologie, diabète et maladies métaboliques
MCU-PH	LANDELLE Caroline	Bactériologie – virologie ; Hygiène hospitalière
PU-PH	LANTUEJOL Sylvie	Anatomie et cytologie pathologiques
PR Ass. Méd.	LARAMAS Mathieu	Cancérologie ; radiothérapie
MCU-PH	LARDY Bernard	Biochimie et biologie moléculaire
MCU - PH	LE GOUELLEC LE PISSART Audrey	Biochimie et biologie moléculaire
PU-PH	LECCIA Marie-Thérèse	Dermato-vénérologie
MCF Ass.MG	LEDOUX Jean-Nicolas	Médecine Générale
PU-PH émérite	LETOUBLON Christian	Chirurgie viscérale et digestive
PU-PH	LEVY Patrick	Physiologie
PU-PH	LONG Jean-Alexandre	Urologie
MCU-PH	LUPO Julien	Bactériologie-virologie ; Hygiène hospitalière
PU-PH	MAIGNAN Maxime	Médecine d'urgence
PU-PH	MAITRE Anne	Médecine et santé au travail
MCU-PH	MALLARET Marie-Reine	Bactériologie – virologie ; Hygiène hospitalière
MCU-PH	MARLU Raphaël	Hématologie ; Transfusion
PR Ass. Méd.	MATHIEU Nicolas	Gastroentérologie ; hépatologie ; addictologie
MCU-PH	MAUBON Danièle	Parasitologie et mycologie
PU-PH	MAURIN Max	Bactériologie-virologie ; Hygiène hospitalière
MCU-PH	MC LEER Anne	Histologie, embryologie et cytogénétique
MCU-PH	MONDET Julie	Histologie, embryologie et cytogénétique
PU-PH	MORAND Patrice	Bactériologie-virologie ; Hygiène hospitalière
PU-PH	MOREAU-GAUDRY Alexandre	Biostatistiques, informatique médicale et technologies de communication
PU-PH	MORO Elena	Neurologie
PU-PH	MORO-SIBILOT Denis	Pneumologie ; addictologie
MCU-PH	MORTAMET Guillaume	Pédiatrie
PU-PH	MOUSSEAU Mireille	Cancérologie ; radiothérapie
PU-PH émérite	MOUTET François	Chirurgie plastique, reconstructrice et esthétique ; brûlologie
MCF Ass.MG	ODDOU Christel	Médecine Générale
PR Ass. Méd.	ORMEZANO Olivier	Cardiologie
MCU-PH	PACLET Marie-Hélène	Biochimie et biologie moléculaire
PU-PH	PAILHE Régis	Chirurgie orthopédique et traumatologie
PU-PH	PALOMBI Olivier	Anatomie
PU-PH	PARK Sophie	Hématologie ; Transfusion
PU-PH	PASSAGGIA Jean-Guy	Anatomie
PR Ass.MG	PAUMIER-DESBRIERES Françoise	Médecine Générale
PU-PH	PAYEN DE LA GARANDERIE Jean-François	Anesthésiologie-réanimation et médecine péri-opératoire
MCU-PH	PAYSANT François	Médecine légale et droit de la santé
MCU-PH	PELLETIER Laurent	Biologie cellulaire
PU-PH	PELLOUX Hervé	Parasitologie et mycologie
PU-PH	PEPIN Jean-Louis	Physiologie
PU-PH	PERENNOU Dominique	Médecine physique et de réadaptation

CORPS	NOM-PRENOM	Discipline universitaire
PU-PH	PERNOD Gilles	Chirurgie vasculaire ; Médecine vasculaire
PU-PH	PIOLAT Christian	Chirurgie infantile
PU-PH	PISON Christophe	Pneumologie ; Addictologie
PU-PH	PLANTAZ Dominique	Pédiatrie
PU-PH	POIGNARD Pascal	Bactériologie-virologie ; Hygiène hospitalière
PU-PH	POLACK Benoît	Hématologie ; Transfusion
PU-PH	POLOSAN Mircea	Psychiatrie d'adultes ; Addictologie
PU-PH	RAMBEAUD Jean-Jacques	Urologie
PU-PH	RAY Pierre	Biologie et médecine du développement et de la reproduction ; gynécologie médicale
PR Ass. Méd.	RECHE Fabian	Chirurgie viscérale et digestive
MCU-PH	RENDU John	Biochimie et biologie moléculaire
MCU-PH émérite	RIALLE Vincent	Biostatistiques, informatique médicale et technologies de communication
PU-PH	RIETHMULLER Didier	Gynécologie-obstétrique ; gynécologie médicale
PU-PH	RIGHINI Christian	Oto-rhino-laryngologie
PU-PH émérite	ROMANET Jean Paul	Ophthalmologie
PU-PH	ROSTAING Lionel	Néphrologie
PU-PH	ROUSTIT Matthieu	Pharmacologie fondamentale ; pharmacologie clinique ; addictologie
MCU-PH	ROUX-BUISSON Nathalie	Biochimie et biologie moléculaire
PR Ass.MG	ROYER DE VERICOURT Guillaume	Médecine Générale
PU-PH émérite	SARAGAGLIA Dominique	Chirurgie orthopédique et traumatologie
MCU-PH	SATRE Véronique	Génétique
PU-PH	SAUDOU Frédéric	Biologie cellulaire
PU-PH	SCHMERBER Sébastien	Oto-rhino-laryngologie
PU-PH	SCHWEBEL Carole	Médecine intensive-réanimation
PU-PH	SCOLAN Virginie	Médecine légale et droit de la santé
MCU-PH	SEIGNEURIN Arnaud	Epidémiologie, économie de la santé et prévention
PU-PH émérite	STAHL Jean-Paul	Maladies infectieuses ; Maladies tropicales
PU-PH	STANKE Françoise	Pharmacologie fondamentale ; pharmacologie clinique ; addictologie
MCU-PH	STASIA Marie-José	Biochimie et biologie moléculaire
PU-PH	STURM Nathalie	Anatomie et cytologie pathologiques
PU-PH	TAMISIER Renaud	Physiologie
PU-PH	TERZI Nicolas	Médecine intensive-réanimation
PU-PH	THEVENON Julien	Génétique
MCU-PH	TOFFART Anne-Claire	Pneumologie ; Addictologie
PU-PH	TONETTI Jérôme	Chirurgie orthopédique et traumatologie
PU-PH	TOUSSAINT Bertrand	Biochimie et biologie moléculaire
PU-PH	VALMARY-DEGANO Séverine	Anatomie et cytologie pathologiques
PU-PH	VANZETTO Gérard	Cardiologie
PU-PH	VUILLEZ Jean-Philippe	Biophysique et médecine nucléaire
PU-PH	WEIL Georges	Epidémiologie, économie de la santé et prévention
PU-PH	ZAOUI Philippe	Néphrologie
PU-PH émérite	ZARSKI Jean-Pierre	Gastroentérologie ; hépatologie ; addictologie

PU-PH : Professeur des Universités - Praticiens Hospitaliers
 MCU-PH : Maître de Conférences des Universités - Praticiens Hospitaliers
 PU-MG : Professeur des Universités de Médecine Générale
 MCU-MG : Maître de Conférences des Universités de Médecine Générale
 PR Ass. Méd. : Professeur des Universités Associé de Médecine
 PR Ass.MG : Professeur des Universités Associé de Médecine Générale
 MCF Ass.MG : Maître de Conférences Associé de Médecine Générale

TABLE OF CONTENTS

RESUME	2
ABSTRACT	4
INTRODUCTION	13
METHODS	15
STUDY DESIGN	15
ETHICAL CONSIDERATIONS	15
PARTICIPANTS	15
ASSESSMENTS TIMING	16
POSTUROGRAPHIC ASSESSMENTS	17
<i>Procedure</i>	17
<i>Instructions and conditions</i>	17
<i>Data analysis</i>	17
CLINICAL DEFICITS AND MOBILITY LIMITATIONS	18
STATISTICAL ANALYSIS	20
RESULTS	22
PARTICIPANTS	22
EVOLUTION OF CLINICAL DEFICITS AND MOBILITY LIMITATION	22
EVOLUTION OF WEIGHT BEARING DISTRIBUTION	23
FACTORS INFLUENCING THE RECOVERY OF WEIGHT BEARING ASYMMETRY	24
THE RELATIONSHIP BETWEEN RECOVERY OF WEIGHT-BEARING ASYMMETRY AND BALANCE	24
DISCUSSION	25
MONITORING AND EVALUATION TOOLS FOR POSTURAL AND BALANCE DISORDERS AFTER STROKE	25
THE RECOVERY OF WBA	26
FACTORS INFLUENCING THE RECOVERY OF WBA	26
THE RELATIONSHIP BETWEEN RECOVERY OF WBA AND BALANCE	27
STATISTICAL ANALYSIS OF RECOVERY	27
STUDY LIMITATION	29
CONCLUSION	30
TABLES AND FIGURES	32
REFERENCES	39
ADDITIONAL MATERIALS	44

INTRODUCTION

Postural disorders represent the leading cause of disability after stroke (1), leading to a loss of autonomy (2) and exposing patients to a high risk of falling (3).

Balance and postural ability can be globally assessed using balance scales dedicated to stroke such as the Postural Assessment Scale for Stroke Patients (PASS) (4), or generic scales such as the Berg Balance Scale (BBS) (5). The main interest of these balance scales is that they are applicable for all patients, regardless the severity of their disorders. However, while these scales only examine the consequences of the impaired postural and balance control, instrumental evaluations such as posturography, can provide information about the underlying mechanisms involved in balance disorders, in order to guide their rehabilitation.

The quiet standing posture of individuals after stroke is characterized by an increase in postural sway and a postural asymmetry expressed by an asymmetrical weight distribution (weight-bearing asymmetry WBA) or by a shift of the center of pressure (CoP) in the mediolateral plane (ML) towards the non-paretic side of the body (6,7). These latter measures, WBA and CoP ML are highly related (8). WBA is very common after stroke: about a third of patients stand asymmetrically in the subacute stroke stage, and this behaviour remains present in the chronic stage (9). The degree of WBA during quiet standing is strongly related to gait variables, such as gait velocity (10), and is associated with the level of gait independence (11).

Studies found that WBA is related to motor weakness (2), asymmetrical muscular tone (12) and somatosensory deficits (13), but also to spatial cognition disorders such as spatial neglect (12) and lateropulsion (14). Indeed, the right hemisphere, known to be the hemisphere of spatial cognition (15), seemed to be involved in WBA (16). Misperception of spatial references and body representations could result in distortion of the coordinates used to distribute loading on the two legs while standing. A strong association has been demonstrated between WBA and a bias in the

representation of the Longitudinal Body Axis (LBA), suggesting that WBA partly reflects an altered representation of egocentric reference in the frontal axis (14).

Therefore, WBA after a stroke is a complex postural behavior, and could be considered to be both a direct consequence of the unilateral hemispheric lesion through the sensitive-motor deficit and the spatial neglect, and also a strategy to compensate for a contralesional lateropulsion induced by a wrong internal model of verticality (17,18). This complexity might explain why studies which have investigated the recovery of the post-stroke WBA present conflicting results. Indeed, some found a decrease of weight-bearing asymmetry over time (7,19,20), while others did not, despite a considerable recovery in terms of independence in walking and activities of daily living (21). In addition, even in studies who found a significant reduction, a WBA of about 10% persisted and it increased with a dual-task interference, indicating that weight bearing never became fully automated (19). Among these longitudinal studies, none of them were able to establish possible determinants of the WBA recovery. This is however a major issue in neurorehabilitation.

Our first goal was to analyze the evolution of weight bearing distribution among a series of patients in the subacute phase after stroke while they received conventional rehabilitation. Then we wanted to compare the individuals who showed a strong recovery of WBA and those who didn't. Finally, we attempted to explore the relationship between the recovery of WBA and balance, assessed by the PASS score. Our hypothesis was that weight-body distribution becomes more symmetric over time. We expected that the individuals who showed a strong WBA recovery may also show an improvement of lower limb muscle strength and spatial cognition. Also, we thought that balance after a stroke can be improved while weight bearing asymmetry didn't recovered, which would be regarded as a compensatory mechanism.

METHODS

Study design

This is a monocentric observational study, using the data of DOBRAS (Determinants of Balance Recovery After Stroke) cohort, in which participants with a first hemispheric stroke, were assessed in routine care, after being admitted in neurorehabilitation department of Grenoble-Alpes University hospital. Assessments of sensory, motor and cognitive deficits were performed at fixed time by trained and multidisciplinary examiners, with blinding to other data and the study hypotheses. Patients were included between 2012 and 2019. Among patients included in DOBRAS Cohort, some had a posturographic registration in the frame of the ancillary study DOBRAS_Initial_Posturography (DOBRAS-IP).

Ethical considerations

The DOBRAS cohort was approved by our institutional review board (CHU Grenoble Alpes) who validated the ClinicalTrials.gov registration (NCT03203109). The study was also registered at the National Committee for Informatics and Freedom (Commission Nationale Informatique et Liberté; CNIL-No.2014874-v1) and was performed in accordance with the Helsinki Declaration. According to French law, observational studies do not require approval by an ethics committee, provided that participants have been informed of the specific research and are not opposed to use of their data. All eligible individuals were informed of the DOBRAS study (orally and in writing) and those who did not want to participate signed an opposition form.

Participants

Eligibility criteria of the DOBRAS study were: age ≥ 18 to 80 years and a first-ever unilateral stroke limited to one hemisphere. Exclusion criteria were: recurrent stroke, complication at the acute stage (malignant infarct, cerebral herniation, severe subarachnoid hemorrhage and

hydrocephalus), dementia, previous disability interfering with balance or vestibular disorders, unstable medical condition or psychiatric problems and not French speaking.

In the present study, we analyzed the evolution of posturographic parameters of the individuals from the DOBRAS cohort who had two posturographic assessments at the subacute phase, recorded at least 14 days apart. To perform a posturographic assessment, they had to be able to stand independently for at least 30 seconds. Individuals with an obvious osteoarticular disorders of the lower limbs or of the trunk were excluded.

Participants of the DOBRAS study were recruited in our rehabilitation department, and so followed a personalized rehabilitation program, taking into account deficits and activity limitations. According to their abilities, they had 2 physiotherapy and 1 occupational therapy sessions per day (total 1h30), plus, if needed, sessions with speech therapist, neuropsychologist, psychologist, or orthoptist. Rehabilitation sessions included weight shifting exercises, balance and gait training.

Assessments timing

First posturographic session (S1) was assessed, if possible, at the day-30 (D30) after stroke. If patients were not able to stand independently on D30 or if they were admitted after D30, they were assessed later, but always within the first three months after stroke onset. Participants were then randomly reassessed at non-fixed times. For the second posturographic session (S2), we chose to analyze the data of the session that most closely matches a delay of 30 days after the first assessment.

Assessments of clinical deficits and mobility limitations were performed at fixed time (30 days, 60 days, 90 days, 120 days). We analyzed the data which best corresponds to the period of the two posturographic sessions.

Posturographic assessments

Procedure

Posturography was performed in bipodal stance, using the commercial two-force platform Feetest6 (Techno Concept©), fixed to the ground in a quiet room dedicated to this activity, and recorded by a trained examiner blinded of the study hypothesis.

Instructions and conditions

Patients stood barefoot, one foot on each of the two platforms, with feet parallel and heels separated by 14cm. This standardization of feet position allowed to accurately and reliably measure the weight body distribution, since WBA is sensitive to feet conditions (22).

For security reasons, participants stood within a handrail shaped behind and besides the plate-forms, with a chair behind them. They were helped to stand-up from this chair and sit down for a rest, at any time, if needed. The examiner checked feet position on the plate-forms before each trial, then stood at the paretic side to prevent fall during trials. Trials requiring help (handrail grip, human assistance) were considered aborted and then repeated.

Participants were instructed to remain as still as possible, with arms hanging alongside the trunk, looking at straight ahead at a visual target (a small color ball of 3 cm diameter) positioned at gaze level on a white wall distant from 2-3 m.

Three trials of 30 sec were recorded. Participants had a few minutes rest between each trial.

If the participant was able to stand with eyes closed, three trials were then assessed without vision.

We decided not to analyze these data since vision does not seem to affect WBA values according to previous studies (19,21).

Data analysis

The mean vertical forces were recorded by the plates under both legs over the duration of the trial and were expressed as a percentage of body weight.

On the basis of a systematic review with meta-analysis (23) having calculated the cut-off values for symmetrical WB (41-59%), participants were considered as asymmetric if they bore < 41% or > 59% of body weight on their paretic side.

Absolute weight-bearing asymmetry was expressed as the difference from the midpoint (50%): 0 represents a perfect weight distribution (50:50)

$$\text{Absolute WBA} = | 50 - \% \text{ of WB under the paretic leg} |$$

Instability is represented by two standard deviations of the CP coordinates along each axis, medio-lateral and antero-posterior, which correspond to the quantity of sway and the dispersion of the CP coordinates.

For each posturographic parameters, values of the 3 trials were averaged for the statistical analyses.

Clinical deficits and mobility limitations

Deficits were evaluated by a battery of well validated tests and scales, assessing motor weakness, spasticity, sensory loss, visual field defect, cognitive and language disorders.

To avoid any statistical inflation, we limited the analyses to the four following clinical parameters, known to be determinants of WBA:

Lower limb motor command was assessed by physiotherapists with the Medical Research Council scale (24) which involves testing muscles against gravity and the examiner's resistance. Scores range from 0 (no contraction) to 5 (full range of motion against gravity with maximal resistance). Eight key muscle groups (hip flexors and extensors, hip abductors and adductors, knee flexors and extensors, ankle flexors and extensors) of the paretic lower limb were tested with a total score from 0 to 40 (normal strength).

Lower limb spasticity was assessed by physiotherapists with the modified Ashworth Scale (25). Scores range from 0 (no increase in tone) to 4 (limb rigid) depending on the increase in muscle tone during a passive movement. Five key muscle groups (hip flexors and adductors, quadriceps,

hamstrings and triceps sural) of the lower paretic limb were tested with a total score from 0 to 20 (severe spasticity).

Spatial neglect was assessed by neuropsychologists with 6 paper and pencil tests and by the ecological Catherine Bergego Scale (26).

Three tests evaluated the non-body neglect. The Bells test (27) is a cancellation task with bells and distractors: result was considered altered with > 6 omissions. The line bisection (28), in which patient is asked to bisect 2 lines (5cm and 20cm): result was considered pathologic with mean ipsilesional deviations > 7 mm. The Gainotti copy (29) is a copying test: result was considered altered with ≥ 1 omission.

Three tests evaluated the body neglect. The thumb-finding test (30) is a simple task that assess the ability to reach the contralesional hand with the ipsilesional arm with eyes closed: result was considered altered with score ≥ 1 . The Fluff test (31), in which the blindfolded patient has to remove 24 targets attached to his clothes in a time limit of 2 mn: result was considered pathologic with < 13 targets detached. The comb and razor test (32), in which patient is asked to comb the hair, to shave (for men) or to make up (for women): result was considered altered with a score $> 11\%$.

The Catherine Bergego Scale result was considered altered with a score ≥ 2 .

A few individuals with severe comprehension (aphasia) or executive troubles were not able to complete the whole neglect battery but had to perform at least three tests to not be considered with missing data. Spatial neglect was considered absent if all test results were normal or light if only one test result was marginally altered, moderate or severe with results of least two tests markedly altered.

Lateropulsion, which is defined by a contralesional tilt in a sitting or standing position, was assessed by physiotherapists using the Scale for Contraversive Pushing (SCP) (33) with total score ranging from 0 to 6 (severe lateropulsion).

Mobility limitation was assessed with a balance and a walking scale dedicated to stroke.

Balance ability was evaluated by the Postural Assessment Scale for Stroke (PASS) (34), which was assessed by physiotherapists. It is used to assess static and dynamic balance of stroke patients evaluating ability to maintain or change a given lying, sitting, or standing posture.

This scale includes 12 items scored from 0 to 3, for a total score from 0 to 36 (good balance skills).

Gait independence was evaluated with the modified Fugl-Meyer Assessment (mGait-FM) (35).

This walking scale evaluate patient performances depending on the degree of assistance with scores ranging from 0 (no walking) to 6 (normal walking).

Statistical analysis

Distributions of the posturographic and clinical parameters were determined using the Shapiro-Wilk test. Continuous data were presented as mean (standard deviation) if they are normally distributed or as median (Q1;Q3) if they are not. Dichotomized data are presented as number (%).

To determine the evolution of clinical and posturographic parameters between the two assessments, we used paired sample t-tests: paired Student t-test if the differences are normally distributed or paired Wilcoxon test if not. Changes (Δ) were represented by the difference between the values of the two sessions.

$$\Delta = \text{score at S2} - \text{score at S1}$$

Then we analyzed more precisely the evolution of balance. As the Minimal Detectable Change for the PASS score is 2.2 (36), we defined “strong recovery” as an improvement ≥ 3 of PASS score.

We considered that the participants who can't have an improvement ≥ 3 of PASS score because of a ceiling effect (i.e. with a PASS score ≥ 34) had already very satisfactory balance abilities. We decided to separate the individuals in three groups: a group who had already a satisfactory PASS score at S1; among the others, we distinguished a group who recovered strongly and a group who didn't.

Similarly, we analyzed the evolution of weight-bearing distribution. As aforementioned, we considered participants with a percentage of body weight loaded on their paretic side between 41 and 59% as symmetric. For weight-bearing asymmetry, the Minimal Detectable Change reach 5% of body weight (37). It means that a difference greater to 5% is not due to random variability (with a 95% confidence level). We defined “strong recovery” as an improvement $> 5\%$ of body weight between the two assessments. We separated the individuals in three groups: a first group who had already a symmetrical body weight distribution at S1, a second group who presented a weight-bearing asymmetry at S1 and who recovered strongly, a third group of individuals who presented a weight-bearing asymmetry at S1 and who showed small or no recovery.

Then we compared the group of individuals who showed a strong WBA recovery with the group of individuals who didn't. To compare proportions of dichotomized variables between the groups, Fisher's exact test was used because the sample wasn't large enough. Means of continuous data were compared between the groups using the Student's t-test for the normal distributions or Wilcoxon test for non-normal distributions.

Finally, we analyze the correlation between the evolution of WBA and the evolution of balance abilities, assessed by the PASS score. We correlated the changes (Δ) of WBA and PASS score with Spearman's rank correlation test due to the non-normal distribution.

Two-sided $p < 0.05$ was considered statistically significant. All statistical analyses were performed using R software (Version 1.2.5001).

RESULTS

Participants

Figure 1 shows the flow diagram of the study. Thirty-one individuals followed in the DOBRAS_IP study had two or more valid posturographic assessments performed at least 14 days apart.

Among those 31 patients who have been assessed at least twice, the median time between stroke onset and the first assessment were 41 (32;70) days and 82 (59;95) days for the second assessment.

The median time period between the two sessions were 28 (26;39) days.

There were 21/31(68%) males, with a median age of 68 (63;73) years old. Stroke was ischemic in 26/31 (84%) and affected the right hemisphere in 17/31 (55%). The median total length of hospital stay since stroke was 91 (73;108) days. The mean FIM score at S1 was 94 (18). A moderate or severe spatial neglect has been identified in 20/31 (65%) participants.

The clinical deficits, mobility limitations and posturographic outcomes assessed at the first session are presented in Table 1 and Table 2 respectively. Only one data was missing and concerned lower limb weakness (n=1).

Overall, 21/31 (68%) individuals had a symmetric distribution of their body weight at S1, 9/31 (29%) loaded less than 41% of body weight on their paretic side and 1/31 (3%) loaded more than 59% on their paretic side.

Evolution of clinical deficits and mobility limitation

Clinical outcomes and mobility limitation scores at S2 and the differences between the sessions (Δ) are presented in Table 1. Participants had a greater lower limb motricity at the second session, with a statistically significant difference (median $\Delta = 1$, $p < 10^{-3}$). The spasticity of the lower limb was stable (median $\Delta = 0$, $p = 0.205$). We decided not to analyze the evolution of neglect due to a lack of data. All mobility scores (PASS, mGait-FM) significantly improved.

Figure 2 shows the individual evolutions of PASS score. None of the participants deteriorated. 13/31 (42%) individuals had already a satisfactory PASS score (as described in the methods) at S1. Among the others, 5/18 (28%) showed a strong recovery (as described in the methods) and 13/18 (72%) didn't.

Evolution of weight bearing distribution

Table 2 shows that the 31 participants were globally more symmetric at the second assessment, with a median difference between the two sessions of 1.4% ($p=0.040$). When selecting only the 10 participants who presented an asymmetric weight distribution at S1, irrespective to the side of the asymmetry, the median difference between the two sessions was 3.2% (from 11.3 to 8.7%, $p=0.004$).

Figure 2a. represents the individual evolutions of weight-body distribution on the paretic side. Among the 21 patients who were symmetric at S1, 19 stayed symmetric at S2 and two became marginally asymmetric, probably due to random variability ($\Delta \leq 5\%$). Among the 9 patients who loaded less than 41% of body weight on their paretic side at S1, 4 recovered strongly (as described in the methods) and 5 didn't. The patient who loaded more than 59% of body weight on his paretic side at S1 showed only a small recovery. None of the 31 participants presented a strong deterioration.

From Figure 2b., representing the individual evolutions of absolute weight-bearing asymmetry, we constituted three groups identified by different colors. A first group with 21 individuals who all were symmetric at S1 and stayed symmetric at S2 (except two). A second group with 4 individuals who were asymmetric at S1, irrespective of the side, and who strongly recovered. And finally, a third group of 6 individuals asymmetric at S1 who showed small or no recovery.

Factors influencing the recovery of weight bearing asymmetry

Tables 3 and 4 compare the group of individuals who were asymmetric at S1 and who strongly recovered to the group with no or small recovery. First, participants who showed a strong WBA recovery were more asymmetric at S1, despite the difference was not statistically significant. They also tended to be more unstable at S1 along both axis, but without significance. Instability decrease was not significantly different between the groups.

Concerning clinical deficits, among the group with strong recovery, participants had a more important initial lower limb weakness, with a significant difference between groups, and tended to have a better motor improvement between the two sessions, but the difference didn't reach significance. Participants tended also to be more spastic and to show more severe lateropulsion but none of the differences was significant. Spatial neglect was equally distributed between groups. Concerning mobility, initial balance was significantly weaker among individuals who showed a strong WBA recovery, and improved more strongly at S2 than the group with no or small WBA recovery. No significant difference was found concerning gait. Moreover, the group with strong recovery benefited from a longer time between the two assessments, despite the difference was not significant.

Finally, no difference was noted according to demographic characteristics, stroke side or stroke mechanism.

The relationship between recovery of weight-bearing asymmetry and balance

Figure 4 shows the correlation between WBA recovery and PASS recovery, each represented by the changes between the two sessions (Δ). Δ WBA and Δ PASS were strongly and significantly correlated ($R=-0.81$; $p=0.005$): the more weight-bearing asymmetry improved, the more balance in daily life recovered.

DISCUSSION

Our study confirms that the weight-bearing distribution becomes more symmetric among a series of patients in the subacute phase post stroke during their inpatient rehabilitation. This is the first study exploring the evolution of weight-bearing distribution at an individual level, using the MDC to detect changes. Among the individuals who presented an asymmetry according to our threshold, 40% showed a strong recovery. These patients who recovered strongly were more heavily impaired at first assessment, indicating that even a severe asymmetry with severe deficits and mobility limitations can be reduced after rehabilitation. Contrary to our hypothesis, the reduction of WBA is strongly associated to the improvement of balance abilities.

Monitoring and evaluation tools for postural and balance disorders after stroke

Balance is one of the major issues in stroke rehabilitation since it represents one of the predictors of rehabilitation outcomes (38,39) and length of stay in rehabilitation center (40). That is why assessing postural and balance after stroke is a major preoccupation of clinicians and researchers, leading to multiple scales developed in the literature. The Postural Assessment Scale for Stroke is a gold standard tool in the evaluation of post-stroke balance disorders. It is applicable for all patients, both in best and poor postural abilities and requires no special equipment. It has demonstrated good psychometric properties. Indeed, studies found a very high reliability (37,41,42) and a high responsiveness (43–45) of the PASS, which are of fundamental importance in a longitudinal study.

Similarly, the assessment of weight-bearing distribution on a two-force platform revealed excellent within and between sessions reliability among individuals with stroke (37,46). One previous study observed poor reliability but they evaluated the mean center of pressure (COP) position along the ML axis with a unique posturographic force-platform (47). This reliability is enhanced by the standardization of assessment conditions, including feet position (22), trial duration (48), visual condition (49), oral instructions (50) and number of trials (51,52).

The recovery of WBA

The present study found that weight-bearing distribution was more symmetric over time. Among the participants who presented an asymmetry according to our threshold, 40% recovered strongly. Most of the previous studies which explored the evolution of posturographic parameters in post-stroke patients included participants at a late stage with a wide period of time between assessments. Sackey et al assessed 69 post-stroke patients on average 11.5 ± 5.0 weeks after stroke and 18 weeks later. De Haart et al followed 37 patients from an average time of 10.0 ± 5.4 weeks post stroke, and then 2, 4, 8 and 12 weeks later. These two latter studies found a similar and significant improvement even if a degree of WBA persisted. In the first study, WBA decreased from 12 to 10% among left stroke and from 12 to 8% among right stroke; in the second study from 12.6% to 9.2%. Laufer et al evaluated 30 elderly patients at an earlier stage (one and two months after stroke onset) and found no recovery of WBA whereas function and mobility improved. However, these longitudinal studies only compared group means, and don't analyze WBA recovery at an individual level.

Factors influencing the recovery of WBA

In this study we tried to define a profile of patients according to their recovery of WBA: our results show that the individuals who improved their WBA seem to have more severe initial deficits, especially regarding the lower limb motor command. This appears to be logical since motor weakness is a known determinant of WBA (2) and a wider deficit let them have a larger margin of progress.

In the aforementioned longitudinal studies, none of them were able to establish a link between WBA recovery and clinical or demographic characteristics. De Haart et al (19) tested the influence of clinical characteristics over time on WBA within a MANOVA design. They showed that the stroke patients presenting an ankle clonus showed on average 98% more weight-bearing

asymmetry, but no interaction effect over time were found for all clinical characteristics. Laufer et al (21) tested the influence of stroke side on WBA recovery and found no main effect. The remaining studies (7,53) didn't analyze the impact of clinical deficits on WBA recovery and none of them describe a profile of patients according to their WBA recovery.

The relationship between recovery of WBA and balance

In the present study, the recovery of WBA and the evolution of balance abilities were highly correlated.

Only one (19) of the studies previously mentioned used a balance scale, which evaluated the sitting balance (Trunk Control Test). They analyzed the recovery of the sitting balance separately from WBA recovery and found an improvement during the follow-up.

The correlation between the amplitude of WBA and poor balance scores was already clear (54–56), but, to our knowledge, the relationship between the recovery of these two variables has never been explored.

This strong association suggests that a recovery of WBA is needed to improve balance in daily life and strengthens the relevance of a specific WBA rehabilitation, but it should be borne in mind that correlation does not imply causal relationship.

Statistical analysis of recovery

Evaluating change and understanding which factors explain or predict stroke recovery is a very important area of rehabilitation research. Thus, it is important to choose the appropriate statistical method.

A first approach consists of using correlation or linear regression to test the relationship between baseline measurements and change. This method has been used in stroke recovery studies and particularly for upper limb function (57). This led to the “proportional recovery rule” (PRR), which stipulates that most individuals poststroke will recover 70% of their potential (57). However, this

approach has been criticized because it suffers from a methodological weakness known as “mathematical coupling” (58,59). It occurs when there exists a formulaic relationship between two variables.

A second approach is to categorize the participants into subgroups according to baseline value and to compare the changes across the subgroups. In this study we chose a related approach: we categorize individuals according to their change and compared baseline values. However, this approach is also questionable owing to “regression to the mean”, which is defined by the tendency for extremely high or extremely low scores to become more moderate upon retesting over time. Therefore, if participants are divided according to their baseline value, it might give the impression that smaller initial scores will improve more than more moderate initial scores. It can be less of a concern if we are dealing with clinical tests with high reliability.

We might then use Analysis of covariance (ANCOVA) with the final score as response variable, adjusting for baseline scores. However, it has been criticized as being biased in the case of unequal baseline scores between groups (60). This occurs when subjects are grouped according to their characteristics (e.g. gender, stroke side, etc.).

Repeated-measures analysis of variance (RM ANOVA) is another statistical method commonly employed in longitudinal studies. However, this technique requires several and strict assumptions (normality, homogeneity of variance, sphericity) that are often violated and assumes that the participants are assessed at the same points in time. Moreover, the focus of such a design is limited to comparison of group means, and it cannot accommodate analysis at the individual level.

Nowadays, more powerful and flexible statistical methods are used in longitudinal studies, called multilevel models (MLM), which regroup several variations (hierarchical linear models (HLM), linear mixed-effect model (LMM), random-effects models or latent growth curve analysis (LGCA), etc.). These models describe change at both the individual and group levels (61,62). They are more flexible and enable for example the possibility of assessing individuals at different times.

These latter techniques have proved their superiority for the analysis of longitudinal studies including at least 3 assessment sessions (63), but are still underused in rehabilitation research.

Study limitation

Some limitations should be considered when interpreting the results.

Firstly, the main limitation is the retrospective analysis of the data. The DOBRAS cohort was not designed for this present study, which explains why posturographic assessments were not recorded at fixed times, like clinical assessments.

Regarding the selection of the population, because posturography requires being able to stand independently for a few seconds, the patients with the most severe balance disorders can't be included. Due to this functional inclusion criterion (be able to stand independently during 30 s), the participants have been included and assessed at different times post-stroke. Moreover, patients who were discharged home early and who quickly recovered could not be assessed a second time and were not included in this study. Therefore, the results of this study only represent standing balance recovery among a selected subgroup of patients with a first hemispheric stroke.

Concerning the primary study outcome, we used a mathematical formula calculating the absolute degree of WBA, which mixed participants who loaded more weight on paretic side with those who loaded more on non-paretic side. This allows easier comparison of changes. It should be kept in mind, even though a previous study (64) found no differences in clinical profile between these two groups of patients.

Regarding the assessment tools, some of our scores suffer from ceiling effect which could bias the results, particularly when change scores are used.

Additionally, no control group was included. While we are not testing the effect of a treatment, the inclusion of healthy-matched controls would have allowed comparison of results with their reference values, rather than using threshold found in literature.

Participants followed a personalized rehabilitation program, and thus we can't know exactly how much specific balance rehabilitation they received, which could be a confounding factor.

Finally, there may have been a lack of statistical power because of the limited number of subjects included in the study.

CONCLUSION

This longitudinal observational study investigated weight-bearing distribution during quiet standing twice at 41 (32;70) and 82 (59;95) days post stroke, in a series of 31 patients who all received conventional rehabilitation. Weight-bearing distribution was significantly more symmetric at the second assessment.

Participants who presented a strong recovery of their asymmetry had more severe deficits at first assessment, especially in term of motor command, and so a wider potential for improvement. This shows that even a severe asymmetry with severe deficits and mobility limitations can be reduced after rehabilitation.

Balance ability, assessed by the PASS score, and WBA recovery were closely associated. This suggests that a recovery of WBA is needed to improve balance in daily life and strengthens the relevance of a specific WBA rehabilitation.

However, because of the retrospective analysis and of the small sample size, these findings must be interpreted with some caution and a larger prospective controlled study adjusted on initial severity should be conducted.

THÈSE SOUTENUE PAR : FOLMER Ophélie

TITRE :

Weight-bearing asymmetry after stroke: recovery or not?

CONCLUSION :

This longitudinal observational study investigated weight-bearing distribution during quiet standing twice at 41 (32;70) and 82 (59;95) days post stroke, in a series of 31 patients who all received conventional rehabilitation. Weight-bearing distribution was significantly more symmetric at the second assessment.

Participants who presented a strong recovery of their asymmetry had more severe deficits at first assessment, especially in term of motor command, and so a wider potential for improvement.

This shows that even a severe asymmetry with severe deficits and mobility limitations can be reduced after rehabilitation.

Recovery of balance ability, assessed by the PASS score, and WBA were closely associated.

This suggests that a recovery of WBA is needed to improve balance in daily life and strengthens the relevance of a specific WBA rehabilitation.

However, because of the retrospective analysis and of the small sample size, these findings must be interpreted with some caution and a larger prospective controlled study adjusted on initial severity should be conducted.

VU ET PERMIS D'IMPRIMER

Grenoble, le : 12/03/2021

LE DOYEN

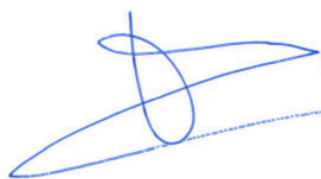


Pour le Président
et par délégation

Le Doyen de Médecine
Pr. Patrice MORAND

Pr. Patrice MORAND

LE PRÉSIDENT DE LA THÈSE



Pr. Dominic PERENNOU
Médecine Physique et Réadaptation
Institut de Rééducation
Hôpital de la CHU de Grenoble
BP 338 - 38054 ECHIROLLES Cedex
Tél. 04 76 76 60 85
N° SIRET 10002184760

Pr. Dominic PERENNOU

TABLES AND FIGURES

Table 1. Evolution of clinical deficits and mobility limitation

	All patients (n=31)			
<i>Clinical deficits</i>	<i>S1</i>	<i>S2</i>	Δ	<i>p</i>
Ll motor command	33 (26 ; 38)	36 (29 ; 39)	+1 (0 ; 3)	<10 ⁻³
Ll spasticity	1 (0 ; 3)	1 (0 ; 2)	0 (0 ; 0)	0.205
Lateropulsion (SCP)	0 (0 ; 0.75)	0 (0 ; 0)	0 (-0.25 ; 0)	0.003
<i>Mobility limitation</i>				
Balance ability (PASS)	32 (30 ; 35)	33 (32 ; 36)	+1 (0 ; 2)	<10 ⁻³
Gait independence (mGait-FM)	5 (3 ; 5)	5 (4 ; 6)	0 (0 ; 1)	<10 ⁻³

S1: first session; Δ : difference between the two sessions; Ll: lower limb; SCP: Scale for Contraversive Pushing; PASS: Postural Assessment Scale for Stroke; mGait-FM: gait item of modified Fugl-Meyer Assessment'
Missing data: Ll motor command (n=1)

Table 2. Evolution of posturographic parameters

	All patients (n=31)			
<i>Posturographic parameters</i>	<i>S1</i>	<i>S2</i>	Δ	<i>p</i>
Absolute WBA (%)	6.8 (3.4 ; 9.7)	4.1 (2.2 ; 8.1)	-1.4 (-4.5 ; 0.9)	0.040
Instability along ML axis, 2 SD (mm)	9.5 (5.2 ; 13.7)	6.6 (4.2 ; 9.7)	-1.4 (-5.1 ; 0.8)	0.020
Instability along AP axis, 2 SD (mm)	12.7 (8.5 ; 16.4)	9.6 (8.0 ; 13.1)	-0.7 (-4.2 ; 1.0)	0.080

S1: first session; Δ : difference between the two sessions; WBA: weight-bearing asymmetry; ML: medio-lateral; AP: antero-posterior

Table 3. Comparison of baseline characteristics and changes between individuals considered as initially asymmetric (n=10) according to their WBA recovery

	No or small WBA recovery (n=6)	Strong WBA recovery (n=4)	p
<i>Demographic characteristics</i>			
Sexe, Male (n,%)	2 (33%)	3 (75%)	0.524
Age (years)	72 (64 ; 74)	66 (62 ; 68)	0.257
BMI (kg/m2)	25.2 (2.7)	28.0 (3.4)	0.219
<i>Stroke characteristics</i>			
Stroke type, Infarct (n,%)	6 (100%)	3 (75%)	0.400
Stroke side, Right (n, %)	4 (67%)	3 (75%)	0.999
<i>Clinical deficits</i>			
Ll motor command			
S1	30 (28 ; 32)	20 (17 ; 23)	0.019
Δ	+2 (1 ; 3)	+5 (2 ; 8)	0.443
Ll spasticity			
S1	1 (0 ; 5)	5 (4 ; 6)	0.281
Δ	+0 (-1 ; 0)	+0 (-1 ; 0)	0.548
Lateropulsion (SCP)			
S1	0.13 (0 ; 0.81)	1 (0.81 ; 1.38)	0.188
Δ	-0.13 (-0.25 ; 0)	-0.63 (-1.13 ; -0.19)	0.314
Neglect, moderate/severe (n,%)			
S1	4 (67%)	3 (75%)	0.999
<i>Mobility limitation</i>			
Balance ability (PASS)			
S1	30 (29 ; 32)	26 (25 ; 27)	0.032
Δ	+2 (0 ; 2)	+6 (5 ; 7)	0.018
Gait independence (mGait-FM)			
S1	4 (3 ; 5)	3 (2 ; 3)	0.052
Δ	+1 (0 ; 2)	+1 (1 ; 2)	0.821

S1: first session; Δ: difference between the two sessions; WBA: weight-bearing asymmetry; BMI: Body Mass Index; Ll: lower limb; SCP: Scale for Contraversive Pushing; PASS: Postural Assessment Scale for Stroke; mGait-FM: gait item of modified Fugl-Meyer Assessment

Table 4. Comparison of baseline posturographic outcomes and changes between the individuals considered as initially asymmetric (n=10) according to their recovery of WBA

	No or small WBA recovery (n=6)	Strong WBA recovery (n=4)	p
<i>Postural characteristics</i>			
Absolute WBA			
S1	10.9 (10.2 ; 11.5)	17.1 (14.6 ; 21.4)	0.257
Δ	-1.8 (-2.2 ; -1.4)	-11.3 (-15.6 ; -6.8)	0.010
Instability along ML axis			
S1	9.5 (6.1 ; 12.4)	12.7 (9.0 ; 18.0)	0.336
Δ	-1.8 (-2.9 ; 0.4)	-3.4 (-7.0 ; 0.0)	0.610
Instability along AP axis			
S1	12.4 (9.7 ; 13.4)	14.5 (12.8 ; 16.1)	0.334
Δ	-2.3 (-5.1 ; -0.8)	0.0 (-3.2 ; 1.5)	0.476
Period time between :			
Stroke-S1	64 (58 ; 75)	95 (75 ; 99)	0.240
S1-S2	33 (27 ; 39)	62 (38 ; 88)	0.134

S1: first session; Δ: difference between the two sessions; WBA: weight-bearing asymmetry; ML: medio-lateral; AP: antero-posterior

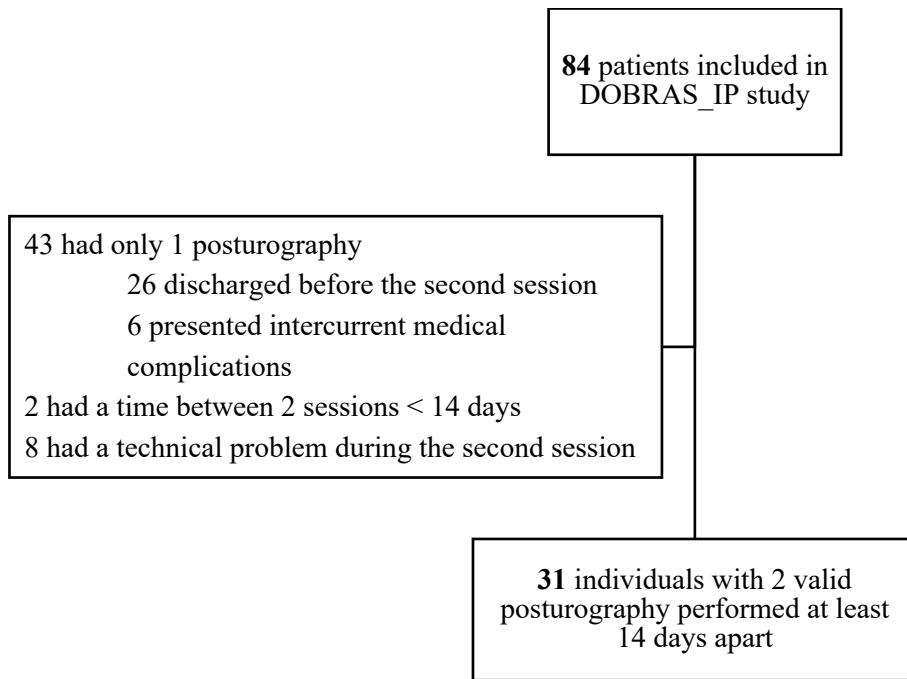


Figure 1. Flow chart

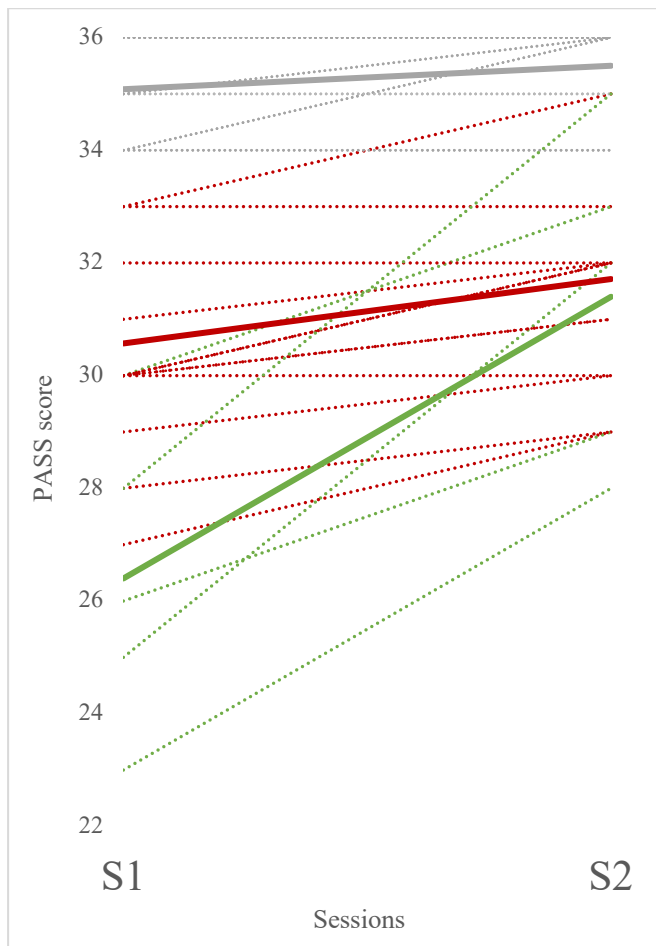


Figure 2. PASS score at first (S1) and second sessions (S2).

Grey represents individuals who have already a satisfactory PASS score (as described in methods) at first session (S1). The others are separated in two groups: those who recovered strongly (as described in the methods) are displayed in green, those who didn't in red. Each dotted line represents an individual. Full lines are the mean of the 3 groups.

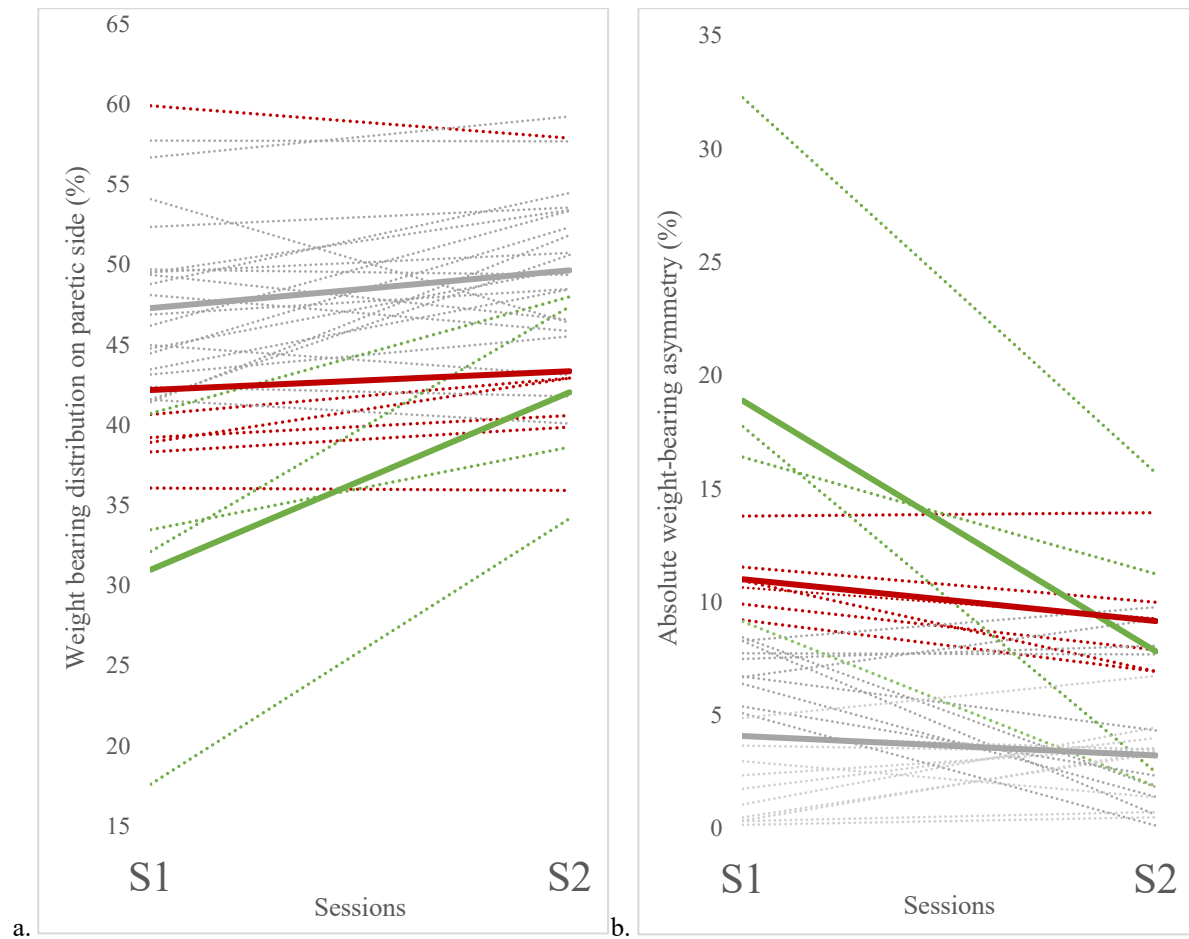


Figure 4. Weight bearing distribution on paretic side (a.) and absolute weight-bearing asymmetry (b.) at first (S1) and second sessions (S2). The symmetric group is displayed in grey, the asymmetric group with strong recovery in green and the asymmetric group with no or small recovery in red. Each dotted line represents an individual. Full lines are the mean of the 3 groups.

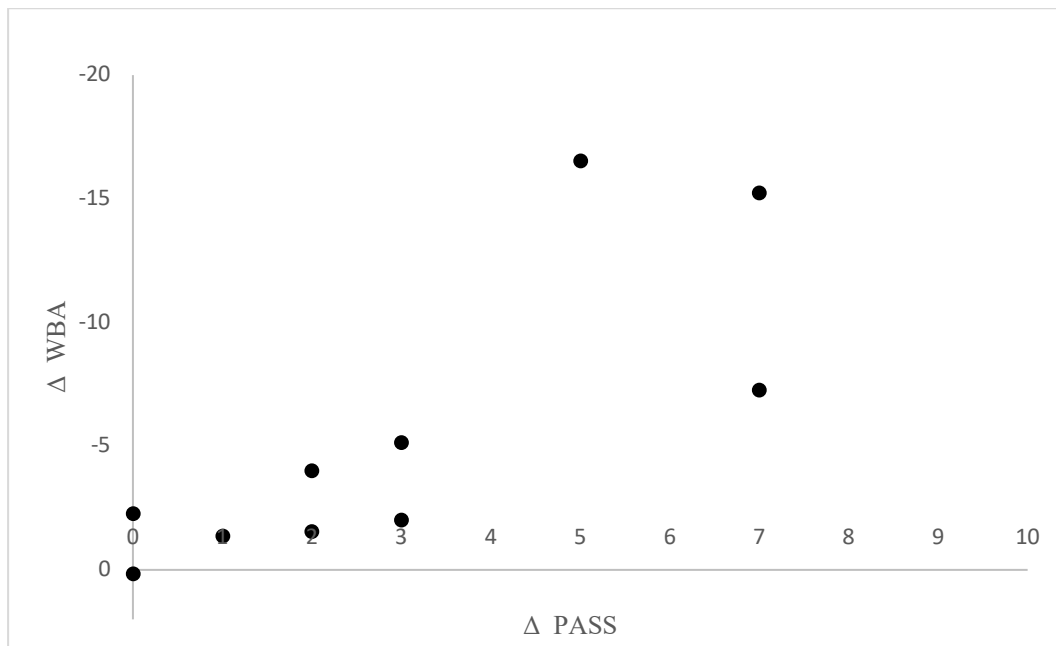


Figure 5. Correlations between WBA recovery (Δ WBA) and balance recovery, assessed by the PASS score (Δ PASS), among the 10 individuals considered as initially asymmetric ($R=-0.81$; $p=0.005$).

REFERENCES

1. Pérennou DA, Bronstein AM. Balance disorders and vertigo after stroke: assessment and rehabilitation. In: Barnes MP, Dobkin BH, Bogousslavsky J, éditeurs. *Recovery after Stroke*. 1^{re} éd. Cambridge University Press 2005; p. 320-96.
2. Sackley CM. The relationships between weight-bearing asymmetry after stroke, motor function and activities of daily living. *Physiotherapy Theory and Practice*. 1990; 6:179-85.
3. Weerdesteyn V, de Niet M, van Duijnhoven HJR, Geurts ACH. Falls in individuals with stroke. *J Rehabil Res Dev*. 2008; 45:1195-213.
4. Benaim C, Pérennou DA, Villy J, Rousseaux M, Pelissier JY. Validation of a Standardized Assessment of Postural Control in Stroke Patients: The Postural Assessment Scale for Stroke Patients (PASS). *Stroke* 1999; 30:1862-8.
5. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health* 1992; 83 Suppl 2:S7-11.
6. Mizrahi J, Solzi P, Ring H, Nisell R. Postural stability in stroke patients: Vectorial expression of asymmetry, sway activity and relative sequence of reactive forces. *Med Biol Eng Comput* 1989; 27:181-90.
7. Sackley CM. Falls, sway, and symmetry of weight-bearing after stroke. *International Disability Studies* 1991; 13:1-4.
8. Genthon N, Gissot A-S, Froger J, Rougier P, Pérennou D. Posturography in Patients With Stroke: Estimating the Percentage of Body Weight on Each Foot From a Single Force Platform. *Stroke* 2008; 39:489-489.
9. Jamal K, Leplaideur S, Lucas T, Naudet F, Bonan I. Postural asymmetry and hemiplegia post-stroke: A systematic review and meta-analysis. *Neurophysiologie Clinique* 2019; 49:446.
10. Nardone A, Godi M, Grasso M, Guglielmetti S, Schieppati M. Stabilometry is a predictor of gait performance in chronic hemiparetic stroke patients. *Gait & Posture* 2009; 30:5-10.
11. Guillebaste B, Rougier PR, Sibille B, Chrispin A, Detante O, Pérennou DA. When Might a Cane Be Necessary for Walking Following a Stroke? *Neurorehabil Neural Repair* 2012; 26:173-7.
12. Genthon N, Rougier P, Gissot A-S, Froger J, Pélissier J, Pérennou D. Contribution of Each Lower Limb to Upright Standing in Stroke Patients. *Stroke* 2008; 39:1793-9.
13. Di Fabio RP, Badke MB. Stance duration under sensory conflict conditions in patients with hemiplegia. *Arch Phys Med Rehabil* 1991; 72:292-5.
14. Barra J, Oujamaa L, Chauvineau V, Rougier P, Perennou D. Asymmetric standing posture after stroke is related to a biased egocentric coordinate system. *Neurology* 2009; 72:1582-7.
15. Halligan PW, Fink GR, Marshall JC, Vallar G. Spatial cognition: evidence from visual neglect. *Trends in Cognitive Sciences* 2003; 7:125-33.
16. Rode G, Tiliket C, Boisson D. Predominance of postural imbalance in left hemiparetic patients.

Scand J Rehabil Med 1997; 29:11-6.

17. Geurts ACH, de Haart M, van Nes IJW, Duysens J. A review of standing balance recovery from stroke. *Gait & Posture* 2005; 22:267-81.
18. Perennou D. Weight bearing asymmetry in standing hemiparetic patients. *J Neurol Neurosurg Psychiatry* 2005; 76:621.
19. De Haart M, Geurts AC, Huidekoper SC, Fasotti L, van Limbeek J. Recovery of standing balance in postacute stroke patients: a rehabilitation cohort study. *Archives of Physical Medicine and Rehabilitation* 2004; 85:886-95.
20. Dickstein R, Nissan M, Pillar T, Scheer D. Foot-Ground Pressure Pattern of Standing Hemiplegic Patients. *Physical Therapy* 1984; 64:19-23.
21. Laufer Y, Sivan D, Schwarzmann R, Sprecher E. Standing Balance and Functional Recovery of Patients with Right and Left Hemiparesis in the Early Stages of Rehabilitation. *Neurorehabil Neural Repair* 2003; 17:207-13.
22. Boumer TC, Martello SK, Devetak GF, Iucksch DD, Scrok ND, Manffra EF. Influence of feet position on COP measures in post-stroke patients in quiet standing. *Gait & Posture* 2018; 66:58-62.
23. Jeanson G, Pérennou D. What are the tools and criteria to diagnose and monitor weightbearing asymmetry in hemiparetic individuals? in preparation.
24. *Aids to the examination of the peripheral nervous system*. Edinburgh: Saunders 2010.
25. Ashworth B. PRELIMINARY TRIAL OF CARISOPRODOL IN MULTIPLE SCLEROSIS. *Practitioner* 1964; 192:540-2.
26. Azouvi P, Olivier S, de Montety G, Samuel C, Louis-Dreyfus A, Tesio L. Behavioral assessment of unilateral neglect: Study of the psychometric properties of the Catherine Bergego Scale. *Archives of Physical Medicine and Rehabilitation* 2003; 84:51-7.
27. Gauthier L, Dehaut F, Joanette Y. The Bells Test: A quantitative and qualitative test for visual neglect. *International Journal of Clinical Neuropsychology* 1989; 11:49-54.
28. Halligan PW, Marshall JC. How Long is a Piece of String? A Study of Line Bisection in a Case of Visual Neglect. *Cortex* 1988; 24:321-8.
29. Gainotti G, Messerli P, Tissot R. Qualitative analysis of unilateral spatial neglect in relation to laterality of cerebral lesions. *Journal of Neurology, Neurosurgery & Psychiatry* 1972; 35:545-50.
30. Bisiach E, Perani D, Vallar G, Berti A. Unilateral neglect: Personal and extra-personal. *Neuropsychologia* 1986; 24:759-67.
31. Cocchini G, Beschin N, Jehkonen M. The Fluff Test: A simple task to assess body representation neglect. *Neuropsychological Rehabilitation* 2001; 11:17-31.
32. Beschin N, Robertson IH. Personal Versus Extrapersonal Neglect: A Group Study of their Dissociation Using a Reliable Clinical Test. *Cortex* 1997; 33:379-84.
33. Karnath H-O, Ferber S, Dichgans J. The origin of contraversive pushing: Evidence for a second graviceptive system in humans. *Neurology* 2000; 55:1298-304.

34. Pérennou D, Bénéaim C, Rouget E, Rousseaux M, Blard JM, Pélissier J. [Postural balance following stroke: towards a disadvantage of the right brain-damaged hemisphere]. *Rev Neurol* 1999; 155:281-90.
35. Lindmark B, Hamrin E. Evaluation of functional capacity after stroke as a basis for active intervention. Presentation of a modified chart for motor capacity assessment and its reliability. *Scand J Rehabil Med* 1988; 20:103-9.
36. Chien C-W, Hu M-H, Tang P-F, Sheu C-F, Hsieh C-L. A Comparison of Psychometric Properties of the Smart Balance Master System and the Postural Assessment Scale for Stroke in People Who Have Had Mild Stroke. *Archives of Physical Medicine and Rehabilitation* 2007; 88:374-80.
37. Martello SK, Boumer TC, Almeida JC de, Correa KP, Devetak GF, Faucz R, et al. Reliability and minimal detectable change of between-limb synchronization, weight-bearing symmetry, and amplitude of postural sway in individuals with stroke. *Res Biomed Eng* 2017; 33:113-20.
38. Sandin KJ, Smith BS. The measure of balance in sitting in stroke rehabilitation prognosis. *Stroke* 1990; 21:82-6.
39. Juneja G, Czynny JJ, Linn RT. Admission balance and outcomes of patients admitted for acute inpatient rehabilitation. *Am J Phys Med Rehabil* 1998; 77:388-93.
40. Brosseau L, Philippe P, Potvin L, Boulanger YL. Post-stroke inpatient rehabilitation. I. Predicting length of stay. *Am J Phys Med Rehabil* 1996; 75:422-30.
41. Breistein K, Gjelsvik BEB, Jørgensen L. The Postural Assessment Scale for Stroke Patients: translation into Norwegian, cultural adaptation, and examination of reliability. *European Journal of Physiotherapy* 2017; 19:207-14.
42. Liaw L-J, Hsieh C-L, Lo S-K, Chen H-M, Lee S, Lin J-H. The relative and absolute reliability of two balance performance measures in chronic stroke patients. *Disability and Rehabilitation* 2008; 30:656-61.
43. Hsieh C, Yu W, Hsueh I, Hou W, Wang Y. A comparison of responsiveness and predictive validity of two balance measures in patients with stroke. *J Rehabil Med* 2012; 44:176-80.
44. Persson CU, Sunnerhagen KS, Danielsson A, Grimby-Ekman A, Hansson P-O. Responsiveness of a modified version of the postural assessment scale for stroke patients and longitudinal change in postural control after stroke- Postural Stroke Study in Gothenburg (POSTGOT). *J NeuroEngineering Rehabil* 2013; 10:8.
45. Hsueh I-P, Chen K-L, Chou Y-T, Wang Y-H, Hsieh C-L. Individual-Level Responsiveness of the Original and Short-Form Postural Assessment Scale for Stroke Patients. *Physical Therapy* 2013; 93:1377-82.
46. Eng JJ, Chu KS. Reliability and comparison of weight-bearing ability during standing tasks for individuals with chronic stroke. *Archives of Physical Medicine and Rehabilitation* 2002; 8:1138-44.
47. Gasq D, Labrunée M, Amarantini D, Dupui P, Montoya R, Marque P. Between-day reliability of centre of pressure measures for balance assessment in hemiplegic stroke patients. *J NeuroEngineering Rehabil* 2013; 10:8.

Rehabil 2014; 11:39.

48. Carpenter MG, Frank JS, Winter DA, Peysar GW. Sampling duration effects on centre of pressure summary measures. *Gait & Posture* 2001; 13:35-40.
49. Kapoula Z, Lê T-T. Effects of distance and gaze position on postural stability in young and old subjects. *Exp Brain Res* 2006; 173:438-45.
50. Zok M, Mazzà C, Cappozzo A. Should the instructions issued to the subject in traditional static posturography be standardised? *Medical Engineering & Physics* 2008; 30:913-6.
51. Lafond D, Corriveau H, Hébert R, Prince F. Intrasession reliability of center of pressure measures of postural steadiness in healthy elderly people. *Archives of Physical Medicine and Rehabilitation* 2004; 85:896-901.
52. Pinsault N, Vuillerme N. Test–retest reliability of centre of foot pressure measures to assess postural control during unperturbed stance. *Medical Engineering & Physics* 2009; 31:276-86.
53. Yanohara R, Teranishi T, Tomita Y, Tanino G, Ueno Y, Sonoda S. Recovery Process of Standing Postural Control in Hemiplegia after Stroke. *J Phys Ther Sci* 2014; 26:1761-5.
54. Bonan I, Butet S, Jamal K, Yelnik A, Tasseel Ponche S, Leplaideur S. Difference between individuals with left and right hemiparesis in the effect of gluteus medius vibration on body weight shifting. *Neurophysiologie Clinique* 2017; 47:419-26.
55. Corriveau H, Hébert R, Raïche M, Prince F. Evaluation of postural stability in the elderly with stroke. *Archives of Physical Medicine and Rehabilitation* 2004; 85:1095-101.
56. Peters S, Ivanova TD, Teasell R, Garland SJ. Is the Recovery of Functional Balance and Mobility Accompanied by Physiological Recovery in People With Severe Impairments After Stroke? *Neurorehabil Neural Repair* 2014; 28:847-55.
57. Prabhakaran S, Zarahn E, Riley C, Speizer A, Chong JY, Lazar RM, et al. Inter-individual Variability in the Capacity for Motor Recovery After Ischemic Stroke. *Neurorehabil Neural Repair* 2008; 22:64-71.
58. Hope TMH, Friston K, Price CJ, Leff AP, Rotshtein P, Bowman H. Recovery after stroke: not so proportional after all? *Brain* 2019; 142:15-22.
59. Hawe RL, Scott SH, Dukelow SP. Taking Proportional Out of Stroke Recovery. *Stroke* 2019; 50:204-11.
60. Van Breukelen GJP. ANCOVA versus change from baseline had more power in randomized studies and more bias in nonrandomized studies. *Journal of Clinical Epidemiology* 2006; 59:920-5.
61. Kozlowski AJ, Pretz CR, Dams-O'Connor K, Kreider S, Whiteneck G. An Introduction to Applying Individual Growth Curve Models to Evaluate Change in Rehabilitation: A National Institute on Disability and Rehabilitation Research Traumatic Brain Injury Model Systems Report. *Archives of Physical Medicine and Rehabilitation* 2013; 94:589-96.
62. O'Connell AA, McCoach DB. Applications of Hierarchical Linear Models for Evaluations of Health Interventions: Demystifying the Methods and Interpretations of Multilevel Models. *Eval Health*

Prof 2004; 27:119-51.

63. Dijkers MP. Chasing Change: Repeated-Measures Analysis of Variance Is So Yesterday!
Archives of Physical Medicine and Rehabilitation 2013; 94:597-9.

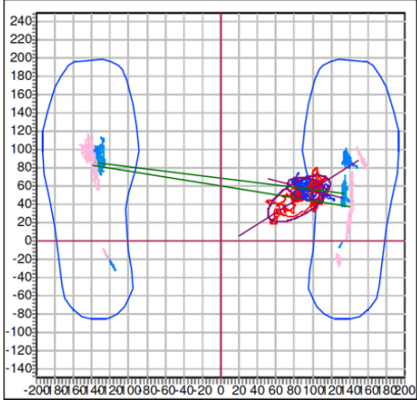
64. Mansfield A, Danells CJ, Zettel JL, Black SE, McIlroy WE. Determinants and consequences for standing balance of spontaneous weight-bearing on the paretic side among individuals with chronic stroke. Gait Posture 2013; 38:428-32.

ADDITIONNAL MATERIALS

Example of a participant evaluated on a force platform (a.), who decreased his weight-bearing asymmetry between the first (b.) and the second (c.) posturographic session.

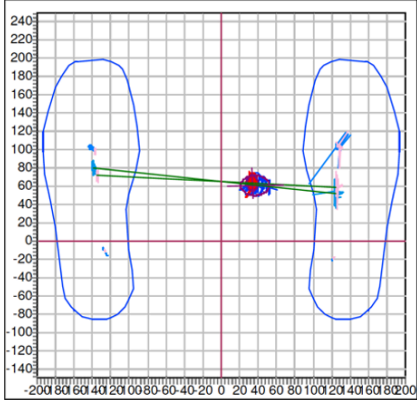


a.



b.

Session 1



c.

Session 2

Medical Research Council for muscle strength

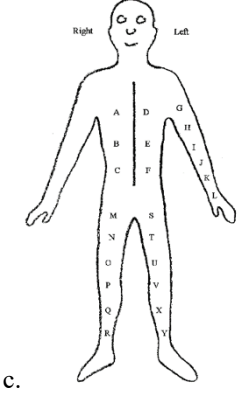
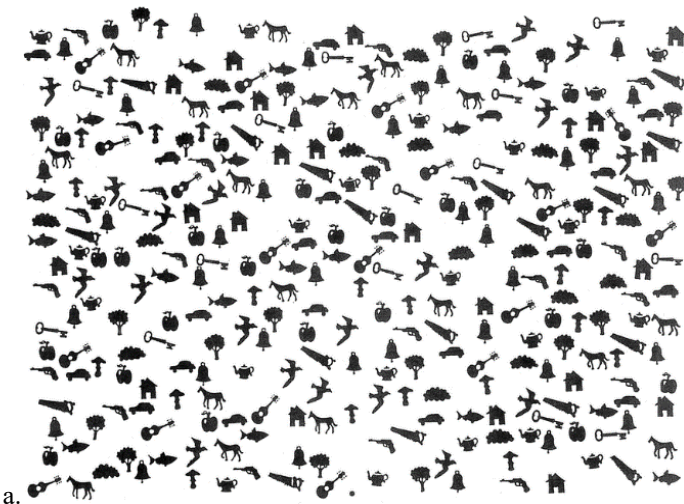
0	No contraction
1	Flicker or trace contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

Modified Ashworth Scale for grading spasticity

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part/s is/are moved in flexion or extension.
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM.
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved.
3	Considerable increase in muscle tone, passive movement difficult.
4	Affected part(s) rigid in flexion or extension.

ROM, range of motion.

Spatial neglect assessment (a. The Bells Test; b. The Gainotti copy; c. The Fluff test; d. The Catherine Bergego Scale)



	0	1	2	3
1. Forgets to groom or shave the left part of his/her face	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Experiences difficulty in adjusting his/her left sleeve or slipper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Forgets to eat food on the left side of his/her plate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Forgets to clean the left side of his/her mouth after eating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Experiences difficulty in looking towards the left	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Forgets about a left part of his/her body (eg, forgets to put his/her upper limb on the armrest, or his/her left foot on the wheelchair rest, or forgets to use his/her left arm when he/she needs to)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Has difficulty in paying attention to noise or people addressing him/her from the left	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Collides with people or objects on the left side, such as doors or furniture (either while walking or driving a wheelchair)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Experiences difficulty in finding his/her way towards the left when traveling in familiar places or in the rehabilitation unit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Experiences difficulty finding his/her personal belongings in the room or bathroom when they are on the left side	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Total score (/30)				

d.

0=no neglect; 1=mild neglect; 2=moderate neglect; 3=severe neglect

Scale for Contraversive Pushing (SCP)

A	Spontaneous body posture	Sitting	Standing
	1 = severe contraversive tilt with falling to that side	<input type="checkbox"/>	<input type="checkbox"/>
	0.75 = severe contraversive tilt without falling	<input type="checkbox"/>	<input type="checkbox"/>
	0.25 = mild contraversive tilt without falling	<input type="checkbox"/>	<input type="checkbox"/>
	0 = inconspicuous	<input type="checkbox"/>	<input type="checkbox"/>
		Total (max = 2)	
B	Use of the nonparetic extremities (abduction &)		
	1 = performed spontaneously, already when at rest	<input type="checkbox"/>	<input type="checkbox"/>
	0.5 = performed only on changing the position (e.g., on transferring from bed to wheelchair)	<input type="checkbox"/>	<input type="checkbox"/>
	0 = inconspicuous	<input type="checkbox"/>	<input type="checkbox"/>
		Total (max = 2)	
C	Resistance to passive correction of tilted posture ^a		
	1 = resistance occurs	<input type="checkbox"/>	<input type="checkbox"/>
	0 = resistance does not occur	<input type="checkbox"/>	<input type="checkbox"/>
		Total (max = 2)	

a. Touch the patient at the sternum and the back. Instruction: "I will move your body sideways. Please permit this movement."

Postural Assessment Scale for Stroke Patients (PASS)

Maintaining a Posture

1. Sitting without support (sitting on the edge of an 50-cm-high examination table [a Bobath plane, for instance] with the feet touching the floor)

0=cannot sit

1=can sit with slight support, for example, by 1 hand

2=can sit for more than 10 seconds without support

3=can sit for 5 minutes without support

2. Standing with support (feet position free, no other constraints)

0=cannot stand, even with support

1=can stand with strong support of 2 people

2=can stand with moderate support of 1 person

3=can stand with support of only 1 hand

3. Standing without support (feet position free, no other constraints)

0=cannot stand without support

1=can stand without support for 10 seconds or leans heavily on

1 leg

2=can stand without support for 1 minute or stands slightly asymmetrically

3=can stand without support for more than 1 minute and at the same time perform arm movements above the shoulder level

4. Standing on nonparetic leg (no other constraints)

0=cannot stand on nonparetic leg

1=can stand on nonparetic leg for a few seconds

2=can stand on nonparetic leg for more than 5 seconds

3=can stand on nonparetic leg for more than 10 seconds

5. Standing on paretic leg (no other constraints)

Same scoring as item 4

Changing Posture

Scoring of items 6 to 12 is as follows (items 6 to 11 are to be performed with a 50-cm-high examination table, like a Bobath plane; items 10 to 12 are to be performed without any support; no other constraints):

0=cannot perform the activity

1=can perform the activity with much help

2=can perform the activity with little help

3=can perform the activity without help

6. Supine to affected side lateral

7. Supine to nonaffected side lateral

8. Supine to sitting up on the edge of the table

9. Sitting on the edge of the table to supine

10. Sitting to standing up

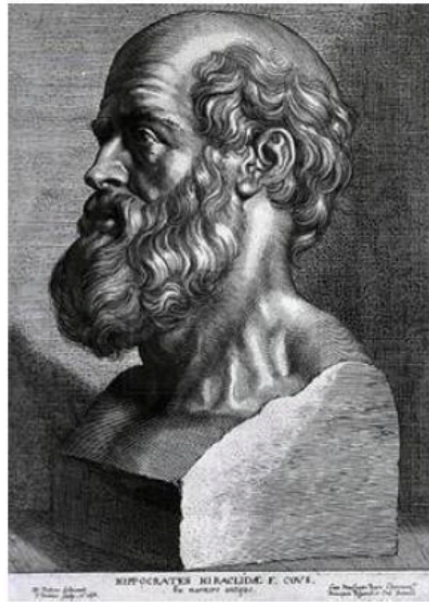
11. Standing up to sitting down

12. Standing, picking up a pencil from the floor

Modified Fugl-Meyer Assessment (mGait-FM)

Lindmark and Hamrin Walking Scale

	Score	Meaning
Needs a human or technical aid	0	Cannot walk
	1	Can take a few steps with the help of 2 persons
	2	Can take a few steps with the help of 1 person
	3	Can walk with a roller, crutches, or quadripods
	4	Can walk with one stick or one crutch
Walk without a technical aid	5	Can walk without a walking aid, but walks slowly or limps
	6	Can walk at a normal speed for his or her age



SERMENT D'HIPPOCRATE

En présence des Maîtres de cette Faculté, de mes chers condisciples et devant l'effigie d'HIPPOCRATE,

Je promets et je jure d'être fidèle aux lois de l'honneur et de la probité dans l'exercice de la Médecine.

Je donnerai mes soins gratuitement à l'indigent et n'exigerai jamais un salaire au dessus de mon travail. Je ne participerai à aucun partage clandestin d'honoraires.

Admis dans l'intimité des maisons, mes yeux n'y verront pas ce qui s'y passe ; ma langue taira les secrets qui me seront confiés et mon état ne servira pas à corrompre les mœurs, ni à favoriser le crime.

Je ne permettrai pas que des considérations de religion, de nation, de race, de parti ou de classe sociale viennent s'interposer entre mon devoir et mon patient.

Je garderai le respect absolu de la vie humaine.

Même sous la menace, je n'admettrai pas de faire usage de mes connaissances médicales contre les lois de l'humanité.

Respectueux et reconnaissant envers mes Maîtres, je rendrai à leurs enfants l'instruction que j'ai reçue de leurs pères.

Que les hommes m'accordent leur estime si je suis fidèle à mes promesses.

Que je sois couvert d'opprobre et méprisé de mes confrères si j'y manque.