UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE CIÊNCIAS MÉDICAS

ADRIANA TERESA SILVA

TREINO DE VIBRAÇÃO DE CORPO INTEIRO NA FUNÇÃO MOTORA EM PACIENTES ACOMETIDOS POR ACIDENTE VASCULAR CEREBRAL

WHOLE BODY VIBRATION TRAINING IN MOTOR FUNCTION IN PATIENTS AFFECTED WITH STROKE

CAMPINAS

2015

ADRIANA TERESA SILVA

TREINO DE VIBRAÇÃO DE CORPO INTEIRO NA FUNÇÃO MOTORA EM PACIENTES ACOMETIDOS POR ACIDENTE VASCULAR CEREBRAL

WHOLE BODY VIBRATION TRAINING IN MOTOR FUNCTION IN PATIENTS AFFECTED WITH STROKE

Tese apresentada à Faculdade de Ciências Médicas da Universidade Estadual de Campinas como parte dos requisitos exigidos para a obtenção do título de Doutora em Ciências Médicas área de concentração em Neurologia

Thesis presented to the School of the State University of Campinas Medical Sciences as part of the requirements for obtain the PhD grade in Medical Sciences area of concentration in Neurology.

ORIENTADOR: DONIZETI CESAR HONORATO

ESTE EXEMPLAR CORRESPONDE À VERSÃO
FINAL DA TESE DEFENDIDA PELA
ALUNA ADRIANA TERESA SILVA, E ORIENTADO PELO
PROF. DR. DONIZETI CESAR HONORATO

CAMPINAS

2015

Agência(s) de fomento e nº(s) de processo(s): Não se aplica.

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca da Faculdade de Ciências Médicas
Maristella Soares dos Santos - CRB 8/8402

Si38t Silva, Adriana Teresa, 1975-
Treino de vibração de corpo inteiro na função motora em pacientes acometidos por acidente vascular cerebral / Adriana Teresa Silva. – Campinas, SP : [s.n.], 2015.

Orientador: Donizeti Cesar Honorato.
Tese (doutorado) – Universidade Estadual de Campinas, Faculdade de Ciências Médicas.

1. Acidente vascular cerebral. 2. Vibração - Uso terapêutico. 3. Capacidade motora. I. Honorato, Donizeti Cesar,1955-. II. Universidade Estadual de Campinas. Faculdade de Ciências Médicas. III. Título.

Informações para Biblioteca Digital

Título em outro idioma: Whole body vibration training in motor function in patients affected with stroke
Palavras-chave em inglês:
Stroke
Vibration, Therapeutic use
Motor ability
Área de concentração: Neurologia
Titulação: Doutora em Ciências Médicas
Banca examinadora:
Donizeti Cesar Honorato [Orientador]
Giovane Galdino de Souza
Adriana Prado Simão
Larissa Carvalho Pereira
Ana Carolina Coan
Data de defesa: 27-08-2015
Programa de Pós-Graduação: Ciências Médicas

BANCA EXAMINADORA DA DEFESA DE DOUTORADO

ADRIANA TERESA SILVA

ORIENTADOR: DONIZETI CESAR HONORATO

MEMBROS:

1. PROF. DR.(A) DONIZETI CESAR HONORATO

2. PROF. DR.(A) GIOVANE GALDINO DE SOUZA

3. PROF. DR.(A) ADRIANO PRADO SIMÃO

4. PROF. DR.(A) LARISSA CARVALHO PEREIRA

5. PROF. DR. (A) ANA CAROLINA COAN

Programa de Pós-Graduação em Ciências Medicas da Faculdade de Ciências Médicas da Universidade Estadual de Campinas.

A ata de defesa com as respectivas assinaturas dos membros da banca examinadora encontra-se no processo de vida acadêmica do aluno.

Data: 27 de agosto de 2015

DEDICATÓRIA

Ao meu pai Antônio Camilo, exemplo de pai, cidadão, homem, marido. Sempre meu Norte.

In memória

A minha mãe Maria Aparecida, sempre em busca de novos desafios e conquistas, exemplo de perseverança e obstinação.

Ao meu marido Paulo Santos, homem em sua totalidade, sem a qual jamais serei completa.

Ao meu filho Saulo Janreta, cada gargalhada sua é minha alegria da vida.

RESUMO

O Acidente Vascular Cerebral (AVC) é um problema de saúde pública relevante em virtude de sua alta frequência e de grande impacto na população. Os sobreviventes apresentam sequelas que implicam algum grau de dependência e um elevado custo social. Minimizar as sequelas e aumentar a recuperação funcional tem sido um ponto importante para os profissionais da reabilitação. O objetivo do **artigo 1** foi verificar os efeitos do treino de vibração de corpo inteiro nos pacientes acometidos por Acidente Vascular Cerebral. A amostra foi constituída de 27 indivíduos com hemiparesia espástica decorrente de AVC. Os instrumentos utilizados para avaliação foram: testes de caminhada de 6 minutos (TC6M), Teste de subir escada (TSE), Teste de *Time Get-Up-and-Go* (TGUG). Os testes foram aplicados antes, após e um *follow-up* após um mês da intervenção. Aplicou-se a terapia vibratória (frequência - 50 Hz e amplitude - 2 mm) por 8 semanas de treino. Nas quatros primeiras semanas foi realizado 4 séries de 60 segundos e nas quatros últimas semanas dobrou o número de séries. Houve diferença estatística para os TC6M, TE e TGUG ($p<0,001$). A terapia vibratória pode contribuir para melhora da função motora em pacientes acometidos por AVC. Em um segundo estudo (**artigo 2**), O objetivo foi investigar o efeito do treinamento de vibração de corpo inteiro na impressão plantar e função motora em pacientes acometidos por acidente vascular cerebral. A amostra foi composta por 28 indivíduos com hemiparesia após AVC que foram randomizados em grupo intervenção (n = 18) e grupo controle (n = 10). Os instrumentos utilizados para avaliação foram o Mini Exame do Estado Mental, fotopodoscopia e o teste de caminhada de 6 minutos (TC6). Para o tratamento foi utilizada a terapia da vibração de corpo inteiro, três vezes por semana, durante 8 semanas. O tratamento foi realizado em duas etapas: a primeira etapa 4 semanas - 4 série de 60 segundos de vibração. Na primeira série paciente em uma posição ereta estática, mantendo os pés separados com os joelhos semi-flexionados a 30°. Na segunda série, a mesma posição apenas com os joelhos fletidos em 90°. Na terceira série posição ortostática, com o apoio de uma perna no membro afetado com o joelho semi-flexionado a 30°. Na quarta série voltou novamente igual à primeira série. A segunda etapa 4 semanas – dobrou-se o número de série. Os dados foram analisados pelo teste t independente e medidas ANOVA repetidas com dois fatores. Não houve diferença estatística nem intergrupos e nem intragrupo ($p = 0,05$) na área de impressão plantar no lado afetado e não afetado, só houve diferença estatística intragrupo no TC6 ($p = 0,03$). Conclui-se que o treinamento de vibração de corpo inteiro não influenciou no aumento da área de impressão plantar e na função motora em pacientes de AVC. No terceiro estudo (**artigo 3**), O objetivo foi verificar a influência do treinamento vibratório de corpo inteiro no sinal eletromiográfico dos músculos reto femural (RF) e tibial anterior (TA) em pacientes acometido AVC. A amostra constituiu de 43 pacientes hemiparético acometido por AVC, onde foram randomizados em 2 grupos: controle (GC, n=19) e intervenção (GI, n=24). Os instrumentos utilizados para avaliação foram o Miniexame do estado mental e a Escala de Avaliação de Fugl-Meyer e eletromiografia (EMG) de superfície na contração isométrica voluntária (CIV) dos músculos RF e TA bilateralmente e simultameamente. Utilizou-se para o tratamento a terapia de vibração de corpo inteiro, 3 vezes na semana por 8 semanas. Os resultados mostram que RMS da atividade EMG não alterou intragrupo e nem intergrupo. Conclui-se que o treino de vibração de corpo inteiro não influenciou o sinal EMG dos músculos RF e TA em pacientes com AVC.

Palavras-chave: Acidente Vascular Cerebral, fisioterapia e reabilitação.

ABSTRACT

Stroke is a relevant public health problem, due to its high frequency and strong impact on the population. The survivors have sequelae involving some degree of dependence and a high social cost, minimize the consequences and enhance functional recovery has been an important point for rehabilitation professionals. The objective of this article was first verify the effects of vibration training on lower limb function in patients affected by stroke. The sample comprised of 27 individuals presenting with spastic hemiparesis due to stroke. The instruments used for evaluation were: The six minute walking test (6MWT), the stair climbing test (SCT) and the timed get up and go test (TUG) were applied to evaluate the lower members' motor function. The tests were applied before and after the intervention, as well as after a follow-up, which was performed 1 month later. Participants received whole body vibration training at a frequency of 50 Hz and 2 mm amplitude, for 8 weeks. In the first 4 weeks, participants underwent a series of four 60-second, periods last 4 weeks, we doubled the number of series of vibration. difference was statistically the 6MWT ,SCT and TUG (P=0.00). Vibration therapy can contribute to the improvement of the lower limbs' motor function in patients affected by stroke. In a second study (Article 2) The objective was to investigate the effect of vibration training in printing plant and motor function in patients affected by stroke. The sample consisted of 28 individuals with hemiparesis after stroke who were randomized into intervention group (n = 18) and control group (n = 10). The instruments used for evaluation were the Mini Mental State Examination, photopodoscopy and the 6-minute walk test (6MWT). For treatment was used the whole body vibration therapy three times a week for 8 weeks. The treatment was performed in two steps: the first step four weeks - 4 series of 60 seconds of vibration. The first patient series in a static standing position, keeping your feet apart with semi-flexed to 30 ° knees. In the second series, the same position only with the knees flexed at 90 °. In third grade standing position, with the support of a leg on the affected limb with semi-flexed to 30° knee. In fourth grade back again like the first series. The second step four weeks - bent the serial number. Data were analyzed by independent t-test and ANOVA repeated measures with two factors. There was no statistical difference or intergroup and intragroup not (p = 0.05) in the print area to plant in the affected and unaffected side, there was only intra-group statistical difference in 6MWT (p = 0.03). It is concluded that whole body vibration training did not influence the increase in print area plant and motor function in stroke patients. In the third study (Article 3) The objective was to verify the influence of vibration training in electrical activity retofemural muscles (RF) and tibialis anterior (TA) in affected stroke patients. The sample consisted of 43 hemiparetic patients affected by stroke, which were randomized into 2 groups: control (CG, n = 19) and intervention (GI, n = 24). The instruments used for evaluation were the Mini-mental state and the Fugl-Meyer Assessment Scale and electromyography (EMG) surface on voluntary isometric contraction (IVC) of RF and TA muscles bilaterally and simultaneously. We used to treat the whole body vibration therapy, 3 times a week for 8 weeks. The results show that rms EMG activity did not affect intra-group and inter-group or. It concludes that the vibration training did not influence the EMG signal from the RF and TA muscles in stroke patients.

Key word: Stroke, Physiotherapy and rehabilitation.

SUMÁRIO

1. INTRODUÇÃO.. 11

2. OBJETIVOS 14

3. METODOLOGIA.. 15

4. RESULTADOS 17

5. DISCUSSÃO GERAL 70

6. CONCLUSÃO.. 72

7. REFERÊNCIAS 73

8. APÊNDICES.. 82

9. ANEXOS.. 85

1. INTRODUÇÃO

O Acidente Vascular Cerebral (AVC) refere-se a sinais e sintomas neurológicos que resultam de sequelas que estão envolvidas com os vasos sanguíneos, de instalação rápida com duração maior que 24 horas[1-3].

No Brasil, é uma das principais causas de morte[4]. Os sobreviventes apresentam sequelas que implicam algum grau de dependência e um elevado custo social, principalmente no primeiro ano após o AVC[5].

As sequelas deixadas pelo AVC são variáveis, dentro delas podemos citar os distúrbios somatossensoriais, visuais, vestibulares e musculoesqueléticos, que vão interferir no controle motor e na qualidade de vida do seu portador[6-9]. Estes déficits neurológicos advêm do local, do tamanho e da área que ocorreu a lesão[10.]

As alterações somatossensoriais poderão afetar negativamente os padrões da marcha como, por exemplo: menor descarga de peso sobre o lado acometido, alteração na velocidade e cadência, simetria, equilíbrio, reação de proteção, comprimento do passo, redução na fase de balanço[11-13]. A capacidade para andar é uma limitação bastante observada na fase inicial da doença, a sua recuperação pode levar meses, e às vezes ser incompleta limitando a velocidade e a resistência aeróbica para a caminhar[14-16].

As informações somatossensoriais são pré-requisitos para a execução do controle voluntário mais preciso[17]. Alguns estudos realizados em macacos, com lesão do córtex somatossensorial, interferiram nas habilidades de executar novas tarefas motoras, na coordenação e na precisão do movimento[18].

A estimulação aferente prolongada em indivíduos saudáveis ou em pacientes com AVC agudos ou crônicos, na forma de estimulação nervosa periférica, pode resultar em aumento da excitabilidade das projeções córticoespinhais, com consequente melhora das aquisições motoras[19-22].

A reabilitação destes pacientes com AVC, na maioria das vezes tem sido um desafio. Minimizar as sequelas e aumentar a recuperação funcional tem sido um ponto importante para os profissionais da reabilitação[23]. Diferentes técnicas têm sido empregadas para recuperação da função destes pacientes. A técnica da vibração do corpo inteiro é um dos recursos capazes de influenciar no controle motor[24-26], sendo uma nova forma de terapia considerada promissora de estimulação somatossensorial. Recentes estudos mostram que a vibração de corpo inteiro tem sido utilizada com sucesso no aumento da atividade muscular e melhora do desempenho motor[27-29]

A vibração de corpo inteiro é definida como um movimento oscilatório dependente da frequência, da amplitude, duração e do tipo de vibração, podendo ser um potente estímulo para respostas neuromusculares[30].

Algumas hipóteses têm sido discutidas a fim de explicar quais seriam os mecanismos fisiológicos envolvidos com esta terapia. A principal hipótese seria o reflexo de vibração tônica (RVT), que se assemelha ao reflexo de estiramento clássico[24,25]. Quando aplicado sobre o corpo, os estímulos mecânicos produzidos pela vibração acionam uma cascata de eventos sobre as vias centrais e periféricas[31,32]. Um destes eventos seria a maior ativação do fuso neuromuscular, induzindo maior recrutamento do motoneurônio α e ativação muscular mais eficiente, a qual poderá ser verificada através da eletromiografia de superfície[,33,34,35]

No entanto, alguns estudos demonstram não haver um incremento da atividade eletromiográfica dos membros inferiores após o estímulo vibratório, apesar de aumentar o desempenho funcional[35,36].

Em atletas a terapia de vibração de corpo inteiro produziu efeitos imediatos e a longo prazo na melhora do desempenho no salto vertical, na flexibilidade e na força[37,38]. Em uma única sessão de vibração de corpo inteiro foi capaz de melhorar a força de contração voluntária máxima em pacientes acometidos por AVC[39].

Várias semanas de treino de vibração de corpo inteiro em diversas lesões centrais foram capazes de promover melhora no desempenho motor. Estudos sugerem que a vibração pode ser uma ferramenta útil para um programa de reabilitação[40-42] e posteriormente poderia facilitar o movimento voluntário através da ativação de áreas motoras corticais demonstrada pelo estudo de Cardinale e Bosco[33].

Lau *et al.*[43] mostraram que um treino de 8 semanas com vibração de corpo inteiro em pacientes com AVC, não foi mais efetivo na melhora da execução motora e diminuição de quedas, quando comparada com o grupo controle.

Dados de alguns estudos relatam que um curto período de aplicação da vibração de corpo inteiro foi capaz de reduzir a espasticidade dos músculos flexores plantares e produziu melhora da função da marcha, como também, melhora no controle postural e aumento da força voluntária máxima do músculo espástico, além de uma redução da ativação da musculatura antagonista em pacientes com AVC[44-46].

Com relação aos estudos supracitados ainda existem controvérsias sobre o efeito produzido pela vibração de corpo inteiro no tecido musculoesquelético principalmente em pacientes com AVC. Há necessidade de documentar melhor os efeitos produzidos pela vibração e sua influência nos diferentes fatores incluindo os parâmetros como frequência, amplitude, tipo de exercício e intensidade. Assim, profissionais que trabalham com a reabilitação de pacientes neurológicos poderiam se beneficiar desta técnica para melhorar o desempenho motor destes pacientes, visto que, a terapia vibratória atualmente está mais acessível nas clínicas de reabilitação.

2. OBJETIVOS

2.1 Geral:

Verificar os efeitos do treino de vibração de corpo inteiro em pacientes acometidos por AVC.

2.2 Específico:

Verificar se o treino de vibração de corpo inteiro irá promover melhora da função motora dos membros inferiores em pacientes acometidos por AVC (**artigo 1**).

Verificar se o treino de vibração de corpo inteiro promoverá alteração da impressão plantar em pacientes acometidos por AVC (**artigo 2**).

Verificar a influência do treino vibratório no sinal eletromiográfico dos músculos reto femural (RF) e tibial anterior (TA) em pacientes acometidos por AVC (**artigo 3)**.

3. METODOLOGIA

As realizações desses estudos obedeceram todos os princípios éticos para pesquisa envolvendo seres humanos conforme a resolução 196/96 do Conselho Nacional de Saúde, recebendo a aprovação do Comitê de Ética em Pesquisa da Universidade do Vale do Sapucaí (ANEXO C). Os artigos II e III foram registrados no registro de ensaio clínico do Brasil (ANEXO D).

Foram realizados três estudos: O primeiro estudo foi verificar a influência do treino vibratório de corpo inteiro na função motora e no desempenho funcional nos membros inferiores em pacientes com AVC. Para realização deste estudo utilizou os testes: avaliação da função motora através da escala Fugl-Meyer e a avaliação da função cognitiva através do teste do Miniexame do estado mental. Esses dois teste foram utilizados para selecionar a amostra. Os testes Caminhada de seis minutos; teste de subir escadas e o teste de *Timed Up and Go* foram empregados para verificar do desempenho funcional. Para a intervenção utilizou a vibração do corpo inteiro através da plataforma vibratória triplanar (Lions®, frequência de 50 Hz e 2mm de amplitude). Os detalhes de todos os teste e procedimentos para realização da intervenção estão descritos na página 19 e 20. No segundo estudo, foi verificar a influência do treino vibratório de corpo inteiro na impressão plantar e no desempenho funcional em pacientes com AVC. Para a realização deste estudo também utilizou os mesmo testes para seleção da amostra. O que diferenciou foi na utilização do podoscópio (Carci®) para avaliar a impressão plantar. Para desempenho funcional aplicou o mesmo teste de Caminhada de seis minutos. Todos os procedimentos quanto a intervenção e realização dos testes estão descritos na página 30. No terceiro estudo, foi verificar a influência do treino vibratório de corpo inteiro no sinal eletromiográfico dos RF e TA em pacientes acometido por AVC. O que diferencia dos estudos anteriores foi utilização da eletromiografia de superfície (EMG system Brasil®) para analisar o sinal eletromiográfico após a aplicação do treinamento vibratório de corpo inteiro por 8 semanas de treino; como também analisar qual o comportamento do sinal eletromiográfico através de uma frequência de 50 Hz e 2 mm de amplitude na plataforma vibratória. Também nesse estudo, verificou qual o comportamento do sinal eletromiográfico no membro parético de pacientes com AVC. Os procedimento da avaliação e de intervenção estão descritos na pagina 53 e 54.

As amostras dos três estudos estavam em tratamento fisioterapêutico no ambulatório de fisioterapia do Hospital das Clínicas Samuel Libânio (HCSL). Foram recrutados deste ambulatório e também do ambulatório de neurologia do HCSL, todos os indivíduos mantiveram o tratamento fisioterapêutico e paralelo a este também realizaram a intervenção com a terapia vibratória de corpo inteiro.

Para a intervenção com a terapia vibratória de corpo inteiro nos três estudos, foram solicitados aos indivíduos permanecer descalço com os pés afastados a uma distância de 25 cm sobre a plataforma vibratória e realizaram quatro atividades de exercício de agachamento numa angulação de 30º e 90º de flexão dos joelhos com apoio bipodal e unipodal sobre o membro parético. Todos os detalhes sobre a intervenção estão descritos nos três artigos no capítulo à frente.

4. RESULTADOS

ARTIGO I

Whole body vibration training for lower limb motor function among stroke patients.

Publicado na revista International Journal of therapy and Rehabilitation 2013;20(5):260-266.

Whole body vibration training for lower limb motor function among stroke patients

Adriana Silva, Andreia Silva, Miqueline Dias, Ruanito Calixto Junior, Beatriz Martinez, Donizeti Honorato, Geraldo Fernandes

Background/aim: *Motor function impairment is a frequent problem in stroke patients and many questions remain about the application of vibration therapy for neurological patients. This study aims to verify the effects of vibration training on lower limb function in patients affected by stroke.*
Methods: *This was a clinical, prospective study. The study's subjects were selected via a convenience sample from Samuel Libanio Hospital's Physical Therapy and Neurology Out-patient clinics in Pouso Alegre, Brazil. The sample comprised of 27 individuals presenting with spastic hemiparesis due to stroke. Participants received whole body vibration training at a frequency of 50 Hz and 2 mm amplitude, for 8 weeks. In the first 4 weeks, participants underwent a series of four 60-second periods of vibration in the following positions: in orthostatic posture, first with the knees semi-flexed at 30°, then with the knees semi-flexed at 90°, and then with the affected knee semi-flexed at 30°, and finally in orthostatic posture again with the knees semi-flexed at 30°. In the last 4 weeks, we doubled the number of series of vibration, but used the same positions. The six minute walking test (6MWT), the stair climbing test (SCT) and the timed get up and go test (TUG) were applied to evaluate the lower members' motor function. The tests were applied before and after the intervention, as well as after a follow-up, which was performed 1 month later.*
Results: *This study found statistical differences in the 6MWT (P=0.00), SCT (P=0.00), and TUG (P=0.00), indicating improvement in the participants' lower limbs motor function.*
Conclusion: *Vibration therapy can contribute to the improvement of the lower limbs' motor function in patients affected by stroke.*

Key words: ■ Vibration ■ Rehabilitation ■ Hemiparesis ■ Function ■ Stroke

Submitted 23 November 2012, sent back for revisions 3 April 2013; accepted for publication following double-blind peer review 12 April 2013

Adriana Silva *is a Physiotherapist and Researcher at the Department of Neurology of the Medical SciencesCollege of State University of Campinas, Brazil;* **Andreia Silva** *is a Physiotherapist and Researcher at the Department of physical Therapy of Federal University of Alfenas, Brazil,* **Miqueline Dias** *is a Physiotherapist and Researcher at Sapucaí Vale university, Pouso Alegre, Brazil;* **Ruanito Calixto Junior** *is a Doctor and Researcher at Sapucaí Vale university, Pouso Alegre, Brazil;* **Beatriz Martinez** *is a Doctor and Researcher at Sapucaí Vale university, Pouso Alegre, Brazil;* **Donizeti Honorato** *is Doctor and Researcher at the Department of Neurology of Medical Sciences College of State University of Campinas, Brazil,* **Geraldo Fernandes** *is a Doctor and Researcher at the Department of Physical Therapy at Federal University of Alfenas, Brazil.*
Correspondence to: Adriana Teresa Silva
E-mail: adrianat.silva@yahoo.com.br

Despite the drop in mortality rates due to cerebrovascular disease in Brazil, this disease remains the main cause of death (Lotufo, 2000). Besides the high mortality rates, a great number of surviving patients present with sequelae that result in some physical dependence and a high social cost, mainly in the first year post-stroke (Pereira et al, 1993).

One of the most frequent sequelae due to stroke is somatosensory change that interferes with motor control (Boivie et al, 1989; Vestergaard et al, 1995; Connell et al, 2008). Prolonged afferent peripheral nerve stimulation on healthy subjects can produce a rise in the excitability of corticospinal projections and, therefore, lead to an improvement of motor acquisitions (Ridding et al, 2001). Conforto et al (2007) reported in their study that stroke patients had benefited from somatosensorial stimulation, which had improved their motor function.

A promising form of somatosensorial stimulation is vibration therapy, which can be a powerful stimulus for neuromuscular responses (Jordan et al, 2005). These improvements are due to reflex muscle contraction that result from the tonic vibration reflex (Hagbarth and Eklund, 1966). It has been reported that vibration generates a reflex muscle contraction via muscle spindle and alpha-motoneuron stimulation, resembling the mechanism of resistance training.

Vibration therapy is defined as an oscillatory movement, which has a variable frequency, amplitude, duration and type. Whole body vibration is a resistance-training type of vibration therapy, which is especially used by athletes and elderly people. While whole body vibration therapy has unfortunately been less well studied in people with neurological diseases, some studies show positive effects of whole body vibration on postural control, balance, muscle strength and gait; and it is safe and well-tolerated by elderly patients

(Bogaerts et al, 2007; Kawanabe et al, 2007).

Acute or chronic vibration for athletes produces improvement in their vertical jump performance, flexibility and strength (Cochrane and Stannard, 2005; Fagnani et al, 2006). In stroke patients, Murrillo et al (2011) found that one single vibration session, at 20 Hz frequency and 5 mm amplitude, enhances maximum voluntary contraction strength. Several weeks of vibration training on patients with Parkinson's disease, multiple sclerosis and spinal cord injuries promoted improvement in their motor performanc, suggesting that vibration can be a useful tool for any rehabilitation program (Hass et al, 2006; Giovanni et al, 2007; Wunderer et al, 2010).

Due to the fact that vibration therapy has been reported to improve mobility, this study aims to verify the effects of this training on patients who have had a stroke.

METHODS

We used a clinical and prospective study design, and conducted this study at the Human Motor Function Laboratory of Vale do Sapucai Unversity, in Pouso Alegre, Minas Gerais, Brazil.

Subjects

This study used a convenience sample of subjects recruited from Samuel Libanio Hospital's Physical Therapy and Neurology Outpatient Clinics in Pouso Alegre, Minas Gerais, Brazil. Thirty-two subjects, aged 60.19 years ±11.39, with hemiparetic sequelae due to stroke were chosen for the intervention group.

Inclusion criteria were: hemiparesis sequelae due to stroke; had a stroke more than 2 months ago; both genders; age above 20 years old; mental competence evaluated using the Mini-exam of Mental Status (Lourenço and Veras, 2006); and decreased motor function evaluated by the Fugl-Meyer scale (Fugl-Meyer et al, 1975; Maki et al, 2006) (see *Table 1*).

The exclusion criteria were: any other neurological damage; had a stroke less than 2 months ago; age less than 20 years; low mental competency; preserved motor function; herniated disc; and acute thrombosis. All subjects signed the consent agreement, and the researchers adhered to the rules in resolution 196/96 of the Brazil National Health Council. The present study was analyzed and approved by the Research Ethics Committee (REC) at Vale do Sapucaí University (protocol number 1499/10).

This study's sample initially included 32 individuals, but five people were lost due to absence during the intervention, leaving 27 participants (see *Table 1*).

Outcome measures

This study used the part of the Fugl-Meyer scale (FMS) to evaluate patients' level of upper and lower limb motor function. The scores from this test determined participants' degree of motor funciton deficit as a score out of 100: less than 50 points=severe; 50 to 84 points=marked; 85 to 95 points=moderate; 96 to 99 points=slight (Fugl-Meyer et al, 1975; Maki et al, 2006).

The study evaluated participants' mental competence using the Mini-Mental State Examination (MMSE), and scored it as follows: no cognitive impairment=19 points; mild cognitive impairment=25 points (Dick et al, 1984; Lourenço and Veras, 2006).

This study used the Stair Climbing Test (SCT) to evaluate participants' ability to climb stairs by measuring the time taken to climb nine rungs of stairs (Vasconcelos et al, 2008). Walking distance was analyzed using the 6 Minute Walk Test (6MWT) (Steffen et al, 2002). The time spent getting up from a chair, walking and sitting down again was measured by the Timed Up and Go Test (TUG) (Wall et al, 2000).

The SCT, 6MWT and TUG measures were obtained before and after the intervention, and at follow-up 1 month later. Demographic data collected in this study included: participants' age; gender; time elapsed post-stroke; affected side;

Table 1. Patients' clinical features (initial sample):

Variables		IG (*n*=32)	
Age (years), Mean (*SD*)		60.18 ±11.38	
TI (months), Mean (*SD*)		40.78 ±64.20	
MMS, Mean (*SD*)		22.31 ±3.38	
FMS, Mean (*SD*)		59.78 ±23.54	
Motor impairment (%):	Severe	34.37	
	Remarkable	59.37	
	Moderate	6.25	
	Light	0	
Gender (%)		67.85	M
		32.14	F
AS (%)		59.37	L
		40.62	R
DS (%)		96.87	R
		3.12	L
Stroke (%)		96.87	I
		3.12	H

IG: intervention group; TI: time of injury; AS: affected side; DS: dominant side; MMS: mini-exam of mental status; FMS: Fugl-Meyer scale; R: right; L: left; M: male; F: female; I: ischaemic; H: haemorrhagic.

Table 2. Experimental protocol session 1				
1st period	**2nd period**	**3rd period**	**4th period**	**5th period**
Preparation	Vibration (knees bent at 30°)	Rest	Vibration (knees bent at 90°)	Rest
60s	60s	60s	60s	60s
6th period	**7th period**	**8th period**	**9th period**	
Vibration (knees bent at 30°)	Rest	Vibration (unipodal landing (affected limb - knees bent at 30°)	Rest	
60s	60s	60s	60s	

Table 3. Patients' clinical features (remaining sample)			
Variables		**IG (*n*=27)**	
Age (years), Mean (*SD*)		60.33 ±11.30	
TI (months), Mean (*SD*)		41.40 ±68.81	
MMS, Mean (*SD*)		22.74 ±3.47	
FMS, Mean (*SD*)		60.96 ±23.07	
Motor impairment (%):	Severe	33.33	
	Remarkable	59.25	
	Moderate	7.40	
	Light	0	
Gender (%)		70.37	M
		29.62	F
AS (%)		62.96	L
		37.03	R
DS (%)		96.29	R
		3.70	L
Stroke (%)		96.29	I
		3.70	H

IG: intervention group; TI: time of injury; AS: affected side; DS: dominant side; MMS: mini-exam of mental status; FMS: Fugl-Meyer scale; R: right; L: left; M: male; F: female; I: ischaemic; H: haemorrhagic.

dominant side; and type of stroke (ischaemic or haemorrhagic) (see *Table 1*).

Experimental protocol

This study was completed in four steps: first, evaluation of clinical data; second, vibration therapy intervention for 2 months; third, re-evaluation after intervention; and fourth, 1 month follow-up.

Each participant received the vibration therapy intervention in two stages. In the first stage they had three sessions per week for 4 weeks, with each session consisting of four applications of 60 seconds of vibration intervention and a 60 second interval in-between. In the second stage, the number of vibration applications was doubled to eight, also consisting of 60 seconds of vibration followed by a 60 second interval in order to avoid fatigue. This protocol was derived from the protocol used by Kihlberg et al (1995) and Tihanyi et al (2007), who demonstrated that 50 Hz vibration for 60 seconds was adequate. The 50 Hz frequency and 2 mm amplitude were applied in order to generate better muscle recruitment, according to Kihlberg et al (1995) and Tihanyi et al (2007).

In this study, participants were placed barefoot onto a tri-planar vibratory foot bed platform (Lion ®), which was set at 50 Hz frequency and 2 mm amplitude. Participants were supported in an orthostatic position, with feet apart and knees bent at 30º in order to avoid resonance frequency (Mester et al, 2006) (see *Figure 1*). Patients underwent 4 periods of 60 seconds of vibration therapy with a 60-second interval between each period. During the first and second periods, participants' knees were bent at 30° in bipedal stance; on the second one, knees were bent at 90° in bipedal stance; on the third second, the knee of the affected side was bent at 30° in unipedal stance; and on the fourth (final) knees were bent again at 30° in bipedal stance (see *Table 2*).

Statistical analysis

This study used descriptive statistics to characterize the clinical variables in this sample. The Shapiro-Wilk test was performed to determine data normality, followed by the Friedman test for comparison between the initial evaluation, final evaluation and follow-up. All of the analysis was undertaken using SPSS version 20.0. The probability level for statistical significance in all tests was set at $P<0.05$.

RESULTS

Table 3 summarizes data produced by the outcome measures and shows data about participants' clinical features, including: cognition level, motor impairment, time since stroke, and whether the stoke was ischaemic or haemorrhagic.

Figure 2 shows the mean and standard devia-

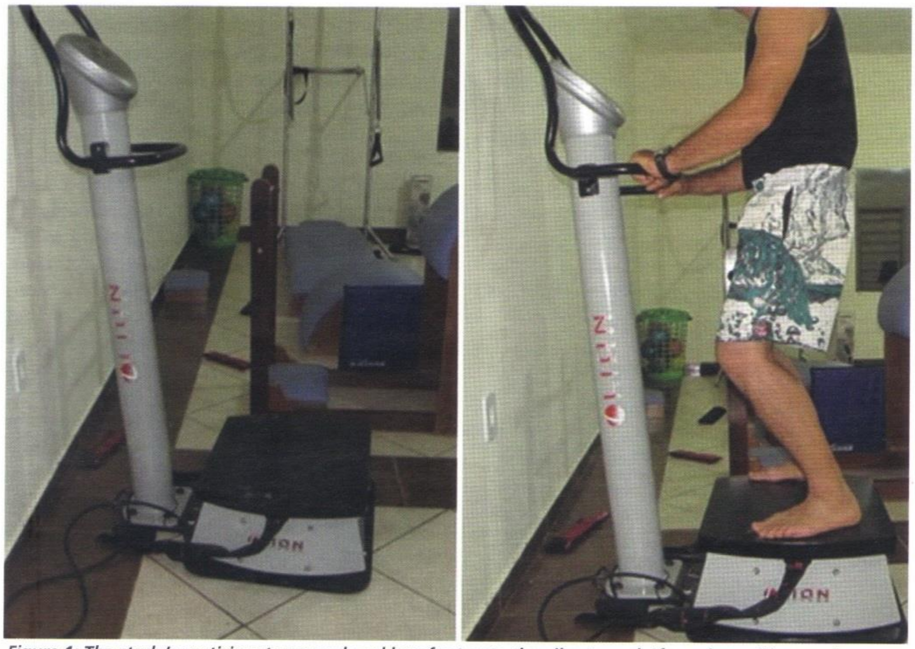


Figure 1: The study's participants were placed barefoot onto the vibratory platform, in positions such as that demonstrated on the right: an orthostatic position, with feet apart, and knees bent at 30°.

tion values obtained from the 6MWT at the initial and final evaluations, as well as follow-up. For the 6MWT, there were significant differences between the initial and final evaluations, as well as between the initial and the follow-up (P<0.00). However, there was no significant difference between the final evaluation and the follow-up (P<0.84).

Figure 3 refers to the mean and standard deviation values obtained from the SCT. For the SCT, there were significant differences between the initial and final evaluations, as well as between the initial and the follow-up (P <0.00). However, there was no significant difference between the final evaluation and the follow-up (P<0.20).

Figure 4 refers to the values of the mean and standard deviation obtained by the TUG variable. There was significant difference between the initial evaluation, the final, and the follow-up (P<0.00).

DISCUSSION

This study's main finding was that whole body vibration training can contribute to improved mobility in individuals who were affected by stroke. This finding was based on data from the SCT, TUG and 6MWT tests, comparing initial, final and follow-up results. These findings agree with many studies that observed the effects of vibration on athletes, elderly people and on patients with central nervous system damage (Bosco et al, 1998; Kawanabe et al, 2007; Ebersbach et al, 2008; Ness and Field-Fote, 2009).

This improvement in mobility could be ascribed to a neural potentiality effect evoked by

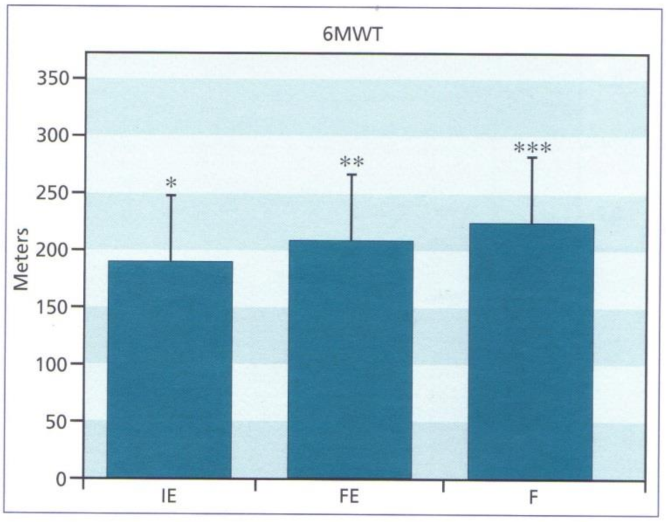


*Figure 2: Mean and standard deviation of 6MWT data. *FE differs from IE (P<0.00); ** F differs from FE (P<0.00); and *** F differs from IE (P<0.00). IE: initial evaluation; FE: final evaluation; F: follow-up.*

vibration stimulus. It is known that during any movement, several afferent inputs interact and can influence neural circuit activity, generating more or less motor unity recruitment depending on the task performed (Duchateau and Enoka, 2002). Sensory receptor stimulation induced by vibration activates type Ia fibers in the muscle spindle, causing a reflex muscle contraction and resulting in improved motor performance.

Rees et al (2007) analyzed the effect of vibration training on muscular performance and mobility in elderly people, and determined that there was improvement in the TUG test, walking speed, and the SCT; this agrees with the findings of the present study.

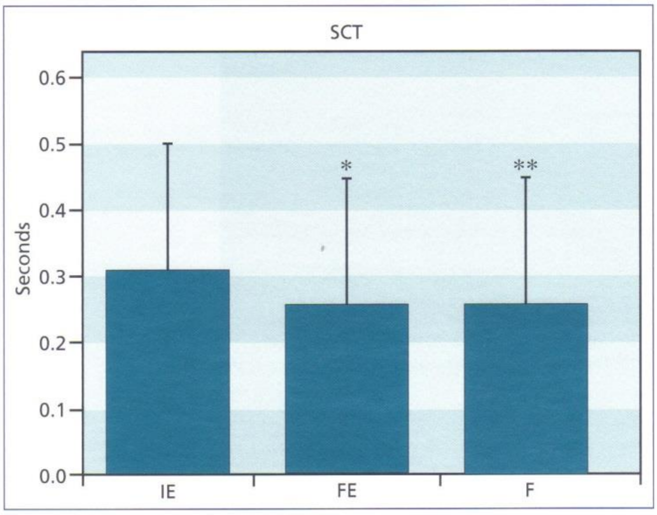


*Figure 3: Mean and standard deviation of SCT data. *FE differs from IE (P<0.00); **F differs from IE (P<0.00). IE: initial evaluation; FE: final evaluation; F: follow-up.*

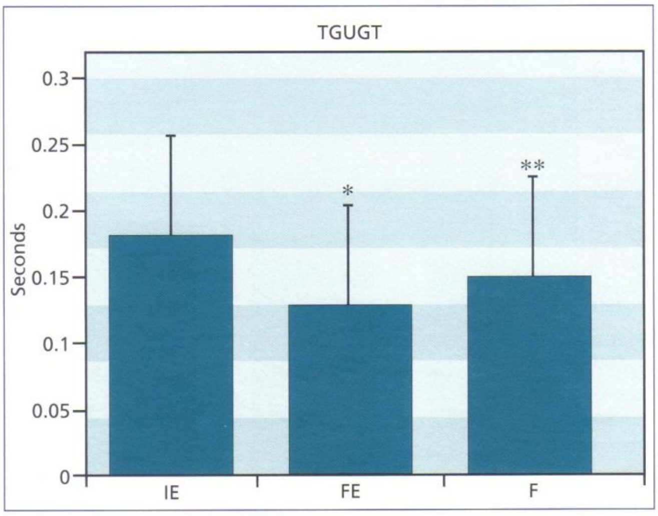


*Figure 4: Mean and standard deviation of TGUGT data. *FE differs from IE (P<0.00); **F differs from IE (P<0.00). IE: initial evaluation; FE: final evaluation; F: follow-up.*

Due to the central nervous system damage caused by stroke, patients often experience weakness, slowness of movement, and loss of dexterity, which affects their performance of functional tasks, thereby limiting quality of life (Kim et al, 1999; Lieber et al, 2004). Some studies show that after whole body vibration training, neuromotor performance improves, but there is still some controversy regarding its use by stroke patients (Nes et al, 2006; Tihanyi et al, 2007; Merkert et al, 2011).

Few studies have evaluated the long-term effects of vibration on stroke patients. Nes et al (2006) researched the effect of 6 weeks of whole body vibration on balance control and the activities of daily living in subacute stroke patients. They found no significant difference between the intervention and the control group in recovering balance control and activities of daily living, a finding that disagrees with the present study. Other studies that used 6MWT and TUG on cerebral palsy and multiple sclerosis patients also did not show significant changes in motor function after vibration training, also disagreeing with the present study's findings (Ahlborg et al, 2006; Schyns et al, 2009; Schuhfried et al, 2012). This difference in results, may be attributed to the sample pattern in the present study, in which the participants had strokes with unilateral body involvement. This is in contrast to the participant population in the studies mentioned above, which had greater motor impairment. Secondly, the present study used different frequency, amplitude and time of application parameters during the vibration intervention, compared to the studies above.

Lau et al (2012) analyzed the effects of a 24 week course of whole body vibration training in chronic stroke patients. Their results showed that there was a similar improvement in lower limb motor function in both the intervention group, which had vibration therapy, with the control, which had leg exercises. These results continued after 1 month without treatment, contrasting with the findings in the present study.

With regards to follow-up, there was no significant difference between the values for SCT and TUG after the intervention and at follow-up, possibly because optimal values for these tests (Newton, 1997; Steffen et al, 2002) had already been achieved after the intervention. However, the 6MWT results showed a significant difference at follow-up. This difference was possibly due to the fact that the 6MWT is also used as a clinical measure for evaluating aerobic capacity and submaximal resistance (Jorgensen et al, 1995). Recovery of walking ability may take months and be incomplete, restricting speed and the ability to walk longer distances (Marin et al, 2001; Pohl et al, 2002). The present study may suggest that an 8-week whole body vibration intervention could enhance patients' ability to walk greater distances and improve their gait speed.

The limitations of this study should be noted, and include the need for a control group and random sample selection. There was also no analysis for confounding factors and this could be a limitation of the present study.

Implications for future research

There is a need to further studies in order to enhance our understanding of the effects of vibration therapy and the influence of different factors, including the parameters used by the device—vibration frequency and amplitude, and the type of exercise performed and its intensity. The results of this study will allow a better prescription of this therapy for stroke patients, which can be used t o reduce the effects caused by a stroke. It can be noted that vibration therapy is currently accessible in rehabilitation clinics, gyms and hospitals; therefore, there is widespread use of this resource, accounting for the need for greater knowledge of the therapy.

CONCLUSION

Vibration therapy can contribute to the improvement of motor function in patients affected by stroke. Eight week vibration training can contribute to the improvement in lower limb function in stroke patients. However, the increasing accessibility of vibration therapy makes the need for further research into the use of this technique timely. There is a need for further investigation into the vibration parameters required during whole body vibration therapy. IJTR

Ahlborg L, Andersson C, Julin P (2006) Whole-body vibration training compared with resistance training: effect on spasticity, muscle strength and motor performance in adults with cerebral palsy. *J Rehabil Med* **38**(5): 302–8

Bogaerts A, Verschueren S, Delecluse C, Claessens AL, Boonen S (2007) Effects of whole body vibation training on postural control in older individuals: A 1 year randomized controlled Trial. *Gait Posture* **26**(2): 309–16

Boivie J, Leijon G, Johansson I (1989) Central post-stroke pain - a study of the mechanisms through analyses of the sensory abnormalities. *Pain* **37**(2): 173–85

Bosco C, Cardinale M, Tsarpela O, Colli R, Tihanyi J, Duvillard V et al (1998) The influence of whole body vibration on jumping performance. *Biol Sport* **15**:157–64

Cochrane DJ, Stannard SR (2005) Acute whole body vibration training increases vertical jump and flexibility performance in elite female field hockey players. *Br J Sports Med* **39**(11): 860–5

Conforto AB, Cohen LG, Santos RL, Scaff M, Marie SKN (2007) Effects of somatosensory stimulation on motor function in chronic cortico-subcotical strokes. *J Neurol* **254**(3): 333–9

Connell LA, Lincoln NB, Radford KA (2008) Somatosensory impairment after stroke: frequency of different deficits and their recovery. *Clin Rehabil* **22**(8): 758–67

Dick JPR, Guiloff RJ, Stewart A, Blackstock J, Bielawska C, Paul EA et al (1984) Mini-mental state examination in neurological patients. *J Neurol Neurosurg Psychiatry* **47**(5): 496–9

Duchateau J, Enoka RM (2002) Neural adaptations with chronic activity patterns in able-bodied humans. *Am J Phys Med Rehabil* **81**(11 Suppl): S17–27

Ebersbach G, Edler D, Kaufhold O, Wissel J (2008) Whole Body Vibration Versus Conventional Physiotherapy to Improve Balance and Gait in Parkinson's Disease. *Arch Phys Med Rehabil* **89**(3): 399–403

Fagnani F, Giombini A, Di Cesare A, Pigozzi F, Di Salvo V (2006) The effects of a whole-body vibration program on muscle performance and flexibility in female athletes. *Am J Phys Med Rehabil* **85**(12): 956–62

Fugl-Meyer AR, Jaasko L, Leyman I, Olsson S, Steglind S (1975) The post-stroke hemiplegic patient: 1. A method for evaluation of physical performance. *Scand J Rehab Med* **7**(1): 13–31

Giovanni Melchiorri G, Andreoli A, Padua E, Sorge R, De Lorenzo A (2007) Use of vibration exercise in spinal cord injury patients who regularly practise sport. *Funct Neurol* **22**(3):151–4

Hagbarth KE, Eklund G (1966) Tonic vibration reflexes (TVR) in spasticity. *Brain Res* **2**(2): 201–3

Hass C, Turbanski S, Kessler K, Schmidtbleicher D (2006) The effects of random whole body vibration on motor symptoms in Parkinson's disease. *NeuroRehabilitation* **21**(1): 29–36

Jordan MJ, Norris SR, Smith DJ, Herzog W (2005) Vibration Training: a overview of the area, training consequences, and future considerations. *J Strength Cond Res* **19**(2): 459–66

Jorgensen HS, Nakayama H, Raaschou HO, Olsen TS (1995) Recovery of walking function in stroke patients: The copenhagen stroke study. *Arch Phys Med Rehabil* **76**(1): 27–32

Kawanabe K, Kawashima A, Sashimoto I, Takeda T, Sato Y, Iwamoto J (2007) Effect of whole-body vibration exercise and muscle strengthening, balance, and walking exercises on walking ability in the elderly. *Keio J Med* **56**(1): 28–33

Kihlberg S, Attebrant M, Gemne G, et al. (1995) Acute effects of vibration from a chipping hammer and a grinder on the hand arm system. *Occup Environ Med* **52**(11): 731–7

Kim P, Warren S, Madill H, Hadley M (1999) Quality of life of stroke survivors. *Qual Life Res* **8**(4): 293–301

Lau RWK, Yip SP, Pang MYC (2012) Whole-body vibration has no effect on neuromotor function and falls in chronic stroke. *Med Sci Sports Exerc* **44**(8): 1409–18

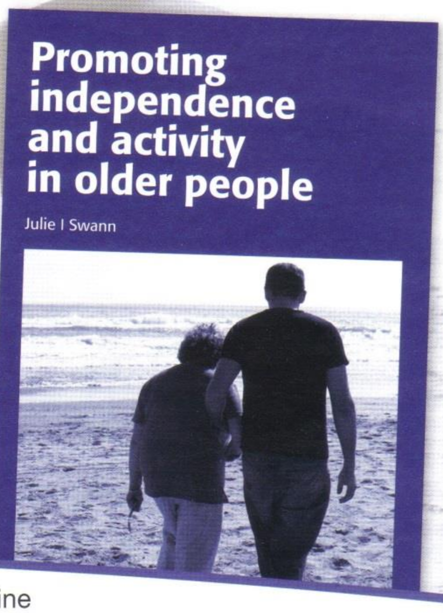
Lieber RL, Steinman S, Barash IA, Chambers H (2004) Structural and functional changes in spastic skeletal muscle. *Muscle Nerve* **29**(5): 615–27

Lotufo PA (2000) Mortalidade pela doença cerebrovascular no Brasil. *Rev Bras Hiperten* **7**(4): 387–91

KEY POINTS

- Lower limb motor function is very important for stroke patients' independence.
- Several factors may affect the efficacy of vibration therapy in neurological patients, for example parameters such as the platform's frequency, the amplitude, the time of exposure to the therapy and the type of exercise.
- Vibration therapy, when applied correctly, can improve stroke patients' lower limb motor function.
- Intervention strategies are necessary in order to improve stroke patients' quality of life as well as their lower limb function.

Lourenço RA, Veras RP (2006) Mini-exame do estado mental:características psicométricas em idosos ambulatoriais. Rev. *Saúde Pública* **40**(4): 712–71
Maki T, Quagliato EMAB, Cacho EWA, Paz LPS, Nascimento NH, Inoue MMEA et al (2006) Estudo de confiabilidade da aplicação da escala de Fugl-Meyer no Brasil. *Rev Bras Fisioter* **10**(2): 177–183
Marin JM, Carrizo SJ, Gascon M, Sanchez A, Gallego B, Celli BR (2001) Inspiratory Capacity, Dynamic Hyperinflation, Breathlessness, and Exercise Performance during the 6-Minute-Walk Test in Chronic Obstructive Pulmonary Disease. *Am J Respir Care Med* **163**(6): 1395–9
Merkert J, Butz S, Nieczaj R, Steinhagen-Thissen E, Eckardt R (2011) Combined whole body vibration and balance training using Vibrosphere. *Z Gerontol Geriat* **44**(4): 256–61
Mester J, Kleinoder H, Yue Z (2006) Vibration training: benefits and risks. *J Biomech* **39**(6):1056–65
Murrillo N, Kumru H, Vidal-Samso J, Benito J, Medina J, Navarro X et al (2011) Decrease of spasticity with muscle vibration in patients with spinal Cord injury. *Clin Neurophysiol* **122**(6): 1183–9
Nes IJWV, Latour H, Schils F, Meijer R, Kuijk AVK, Geuts ACH (2006) Long-Term Effects of 6-Week Whole-Body Vibration on Balance Recovery and Activities. *Stroke* **37**(9): 2331–5
Ness LL, Field-Fote EC (2009) Whole-boby vibration improves walking function in individuals with spinal cord injury: A pilot study. *Gait Posture* **30**(4): 436–40
Newton RA (1997) Balance screening of an inner city older adult population. *Arch Phys Med Rehabil* **78**(6): 587–91
Pereira CF, Lemos MM, Benevenuto MC, Fonseca GA (1993) Enfoque sobre pesquisa no AVC. *Med Reabil* **34**(36): 9–13
Pohl PS, Duncan PW, Perera S, Liu W, Lai SM, Studenski S, Long J (2002) Influence of stroke-related impairments on performance in 6-minute walk test. *J Rehabil Res Dev* **39**(4): 439–44
Rees S, Murphy A, Watsford M (2007) Effects of vibration exercise on muscle performance and mobility in an older population. *J Aging Phys Act* **15**(4):367–81
Ridding MC, McKay DR, Thompson PD, Miles TS (2001) Changes in corticomotor representations induced by prolonged peripheral nerve stimulation in humans *Clin Neurophysiol* **112**(8): 1461–9
Schuhfried O, Mittermaier C, Jovanovic T, Pieber K, Paternostro-Sluge T (2012) Effects of 3 weeks' whole body vibration training on muscle strength and functional mobility in hospitalized persons with multiple sclerosis. *J Scler Mult* **18**(4): 498–505
Schyns F, Noble E, Paul L, Finlay K, Ferguson C (2009) Vibration therapy in multiple sclerosis: a pilot study exploring its effects on tone, muscle force, sensation and functional performance. *Clin Rehabil* **23**(9): 771–81
Steffen TM, Hacker TA, Mollinger L (2002) Age and gender-related test performance in community-dwelling elderly people: six-minute walk test, Berg balance scale, Time up & Go test, and gait speeds. *Phys ther* **82**(2): 128–37
Tihanyi TK, Horváth M, Fazekas G, Hortobágyi T, Tihanyi J (2007) One session of whole body vibration increase voluntary muscle strength transiently in patients with stroke. *Clin Rehabil* **21**(9): 782–93
Vasconcelos KSS, Dias JMD, Dias RC (2008) Impacto do grau de obsesidade nos sintomas e na capacidade funcional de mulheres com osteoartrite de joelhos. *Fisioterapia e Pesquisa* **15**(2): 125–130
Vestergaard K, Nielsen J, Andersen G, Ingeman-Nielsen M, Arendt-Nielsen L, Jensen TS (1995) Sensory abnormalities in consecutive, unselected patients with central post-stroke pain. *Pain* **61**(2): 177–86
Wall JC, Bell C, Campbell S, Davis J (2000) The time get-up-and-go test revisited: Measurement of the component tasks. *J Rehabil Res Dev* **37**(1): 109–13
Wunderer K, Schabrun SM, Chipchase LS (2010) Effects of whole body vibration on strength and functional mobility in multiple sclerosis. *Physiother Theory Pract* **26**(6): 374–84



ARTIGO II

Efeito do treinamento vibratório na impressão plantar em pacientes acometidos por acidente vascular cerebral – ensaio clínico randomizado

Aceito para publicação na revista International Journal of therapy and Rehabilitation 2015;XXXX.

https://br-mg5.mail.yahoo.com/neo/launch?.rand=eb6m45jf3apbv#8576949018

Imprimir - Fechar janela - Clique em Mais na parte inferior do email para imprimir uma mensagem única

Assunto:	[IJTR] 2014:117:3 EFFECT OF VIBRATORY TRAINING ON PLANTAR IMPRESSION IN PATIENTS SUFFERING FROM CEREBRAL VASCULAR ACCIDENT - a RANDOMIZED CLINICAL TRIAL
De:	ijtr@markallengroup.com (ijtr@markallengroup.com)
Para:	adrianat.silva@yahoo.com.br;
Data:	Sexta-feira, 31 de Julho de 2015 9:59

Dear Adriana Teresa Silva, Antônio Carvalho, Marília Andrades, Ruanito Calixto Junior et al.,

Thank you for submitting your revised article, 'EFFECT OF VIBRATORY TRAINING ON PLANTAR IMPRESSION IN PATIENTS SUFFERING FROM CEREBRAL VASCULAR ACCIDENT - a RANDOMIZED CLINICAL TRIAL', to the International Journal of Therapy and Rehabilitation. We are very pleased to inform you that we would like to accept your article for publication in the journal. The article will be published in an upcoming journal, and I will contact you shortly with a proofed version.

With best wishes,

Lee-Mey Goh
Editor, IJTR
International Journal of Therapy and Rehabilitation
St Jude's Church
Dulwich Road
London
SE24 0PB

Tel: 020 7738 5454
Fax: 020 7978 8316
Email: ijtr@markallengroup.com

Sent from the EPRESS journal management system, http://www.epress.ac.uk

EFFECT OF VIBRATORY TRAINING ON PLANTAR IMPRESSION IN PATIENTS SUFFERING FROM *CEREBRAL VASCULAR ACCIDENT* - A RANDOMIZED CLINICAL TRIAL

Adriana Teresa Silva[1], Antônio José Bernardes Carvalho[2], Marília Fernandes Andrades[3], Ruanito Calixto Junior[2], Miqueline Pivoto Farias Dias[2], Andréia Maria Silva[4], Beatriz Bertolaccini Martinez [5], Donizeti Cesar Honorato[6].

[1]Physiotherapist, MSc, Researcher at the Department of Neurology of the Medical Sciences College of the State University of Campinas (UNICAMP), SP, Brazil.
[2]Physiotherapist, University of the Vale do Sapucaí (UNIVÁS), Pouso Alegre – MG, Brasil.
[3]Physiotherapy student of the Federal University of Alfenas (UNIFAL), Alfenas – MG, Brasil.
[4]Physiotherapist, PhD, Federal University of Alfenas (UNIFAL), Alfenas – MG, Brasil.
[5]Doctor, PhD, University of the Vale do Sapucaí (UNIVÁS), Pouso Alegre – MG, Brazil.
[6]Doctor, PhD, Department of Neurology of the Medical Sciences College of the State University of Campinas (UNICAMP), Campinas – SP, Brasil

Mailing address:
Adriana Teresa Silva
Rua: Irene de Sousa Totti, 160, Jardim Aeroporto, Alfenas/MG, Brazil, CEP:37130-000, Tel: (35) 99372131, e-mail: adrianat.silva@yahoo.com.br

Abstract

The aim of this study was to investigate the effect of vibration training on plantar impression and motor function in patients affected by stroke. The sample consisted of 28 individuals with hemiparesis after stroke who were randomization to the intervention group (n = 18) and control group (n = 10). The instruments used for evaluation were the Mini-Mental State Examination, photopodoscopy and the 6-

minute walk test (6MWT). For treatment whole-body vibration therapy was used, 3 times a week for 8 weeks. The treatment was carried out in two steps: the first step 4 weeks - 4 sets of 60 seconds of vibration. In the first patient series in a static standing position, keeping your feet apart with knees semiflexed to 30 °. In the second series the same position only with knees flexed at 90°. In third grade static standing position with one-leg support on the affected limb with semiflexed knee to 30 °. In fourth grade returning again equal to the first series. The second step 4 weeks - double the series. Data were analyzed by independent t-test and repeated measures ANOVA with two factors. There was no intergroup nor intragroup statistical difference (p=0.05) in the plantar impression area on the affected and unaffected side, there was only intragroup statistical difference in the 6MWT (p = 0.03). It is concluded that whole-body vibration training did not influence in the increase of the plantar impression area and motor function in CVA patients.

Key Words: vibrating platform, rehabilitation and Cerebral Vascular Accident.

Conflict of interest: there is no conflict of interest.

INTRODUCTION

The foot is the structure responsible for the interaction between the body and detection of ground alterations, acting as a rigid lever that gives impulse to the gait. It modifies the distribution of body weight for the individual to adapt to the environment and to avoid possible falls (Ledoux and Hillstrom 2002). Structural changes of the foot therefore have high potential to promote alteration of the load distribution on its own structure (Ledoux and Hillstrom 2002).

When the weight load on the feet is not distributed properly, there occurs an imbalance that can cause a number of changes in the gait cycle (Griffin et al, 1999; Pai et al, 1994; Sackley, 1991). These gait changes can be very well seen in stroke patients due to loss of motor control, hemiparesis and spasticity of the gastrocnemius and soleus muscles of the affected side (Costa et al, 2006; Wong et al, 2004; Laufer et al, 2000).

Chen et al (2007) reported that stroke patients have an altered plantar shock absorbing stage when compared with people who have normal motor control. The gait cycle mid-swing phase is dominated by the flexor pattern to ensure foot release from the surface. In the terminal swing and loading response phase in the gait cycle, the tibialis anterior muscle action is lost, since the control of the ankle flexor pattern switches to the extensor pattern and the soleus starts its action prematurely. This results in the initial contact of the support of the forefoot instead of the hindfoot, decreasing the foot contact surface on the ground (Perry, 2005).

Usually the hemiparetic gait is uncoordinated, with altered speed and cadence, symmetry, swing, protection reaction, step length, swing phase reduction and has high energy consumption (Griffin et al, 1999; Olney and Richards, 1996; Pai et al, 1994; Sackley, 1991)

There are many neurophysiological techniques for the transfer of weight and weight support on the affected leg in the rehabilitation of hemiparetic patients, some of these techniques precede gait training or are conducted in various positions (Lennon, 2001; Dickstein et al, 1984).

The whole-body vibration (WBV) has been recently implemented to improve the biomechanical function of the entire musculoskeletal system, which aims to stimulate the somatosensory system generating neural plasticity with beneficial effects on functional recovery of these patients (Conforto et al, 2010; Mileva et al, 2009; Bogaerts et al, 2007; Tihanyi et al, 2007; Jordan et al, 2005; Van et al, 2004).

Therefore, the WBV holds great promise for the field of physical rehabilitation, however further study is needed in the population with stroke. Thus, the objective of this study is to determine the effect of vibration training on plantar impression and motor function in stroke affected patients.

METHOD

Study Design:

This is a clinical, parallel, randomized, blinded prospective trial, conducted in the Human Motricity Laboratory at the University of Vale do Sapucai, Pouso Alegre, MG, Brazil. All participants signed an informed consent and researchers respected precepts contained in Resolution 196/96 of the National Health Council. The study was reviewed and approved by the University of Vale do Sapucai Ethics Committee

(CEP) on nº1499 / 10 protocol. The study obtained the Brazilian clinical trial registration number: RBR-34v9px.

The study was conducted from March to December 2013, patients were recruited from a list of the Neurology ambulatory care unit of the Hospital Clínicas Samuel Libânio, Pouso Alegre – MG. Three researchers were involved in the study: the first researcher only made phone contact with forty-eight individuals and also conducted the allocation of the research participants, in the control group and intervention group; the second researcher conducted the assessment at the beginning and end of the intervention, there was blinding of the second research, in which only thirty-five met the inclusion criteria of the study; the third researcher conducted the intervention. Seven patients were excluded because the survey did not complete the intervention protocol, leaving Twenty-eight patients.Participants were divided into two groups: intervention group (IG - n = 18) and control group (CG - n = 10) by a lottery method in which the participants' names were placed in an envelope and called one by one. (Figure 1)

Figure 1:

Sample

Twenty-eight patients (17 men and 11 women) with sequelae from hemiparesis due to CVA were selected for the study. The participates were divided into two groups: control (n = 10) and intervention (n = 18) and met the following inclusion criteria: hemiparesis after stroke, lesions persisting for more than 2 mos, either sex, 20 yrs or older, mental competency as assessed by the Mini-Mental State Examination (Lourenço and Veras, 2006);, and reduced motor function as assessed by the Fugl-Meyer Assessment scale (Maki *et al*, 2006; Fugl-Meyer e*t al*, 1975).

Instruments used for evaluation

Motor function impairment was assessed using the Fugl-Meyer Assessment Scale (FMA) - only the upper and lower limb motor function session (score of 100 points); through this scale the level of motor impairment was determined (less than 50 points - severe, 50 to 84 points - marked, 85-95 points - moderate, 96 to 99 points - mild (Maki et al, 2006; Fugl-Meyer at al, 1975), the mental competence was evaluated through the M*ini–mental* state *examination* MMSE (literate score 19 points and illiterate 25 points) (Lourenço and Veras, 2006), the distance covered was assessed by the 6-minute walk test (6MWT), plantar impression registration was evaluated by photopodoscopy.

To evaluate the registration of plantar impressions before and after intervention, patients were positioned on a podoscope (Carci®), barefoot, bipedal support and upright posture. An Ethylene-vinyl acetate rectangle, 7.5 cm wide, was placed to maintain a standard distance between the feet. The image of the plantar impression reflected in the mirror of the podoscope was captured by a digital camera (Canon®) 12.1 megapixels, positioned on a tripod (First Moonlight® 6156), opposite it, at a distance of 24 cm and a height 45 cm from the ground. The distance and time were defined to allow the framing of the image reflected in the podoscope mirror without the use of any camera approximation (zoom) (Moreno and Gutiérres, 2011; Ribeiro et al, 2006; Aydog et al, 2005). These images were then stored at a resolution of 1600 x 1200 pixels for subsequent analysis in the image program (Image Pro Plus version 5.0). The plantar impressions registrations, after analysis, were given by area (cm ^{2}) (Figure 2).

FIGURE 2

To determine the distance traveled in the 6MWT a 10-meter distance was marked on the ground and the patients asked to walk for a period of 6 minutes (Steffen et al, 2002). Distance traveled in this period was recorded before and after the intervention.

Instrument used for intervention

The instrument used for intervention was the vibration platform brand Lion - triplanar®, frequency 50 Hz, amplitude 2 mm (Mester et al, 2006).

Experimental protocol

The procedure was performed in four steps: First, evaluation with the FMA and MMSE scales for sample selection; second step, photopodoscopic and 6MWT evaluations; third step, intervention with WBV therapy; fourth step, revaluation.

The IG performed the whole body vibration therapy,), the intervention was performed three times a week for 8 weeks. The procedure was divided into two phases: a first phase (4 weeks) and second phase (4 weeks). In the first phase there were 4 sets of 60 seconds, with 60 seconds of rest in each set. In the first series the patient was in a static standing position with bipedal support and hands resting on the device, keeping the feet apart with knees semi-flexed at 30º. In the second series the same position was employed, but with the knees flexed 90°. In third series the same position was employed as in the first, but with the unipedal support of the affected member with the knee semi-flexed at 30°. In fourth series was conducted in a manner identical to the first, without modifications. Participants remained resting on the vibrating platform while maintaining the static standing position with knees extended. The second stage was conducted as the first, but with twice the number of series. All participants were positioned barefoot on the vibrating platform, with support for the upper members and a mark was placed on the vibration platform for foot placement (Silva et al, 2014) (Figure 3, 4).

The CG did not undergo or receive WBV, only the evaluation and reevaluation.

FIGURE 3
FIGURE 4

Statistical Analysis

Descriptive statistics were used to characterize the sample relative to the clinical and demographic variables. The *Shapiro-Wilk* test was used to determine the normality of the data. The independent t test was used to compare the baseline characteristics of the CG and the IG. We used the repeated ANOVA with two factors (time and group) for the variable measure area and 6MWT. All the analyses were executed using the Statistical Package for the Social Sciences (version 20.0). The probability level for statistical significance in all the tests was set at $p<0.05$.

RESULTS

Table 1 provides information on the clinical data, level of cognition, motor impairment, type of injury, affected side, dominant side. All participants had clinically documented strokes. The groups did not differ from each other in age, cognitive level and motor function.

TABLE 1

Table 2 describes the variable values found for the intergroup and intragroup affected side (AS) and unaffected side (UAS) plantar impression area and the 6-minute walk test (6MWT). Note that there was no intragroup nor intergroup statistical difference for the AS and UAS plantar impression area, there was only a difference in 6MWT for the intragroup.

TABLE 2

DISCUSSION

The finding of this study shows that whole-body vibration did not influence the plantar impression area of the affected side and the unaffected side of the body. Only the 6-minute walk test influenced the intragroup, with no intergroup difference. This positive response with respect to distance traveled has also been demonstrated in various other studies (Silva et al, 2013; Machado et al, 2010; Ness and Field-Fote, 2009; Bruyere et al , 2005). The response of this improvement can be attributed due to the vibratory stimulus, which causes increased activation of the neuromotor spindle afferents with consequent motoneuron activation, triggering a muscle reflex contraction, leading to better activity performance (Mileva et al, 2009; Bove et al, 2003; Carlsoo, 1982). This finding is in agreement with other studies (Silva et al, 2013; Ness and Field-Fote, 2009, and contradicts findings of other studies (Silva et al, 2014; Lau et al, 2012; Brogardh et al, 2012; Rees et al, 2007; Ahlborg et al, 2006).

The present study is the first study that verifies the vibrating effect in the area of plantar impression, we note that the vibration was not able to generate an increase in the intergroup and intragroup plantar impression area. It is noticed that if there is an increase in the plantar area, it can deduce that ther will be a better weight distribution on the affected side and would lead to improved asymmetry with consequent realization of functional activity (Wanderley et al, 2011; Mudie et al, 2002; Turnbull et al 1996; Sackley, 1990). Despite having no improvement in plantar impression in the present study, there was benefit in the distance covered. Contrary to the findings of this study (Wanderley et al, 2011), a study was conducted which identified the effect of vibratory stimulation on the plantar region in 60-year old individuals and found an improvement in posturography in the intervention group compared with the control group. The results of this present study regarding the area can be justified by the evaluation method applied, perhaps it not being sensitive enough to capture such changes.

Conforto et al (2010) emphasizes the importance of the effects of training with sensory stimulation, such as vibration, on cortical plasticity and motor function in chronic and subacute patients affected by CVA. Neuronal plasticity occurs through adaptation of the nervous system to training, generates the functional adjustment in these patients and leads to a reorganization of cortical maps that will contribute to the recovery and improvement of the movements of the compromised patient (Schaechter, 2004; Johansson, 2000). Magnusson et al (1994) mention that all sensory stimulation improves the functional outcome of activities of daily living (ADL) for patients with hemiplegia.

Study limitations and future research

The limitations of this study should be noted. First, the instrument used to evaluate the plantar area may not be so sensitive for data analysis, according to the need for a follow-up to verify the permanence of the results. Understanding the effects produced by vibration therapy are important due to the fact that this instrument is more accessible to therapists and produces effects even less clear for the population affected by CVA.

Implication for rehabilitation

- WBV is being used to improve the biomechanical function of the entire musculoskeletal system, The further understanding about the use of vibratory therapy for CVA patients' needs to be more enlightened. It is observed in some studies that the VCI is capable of generating neuronal plasticity.

CONCLUSION

Whole-body vibration training was not able to change the plantar impression area and motor function in CVA patients.

REFERENCES:

Ahlborg L, Andersson C, Julin P (2006) Whole-body vibration training compared with resistance training: effect on spasticity, muscle strength and motor performance in adults with cerebral palsy. *J Rehabil Med* 38(5):302–8.

Aydog ST, Tetik O, Demirel HA, Doral MN (2005) Differences in sole arch indices in various sports. *Br J Sports Med* 39:1-5.

Bogaerts A, Verschueren S, Delecluse C, Claessens AL, Boonen S (2007) Effects of whole body vibration training on postural control in older individuals: A 1 year randomized controlled trial. *Gait & Posture* 26(2):309-316.

Bove M, Nardone A, Schieppati M (2003) Effects of leg muscle tendon vibration on group Ia and group II reflex responses to stance perturbation in humans. *J Physiol* 550:617-630.

Brogardh C, Flansbjer UB, Lexell J (2012) No specific effect of whole-body vibration training in chronic stroke: a double-blind randomized controlled study. *Arch Phys Med Rehabil* 93:253-8.

Bruyere O, Wuidart MA, Palma ED, Gourlay M, Ethgen O, Richy F, Reginster JY (2005) Controlled Whole Body Vibration to Decrease Fall Risk and Improve Health-Related Quality of Life of Nursing Home Residents. *Arch Phys Med Rehabil* 86:333-337.

Carlsoo S (1982) The effect of vibration on the skeleton, joints and muscle. A review of the literature. *Appl Ergon, Maryland Heights* 13(4):251-258.

Chen CY, Hong PWH , Chen CL, Chou SW, Wu CY, Cheng PT, Tang FT, Chen HC (2007) Ground Reaction Force Patterns in Stroke Patients with Various Degrees of Motor Recovery Determined by Plantar Dynamic Analysis. *Chang Gung Med J* 30(1):62-71

Conforto AB, Ferreiro KN, Tomasi C, Santos RL, Moreira VL, Nagahashi SK, *et al.* (2010) Effects of somatosensory stimulation on motor function after subacute stroke. *Neurorehabil Neural Repair* 24(3):263-272.

Costa MCF, Bezerra PP, Oliveira APR (2006) Impacto da hemiparesia na simetria e na transferência de peso: repercussões no desempenho funcional. *Rev Neuroc* 14(2):10-13.

Dickstein R, Nissan M, Pillar T, Scheer D (1984) Foot-Ground Pressure Pattern of Standing Hemiplegic Patients Major Characteristics and Patterns of Improvement. *Phys Ther* 64(1):19-23.

Fugl-Meyer AR, Jaasko L, Leyman I, Olsson S, Steglind S (1975) The post-stroke hemiplegic patient: 1. A method for evaluation of physical performance. *Scand J Rehab Med* 7:13-31.

Griffin MP, Olney SJ, McBride ID. Role of symmetry in gait performance of stroke subjects with hemiplegia. Gait & Posture 199;53:132-142.

Johansson BB (2000) Brain Plasticity and Stroke Rehabilitation: The Willis Lecture. *Stroke* 31:223-230.

Jordan MJ, Norris SR, Smith DJ, Herzog W (2005) Vibration training: An overview of the area, training consequences, and future considerations. *J Strength and Cond Res* 19(2):459-466.

Lau RW, Yip SP, Pang MY (2012) Whole-body vibration has no effect on neuromotor function and falls in chronic stroke. *Med Sci Sports Exerc* 8:1409-18.

Laufer Y, Dickstein R, Resnik S, Marcovitz E (2000) Weight-bearing shifts of hemiparetic and healthy adults upon stepping on stairs of various heights. *Clin Rehabil* 14:125–129.

Ledoux WR, Hillstrom HJ (2002) The distributed plantar vertical force of neutrally aligned and pes planus feet. *Gait and Posture* 15:1–9.

Lennon S, Baxter D, Ashburn A (2001)Physiotherapy based on the Bobath concept in stroke rehabilitation: a survey within the UK . *Disabil Rehabil* 23(6):254-262.

Lourenço RA, Veras RP (2006) Mini-exame do estado mental:características psicométricas em idosos ambulatoriais. *Rev. Saúde Pública* 40:712-71.

Machado A, Garcia-Lopez D, Gonzalez-Gallego J, Garatachea N (2010) Whole-body vibration training increases muscle strength and mass in older women: a randomized-controlled trial. *Scand J Med Sci Sports* 20:200-207.

Magnusson M, Johansson K, Johansson BB (1994) Sensory stimulation promotes normalization of postural control after stroke. *Stroke* 25:1176-1180.

Maki T, Quagliato EMAB, Cacho EWA, Paz LPS, Nascimento NH, Inoue MMEA,Viana MA (2006) Estudo de confiabilidade da aplicação da escala de Fugl-Meyer no Brasil. *Rev Bras Fisioter* 10:177-183.

Mester J, Kleinoder H, Yue Z (2006) Vibration training: benefits and risks. *J Biomech* 39(6): 1056–65.

Mileva KN, Bowtell JL; Kossev AR (2009) Effects of low-frequency whole-body vibration on motor-evoked potentials in healthy men. *Experimental Physiology* 94(1):103-116.

Moreno AAS, Gutiérres FC (2011) Digital podoscope for remote diagnosis. Proc. SPIE 8287, *Eighth Symposium Optics in Industry*, 82870K.

Mudie MH, Mercay UW, Radwan S, Lee L (2002) Training symmetry of weight distribution after stroke: a randomized controlled pilot study comparing task-related reach, Bo bath and feedback training approaches. *Clin Rehabil* 16:582-592.

Ness LL e Field-Fote EC (2009) Whole-boby vibration improves walking function in individuals with spinal cord injury: A pilot study. *Gai & Posture* 30:436-440.

Olney SJ, Richards C (1996) Hemiparetic gait following stroke. Part I: Characteristics. *Gait & Posture* 4:136-148.

Pai YC, Rogers MW, Hedman LD, Hanke TA (1994) With Hemiparesis Alterations in Weight-Transfer Capabilities in Adults With Hemiparesis. *Phys Ther* 74: 647-657.

Perry J. Análise de Marcha – Marcha patológica, editora Manole, 2005.

Rees S, Murphy A, Watsford M (2007) Effects of Vibration Exercise on Muscle Performance and Mobility in an Older Population. *J Aging Phys Activ* 15:367-381.

Ribeiro AP, Trombini-Souza F, Iunes DH E Monte-Raso VV (2006) Confiabilidade inter e intra-examinador da fotopodometria. *Rev. Bras. Fisioter* 10(4):435-439.

Sackley CM (1991) Falls, sway, and symmetry of weight-bearing after stroke. *Disabil Rehabil* 13(1):1-4.

Sackley CM (1990) The relationships between weight-bearing asymmetry after stroke, motor function and activities of daily living. *Phys Theory and Practice* 6(4):179-185.

Schaechter JD (2004) Motor rehabilitation and brain plasticity after hemiparetic stroke. *Progress in Neurobiol* 74(1):61-72.

Silva A, Silva A, Dias M, Junior RC, Martinez B, Honorato D, Fernandes G (2013) Whole body vibration training for lower limb motor function among stroke patients. *International J Therapy and Rehabil* 20(5):260-66.

Silva AT, Dias MPF, Calixto R, Jr, Carone AL, Martinez BB, Silva AM, Honorato DC (2014) Acute effects of whole-body vibration on the motor function of patients with stroke: a randomized clinical trial. *Am J Phys Med Rehabil* 93:310-19.

Steffen TM, Hacker TA, Mollinger L (2002) Age and genderrelated test performance in community-dwelling elderly people: Six-minute walk test, Berg Balance Scale, Time Up & Go test, and gait speeds. *Phys Ther* 82:128-37.

Tihanyi TK, Horváth M, Fazekas G, Hortobágyi T, Tihanyi J (2007) One session of whole body vibration increase voluntary muscle strength transiently in patients with stroke. *Clin Rehabil* 21:782-793.

Turnbull GL, Charteris J, Wall JC (1996) Deficiencies in Standing Weight Shifts by Ambulant Hemiplegic Subjects. *Arch Phys Med Rehabil* 77:356-362.

Van Nes IJW, Geurts ACH, Hendricks HT, Duysens J (2004) Short-term effects of whole-body vibration on postural control in unilateral chronic stroke patients: Preliminary evidence. *Am J Phys Med Rehabil* 83:867– 873.

Wanderley FS, Alburquerque-Sendín F, Parizotto NA, Rebelatto JR (2011) Effect of Plantar Vibration Stimuli on the Balance of Older Women: A Randomized Controlled Trial. *Arch Phys Med Rehabil* 92:199-206.

Wong AM, Pei YC, Hong WH, Chung CY, Lau YC, Chen CP (2004) Foot Contact Pattern Analysis in Hemiplegic Stroke Patients: An Implication for Neurologic Status Determination. *Arch Phys Med Rehabil* 85:1625-1630.

Figure 1: Study design and CONSORT diagram showing the flow of participants

Before **After**

Figure 2: Plantar impressions registrations

Figure 3: Patient's position on the vibration platform

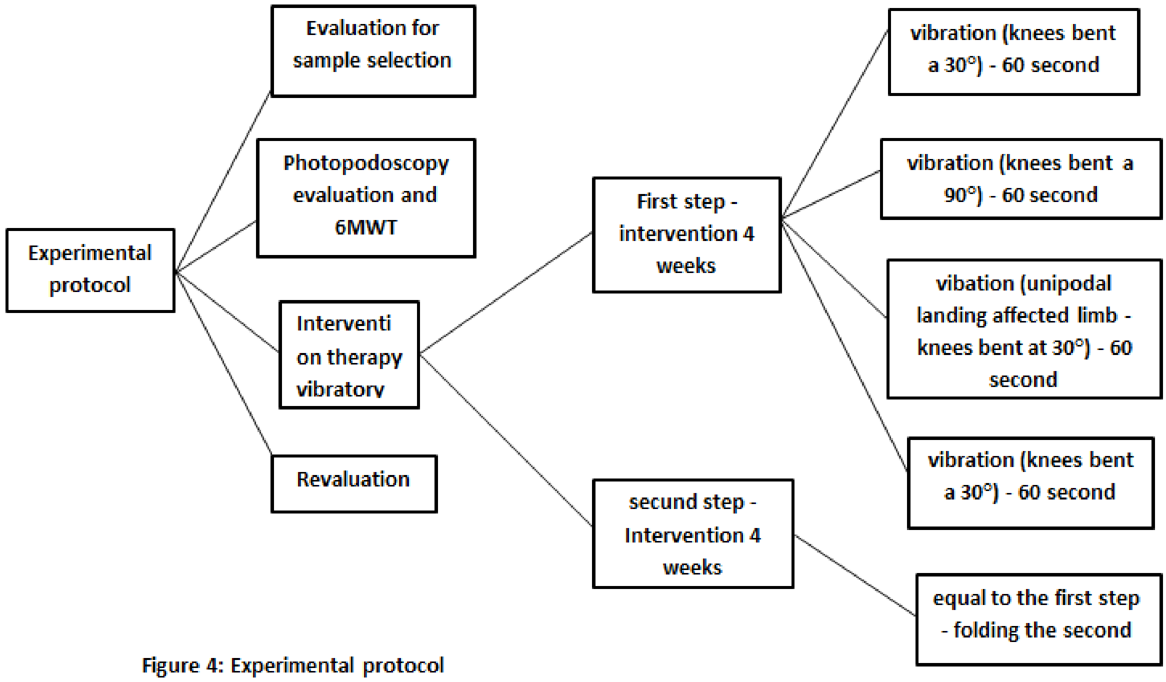


Figure 4: Experimental protocol

Table 1: Shows the mean, standard deviation and p value of clinical and demographic features of the CG and IG.

Variables	IG (n=18)	CG (n=10)	P value
Age (years), Mean (SD)	62±9.92	57.4±11,61	0.27
MMS, Mean (SD)	23.11±3.91	25.8±2,93	0.70
FMS, Mean (SD)	58±22.50	70.3±18.03	0.15
Motor impairment (%):			
Severe	38.88	10	
Remarkable	55.55	50	
Moderate	5.55	40	
Light	0	0	
Gender (%)	61.11 M	60 M	
	38.88 F	40 F	
AS (%)	61.11 L	80 L	
	48.88 R	20 R	
DS (%)	100 R	100 R	
	0 L	0 L	
Stroke (%)	94.44 I	70 I	
	5.55 H	30 H	

IG: intervention group; CG: control group; AS: affected side; DS: dominant side; ; MMS: mini-exam of mental status; FMS: Fugl-Meyer scale; R: right; L: left; M: male; F: female; I: ischemic; H: hemorrhagic.

Table 2: Mean, standard deviation and p value the variables area AS, area US e 6MWT the CG and IG.

Variables	IG (n=18)		CG (n=10)		P values	
	Before	After	Before	After	Intragroup	Intergroup
Area AS	84.27±24.36	103.55±15.75	396.77±88.79	399.76±71.21	0.18	0.37
Area US	94.64±17.89	102.67±18.47	431.68±55.28	418.06±59.96	0.72	0.67
6MWT	159.72±61.22	189.61±65.40	193.8±124.19	205.4±102.59	0.03	0.34

IG: intervention group; CG: control group; AS: affected side; US: unaffected side; 6MWT: Six-Minute Walk Test.

International Journal of Therapy and Rehabilitation

Introduction

The International Journal of Therapy and Rehabilitation (IJTR) is an accessible and peer-reviewed forum for the dissemination of high quality original research and the discussion of new ideas and developments in all areas of therapy and rehabilitation. With its strong interdisciplinary and international focus, IJTR raises awareness of the national and international research and issues affecting therapists, and encourages collaboration and sharing of new ideas between professionals worldwide. Joint and group authorship of submissions is very welcome. The following categories of articles are invited.

Categories of submission

Maximum word count and reference limits are provided for each category of submission. Any necessity to extend beyond the limits should be discussed with the Managing Editor.

1. Editorials

These are short articles that aim to discuss or report on current issues in therapy and rehabilitation. You may use it as a platform to present findings from a recent study/report, or to highlight change, debate or controversial issues, to which you feel the readership should be alerted. Editorials are welcomed from all health-care professionals. Abstracts and key points are not required.

Maximum word count: 800 words. Reference limit: 20

2. Research

IJTR welcomes quantitative, qualitative and mixed methodology primary research that addresses any aspect of rehabilitation and therapy practice, education and management. Abstracts and key points are required as per technical guidelines. We suggest that you follow the following general structure and adapt it according to your specific focus and methodology:

- *Introduction* as per technical guidelines; providing the context for the study.
- *Brief literature review:* appraising the relevant literature and identifying gaps in the literature. This review should also serve to justify the study, clearly stating aims / objectives and hypotheses as appropriate.
- *Methods*: These should encompass the following aspects with headings and content specific to the methodological framework of the research:
  i) methodology - Including factors such as conceptual framework, design, randomization, blinding, placebo control, case control, methods, measurement tools as appropriate.
  ii) setting and timescales —Including general location and provide month and year study was commenced/completed.
  iii) participants – Explaining the nature of the sample and how participants were selected, including inclusion/ exclusion criteria. Numbers entering and completing the study should be stated, along with key subject details as appropriate.
  iv) ethical approval for the study
  v) interventions – Details of any intervention protocol, duration, who was involved and in what setting should be provided as appropriate.
  vi) outcome measures used should be described and justified as appropriate.
- *Findings*: The findings need to be presented in an accessible way; using appropriate data analysis, tables/figures/diagrams, and anonymized direct quotations as appropriate (see technical guidelines).
- *Discussion*: The main findings should be stated, and the discussion should evaluate the strengths and limitations of the study. The methodology and findings of the study should be compared and contrasted to published research in the area. The findings should be interpreted and possible reasons for the findings should be explored. The implications for the therapy and rehabilitation professions should be explored.
- *Conclusions*: as per technical guidelines and to include implications for practice.

Maximum word count: 5000 words; Reference limit: 50

3. Case reports

These articles are invited from authors who have an interesting case or therapy approach, the details of which would have important implications for the IJTR readership. Cases that demonstrate novel approaches to interdisciplinary working are particularly welcomed. Case reports must begin with a case history, and then detail the therapy pathway; highlighting clinical reasoning and reflection processes, from assessment to outcome. Evidence-based practice is required. Signed consent for publication from participants is required (see ethics statement in Editorial Policy). An abstract and key points, as per technical guidelines, are required and the inclusion of tables and figures is strongly encouraged.

Maximum word count: 2000 words. Reference limit: 25

4. Critical reviews

Critical reviews provide a clear and up-to-date account of a topic that is relevant to health professionals working in therapy and rehabilitation. The aim is to provide an update of recent developments and encourage interest and further discussion/work on the subject. Abstracts and key points are required and the inclusion of tables and figures, as per technical guidelines, is strongly encouraged. The following is a useful general structure that can be adapted to suit the individual case; and different methodological approaches to a review are welcomed:

- *Introduction:* as per technical guidelines.
- *Methods*: This should provide detail of the methodology used for the review, including for example: search strategies, inclusion/exclusion criteria for research papers, evaluation of the quality of evidence gathered, details of analysis, as appropriate.
- *Review evidence*: This should address the review topic methodically; with sub-headings to signpost each section. All statements should be supported by evidence, and the quality and relevant details of this evidence should be provided. Where the quality of the research limits the ability to draw strong inferences it should be clearly stated.
- *Conclusions:* as per technical guidelines, and should summarize the review evidence, and highlight areas for further research/work. Limitations of the review should be stated. Sources of further information and details of research currently under way are useful.

Maximum word count: 3000 words; Reference limit: 100

5. Analysis

These are evidence-based essays, which allow the author to discuss and raise awareness of important developments and issues relating to an identified area of therapy and rehabilitation. Submissions are particularly welcome for areas that may benefit from input from a variety of professions, or from the perspective of different countries. When discussion is centred on a controversial area, it may be appropriate to approach the article as a debate and recruit a further author to present

a different side of the argument. Alternatively, we can commission a second author for this purpose through use of a commentary. Analysis articles should follow the general guidelines regarding abstract, key points, introduction and conclusions. The main body of the article should include use of sub-headings and make use of figures and tables as appropriate. Key statements and information must be supported by research, and research detail provided to support proposed arguments. The analysis may afford the opportunity to express opinion and propose arguments, and these should be stated as such. For this purpose, the background of the author should be declared.
Maximum word count: 3000 words; Reference limit: 40

6. Letters to the editor:
These can provide comment on previous articles in the journal or on any relevant topic to therapy and rehabilitation. The editor reserves the right to shorten letters.
Maximum word count: 500 words; reference limit: 5

Technical guidelines

Submission
Articles for IJTR should be submitted on-line at http://www.epress.ac.uk/ijtr/webforms/author.php. If there are any difficulties keeping to the specifications of the article category, please discuss the matter with the Managing Editor, Joanna Bakewell, on 020 7501 6747 or email: ijtr@markallengroup.com. Please ensure that all pages are numbered. When the article is submitted you will receive an email confirming that your article has arrived and is being reviewed. IJTR uses a double-blind peer review process; with at least two independent opinions sought on all papers and referees serving only in their areas of expertise. This review process will take four to six weeks. Details for the submission of amended or revised articles will be sent to you by email.

Title page
The title page should carry:
- Title of the article and category of article being submitted (see below)
- The names of the authors (with initials or first names, whichever is preferred).
- Institutional affiliation of each author.
- Full details of each author's current appointment.
- Name, address, email address and contact telephone number of the author responsible for correspondence.

Authorship
All authors should have made substantive intellectual contribution to the study in the following areas: 1) conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

Acknowledgements
All contributors who do not meet the criteria for authorship as defined above should be listed in an acknowledgments section. The authors should disclose the identity of the people and the entity who provided assistance with study design, data collection, data analysis, or manuscript preparation. Financial and material support should also be acknowledged.

Abstract
This should be between 100 and 200 words in length. It is designed to develop the reader's interest in the article, covering where appropriate, the aims, methodology, results and conclusion of the article, under these sub-headings.

Main introduction
The introduction should state the main purpose or question that the article aims to answer or address, and frame the question in the appropriate context. The introduction should explain the importance of addressing the topic and indicate what approach will be used in doing so.

Headings
Please use plenty of headings and indicate clearly the 'importance' you attach to each one.

Main body
Given the wide scope of the Journal, the articles should be aimed at an interdisciplinary and international audience. Therefore knowledge of specific organizations, practices and policies must not be assumed. Please see article category instructions for specific guidance on content.

Conclusions
The conclusions should be succinct and logically ordered summaries of data you have presented. Identify gaps in present knowledge and suggest future initiatives.

Key phrases
Please supply five to eight key phrases that summarise the major themes of your article. These will appear at the end of the article.

Abbreviations and units
Abbreviations should be defined at their first mention. SI units should always be used.

Tables and figures
Tables and figures are a useful resource to readers. It is the author's responsibility to ensure that permission is received from the copyright holder for the reproduction of figures and tables before submission. Tables and figures should not be embedded in the text, but should be included on a separate page at the end of the document. Authors should indicate in the text approximately where tables and figures should be inserted.

Tables
1. Place references and explanatory matter in footnotes, not headings.
2. Explain in footnotes all abbreviations that are used in each table.
3. If you use data from another published or unpublished source, obtain permission and acknowledge fully.
4. Number tables consecutively in order of their first citation. Ensure that each table is cited in the text.

Figures (illustrations, graphs, bar charts and photographs)
1. Colour is encouraged.
2. If a figure has been published previously, acknowledge the original source and submit written permission from the copyright holder to reproduce the material.
3. Figures should be numbered consecutively in order of their first citation in the text.
4. When submitting an article low resolution GIF or JPG images should be used, ideally placed at or very near the position that they will run in the article. Figures should be scaled so that they are between about 300 and 600 pixels in height and width.
5. If the article is accepted for publication, electronic copies of images will be requested. These should be high resolution (at least 300 dpi) with an image width of 10cm, saved as jpegs or tiffs.

Author instructions

Conflict of interest
All authors should provide a conflict of interest statement at the end of the text. Please see Editorial Policies for details.

References
Authors are responsible for verifying the accuracy and completeness of references.

In the text

1. Use the name and year (Harvard) system for references in the text:
   As Black and White (1987) have shown...
   As already reported (Black and White, 1987)...
2. For three or more authors print the first author's name followed by et al:
   e.g. As Black et al (1987) have shown...
3. When several references are cited simultaneously, the order should be chronological.

In the reference list

1. Arrange references alphabetically by first author's name.
2. Print the names and initials of all authors for references with six or less authors:
   Black B, Green G (1965)...
   Black B, White W (1963)...
   Black B, White W, Green G, Brown B, Tan T (1973)...
   Black B, Green G, Tan T (1974)...
   Black B, Abel C, Tan T (1975)...

The last three references in the above list are in chronological order as they are cited in the text as 'Black et al'.
For seven or more authors print the first three and add 'et al'–these references are arranged chronological order.

3. The sequence for a journal article is: author(s) (year) Title. *Journal (abbreviated as in PubMed)* **volume** (issue): first–last page numbers. For example:
   Smith B, Abel CH (1987) Sexual hypersensitivity. *Br J Hosp Med* **33**(1): 40–6
4. The sequence, layout and punctuation for books are:
   Personal author:
   Laidler P (1994) *Stroke Rehabilitation: Structure and Strategy.* Chapman & Hall, London
   Editor:
   Cusack L, Singh S (1994) *HIV and AIDS Care: Practical Approaches.* Chapman & Hall, London: 125–6
   Chapter in Book:
   Samuels B (1979) Pulmonary complications of AIDS. In: Rand A, Long B, eds. *Management of AIDS.* Butterworths, London: 387–95
5. Articles that have been submitted for publication but not yet accepted are not acceptable as references. They should be cited in the text as 'unpublished observations' (XY Smith, unpublished observations, with or without a date). Similarly, 'personal communication' should be inserted in the text in parentheses.
6. Articles that have been accepted for publication but not yet published may be included in the reference list:
   Abel HL (1988) Endometriosis. *Br J Hosp Med* (in press)
7. World wide web: Ensure address is not a homepage but leads directly to the relevant document. Accessed date is the date the subeditor checks the referemce.
   Author (1999) Title. www.etc.com/index.html (accessed 5 September 2007)

IJTR editorial policy

General statement
IJTR aims to publish articles that meet acceptable ethical and research governance standards.

Ethical approval
Authors should indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and the Helsinki Declaration of 1975, as revised in 2000. Research articles must clearly state how ethical and/or research governance approval was satisfied. Authors must state that anonymity and confidentiality were assured, and must ensure that any procedures were performed in compliance with relevant laws and institutional guidelines. Informed consent from participants should be detailed. The details of the ethical committee granting approval must be included.

Identifying details should be omitted if they are not essential. Information or illustrations that may identify a patient/volunteer must state that consent has been obtained giving permission for the material to be published. A consent form must be signed and dated by the authors, the patient(s) and a witness, with their names printed underneath prior to publication.

Conflict of interest
A conflict of interest statement must be provided, that declares any details, such as author payment or equipment provision by a third party or other competing financial interests, which may have influenced the professional judgement of the authors. Any financial and material support received must be detailed in the acknowledgements section.

Copyright
IJTR will only consider submissions if the content has not been published, or submitted simultaneously for publication elsewhere. Articles must not substantially duplicate material already published. Implicit in the act of submission of a manuscript is author compliance with this policy. When submitting a paper the author must provide a full statement about all submissions and previous reports that might be regarded as duplicate publication of the same or very similar work.

An author must not plagiarize the work of others or self-plagiarize the author's previous work. Exact wording of another author's work must be enclosed in quotation marks, and supported by a reference including the page number. Authors may paraphrase another author's work but must credit the original source in the text. Implicit in the act of submission of a manuscript is affirmation by the author(s) that the submission is their original work.

IJTR retains the copyright of all material it publishes. Permission for authors to reproduce extracts from their own articles can be requested with due acknowledgment to IJTR. The Publication Form must be signed by all authors upon acceptance of an article for publication.

ARTIGO III

A influência do treinamento vibratório no sinal eletromiográfico em pacientes acometidos por Acidente Vascular Cerebral – ensaio clinico randomizado.

Submetido à revista Physiotherapy Theory and Practice

Imprimir - Fechar janela - Clique em Mais na parte inferior do email para imprimir uma mensagem única

Assunto:	Physiotherapy Theory and Practice - Manuscript ID UPTP-2015-0258
De:	ellen.hasson@angelo.edu (ellen.hasson@angelo.edu)
Para:	adrianat.silva@yahoo.com.br;
Data:	Terça-feira, 6 de Outubro de 2015 16:49

06-Oct-2015

Dear Mrs Silva:

Your manuscript entitled "INFLUENCE OF VIBRATION TRAINING ON ELECTROMYOGRAPHIC SIGNAL IN CEREBRAL VASCULAR ACCIDENT AFFECTED PATIENTS – A RANDOMIZED CLINICAL TRIAL." has been successfully submitted online and is presently being given full consideration for publication in Physiotherapy Theory and Practice.

Your manuscript ID is UPTP-2015-0258.

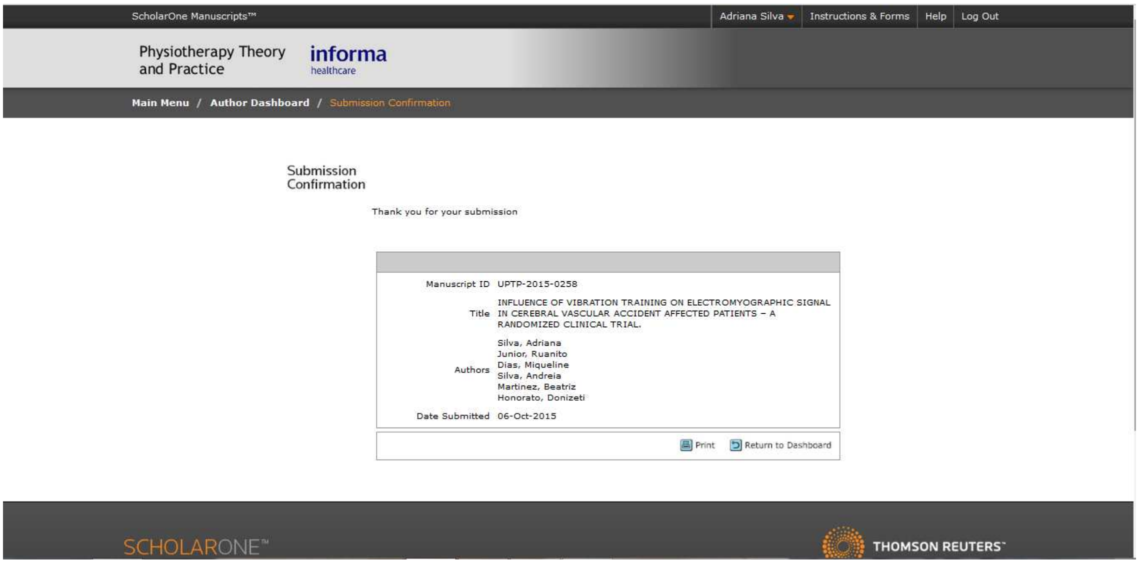
Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to Manuscript Central at https://mc.manuscriptcentral.com/uptp and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Center after logging in to https://mc.manuscriptcentral.com/uptp.

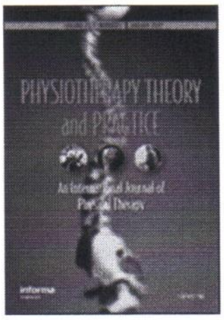
Thank you for submitting your manuscript to Physiotherapy Theory and Practice.

Sincerely,
Physiotherapy Theory and Practice Editorial Office

There are now over 1050 Taylor & Francis titles available on our free table of contents alerting service! To register for this free service visit: www.informaworld.com/alerting.



Physiotherapy Theory and Practice



INFLUENCE OF VIBRATION TRAINING ON ELECTROMYOGRAPHIC SIGNAL IN CEREBRAL VASCULAR ACCIDENT AFFECTED PATIENTS – A RANDOMIZED CLINICAL TRIAL.

Journal:	*Physiotherapy Theory and Practice*
Manuscript ID	Draft
Manuscript Type:	Research Report
Keywords:	vibrating platform, rehabilitation, stroke

INFLUENCE OF VIBRATION TRAINING ON ELECTROMYOGRAPHIC SIGNAL IN CEREBRAL VASCULAR ACCIDENT AFFECTED PATIENTS – A RANDOMIZED CLINICAL TRIAL.

ABSTRACT

The objective of this study was to determine the influence of vibration training on the electromyographic signal of the rectus femoris (RF) and tibialis anterior (TA) muscles in patients affected Cerebral Vascular Accident (CVA). The sample consisted of 43 hemiparetic patients affected by stroke, who were randomized into 2 groups: control (CG, n = 19) and intervention (IG, n = 24). The instruments used for evaluation were the Mini-mental state, the Fugl-Meyer Assessment Scale and surface electromyography (EMG) during bilateral and simultaneous voluntary isometric contraction (VIC) of RF and TA muscles. Whole body vibration therapy (WBV) was used as treatment 3 times a week for 8 weeks. The results show that rms EMG activity did not alter, intra-group nor inter-group. We concluded that the vibration training did not influence the EMG signal from the RF and TA muscles in CVA patients.

Uniterms: vibrating platform, rehabilitation and Cerebral Vascular Accident.

INTRODUCTION

The whole body vibration (WBV) is an exercise modality that has been applied in clinical practice and investigated in the scientific community. WBV is an intervention able to generate a sinusoidal vibration and oscillatory waves, being dependent on the frequency, amplitude and vibration type (Jordan, Norris, Smith and Herzog, 2005). These stimuli are transmitted to the body, being picked up by sensory receptors, most likely muscle spindles, and cause positive effects on the musculoskeletal system with consequent improvement in performance of athletes, the elderly and central lesions (Karatranstou, 2013; Mason, 2012; Bove, Nardone and Schieppati, 2003).

Some studies show that a WBV session and training with vibration therapy can produce improvements in motor function and increase the strength of maximum voluntary contractions in patients suffering from central lesions (Liao *et al*, 2015; Silva, 2013; Murrillo *et al*, 2011). However, conflicting results have been reported (Lau *et al*, 2012; Brogardh *et al,* 2012). There is still a need to better understand and substantiate the biomechanical and physiological mechanism alterations from the vibration effect on patients suffering from CVA. To address this issue, surface electromyography is an instrument used to quantify the strength signal /EMG relationship, the muscle activation level, the muscle activation timing and muscle fatigue signal (De Luca, 1997).

Recently Pollock *et al* (2010) observed a 5-50% increase in the maximum voluntary contraction muscle activity of six lower limb muscles in healthy adults during whole body vibration. Liao *et al* (2015) demonstrate a significant increase in the activity of the vastus lateralis and gastrocnemius muscles, about 10 to 20% of the maximum voluntary contraction in post CVA patients. They also observed similar responses in the electromyographic activity of the paretic and non-paretic limb muscles. However, electromyographic responses of the tibialis anterior muscle and rectus femoris have been little investigated. Thus, the aim of this study was to determine the influence of vibration training on the electromyographic signal of the rectus femoris (RF) and tibialis anterior (TA) muscles in patients affected with CVA. The study hypotheses were as follows: (1) The EMG activity of the RF and AT muscles can significantly increase after eight weeks of vibration training; (2) vibration training at a frequency of 50 Hz and an amplitude of 2 mm might modify the RF and TA muscle electromyographic signals and (3) the vibration training can have more significant effects on the paretic side.

METHODOLOGY

Study design:

This is a clinical, parallel, prospective, randomized, blinded trial, conducted in the human movement laboratory at the University of Sapucaí Vale, Pouso Alegre, MG, Brazil. This study received approval from the Human Research Ethics Committee of the University of Sapucaí Vale (UNIVÁS), Pouso Alegre, MG, Brazil under protocol number 1499/10 and was carried out in compliance with Resolution 196/96 of the Brazilian National Board of Health. This study was entered into the Brazilian register of clinical trials under code RBR-34v9px.

The study was carried out from August 2013 to July 2014. Participants were recruited from a physiotherapy and neurology outpatient care list of the Hospital Clínicas Samuel Libânio, Pouso Alegre – MG, Brasil. In this study, three researchers were involved: Researcher 1 first came into contact with sixty-eight participants and also conducted the allocation of the study participants; Researcher 2, performed the initial and final evaluations, of which only fifty corresponded to the inclusion criteria of the study; Researcher 3, conducted the intervention. Seven participants were excluded from the study for not showing up at the evaluation and quit the intervention. Participants were divided into two groups: intervention group (IG - n = 24) and control group (CG - n = 19). The participants were randomly allocated to the different groups using cards enclosed in sequentially numbered opaque envelopes. This process was carried out by a member of the team who was not involved in the recruitment process or development of the study (Figure 1).

Figure 1

Sample size was estimated based on evidence from a previous WBV. A_previous study that examined the vastus laterallis muscle activity dutring WBV in people after stroke (Tihanyi *et al*. 2010).

Sample:

Forty-three patients (60.19 ± 11.39 years of age), with consequent hemiparesis due to CVA, were selected for the evaluation, according to the following inclusion criteria: hemiparesis due to CVA; over 2 months of injury; both genders; over 20 years of age; mentally competente - measured by the Mini Mental State Examination, Brazilian version (Lawrence and Veras, 2006); motor function reduction - assessed by Fugl-Meyer Assessment Scale – FMA (Fugl-Meyer *et al*, 1975; Maki *et al*, 2006) (see Table 1).

Assessment Instruments

The participants were assessed using the following instruments: the motor function section of FMA (with a maximum total score of 100) was used to assess the upper and lower limb motor function (Fugl-Meyer *et al*, 1975), the motor impairment level was determined through this scale (less than 50 points - severe, 50 to 84 points - remarkable, 85-95 points - moderate, 96 to 99 points - light (Fugl-Meyer *et al*, 1975; Maki *et al*, 2006); the mini-mental state examination (MMSE) was used to assess the cognitive capacity, with a cutoff point of 25 for the illiterate and 19 for the literate (Lourenço e Veras, 2006); surface electromyography (EMG) was used to assess the pattern of muscle activation during voluntary isometric contraction (VIC) (De Luca, 1997).

Electromyographic (EMG) Evaluation Procedures

Electromyographic signals were collected using a four-channel device (EMG system of Brasil Ltda.®), model EMG-800C, including pre-amplified active bipolar electrodes with a 20x gain, a 20-500 Hz analog bandpass filter, and a common mode rejection ratio>100 dB. Electromyographic signals were collected with a sampling frequency of 2 KHz and were digitized using a 16-bit A/D converter. Disposable silver/silver chloride (Ag/AgCl) circular electrodes with a 10-mm diameter (MediTrace®) were placed at 20-mm intervals.

First, electromyographic signals were collected bilaterally and simultaneously from the tibialis anterior (TA) and rectus femoris (RF) muscles during WBV (Di IGminiani *et al*, 2013; Fratini *et al*, 2009; Dionisio, 2008; Bevilaqua-Grossi, 2005). To establish the WBV reference values, the volunteers stood in the orthostatic position on a rubber mat with the feet apart, knees flexed to 30 degrees, and hips flexed to 10 degrees, while placing the hands on a flat surface for support. A goniometer was placed on the knees to maintain the 30-degree flexion. The participants were requested to perform a sustained isometric contraction (by applying maximum strength against the ground surface) for 5 seconds. The participants performed three 5-second WBV series with 1-minute rest intervals between the series, while following the examiner's verbal requests for maximum contraction.

For the purpose of analysis, the skin was cleansed using a piece of cotton and 70% alcohol, and trichotomy was performed before the active electrodes were placed along the direction of the muscle fibers (TA and RF). For placement of the TA electrodes, the participants sat on a table with the knees half-flexed and were requested to perform dorsiflexion with ankle inversion; in that position, the electrode was placed at a position one-third below the fibula, with a 2-cm distance between the electrodes. In the case of RF, the participants sat on a table with the knees slightly flexed and the upper part of the trunk slightly stretched; in that position, the electrode was placed at the midpoint of a line extending from the anterior-superior iliac spine to the patellar upper margin. The reference electrode was placed on the right ankle (Seniam, 2010).

Experimental protocol

The procedure was performed in four steps: First, evaluation with the FMA and MMSE scales for sample selection; second step, evaluation with electromyography; third step, intervention with WBV therapy; fourth step, revaluation.

The IG performed the whole body vibration therapy, the intervention was performed three times a week for 8 weeks. The procedure was divided into two phases: a first phase (4 weeks) and a second phase (4 weeks). In the first phase there were 4 sets of 60 seconds, with 60 seconds of rest in each set. In the first series the patient was in a static standing position with bipedal support and hands resting on the device, keeping the feet apart with knees semi-flexed at 30º. In the second series the same position was employed, but with the knees flexed 90°. In the third series the same position was employed as in the first, but with the unipodal support of the affected member with the knee semi-flexed at 30°. The fourth series was conducted in a manner identical to the first, without modifications (Figure 2). Participants remained resting on the vibrating platform while maintaining the static standing position with knees extended. The second stage was conducted as the first, but with twice the number of series. All participants were positioned barefoot on the vibrating platform, with support for the upper members and a mark was placed on the vibration platform for foot placement (Silva *et al*, 2014).

Figure 2

Processing of the EMG Signal

To analyze the activity of the investigated muscles, the root mean square of the EMG signal amplitude was calculated. All the signals were processed using Matlab software routines (The MathWorks Inc, Natick, MA). The EMG signal length was 5 secs, but the first and last seconds were disregarded; therefore, a period of 3 secs was analyzed, which was used to establish the reference value, the maximum root mean square, of each analyzed signal before and after the intervention to achieve reliable measurements. The reference value was divided by the greatest value of all the analyzed signals and then multiplied by 100.

Statistical analysis

Descriptive statistics were used to characterize the sample relative to the clinical and demographic variables. The independente t test was used to compare the baseline characteristics of the CG and the IG. The Shapiro-Wilk test was performed to determine the normality of the data. Then for comparison within groups the Wilcoxon test was used, and for comparison between groups, the Mann Whitney test._All analyses were executed using the SPSS package (version 20.0). The probability level for statistical significance in all tests was set at $p<0.05$.

RESULTS

The sample consisted of forty-three individuals, having lost seven participants because of missing the intervention. Table 1 presents the clinical characteristics of the remaining sample. There was no statistical difference in age, cognition level and motor dysfunction.

Table 1

EMG activity of paretic and nonparetic leg RF and TA

Table 2 presents the paretic and non-paretic RF and TA muscular activity compared before and after the intervention and between groups. The rms EMG activity did not alter after the intervention with WBV nor when compared with the CG. Statistical analysis confirmed these non-significant observations where the $p \geq 0.05$ and the effect size was low.

Table 2

DISCUSSION

The main finding in this study reveals that WBV training did not influence the electromyographic signal in RF and TA muscles. This finding confirms with the response found in the study of Bosco *et al* (1999) and Bosco *et al* (2000), where the RF and VL EMG rms did not alter after the vibration treatment, but improved functional performance in athletes and also in patients with CVA (Silva *et al*, 2013). This can be justified by improved neuromuscular efficiency leading to a reduction of EMG activity due to the increase in muscular endurance (Bosco *et al*, 2000). Endurance training over a long period may be able to increase concentration of strength associated with reduced electromyographic activity (Bosco *et al*, 2000; Komi *et al*, 1978). At the start of the training program there is a biologicl adaptation, i.e., improved neural efficiency of the supraspinatus center, descending tract, spinal circuit and motor connections and neuromuscular junctions (Komi *et al,* 1978; Carroll *et al,* 2001; Enoka, 1997).

In the protocol proposed in the present study, there was alteration only in the series number, and the intervention occurred in a period of 8 weeks, i.e. seeking endurance training. Studies suggest that WBV training may result in neuromuscular adaptations similar to the effects produced by endurance training. This stems from the change in the connectivity between corticospinal cells and spinal motor neurons. (Delecluse *et al,* 2003; Aagard *et al*, 2001; Aagard *et al,* 2002).

The sample studied in this work consisted of patients with central lesions resulting in muscle weakness. This weakness stems from motoneuronal physiology changes (motor unit loss, alterations in recruitment order and motor unit firing rates); changes in peripheral nerve conduction; muscle changes (alterations in morphology, motor unit contractile properties and changes in mechanical properties) (Bourbonnais and Noven, 1989; Hafer-Macko, Ryan, Ivey and Macko, 2008). The changes in muscle properties include atrophy of Type II fibers and increased proportion of Type I fibers with consequent loss of motor function. The progressive endurance training is an effective form of intervention to improve strength and improve gait performance (Flansbjer, Miller, Downham and Lexell, 2008).

Another explanation may be due to co-activation of agonist and antagonist muscles during the WBV associated with the isometric squat. This could mask any further increases in the electromyographic activity of agonist muscles due to the balance between excitatory (afferent Ia) and inhibitory input (activation of Golgi tendon organs, skin receptors and mechanoreceptors) (Di IGmiani *et al*, 2012; Avelar *et al,* 2013). One should take into consideration that in the aforementioned studies the electromyographic signal was collected during the vibration training and in the present study, after the vibration training.

Another point to be analyzed is related to the frequency used in the intervention protocol, 50Hz, which was not able to modify the electromyographic signal. Some researchers found that vibration is able to induce increased EMG activity, due to the synchronization of motor units, which can be dependent on the vibration frequency (Matthews and Stein, 1969; Cordo *et al,* 1993; Roll *et al.,*1989. In the study by Di Gimiani *et al*. (2012) they used the frequencies from 20 to 55 Hz, 55 Hz producing little muscle activation of the lateral gastrocnemius, unlike in the vastus lateralis. It is suggested increasing the vibration frequency may lead to reduced EMG activity due to the presynaptic inhibition caused by continuous vibratory stimulus. Some studies have highlighted that 30 Hz caused a greater effect on the electromyographic signals in patients with central lesions and athletes (Ness and Field-Fote, 2009; Liao *et al.,* 2014; Cardinale and Lim, 2003). Researchers reported that rates below 20 Hz may cause a resonance effect to the body, and is not indicated for intervention. (Randall *et al,* 1997; Mester *et al.,* 2002).

Contrary to the findings of this present study, others have found increased EMG activity of various lower limb muscles (Liao *et al*, 2015; Liao *et al*, 2014; Madou, 2011), this can be justified by the data collection being held during vibration training unlike in the present study, in which collection was performed before and after intervention. According to De Luca (1997) the RMS (Root Meas Square) is very susceptible to interference from the external environment, thus the necessity of data normalization.

Regarding the influence of vibration on the control group and intergroup and intragroup intervention of the lower paretic and non-paretic limb, there was no statistical difference and EMG values were similar on both sides after the vibration training. In contrast, Liao *et.al*, 2014, found a significant increase in electromyographic activity in both members for the vastus lateralis and gastrocnemius during different exercises in patients with chronic CVA during vibration training. Similar responses were also found in the study by Liao *et al*., 2015 for TA muscles and biceps femoris during the WBV and in the study by Tihanyi *et al*., 2010, after the intervention.

Limitations and future research

Some limitations should be pointed out, such as the need to change protocols such as: variation of frequency, the use of isotonic exercise and long-term revaluation to estimate the best protocol for the rehabilitation of patients with CVA.

CONCLUSION

We conclude that the vibration training did not influence the EMG signal of the RF and TA muscles in patients with CVA.

BIBLIOGRAPHIC REFERENCE

Aagaard P, Andersen JL, Dyhre-Poulsen P, Leffers AM, Wagner A, Magnusson SP, Halkjær-Kristensen J, Simonsen EB 2001 A mechanism for increased contractile strength of human pennate muscle in response to strength training: changes in muscle architecture. Journal of Physiology 534(2):613–623.

Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P 2002 Increased rate of force development and neural drive of human skeletal muscle following resistance training. J Appl Physiol 93:1318–1326.

Avelar NCP, Ribeiro VGC, Mezêncio B, Fonseca SF, Tossige-Gomes R, Costa SJ, Szmuchrowski L, Gripp F, Coimbra CC, Lacerda ACR 2013 Influence of the knee flexion on muscle activation and transmissibility during whole body vibration. Journal of Electromyography and Kinesiology 23(4):844-850.

Bevilaqua-Grossi D, Felicio LR, Simões R, Coqueiro KRR, Monteiro-Pedro V 2005 Avaliacão eletromiográfica dos músculos estabilizadores da patela durante exercício isométrico de agachamento em indivíduos com síndrome da dor femoropatelar. Rev Bras Med Esporte 11:159-63

Bosco C, Colli R, Introini E, Cardinale M, Tsarpela O, Madella A, Tihanyi J, Viru A 1999 Adaptive responses of human skeletal muscle to vibration exposure. Clin Physiol 2:183–7.

Bosco C, Iacovelli M, Tsarpela O, Cardinale M, Bonifazi M, Tihanyi J, Viru M, De Lorenzo A, Viru A 2000 Hormonal responses to whole_body vibration in men. Eur J Appl Physiol 81(6):449-54.

Bourbonnais D, Noven SV 1989 Weakness in patients with hemiparesis. Am J Occup Ther 1989;43(5):313-9

Bove M, Nardone A, Schieppati M 2003 Effects of leg muscle tendon vibration on group Ia and group II reflex responses to stance perturbation in humans. J Physiol 550: 617-630.

Brogardh C, Flansbjer U-B, Lexell J 2012 No specific effect of wholebody vibration training in chronic stroke: a double-blind randomized controlled study. Arch Phys Med Rehabil 93(2):253–8.

Cardinale M, Lim J 2003 Electromyography Activity of Vastus Lateralis Muscle During Whole-Body Vibrations of Different Frequencies. Journal of Strength and Conditioning Research 17(3):621-624.

Carroll TJ, Riek S, Carson RG 2001 Neural adaptations to resistance training: implications for movement control. Sports Med 31:829-840.

Cordo P, Gandevia SC, Hales JP, Burke D, Laird G 1993 Force and displacement-controlled tendon vibration in humans. Electroencephalogr Clin Neurophysiol 1:45-53.

De Luca C 1997 The use of surface electromyography in biomechanics. J Appl Biomech 13(2):135–63

Delecluse C, Roelants M, Verschueren S 2003 Strength Increase after Whole-Body Vibration Compared with Resistance Training. Medicine & Science in Sports & Exercise 6:1033-1041.

Di Giminiani R, Masedu F, Tihanyi J, Scrimaglio R, Valenti M 2013 The interaction between body position and vibration frequency on acute response to whole body vibration. J Electromyogr Kinesiol 23:245–51.

Dionisio VC, Almeida GL, Duarte M, Hirata RP 2008 Kinematic, kinetic and EMG patterns during downward squatting. J Electromyogr Kinesiol 18:134-43.

Enoka RM 1997 Neural adaptations with chronic physical activity. J. Biomech 30:447–455.

Flansbjer UB, Miller M, Downham D, Lexell J 2008 Progressive resistance training after stroke: effects on muscle strength, muscle tone, gait performance and perceived participation. J Rehabil Med 40:42-48.

Fratini A, La Gatta A, Bifulco P, Romano M, Cesarelli, M 2009 Muscle motion and EMG activity in vibration treatment. Medical Engineering & Physics 31:1166-1172.

Fugl-Meyer AR, Jaasko L, Leyman I, Olsson S, Steglind S 1975 The post-stroke hemiplegic patient: 1. A method for evaluation of physical performance. *Scand J Rehab Med* 7:13-31.

Hafer-Macko CE, Ryan AS, Ivey FM, Macko RF 2008 Skeletal muscle changes after hemiparetic stroke and potential beneficial effects of exercise intervention strategies. J Rehabil Res Dev 45(2): 261–272.

Jordan MJ, Norris SR, Smith DJ, Herzog W 2005 Vibration training: An overview of the area, training consequences, and future considerations. Journal of Strength and Conditioning Research 19(2): 459-466.

Karatranstou K, Gerodimos V, Dipla K, Zafeiridis A 2013 Whole-body vibration training improves flexibility, strength profile of knee flexors, and hamstrings-to-quadriceps strength ratio in females. Journal of Science and Medicine in Sport 16(5):477-481

Komi PV, Viitasalo JT, Rauramaa R, Vihko V 1978 Effect of isometric strength training on mechanical, electrical, and metabolic aspects of muscle function. Eur J Appl Physiol 40:45-55.

Lau RWK, Yip SP, Pang MYC 2012 Whole-body vibration has no effect on neuromotor function and falls in chronic stroke. Med Sci Sports Exerc 44(8):1409–18;

Lennon, S 2001 Gait Re-education Based on the Bobath Concept in Two Patients With Hemiplegia Following Stroke Phys Ther 81:924-935.

Liao LR, Lam FMH; Pang MY, Jones AYM, Ng GYF 2014 Leg Muscle Activity during Whole-Body Vibration in Individuals with Chronic Stroke. Med. Sci. Sports Exerc 46(3):537-545

Liao LR, Ng GYF, Jones AYM, Chung RC, Pang MY 2015 Effects of vibration intensity, exercise, and motor impairment on leg muscle activityinduced by whole-body vibration in people with stroke. Phys Ther 95:xxx–xxx.

Lourenço RA, Veras RP 2006 Mini-exame do estado mental: características psicométricas em idosos ambulatoriais. *Rev. Saúde Pública* 40:712-71.

Madou KH 2011 Leg muscle activity level and rate of perceived exertion with diferente whole-body vibration frequencies in multiple sclerosis patients: An exploratory approach. Hong Kong Physiotherapy Journal 29:12-19.

Maki T, Quagliato EMAB, Cacho EWA, Paz LPS, Nascimento NH, Inoue MMEA,Viana MA 2006 Estudo de confiabilidade da aplicação da escala de Fugl-Meyer no Brasil. *Rev Bras Fisioter* 10:177-183.

Mason RR, Cochrane DJ, Denny GJ, Firth EC, Stannard SR 2012 Is 8 weeks of side-alternating whole-body vibration a safe and acceptable modality to improve functional performance in multiple sclerosis? Disability and Rehabilitation 34(8):647-654.

Matthews PB, Stein RB 1969 The sensitivity of muscle spindle afferents to small sinusoidal changes of length. J Physiol 200:723-43

Mester J, Spitzenpfeil P, Yue ZY 2002 Vibration loads: Potential for strength and power development, in Komi PV (ed):Strength and Power in Sport. UK, Oxford, Blackwell, :488-501.

Murrillo N, Kumru H, Vidal-Samso J, Benito J, Medina J, Navarro X, Sole J 2011 Decrease of spasticity with muscle vibration in patients with spinal Cord injury. Clinical Neurophysiology 122:1183-1189.

Ness LL, Field-Fote EC 2009 Whole-body vibration improves walking function in individuals with spinal cord injury: A pilot study. Gait Posture 30:436-4;

Pollock RD, Woledge RC, Mills KR, Martin FC, Newham DJ 2010 Muscle activity and acceleration during whole body vibration: Effect of frequency and amplitude. Clinical Biomechanics 2(8):840-846.

Randall JM, Matthews RT, Stiles MA 1997 Resonant frequencies of standing humans.Ergonomics 40(9):879–86.

Roll JP, Vedel JP, Ribot E 1989 Alteration of proprioceptive messages induced by tendon vibration in man: a microneurographic study. Experimental Brain Research 76(1):213-222.

Silva A, Silva A, Dias M, Calixto Junior R, Martinez B, Honorato D, Fernandes G 2013 Whole body vibration training for lower limb motor function among stroke patients.Int J Ther Rehabil 20:260-6

Silva AT, Dias MPF, Calixto R, Jr, Carone AL, Martinez BB, Silva AM, Honorato DC 2014 Acute effects of whole-body vibration on the motor function of patients with stroke: a randomized clinical trial. Am J Phys Med Rehabil 93(4):310-9

Tihanyi J, Di Giminiani R, Tihanyi T, Gyulai G, Trzaskoma L, Horváth M 2010 Low resonance frequency vibration affects strength of paretic and non-paretic leg differently in patients with stroke. Acta Physiol Hung 97(2):172–82.

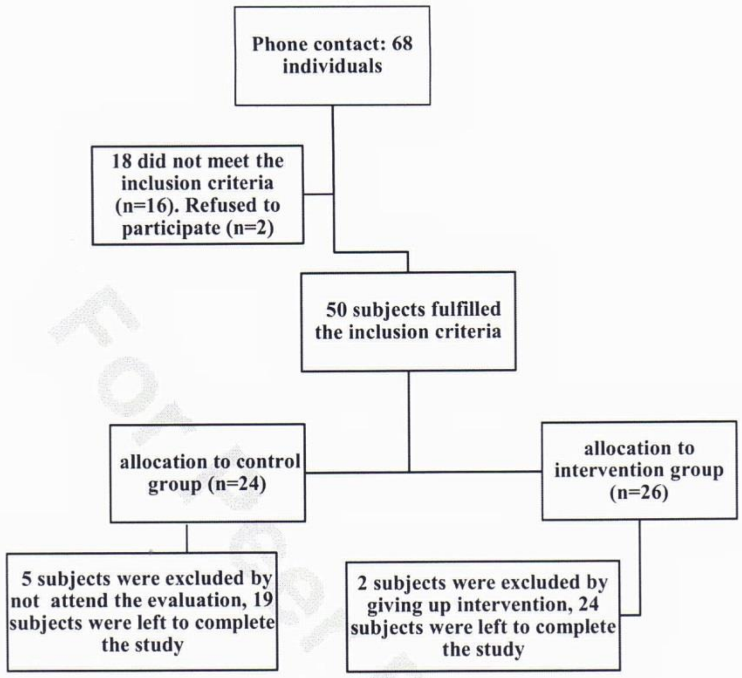


Figure 1: Study design and CONSORT diagram showing the flow of participants

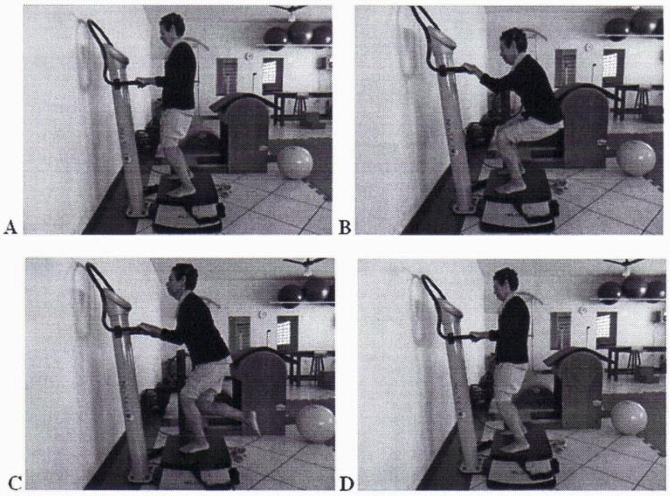


Figure 2: Patient position on the vibrating platform. A: First patient series in upright posture with bipedal support and the knees semi-inflected to 30; B: Second series, the same position was used, but with your knees bent at 90 degrees; C: Third grade, the same position was employed as the first, but with one foot on the affected limb with semiflexion knee 30; D: Fourth grade was conducted identically to the first
193x140mm (96 x 96 DPI)

Table 1: Patients' clinical features

Variables		IG (n=24)	CG (n=19)	p value
Age (years), Mean (SD)		60,62±,12,11	60,35±12,22	0,89
MMS, Mean (SD)		22,95±3,64	24,21±3,55	0,88
FMS, Mean (SD)		59,33±21,43	68,1±19,77	0,83
Motor impairment (%):	Severe	37,5	21,05	
	Remarkable	54,16	36,84	
	Moderate	8,33	36,84	
	Light	0	5,26	
Gender (%)		66,66 M	63,15 M	
		33,33 F	36,84 F	
AS (%)		62,5 L	50 L	
		37,5 R	50 R	
DS (%)		95,83 R	100 R	
		4,16 L	0 L	
Stroke (%)		95,83 I	84,21 I	
		4,16 H	15,78 H	

IG: intervention group; CG: control group; AS: affected side; DS: dominant side; MMS: mini-exam of mental status; FMS: Fugl-Meyer scale; R: right; L: left; M: male; F: female; I: ischemic; H: hemorrhagic.

Table 2: Comparison of inter electromyographic activity and RMS analyzed within groups of muscles.

Muscles		IG (n=24) Before	IG (n=24) After			CG (n=19) Before	CG (n=19) After			Intergroup Before	Intergroup After
		(95% CI)		p*	d*	(95% CI)		p*	d*	$p^{\#}$	$p^{\#}$
Rectus Femoris	AS	90.06(8.51) 85.96–94.17	87.74(10.71) 82.58-92.90	0.5	0.23	89.76(6.83) 86.46-93.05	87.88(7.78) 84.12-91.63	0.3	0.25	0.5	0.8
	US	83.72(13.81) 77.06-90.38	84.41(9.06) 80.04-88.78	0.8	0.05	88.58(8.68) 84.39-92.77	87.32(8.27) 83.33-91.31	0.5	0.14	0.6	0.1
Tibialis Anterior	AS	86.97(15.14) 79.66-94.27	82.23(18.81) 73.16-91.30	0.6	0.27	85.74(11.59) 80.15-91.33	83.43(12.24) 77.53-89.33	0.5	0.19	0.6	0.2
	US	79.77(22.22) 69.06-90.48	79.95(21.50) 69.59-90.32	0.8	0.00	86.3(9.05) 81.94-90.66	85.28(10.28) 80.33-90.24	0.6	0.10	0.7	0.8

AS: Affected Side; US: Unaffected Side; IG: intervention Group; CG: Control Group; CI: Confidence interval; *Wilcoxon test; #Mann-Whitney test; d*: effect size.

5. DISCUSSÃO GERAL

Estudo I

Treinamento de vibração do corpo inteiro na função motora dos membros inferiores em pacientes acometidos por Acidente Vascular Cerebral.

Observou-se melhora no desempenho funcional e na mobilidade analisado pelos TC6M; TSE e TUG, demonstrando que a vibração de corpo inteiro influenciou na função motora em pacientes acometido por AVC. Maiores detalhes estão descritos na página 21-23. Estes achados também foram evidenciados em vários estudos realizados com lesão central, atletas e idosos. Esta melhora pode ser atribuída pela potencialização neural induzida pelo reflexo de vibração tônica.

Estudo II

Efeito do treinamento vibratório na impressão plantar em pacientes acometidos por Acidente Vascular Cerebral – ensaio clínico randomizado.

Sete indivíduos foram exclusos do estudo por desistirem da intervenção e não comparecerem na avaliação. Não houve diferença estatística intergrupo e nem intragrupo para a área da impressão plantar nas houve intragrupo para o TC6M, demonstrando que a vibração de corpo inteiro não influenciou na área de impressão plantar e na função motora em pacientes acometidos por AVC. Maiores detalhes estão descritos na página 32-34 . Há poucas evidências científicas com relação a impressão plantar em pacientes acometidos por AVC que utilizaram a vibração de corpo inteiro sendo o primeiro estudo a analisar. Os resultados observados no presente estudo demonstrou que o método de análise necessita ser mais fidedigno para captar uma variação impressão plantar. Mais detalhes estão descritos no página 32-34.

Estudo III

A influência do treinamento vibratório no sinal eletromiográfico em pacientes acometidos por Acidente Vascular Cerebral – ensaio clinico randomizado.

Houve uma perda amostral de sete indivíduos por desistirem da intervenção e não comparecerem na avaliação. O treino vibração de corpo inteiro por 8 semanas não influenciou no RMS do sinal eletromiográfico dos músculos reto femural e tíbia anterior em pacientes acometidos por AVC. Resultados também foram observados em vários estudos, isso poderia ser justificado pela melhora da eficiência neuromuscular acarretando redução na atividade EMG devido ao aumento na resistência muscular. Mais detalhes estão descritos na página 56-59.

6. CONCLUSÃO

Estudo I

O treino vibratório de corpo inteiro pode contribuir para melhora da função motora em pacientes acometidos por AVC.

Estudo II

O treino vibratório de corpo inteiro não influenciou no aumento da área da impressão plantar em pacientes cometidos por AVC.

Estudo III

O treino vibratório de corpo inteiro não influenciou no sinal eletromiográfico dos músculos RF e TA de pacientes acometidos por AVC.

7. REFERÊNCIAS

1. Braga JL, Alvarenga RMP, Neto, JBMM. Acidente Vascular Cerebral. Rev. Bras. de Med. 2003;60(3):88-96.

2. Joaquim AF, Avelar WMA, Pieri A, Cendes F. Acidente Vascular Isquêmico. Rev. Bras. de Med. 2007;67(12):6-13.

3. Carr J, Shepherd. Acidente Vascular Cerebral. In: Carr J, Shepherd R. Reabilitação Neurológica – Otmizando o desempenho motor. São Paulo: Manole; 2008. p-253-290.

4. Garritano CR, Luz PM, Pires MLE, Barbosa MTS, Batista KM. Análise da Tendência da Mortalidade por Acidente Vascular Cerebral no Brasil no Século XXI. Arq Bras Cardiol 2012;98(6):519-527.

5. Lotufo P. Stroke in Brazil: a neglected disease. Sao Paulo Med J 2005;123(1):3-4.

6. Kim P, Warren S, Madill H, Hadley M. Quality of life of stroke survivors. Qual Life Res 1999;8(4):293-301.

7. Nes IJWV, Latour H, Schils F, Meijer R, Kuijk AV, Geurts ACH. Long-Term Effects of 6-Week Whole-Body Vibration on Balance Recovery and Activities of Daily Living in the Postacute Phase of Stroke: A Randomized, Controlled Trial. Stroke 2006;37:2331-2335.

8. Boivie J, Leijon G, Johansson I. Central post-stroke pain - a study of the mechanisms through analyses of the sensory abnormalities. Pain 1989;37:173-185.

9. Connell LA, Lincoln NB, Radford KA. Somatosensory impairment after stroke: frequency of different deficits and their recovery. Clin Rehabil 2008;22:758-767.

10. Bederson JB, Pitts LH, Tsuji M, Nishimura MC, Davis RL, Bartkowski H. Rat Middle Cerebral artery occlusion: evaluation of the model and development of a neurologic examination. Stroke 1986;17:472-476.

11. Olney SJ, Richards C. Hemiparetic gait following stroke. Part I: Characteristics. Gait & Posture 1996;4:136-148.

12. Vestergaard K, Nielsen J, Andersen G, Ingeman-Nielsen M, Arendt-Nielsen L, Jensen TS. Sensory abnormalities in consecutive, unselected patients with central post-stroke pain. Pain 1995;61:177-186.

13. Spinazzola L, Cubelli R, Sala SD. Impairments of trunk movements following left or right hemisphere lesions: dissociation between apraxic errors and postural instability. Brain 2003;126:2656-2666.

14. Chen PT, Wu SH, Liaw MY, Wong AMK, Tang FTT. Symmetrical body-weight distribution training in stroke patients and its effect on fall prevention. Arch Phys Med Rehabit 2001;82:1650:1654.

15. Marin JM, Carrizo SJ, Gascon M, Sanchez A, Gallego B, Celli BR. Inspiratory Capacity, Dynamic Hyperinflation, Breathlessness, and Exercise Performance during the 6-Minute-Walk Test in Chronic Obstructive Pulmonary Disease. Am J Respir Care Med 2001;163:1395-1399.

16. Pohl PS, Duncan PW, Perera S, Liu W, Lai SM, Studenski S, Long J. Influence of stroke-related impairments on performance in 6-minute walk test. J. Reh. Res. Dev. 2002;39:1-6.

17. Lundy-Ekman L. Neurociência – fundamentos para a reabilitação, editora Elsevier, 3 ed., 2008.

18. Pavlides C, Miyashita E, Asanuma H. Projection from the sensory to the motor córtex is important in learning motor skills in the monkey. J Neurophysiol 1993;70:733-741.

19. Kami N, Shashank T, Mohammed H, Lazar L. Jain N. Reorganization of the Primary Motor Cortex of Adult Macaque Monkeys after Sensory Loss Resulting from Partial Spinal Cord Injuries. JNeuroci. 2011;31(10):3696-3707.

20. Michael C. Riddinga MC, McKayb DR, Thompsona PD, Miles TS. Changes in corticomotor representations induced by prolonged peripheral nerve stimulation in humans Clin Neurophysiol 2001;112, 1461-1469.

21. Conforto AB, Cohen LG, Santos RL, Scaff M, Marie SKN. Effects of somatosensory stimulation on motor function in chronic cortico-subcotical strokes. J Neurol 2007;254, 333-339.

22. Conforto AB, Ferreiro KN, Tomasi C, Santos RL, Moreira VL, Nagahashi SK, *et al*. Effects of somatosensory stimulation on motor function after subacute stroke. Neurorehabil Neural Repair 2010;24(3)263-272.

23. Celnik P, Hummel F, Harris-Love M, Wolk R. Somatosensory stimulation enhances the effects of training functional hand tasks in patients with chronic stroke. Arch Phys Med Rehabil 2007;88:1369-1376.

24. da Cunha IT Jr, Lim PA, Qureshy H, Henson H, Monga T, Protas EJ. Gait outcomes after acute stroke rehabilitation with supported treadmill ambulation training: a randomized controlled pilot study. Arch Phys Med Rehabil 2002;83:1258-65.

25. Hagbarth KE, Eklund G. Tonic vibration reflexes (TVR) in spasticity. Brain Res 1966;2:201-203.

26. Hagbarth KE, Eklund G. The effects of muscle vibration in spasticity, rigidity, and cerebellar disorders. J Neurol Neurosur Psychiat. 1968;31:207-213.

27. Liao LR, Ng GYF, Jones AYM, Chung RCK, Pag MYC. Effects of vibration intensity, exercise, and motor impairment on leg muscle activity induced by whole-body vibration in people with stroke. Phys Ther 2015:xx

28. Tankisheva E, Bogaerts A, Boonen S, Feys H, Verschueren S. Effects of Intensive Whole-Body Vibration Training on Muscle Strength and Balance in Adults With Chronic Stroke: A Randomized Controlled Pilot Study. Arch of Phys Med Rehabil 2014;95(3): 439-446

.

29. Liao LR, Lam FMH; Pang MY, Jones AYM, Ng GYF. Leg Muscle Activity during Whole-Body Vibration in Individuals with Chronic Stroke. Med. Sci. Sports Exerc. 2014;46(3):537-545.

30. Jordan MJ, Norris SR, Smith DJ, Herzog W. Vibration Training: a overview of the area, training consequences, and future considerations. J Strength Cond Res 2005;19, 459-466.

31. Mileva KN, Bowtell JL, Kossev AR: Effects of low frequency whole-body vibration on motor-evoked potentials in healthy men. Exp Physiol 2009;94:103-16

32. Steyvers M, Levin O, Verschueren SM, et al: Frequency-dependent effects of muscle tendon vibration on corticospinal excitability: A TMS study. Exp Brain Res 2003;151:9-14.

33.Cardinale M, Bosco C. The use of vibration as an exercise intervention. Exerc. Sport Sci. Ver. 2003;31(1):3-7.

34. Bosco C, Iacovelli M, Tsarpela O, Cardinale M, Bonifazi M, Tihanyi J, et al. Hormonal responses to whole-body vibration in men. Eur J Appl Physiol 2000;81(6):449–54

35. Bosco C, Colli R, Introini E, Cardinale M, Tsarpela O, Madella A, et al. Adaptive responses of human skeletal muscle to vibration exposure. Clin Physiol 1999;19(2):183–7.
36. Herrero AJ, Menendez H, GIL L, Martín J, Martín T, García-López D, Gil-Agudo A, Marín PJ. Effects of whole-body vibration on blood flow and neuromuscular activity in spinal cord injury. Spinal Cord 2011;49(9):554-559.

37. Cochrane DJ, Stannard SR. Acute whole body vibration training increases vertical jump and flexibility performance in elite female field hockey players. Br J Sports Med 2005;39:860-865.

38. Fagnani F, Giombini A, Di Cesare A, Pigozzi F, Di Salvo V. The effects of a whole-body vibration program on muscle performance and flexibility in female athletes. Am J Phys Med Rehabil 2006;85:956-962

39. Tihanyi TK, Horváth M, Fazekas G, Hortobágyi T, Tihanyi J, One session of whole body vibration increase voluntary muscle strength transiently in patients with stroke. Clin Rehabil 2007; 21:782-793.

40. Hass C, Turbanski S, Kessler K, Schmidtbleicher D. The effects of random whole body vibration on motor symptoms in Parkinson's disease. NeuroRehabil 2006;21:29-36.

41. Wunderer K, Schabrun SM, Chipchase LS. Effects of whole body vibration on strength and functional mobility in multiple sclerosis. Phys Theory Practice 2010;26:374-384.

42. Giovanni Melchiorri G, Andreoli A, Padua E, Sorge R, De Lorenzo A. Use of vibration exercise in spinal cord injury patients who regularly practise sport. Fneur 2007;22:151-154.

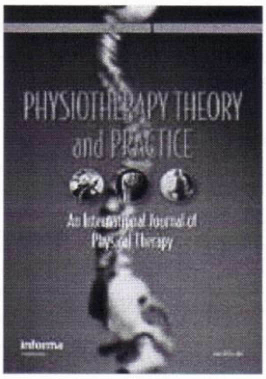
43. Lau RWK, Yip SP, Pang MYC. Whole-body vibration has no effect on neuromotor function and falls in chronic stroke. Med Sci Sports Exerc. 2012;44(8):1409-18.

44. Chan KS, Liu CW, Chen TW, Weng MC, Huang MH, Chen CH. Effects of a single session of whole body vibration on ankle plantarflexion spasticity and gait performance in patients with chronic stroke: a randomized controlled trial. Clin Rehabil 2012;26(12):1087-1095.

45. Van Nes IJW, Geurts ACH, Hendricks HT, Duysens J. Short-term effects of whole-body vibration on postural control in unilateral chronic stroke patients: Preliminary evidence. J Phys Med J Am Rehabil. 2004;83(11):867-73.

46. Murrillo N, Kumru H, Vidal-Samso J, Benito J, Medina J, Navarro X, Sole J. Decrease of spasticity with muscle vibration in patients with spinal Cord injury. Clin Neurophys 2011;122:1183-1189.

Physiotherapy Theory and Practice



Instructions for Authors

Submission of Manuscripts

Please submit your original manuscript electronically through ScholarOne Manuscripts at http://mc.manuscriptcentral.com/uptp. All articles are sent anonymously to at least two referees and are subject to editorial revision. Authors may give the names and e-mail addresses of up to four persons whom they judge would have appropriate knowledge and expertise to review their manuscript during the submission process.

Physiotherapy Theory and Practice considers all manuscripts on the strict condition that they are the property (copyright) of the submitting author(s), have been submitted only to ***Physiotherapy Theory and Practice***, that they have not been published already, nor are they under consideration for publication, nor in press elsewhere. Authors who fail to adhere to this condition will be charged all costs which ***Physiotherapy Theory and Practice*** incurs, and their papers will not be published. Copyright will be transferred to the journal ***Physiotherapy Theory and Practice*** and Informa UK Ltd., if the paper is accepted.

Resubmission of Manuscripts

When manuscripts are returned to authors for revision with referees' comments, the revised paper and response letter should be transmitted to the Editor via the ScholarOne Manuscripts website. A response letter should detail the action taken with regard to each point raised by the referees. If it is felt that no change is appropriate with regard to a specific point, this should be clearly explained.

Presentation of Manuscripts

The manuscript, in English, should be double line spaced with a margin of at least one inch on all sides. It should commence with a separate cover letter, showing title and author names. Each author should indicate his/her professional discipline, current appointment, and degree. A full address and email address is required for each author.

An abstract of not more than 200 words must be submitted for each paper.

There is **no word limit for articles**, but authors should keep their submissions as concise as possible.

Headings

Normally, only two categories of heading should be used. Major ones should be typed in capital letters in the middle of the page and underlined; sub-headings should be typed in lowercase and also underlined. Headings should not be numbered.

Data and Terminology

All quantitative measurements should be given in System International (SI) units. Authors should indicate the statistical techniques to determine significance, etc. Where percentages are given, the actual numbers on which these are based should also be provided.

Tables, figures and illustrations

The same data should not be reproduced in both tables and figures. The usual statistical conventions should be used: a value written 10.0 ± 0.25 indicates the estimate for a statistic (e.g. a mean) followed by its standard error. A mean with an estimate of the standard deviation will be written 10.0 SD 2.65. Contributors reporting ages of subjects should specify carefully the age groupings: a group of children of ages e.g. 4.0 to 4.99 years may be designated 4 +; a group aged 3.50 to 4.49 years 4 ± and a group all precisely 4.0 years, 4.0.

Tables and figures should be referred to in text as follows: figure 1, table 1, i.e. lower case. 'As seen in table [or figure] 1 ...' (not Tab., fig. or Fig).

The place at which a table or figure is to be inserted in the printed text should be indicated clearly on a manuscript:

Insert table 2 about here

Each table and/or figure must have a title that explains its purpose without reference to the text. Tables and/or figure captions must be saved separately, as part of the file containing the complete text of the paper, and numbered correspondingly. The filename for the tables and/or figures should be descriptive of the graphic, e.g. table 1, figure 2a.

Tables

Tables should be used only when they can present information more efficiently than running text. Care should be taken to avoid any arrangement that unduly increases the depth of a table, and the column heads should be made as brief as possible, using abbreviations liberally. Lines of data should not be numbered nor run numbers given unless those numbers are needed for reference in the text. Columns should not contain only one or two entries, nor should the same entry be repeated numerous times consecutively. Tables should be grouped at the end of the manuscript on uploaded separately to the main body of the text.

Figures and illustrations

Figures must be uploaded separately and not embedded in the text. Avoid the use of colour and tints for purely aesthetic reasons. Figures should be produced as near to the finished size as possible. Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC). All files must be 300 dpi or higher.

Please note that it is in the author's interest to provide the highest quality figure format possible. Please do not hesitate to contact our Production Department if you have any queries.

References

The accuracy and completeness of references are of the utmost importance. The need to query inaccurate or incomplete references causes unnecessary delay.

References in the Text: These should be quoted by the name(s) of the author(s) and the date of publication. In the case of four authors, all names should be stated. In the case of more than four authors, only the first should be stated, followed by "et al". References must not be indicated by numbers. When more than one reference is cited, these should be separated by a semi-colon; for example (Jull and Bullock, 1987; Bogduk and Twomey, 1987). Authors must specifically ensure that all references in the text also appear in the reference list, and vice versa.

Reference List: This should appear at the end of the paper in alphabetical order. The author's name should be followed by his/her initials (unpunctuated), and separated from that of the next author by a comma. The names of all authors should be given (do not use "et al" in the reference list). Next should appear the date of publication, followed by details of the work in question:

Journal articles: The title of the article should be given in full, followed by the full title of the journal (not abbreviated and not underlined). The volume number (but not the part number) appears next, separated from the first and last pages by a colon. The required use of punctuation and capital letters is illustrated in the following example:

Burns YR, Mohay HA, Croker AJ 1987 The predictive value of development testing of children under the age of 2 years. Physiotherapy Theory and Practice 3: 2–10b.

Books: The required format for reference to books is illustrated in the following examples. Again, note the use of punctuation and capital letters:

Maitland GD 1986 Vertebral manipulation, 5th edn. London, Butterworths. Bowsher D 1984 Central pathways and mechanisms of pain sensation. In: Holden AV, Winlow W (eds) The neurobiology of pain, pp 17–21. Manchester, Manchester University Press.

Footnotes

These should only be used for manufacturer's details of products quoted in the text, or to elucidate technical details when to do so within the text would adversely affect its readability. Footnotes should be numbered consecutively from 1, and cited in the text with a superscript number. Footnotes should appear after the reference list, not on the page in question.

Acknowledgments and Declaration of Interest sections

Acknowledgments and Declaration of interest sections are different, and each has a specific purpose. The Acknowledgments section details special thanks, personal assistance, and dedications. Contributions from individuals who do not qualify for authorship should also be acknowledged here. Declarations of interest, however, refer to statements of financial support and/or statements of potential conflict of interest. Within this section also belongs disclosure of scientific writing assistance (use of an agency or agency/ freelance writer), grant support and numbers, and statements of employment, if applicable.

<u>Acknowledgments section</u>

Any acknowledgments authors wish to make should be included in a separate headed section at the end of the manuscript preceding any appendices, and before the references section. Please do not incorporate acknowledgments into notes or biographical notes.

<u>Declaration of Interest section</u>

All declarations of interest must be outlined under the subheading "Declaration of interest". If authors have no declarations of interest to report, this must be explicitly stated. The suggested, but not mandatory, wording in such an instance is: *The authors report no declarations of interest.* When submitting a paper via ScholarOne Manuscripts, the "Declaration of interest" field is compulsory (authors must either state the disclosures or report that there are none). If this section is left empty authors will not be able to progress with the submission.

Please note: for NIH/Wellcome-funded papers, the grant number(s) must be included in the Declaration of Interest statement.

Click here to view our full Declaration of Interest Policy.

8. APÊNDICES

A. Ficha de avaliação

a) IDENTIFICAÇÃO:

Indivíduo: Idade: Sexo:

Tempo médio de lesão após AVE meses:

Lado acometido pela lesão Direito ( ) Esquerdo ( )

Lado dominante Direito ( ) Esquerdo ( )

AVEi ( ) AVE H ( )

Grau de acometimento Fugl Meyer: ( ) leve ( ) moderado ( ) gravemente acometido

HMA:

AP:

Teste de Caminhada de 6 minutos:

Distância percorrida____

B. Termo de Consentimento Livre Esclarecido (TCLE)

Título do Projeto**: Análise dos efeitos da plataforma de vibração de baixa freqüência em pacientes acometidos por AVE crônico**

1. Responsáveis: Adriana Teresa Silva*, Dr. Donizete César Honorato**

* Universidade do Vale do Sapucaí UNIVAS e **Universidade estadual de Campinas (UNICAMP)

3.Eu, ________________________________ compreendo que fui convidado para participar como voluntário(a) nesta pesquisa que tem por objetivo verificar os efeitos da plataforma de vibração de baixa freqüência em pacientes acometidos por AVE crônico . A minha participação neste estudo não é remunerada, assim como também os pesquisadores não terão qualquer benefício financeiro com ele.

4. Riscos para o paciente: Esta pesquisa não oferece nenhum risco desde seguir as normas estabelecidas para a aplicação da terapia vibração.

5. Direito de privacidade:

Estou ciente de que a minha identidade será preservada e que as informações obtidas com a pesquisa serão divulgadas, de forma que os resultados não poderão ser relacionados à minha pessoa.

6. Declaração de danos:

Caso ocorra algum dano à minha pessoa, ainda que improvável, resultante diretamente da minha participação nesta pesquisa, o pesquisador e a Instituição serão responsáveis.

7. Recusa ou Retirada:

Eu compreendo que minha participação é voluntária e eu posso recusar ou retirar meu consentimento a qualquer momento, sem que isso prejudique meu futuro nesta Instituição.

Eu confirmo que a pesquisadora Adriana Teresa Silva explicou os objetivos desta

pesquisa e os procedimentos a que serei submetido (avaliação e tratamento) Serei submetido ao tratamento realizado 3 vezes por semana por um período de 2 mês. Durante a realização do tratamento estarei em pé em cima do aparelho com os joelhos dobrados para evitar riscos para a minha pessoa, li e compreendi este formulário de consentimento. Portanto, concordo em participar desta pesquisa e uma cópia deste formulário ficará em meu poder e a outra com a pesquisadora.

Pouso Alegre, ___/___/___

____

Pesquisadora Adriana Teresa Silva

____

Pesquisado

CPF ou RG

Para qualquer dúvidas e esclarecimentos

Comitê de Ética em Pesquisa

Horário de funcionamento: 14:00 a 20:00

(35) 3449-2199

9. ANEXOS

A. Avaliação Cognitiva

MINI EXAME DO ESTADO MENTAL

Mini-Mental de Folstein (1975), adaptado por Brucki *et al* (2003)			
Orientação Temporal (05 pontos) *Dê um ponto para cada ítem*	Ano		
	Mês		
	Dia do mês		
	Dia da semana		
	Semestre/Hora aproximada		
Orientação Espacial (05 pontos) *Dê um ponto para cada ítem*	*Estado*		
	Cidade		
	Bairro ou nome de rua próxima		
	Local geral: que local é este aqui (apontando ao redor num sentido mais amplo: hospital, casa de repouso, própria casa)		
	Andar ou local específico: em que local nós estamos (consultório,dormitório, sala, apontando para o chão)		
Registro (3 pontos)	*Repetir: GELO, LEÃO e PLANTA*		
Atenção e Cálculo (5 pontos) Dê 1 ponto para cada acerto. Considere a tarefa com melhor aproveitamento.	*Subtrair 100 – 7 = 93 – 7 = 86 – 7 = 79 – 7 = 72 – 7 = 65*		
	Soletrar inversamente a palavra MUNDO=ODNUM		
Memória de Evocação (3 pontos)	Quais os três objetos perguntados anteriormente?		
Nomear dois objetos (2 pontos)	*Relógio e caneta*		
Repetir (1 ponto)	*"NEM AQUI, NEM ALI, NEM LÁ"*		
Comando de estágios (3 pontos) Dê 1 ponto para cada ação correta)	*"Apanhe esta folha de papel com a mão direita, dobre-a ao meio e coloque-a no chão"*		
Escrever uma frase completa (1 ponto)	"Escreva alguma frase que tenha começo, meio e fim"		
Ler e executar (1 ponto)	*FECHE SEUS OLHOS*		
Copiar diagrama (1 ponto)	*Copiar dois pentágonos com interseção*		
	PONTUAÇÃO FINAL (escore = 0 a 30 pontos)		

B. Escala de Avaliação de Fugl-Meyer

I. Movimentação Passiva de Dor (Tarefas realizadas deitado em supino)

Área	Teste	Pontuação		Pontuação
		Mobilidade	Dor	
1. Ombro	Flexão			**Mobilidade:**
	Abdução a 90º			
	Rot. Externa			**0-** apenas alguns graus de movimento.
	Rot. Interna			**1-** grau de mobilidade passiva diminuída
2. Cotovelo	Flexão			
	Extensão			**2-** grau de mobilidade passiva normal
3. Punho	Flexão			
	Extensão			
4. Dedos	Flexão			
	Extensão			
5.Antebraço	Pronação			
	Supinação			
6. Quadril	Flexão			
	Abdução			
	Rot. Externa			**Dor:**
	Rot. Interna			
7. Joelho	Flexão			**0-** dor forte durante todos os graus de movimento.
	Extensão			**1-** alguma dor. **2-** nenhuma dor.
8. Tornozelo	Dorsiflexão			
	Flexão plantar			
9. Pé	Eversão			
	Inversão			
Pontuação Total Obtida:				

II. Sensibilidade

Teste	Pontuação	Pontuação Máxima
1. Exterocepção: Membro Superior ( ) Palma da Mão ( ) Coxa ( )	**0-** anestesia. **1-** hipoestesia/disestesia. **2-** normal.	8 pontos

Sola do Pé ( )		
2. Propriocepção: Ombro ( ) Cotovelo ( ) Punho ( ) Polegar ( ) Quadril ( ) Joelho ( ) Tornozelo ( ) Hálux ( )	**0-** nenhuma resposta correta (ausência de sensação). **1-** ¾ das respostas são corretas, mas há diferença considerável com o lado não afetado. **2-** todas as respostas são corretas.	16 pontos
Pontuação Total Obtida:		24 pontos

III. Função Motora Extremidade Inferior – Parte I

Teste	Pontuação	Pontuação Máxima
1. Motricidade Reflexa: a) Aquileu ( ) b) Patelar ( )	**0-** sem atividade reflexa. **2-** atividade reflexa pode ser avaliada	4 pontos
2. Atividade Reflexa Normal: Adutor, patelar e aquileu ( )	**0-**2 ou 3 reflexos estão marcadamente hiperativos. **1-** 1 reflexo está hiperativo ou 2 estão vivos. **2-** não mais que 1 reflexo está vivo.	2 pontos
Motricidade Ativa **3. Sinergia flexora** a) Flexão Max. Quadril ( ) b) Flexão Max. Joelho ( ) c) Flexão Max. Tornozelo ( )	**0-** a tarefa específica não pode ser realizada. **1-** a tarefa pode ser realizada em parte. **2-** a tarefa é realizada em todo o grau de movimento nas 3 articulações.	6 pontos
4. Sinergia Extensora a) Extensão de Quadril ( ) b) Adução de Quadril ( ) c) Extensão do Joelho ( ) d) Flexão Plantar ( )	**0-** a tarefa específica não pode ser realizada. **1-** apenas pouca força. **2-** força normal ou perto do normal (comparado ao lado não afetado).	8 pontos

IV. Coordenação/Velocidade Extremidade Inferior

Teste	Pontuação	Pontuação Máxima
a) Tremor ( ) b) Dismetria	**0-** tremor marcante **1-** tremor leve **2-** sem tremor **0-** dismetria marcante **1-** dismetria leve	

	2- sem dismetria	6 pontos
c) Velocidade: calcanhar-joelho 5 vezes ( )	**0-** 6 seg. mais lento que o lado não afetado. **1-** 2 a 5 seg. mais lento que o lado afetado. **2-** menos 2 segundos de diferença.	

Tarefas Realizadas Sentado

V. Equilíbrio na Posição Sentada – Parte I

Teste	Pontuação	Pontuação Máxima
a) Sentado sem apoio e com os pés suspensos ( )	**0-** não consegue se manter sentado sem apoio. **1-** permanece sentado sem apoio por pouco tempo. **2-** permanece sentado sem apoio por pelo menos 5 min. e regula postura do corpo em relação a gravidade.	6 pontos
b) Reação de pára-quedas no lado não afetado ( )	**0-** não ocorre abdução de ombro, extensão do cotovelo para evitar a queda. **1-** reação de pára-quedas parcial. **2-** reação de pára-quedas normal.	
c) Reação de pára-quedas no lado afetado ( )	**0-** não ocorre abdução de ombro, extensão do cotovelo para evitar a queda. **1-** reação de pára-quedas parcial. **2-** reação de pára-quedas normal.	

VI. Função Motora Extremidade Superior

Teste	Pontuação	Pontuação Máxima
1. Motricidade Reflexa: a) Bíceps ( ) b) Tríceps ( )	**0-** sem atividade reflexa. **2-** atividade reflexa presente.	4 pontos
Motricidade Ativa **2. Sinergia Flexora:** a) Elevação ( ) b) Retração do Ombro ( ) c) Abdução + 90º ( ) d) Rot. Externa ( ) e) Flexão de Cotovelo ( ) f) Supinação de Antebraço	**0-** a tarefa não pode ser realizada completamente. **1-** a tarefa pode ser realizada parcialmente. **2-** a tarefa é realizada perfeitamente.	12 pontos

3. Sinergia Extensora: a) Adução do Ombro/ rot. Interna ( ) b) Extensão do Cotovelo ( ) c) Pronação de Antebraço ( )	**0-** a tarefa não pode ser realizada completamente. **1-** a tarefa pode ser realizada parcialmente. **2-** tarefa perfeita	6 pontos
4. Movimentos Sinérgicos Combinados: a) Mão a Coluna Lombar b) Flexão do Ombro de 0º a 90º (Cotov. A 0º e antebraço neutro) ( ) c) Prono- Supino (cotov. 90º , ombro 0º) ( )	**0-** a tarefa não pode ser realizada completamente. **1-** a mão não passa pela espinha ilíaca antero-superior **2-** a tarefa é realizada perfeitamente **0-** se no início do movimento o braço é abduzido ou o cotovelo é fletido. **1-** se na fase final do movimento, o ombro abduz e/ou ocorre flexão do cotovelo. **2-** a tarefa é realizada perfeitamente **0-** não ocorre posicionamento correto do cotovelo e ombro e/ou pronação e supinação não pode ser realizada completamente. **1-** prono- supino pode ser realizada com ADM limitada e ao mesmo tempo o ombro e cotovelo estejam corretamente posicionados. **2-** a tarefa é realizada completamente.	6 pontos
5. Movimentos com Sinergia: a) Abdução de Ombro a 90º com Cotovelo estendido e pronado ( ) b) Flexão de ombro de 90º a 180º ( ) c) Prono- Supinação ( )	**0-** não é tolerado nenhuma flexão de ombro ou desvio de pronação do antebraço no início do movimento. **1-** realiza parcialmente ou ocorre flexão do cotovelo e o antebraço não se mantém pronado na fase tardia do movimento. **2-** a tarefa pode ser realizada sem desvio. **0-** o braço é abduzido e cotovelo fletido no início do movimento. **1-** o ombro abduz e/ou ocorre flexão de cotovelo na fase final do movimento. **2-** a tarefa é realizada perfeitamente. **0-** Posição não pode ser obtida pelo paciente e/ou prono- supinação não pode ser realizada perfeitamente. **1-** atividade de prono- supinação pode ser realizada mesmo com ADM limitada e ao mesmo tempo o ombro e o cotovelo estejam corretamente posicionados. **2-** a tarefa é realizada perfeitamente	6 pontos

***Avaliar o item 6 se o paciente conseguiu atingir a <u>nota máxima</u> de 6 pontos no intem 5.**

6. Atividade Reflexa nl: Bíceps, Flexores dos dedos e Tríceps ( )	**0-** 2 ou 3 reflexos são hiperativos. **1-** 1 reflexo está marcadamente hiperativo ou 2 estão vivos. **2-** não mais de um reflexo está vivo e nenhum está hiperativo.	2 pontos

7. Controle de Punho: a) Cotovelo 90º, ombro 0º e pronação (assistência) ( ) b) Máxima flexo-extensão lenta de punho, com cotovelo 90º, ombro 0º, dedos fletidos e pronação (auxílio se necessário) ( ) c) Dorsiflexão com cotovelo a 0º, ombro a 30º e pronação (auxílio) ( ) d) Máxima flexo-extensão, com cotovelo 0º, ombro a 30º e pronação (auxílio) ( ) e) Circundunção ( )	**0-** o paciente não pode dorsifletir o punho na posição requerida. **1-** a dorsiflexão pode ser realizada mas sem resistência alguma. **2-** a posição pode ser mantida contra alguma resistência. **0-** não ocorre movimento voluntário. **1-** o paciente não move ativamente o punho em todo o grau de movimento. **2-** a tarefa pode ser realizada. Idem ao anterior. **0-** não ocorre movimento voluntário. **1-** o paciente não move ativamente o punho em todo o grau de movimento. **2-** a tarefa pode ser realizada. Idem anterior.	10 pontos
8. Mão: **a) Flexão em massa dos dedos ( )** **b) Extensão em massa dos dedos ( )** **c) Preensão 1: art. Metacarpofalangeanas (II a V) estendidas e interfalangeanas distal e proximal fletidas. Preensão contra resistência ( )** **d) Preensão 2: O paciente é instruído a aduzir o polegar e segurar um papel interposto entre o polegar e o dedo indicador ( )** **e) Preensão 3: O paciente põe a digital do polegar contra a do dedo indicador, com um lápis interposto** **( )** **f) Preensão 4: Segurar com firmeza um objeto cilíndrico, com o superfície volar do primeiro e segundo dedos contra os demais ( )**	**0- não ocorre flexão alguma.** **1- ocorre alguma flexão dos dedos.** **2- flexão completa (comparada com mão não afetada)** **0- nenhuma atividade ocorre** **1- ocorre relaxamento (liberação) da flexão em massa** **2- extensão completa (comparada com mão não afetada)** **0- posição requerida não pode ser realizada.** **1- a preensão é fraca.** **2- a preensão pode ser mantida contra considerável resistência.** **0- a função não pose ser realizada.** **1- o papel pode ser mantido no lugar mas não contra um leve puxão.** **2- um pedaço de papel é segurado firmemente contra um puxão.** **0- a função não pode ser realizada.** **1- o lápis pode ser mantido no lugar mas não contra um leve puxão.** **2- o lápis é segurado firmemente.** **0- a função não pode ser realizada.** **1- o objeto pode ser mantido no lugar mas não contra um leve puxão.** **2- um objeto é segurado firmemente contra um puxão.**	**14 pontos**

g) Preensão 5: O paciente segura com firmeza uma bola de tênis ( )	**0- a função não pode ser realizada.** **1- o objeto pode ser mantido no lugar mas não contra um leve puxão.** **2- um objeto é segurado firmemente contra um puxão.**	

VII. Coordenação/ Velocidade do Membro Superior

Muitos pacientes com função motora próximo ao normal irão se queixar de descoordenação e lentidão dos movimentos. Por esta razão, um teste combinando coordenação/velocidade do movimento incluída.

Teste	Pontuação	Pontuação Máxima
a) Tremor ( )	**0-** tremor marcante **1-** tremor leve **2-** sem tremor	
b) Dismetria	**0-** dismetria marcante **1-** dismetria leve **2-** sem dismetria	6 pontos
c) Velocidade: index-nariz 5 vezes e o mais rápido que conseguir ( )	**0-** 6 seg. mais lento que o lado não afetado. **1-** 2 a 5 seg. mais lento que o lado afetado. **2-** menos 2 segundos de diferença.	

VIII. Função Motora Extremidade Inferior – Parte II

Teste	Pontuação	Pontuação Máxima
5. Movimento combinando sinergias: a) A partir de leve extensão de joelho, realizar uma flexão de joelho além de 90º ( )	**0-** sem movimento ativo. **1-** o joelho pode ativamente ser fletido até 90º (palpar os tendões dos flexores do joelho). **2-** o joelho pode ser fletido além de 90º.	
b) Dorsiflexão do tornozelo ( )	**0-** sem movimento ativo. **1-** atividade flexora incompleta. **2-** dorsiflexão completa (comparar com lado não afetado).	4 pontos

Tarefas realizadas na posição ortostática

IX. Função da Extremidade Inferior – Parte II

Teste	Pontuação	Pontuação Máxima
6. Movimento sem sinergia: a) Quadril a 0º, realização a flexão do joelho mais que 90º ( )	**0-** o joelho não pode ser fletido se o quadril não é fletido simultaneamente. **1-** inicia a flexão do joelho sem flexão do quadril, porém não atinge os 90º de flexão do joelho ou flete o quadril. **2-** tarefa realizada completamente.	
b) Dorsiflexão do tornozelo ( )	**0-** a tarefa não é realizada. **1-** a tarefa pode ser realizada parcialmente (comparado com o lado não afetado).	4 pontos

	2- tarefa perfeita (comparado com o lado não afetado).	

X. Equilíbrio em Pé – Parte II

Teste	Pontuação	Pontuação Máxima
c) Manter-se em pé com apoio ( )	**0-** não consegue ficar de pé. **1-** de pé com apoio máximo de outros. **2-** de pé com apoio mínimo por 1 min.	
d) manter-se em pé sem apoio ( )	**0-** não consegue ficar de pé sem apoio. **1-** pode permanecer em pé por 1min e sem oscilação, ou por mais tempo, orem com alguma oscilação. **2-** bom equilíbrio, pode manter o equilíbrio por mais de 1 min com segurança.	
e) Apoio único sobre o lado não afetado ( )	**0-** posição não pode ser mantida por mais de 1-2 seg (oscilação). **1-** consegue manter-se em pé, com equilíbrio, por 4 a 9 segundos. **2-** pode manter o equilíbrio nesta posição por mais de 1 min com segurança.	
f) Apoio único sobre o lado afetado ( )	**0-** posição não pode ser mantida por mais de 1-2 seg (oscilação). **1-** consegue manter-se em pé, com equilíbrio, por 4 a 9 segundos. **2-** pode manter o equilíbrio nesta posição por mais de 1 min com segurança.	8 pontos

C. Parecer do comitê de Ética

UNIVÁS
Universidade do Vale do Sapucaí

COMITÊ DE ÉTICA EM PESQUISA
PROTOCOLO Nº 1499/10

TÍTULO: ANÁLISE DOS EFEITOS DA PLATAFORMA VIBRATÓRIA DE BAIXA FREQUÊNCIA EM PACIENTES ACOMETIDOS POR ACIDENTE VASCULAR ENCEFÁLICO CRÔNICOS

AUTORA: Adriana Teresa Silva

ORIENTADOR: Prof. Dr. Donizeti Cézar Honorato
CO-ORIENTADORA: Profª. Dra. Beatriz Bertolaccini Martínez
CO-ORIENTADOR: Prof. Dr. Antônio Carone

O Comitê de Ética em Pesquisa da Faculdade de Ciências da Saúde Dr. José Antônio Garcia Coutinho, da Universidade do Vale do Sapucaí, reunido em 13 de dezembro de 2010, após análise do protocolo de pesquisa, votou pela sua APROVAÇÃO.

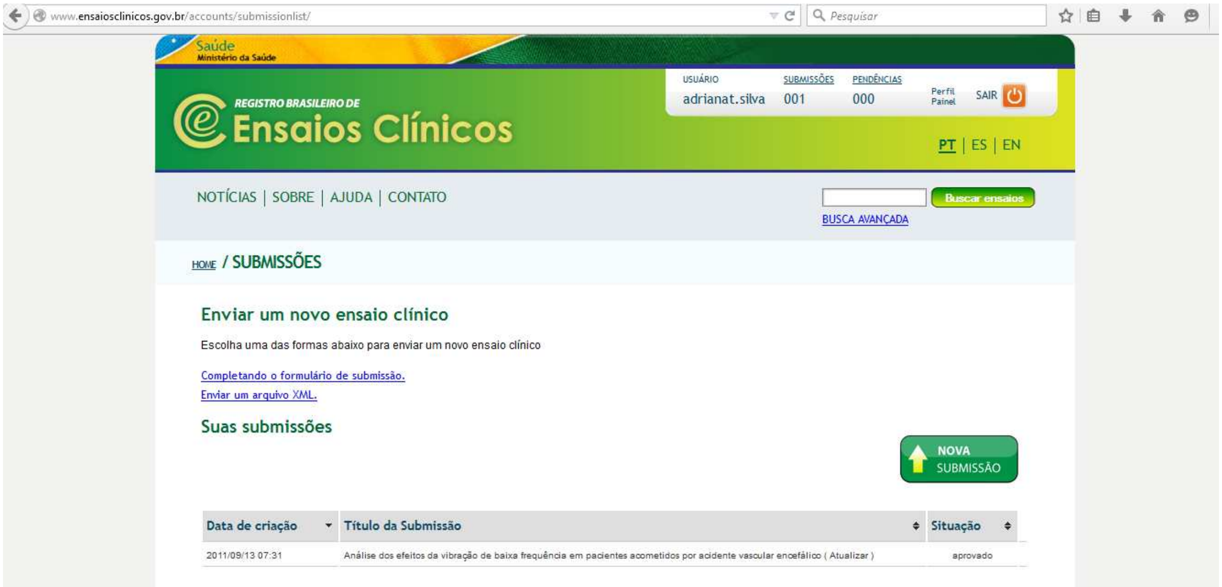
Diante desse parecer, o pesquisador deverá apresentar a este CEP dois relatórios, sendo o primeiro após a obtenção dos resultados do estudo, em janeiro de 2012 e o segundo, contendo todo o relatório final, previsto para março de 2012.

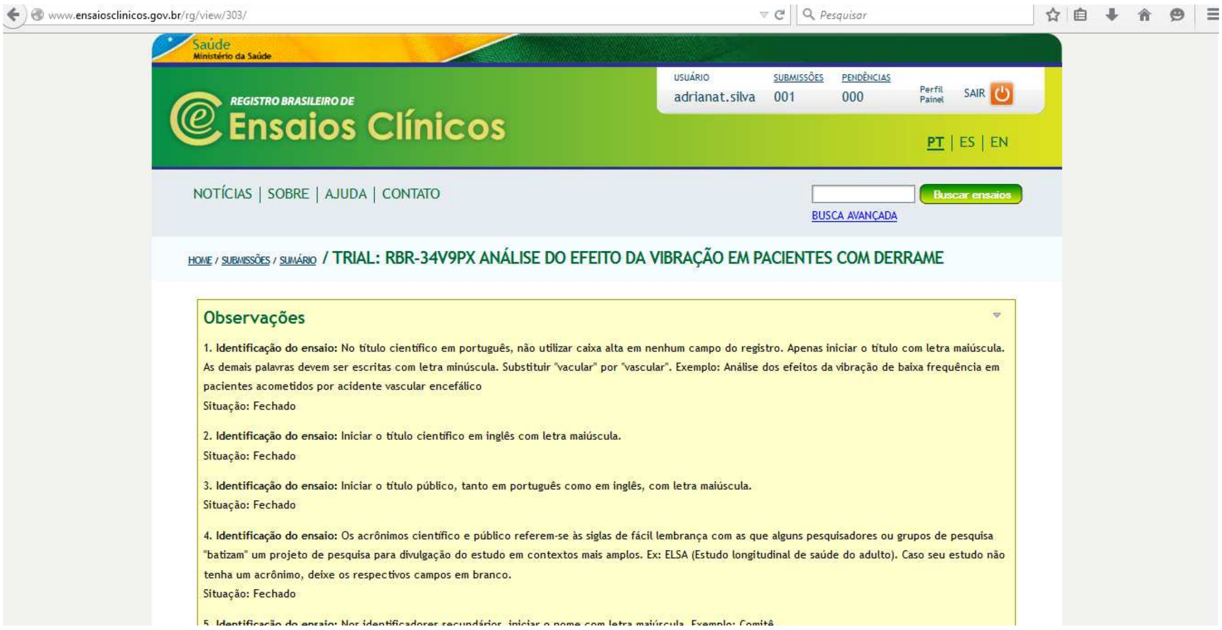
Pouso Alegre, 18 de janeiro de 2011.

Prof. Dr. José Vitor da Silva
- Coordenador do Comitê de Ética em Pesquisa -

Pró-Reitoria de Pós-Graduação e Pesquisa
Avenida Pref. Tuany Toledo, 470 – Fátima I – Tel. (35) 3449-2199
37550-000 - Pouso Alegre/MG - e-mail: pesquisa@univas.edu.br

D. Registro de ensaio clínico





Campinas, 13outubro de 2015

Permissions Departament International Journal of Therapy and Rehabilitation

MA Healthcare Ltd, St Jude's Church, Dulwich Road, London SE24 OPB, UK Tel:+44 (0)2077385454

We are writing to you in order to obtain a permission to re-use material included in the following article(s) published in International Journal of Therapy and Rehabilitation for inclusion in my Ph.D. thesis: Whole body vibration training in motor function in patients affected with stroke.

Silva A, Silva A, Dias M, Junior RC, Martinez B, Honorato D, Fernandes G (2013) Whole body vibration training for lower limb motor function among stroke patients. International J Therapy and Rehabil 20(5):260-66.

This thesis/dissertation is for academic use only and it is not going to be used for comercial, advertising or promotion purposes. I am planning to make seven printed copies of my thesis/dissertation. One of these copies will be displayed at The University (Universidade Estadual de Campinas – UNICAMP, Campinas, SP, Brazil) library. In addition, an eletronic version of the thesis will be made available at the University Thesis Database. I thank you very much in advance.

Best regards

Adriana Teresa Silva

Adrianat.silva@yahoo.com.br

Declaração dos direitos autorais

Eu, Adriana Teresa Silva e colaboradores, declaro para os devidos fins de que não estão infringindo o direito autoral transferido à editora.

Adriana Teresa Silva