Research Article
http://dx.doi.org/10.17784/mtprehabjournal.2014.12.211

Effect of mobilization time by maitland method in nonspecific low back pain and neck pain.

Efeito do tempo de mobilização pelo método maitland nas cervicalgias e lombalgias inespecíficas.

Luís Eugênio Silva de Aguiar[1], Mafra Raiele Torres Oliveira[1], Rafael Rêgo Caldas[1], Mariana Cavalcanti Correia[1], Sérgio Rocha[2], Maíra Izzadora Souza Carneiro[3], Angélica da Silva Tenório[4], Marcelo Renato Guerino[4], Kátia Karina Monte-Silva[4], Maria das Graças Rodrigues de Araújo[4].

Physical Therapy department, Universidade Federal de Pernambuco (UFPE), Recife (PE), Brazil.

Abstract
Introduction: Maitland method is a technique of manipulation and joint mobilization to reduce pain, recovery of mobility and joint alignment. **Objective:** to analyze the effects of spinal manipulation in Maitland pains of cervical and lumbar spine, considering reducing the exposure time of each maneuver on pain, range of motion and muscle function. **Method:** Eleven randomly patients assigned to two groups: (i) Experimental Conventional (GEC;06): conventional technical indications, (ii) Experimental Modified (GEM;05): protocol with the same maneuvers, but reduced application time. All evaluated before (t0) and after (t1) the period of therapeutic sessions with Visual Analogue Scale (VAS) for pain, Flexibility Test Bank with Wells and Surface Electromyography (EMG) for muscle electrical activity of the cervical and lumbar regions. The data were statistically analyzed; $p < 0.05$. **Results:** In GEM pain decreased significantly ($p=0.047$), muscle electrical activity in the cervical region showed a significant trend ($p=0.068$). Flexibility in GEC was improved, but not significantly. tended *Root Mean Square* in the cervical region of the GEM ($p=0.068$) to achieve significant value, but this trend was not observed in GEC. In the lumbar region there were no differences in both groups. **Conclusion:** Volunteers in both groups had positive results even though not statistically significant. The effects of reduced time and time recommended by Maitland (1 minute) the sessions were effective in decreasing symptoms, pain and restricted joint mobility, but we consider important to continue further studies in this knowledge and practice of physical therapy area.
Keywords: Neck Pain, Low Back Pain, Articular Mobilization, Electromyography

Resumo
Introdução: Método Maitland é uma técnica de manipulação e mobilização articular para redução da dor, recuperação da mobilidade e alinhamento articular. **Objetivo**: Analisar efeitos da manipulação vertebral de Maitland nas algias da coluna cervical e lombar, considerando redução do tempo de aplicação de cada manobra sobre a dor, a amplitude de movimento e a função muscular. **Método:** 11 pacientes aleatoriamente alocados em 2 grupos: (i)Experimental Convencional (GEC;06): indicações convencionais da técnica; (ii)Experimental Modificado (GEM;05): protocolo com mesmas manobras, mas tempo de aplicação reduzido. Todos avaliados antes (t0) e após (t1) o período das sessões terapêuticas com Escala Visual Analógica (EVA) para dor, Teste de Flexibilidade com Banco de Wells e Eletromiografia de Superfície (EMG) para atividade elétrica muscular das regiões cervical e lombar. Os dados foram analisados estatisticamente; $p<0,05$. **Resultados:** No GEM dor diminuiu significativamente ($p=0,047$), atividade elétrica muscular na região cervical mostrou tendência significante ($p=0,068$). Na flexibilidade no GEC houve melhora, mas não significativa. Houve tendência do *Root Mean Square* na região cervical do GEM ($p=0,068$) à atingir valor significativo, mas esta tendência não foi observada no GEC. Na região lombar não houve diferenças nos dois grupos estudados. **Conclusão:** Os voluntários nos dois grupos obtiveram resultados positivos mesmo que não significantes estatísticamente. Os efeitos da redução do tempo e do tempo preconizado por Maitland (1 minuto) nas sessões foram eficazes para diminuição dos sintomas, dor e restrição da mobilidade articular, mas consideramos importante a continuidade de mais estudos nessa área do conhecimento e da práxis da fisioterapia.
Palavras-chave: Mobilização Articular, Cervicalgia, Lombalgia, Eletromiografia

Submission date 11 August 2014, Acceptance date 7 November 2014, Publication date 14 November 2014.

1. Physical therapy student, Universidade Federal de Pernambuco (UFPE), Recife(PE), Brazil.
5. PhD student, neuropsychiatry program, Universidade Federal de Pernambuco (UFPE), Recife(PE), Brazil.
3. Master student, Physical Therapy program, Universidade Federal de Pernambuco (UFPE), Recife(PE), Brazil.
4. Professor of Physical therapy school, Universidade Federal de Pernambuco (UFPE), Recife(PE), Brazil.

Corresponding Author
Maria das Graças Rodrigues de Araújo - Laboratório de Cinesioterapia e Recursos Terapêuticos Manuais - Departamento de Fisioterapia, Universidade Federal de Pernambuco (UFPE) - Av. Jornalista Aníbal Fernandes, s/n - Cidade Universitária, Recife (PE), Brazil. - Zip Code: 50740521. Phone/Fax: (81)2126-8939. - E-mail: mgrodriguesaraujo@homail.com \ mgra@ufpe.br

INTRODUCTION

Vertebral pains are multifactorial disorders resulting from postural problems, environmental factors, body structure changes, prolonged stay in a certain position, level of physical activity, type of work, sedentary behaviors.[1,2] Worldwide, 60% to 80% of people have or have pain in the spine,[3] is the leading cause of work absenteeism with economic losses.[4]

Low back pain leads this condition, approximately 10% to 20% of patients develop chronic condition (pain and disability for longer than three months).[5] Affects men over 40 and women between 50 and 60 years; and it is associated with little flexibility, mainly the trunk and hip.[2,6]

The neck pain is prevalent between 10% and 20% in females approximately 50 years. It is related to sudden movements, long stay in forced position, stress, trauma and loss of range of motion.[6,7]

The biomechanical changes may be caused by postural habits, age or the onset time of pain conditions, leading to tissue vulnerability in some cases the muscular hypotonia, (8) paraspinal muscle wasting even after regression of symptoms.[9]

Studies of paraspinal muscles reflect the emphasis on muscle dysfunction in chronic pain and the analysis of surface electromyographic signal (EMG). It is an objective and non-invasive method of assessment of muscle function.[10] Numerous treatments are proposed since drugs, manual therapy, acupuncture, electrotherapy, exercises, strength, postural patient education.[5,7] However, the methods of articular mobilization/manipulation of the spine to treat pains is a frequently used practice and recommended in therapy.[7,11,12]

The joint mobilization proposed by Maitland is based on the evaluation and treatment by oscillatory, rhythmic passive movements. The evaluation is performed by passive movement and palpation of the area to be treated.[3] The passive movements are graduated into five levels according to the degree of accessory movements present in the joints. Grades I and II correspond to the application of slow oscillatory movements in the early range of motion in the presence of pain assessed regions. Grades III and IV are carried out at the end of range of motion, or from the resistance given by the periarticular tissues to restore joint mobility in the presence of restraint. The V level, known as manipulation, is small amplitude and high speed.[13,14]

Maitland sessions with four states that the patient may already have satisfactory results provided they meet intervals between each of the four sessions. It indicates that between the first and the second interval of two to three days; the second to third three to four days; Five to seven days of the third to last. [13,14]

Considering the above, the objective of this study was to analyze the effects of spinal manipulation in Maitland pains of the cervical and lumbar spine, considering the reduction of the time of application for each maneuver on pain, range of motion and muscle function.

METHODS

This is a study of quasi-experimental type, blind, held from September 2011 to June 2012 in Laboratório de Cinesioterapia e Recursos Terapêuticos Manuais do Departamento de Fisioterapia da Universidade Federal de Pernambuco (UFPE) aproved by RBR-78bq5x.

Volunteers were asked through informative posters distributed on the campus of UFPE. After screening were included in the study subjects with neck pain above or chronic low back pain (> 6 weeks) of unspecified origin, aged between 18 and 55 years, and that did not fit as a contraindication for Maitland Method (MM), for example, herniated disc.

All participants signed the informed consent, as ethical requirements and was later made history (reporting of symptoms, history of related diseases, physical activity, age, gender, education, marital status) to characterize the sample. All were asked about the number of sessions, and in case of no-show, there would be exclusion from the treatment; and could not participate in further involvement in the research treatment period in order to avoid confounding factors that interfere in the results.

According to the protocol recommended by Maitland, it was established that all volunteers receive interventions with three days apart from the first to the second session; the second to the third session, four days and seven days of the third to fourth and final session.[13,14]

Patients who met the eligibility criteria were divided into two groups: (i) Conventional Experimental Group (CEG): received MM protocol with repetitions of 1 minute; (ii) Modified Experimental Group (MEG): This group was reduced to half of the time for both demonstrations, such as for traction, and maintained the number of repetitions for the first three manipulations and a repetition to the latter.

Application of Maitland Method (MM)

1. Cervical Region - Central anterior-posterior and one-sided pressure application (the region on each side), followed by demonstrations of flexion, extension, lateral bending and rotation to both sides, followed by longitudinal movement and terminated with traction.

2. Lumbar Region - In the lumbar region high (L1 and L2) was applied a central vertebral pressure, pressure vertebral transverse with posterior rotation and traction, while the low lumbar (L3 to L5) was used longitudinal traction and movement.

The manipulations were performed in CEG with three replications, sixty seconds each, and finished with traction to the end of the process for thirty seconds. MEG was kept in the number of repetitions with a reduced half the application time (thirty seconds), including pull (fifteen seconds) at the end of the application. All had the same interval between sessions, that is, three, four and seven days, respectively. Volunteers who reported discomfort or impairment both in the neck and in the lumbar region were asked which was the most crippling at the time of assessment and therefore selected to be treated.

Patient Assessment

Were evaluated before the first session (T0) and reassessed after the last intervention (T1) held by a reviewer blinded to the intervention that each volunteer would receive. After anamnesis, the volunteers were evaluated by three assessment tools:

Visual Analogue Scale (VAS) - scored a scale of 0 (no pain) to 10 (maximum pain), of 10cm that quantifies the pain threshold. Both in the evaluation, as the revaluation was asked and learned that each volunteer inform the "average" pain in the cervical spine or lower back. Between 0-2 are considered mild pain, moderate 3-7 and 8-10 intense.[15]

Bench of Wells - assesses flexibility; individuals were seated on mats with plantar surfaces in full contact with the front face of the bank, knee extension and hips flexed. Were instructed to move the scalimeter the bench the maximum they could, performing anterior trunk flexion, with guidance to avoid postural compensations. The value obtained for each try was expressed in centimeters (cm) and recorded by the examiner. [16]

Brasil SA. Patient in prone, skin cleaned with alcohol, surface electrodes pairs (diameter-1cm, with attachment adhesive) were placed bilaterally, 2.5 cm distant from each other in paraspinal musculature of the third thoracic vertebra (T3), the first lumbar vertebra (L1) and the styloid process of the right ulna (ground wire, reference electrode to ensure the signal quality). Electrode placement procedures followed the recommendations SENIAM (Surface-EMG for the Non Invasive Assessment of Muscle). We used standard equipment filter (Low Pass Filter = 10 Hz; High Pass = 500 Hz and Butterwort = 4th order) values similar to those used by Tanaka and coloboradores (2002).[17] The patient was advised to stay at rest (1 minute) and collected the electrical activity of the muscles; then conducted extension of the column with maximum contraction of the muscles in the same period of time (1 minute). 5 first seconds were eliminated (0-4,9s) and the last 5 (55.1 to 60) of the sample window, leaving 50 seconds, 20 seconds and chosen the more continuous harmonics with minimal disruption, and the analyzed EMG data the values of the RMS (Root Mean Square) in the two conditions cited. This normalization between activity and rest RMS was to eliminate existing changes between individuals, for example, body mass constitution, within each group.[17,18]

Data Analysis

Statistical analysis was performed descriptively to demographic and anthropometric variables to characterize the sample (gender, age, weight, height, BMI, pathology, neck or low back pain).

To verify the normal distribution of data for the measurement variables we used the Kolmogorov-Smirnov test; for the analysis of intergroup normal Mann-Whitney test.

Multifactorial ANOVA with repeated measures (2X2) was used to investigate the main and interaction effects between the groups before and after the intervention, if there was significance indication, we used the Bonferroni post hoc test. The level of significance was p ≤ 0:05.

RESULTS

Twenty-six volunteers interested for the study, who came in contact through the phone numbers provided in the information leaflets distributed on the campus of UFPE. However, 01 were excluded because the failure to contact the same, and 6 patients had characteristics incompatible with the study. Initially, the sample consisted of 19 individuals, 8 did not complete the treatment, so the final sample consisted of 11 volunteers (06 of CEG and 05 of the MEG) as the flowchart in Figure 1.

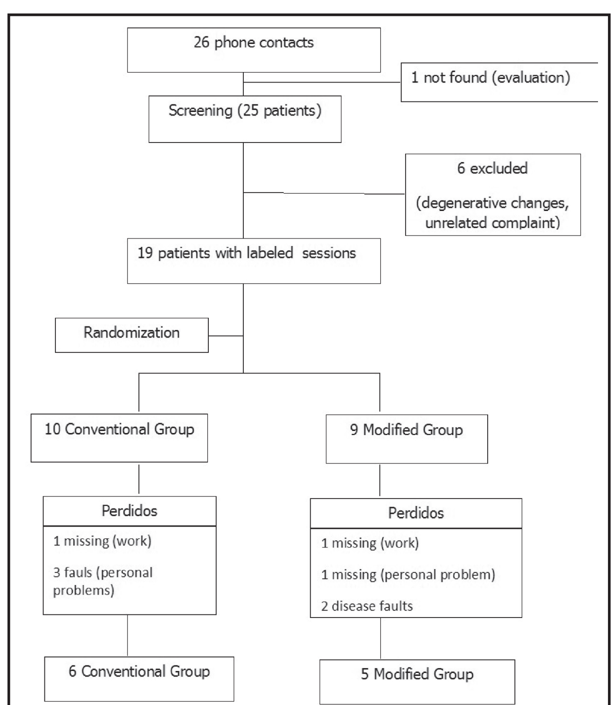

Figure 1. Flowchart of patients selection

At the end of the CEG intervention period was composed of 6 patients, 3 women and 3 men, mean age of 28.83 years (± 7.05) and distribution of four low back pain pathology frequency for two neck pain; while the MEG, with 5 subjects, 3 females and 2 males, mean age of 35 (± 18.48) and distribution of 3 back pain pathology frequency for 2 neck pain. The sample characterization data are shown in Table 1.

Figure 2 is the difference observed in the evaluation of the Visual Analogue Scale (VAS). Significance level was found ($p = 0.047$) in the analysis of the GEM, with $p < 0.05$, for data evaluation and reevaluation.

The degree of flexibility obtained in the evaluation and reassessment there was no significant difference ($p > 0.05$) in both groups. There was, however, the GEC one to improve flexibility trend (Figure 3).

It is observed in Figure 4 that despite the small sample size, there was a tendency for the RMS (Root Mean Square) in the cervical area of the MEG ($p = 0.068$) reaching the mean value; however, this trend was not observed in the cervical region of the CEG.

In Figure 5, the electromyographic evaluation performed in the lumbar region showed no differences in the evaluation (t0) or the revaluation (t1) for both groups.

DISCUSSION

The present study showed that pain decreased significantly in the Modified experimental group (GEM). In the Conventional Experimental Group (CEG), the Maitland method was effective in reducing pain symptoms, corroborating with the results of Jesus-Moraleida et al.[(19)] which evaluated 62 patients with neck pain who were treated with oscillatory mobilization of large-scale Maitland (grade III) in the anteroposterior direction; another study involving 30 subjects with low back pain assessed the immediate effect of posterior-anterior mobilization and exercises in the extension of the lumbar spine, both procedures decreased pain.[(20)] On the other hand the study of Aquino and colleagues[(21)] showed no significant difference between groups in pain intensity after treatment in patients with non-specific origin neck.

The spinal manipulation presents as a characteristic the immediate effect on pain, induces neurophysiologic and secure a beneficial effect for the patient by mechanical stimulation of sensory neurons of the zigoapofisaries capsule facets, a local hypoalgesia,[(13,22)] this occurs because the system noradrenergic descending acts on spinal cord and inhibits the release of P substance by stimulating the release of endogenous opioids.[(23)] The spinal manipulation still improves joint mobility and restores all the moves, so the correction articulate made in any segment of the spine, or the skeletal system, influences the neurological, muscular and skeletal system in general.[(24)]

The flexibility improved in CEG, which was observed in the study of Zatarin & Bortolazzo[(25)] in 21 women

Table 1. Characteristics of the sample under frequency distribution and numerical values (Mean and SD).

	CEG	MEG	p ≤ 0,05
Gender n			0.608 a
Male	3	2	
Female	3	3	
Age, years	28.83 ± 7.05	35 ± 18.48	0.931 b
Mass, Kg	65.01 ± 10.95	66.86 ± 19.19	1.00 b
Height, meters	1.68 ± 0.10	1.64 ± 0.11	0.429 b
Sintomatoly			0.652 a
Low back pain	4	3	
Neck pain	2	2	
VAS	2.83 ± 1.72	5 ± 1.87	0.082 b
Flexibility	24.4 ± 22.25	11.3 ± 12.74	0.032 b
RMS neck	23.1 ± 17.1	22.1 ± 15.6	0.424 b
RMS Low back	27.9 ± 11.9	21.6 ± 7.4	0.329 b

[1] Conventional Experimental group that received treatment with normal mobilization time values;
[2] Modified experimental group that received treatment with reduced mobilization of time values;
a Chi-Square test; b Mann-Whitney test.

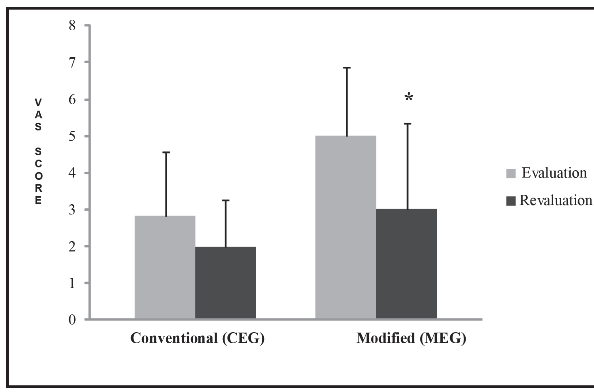

Figure 2. Evaluation of the Visual Analogue Scale (VAS). Bars represent the mean values obtained in the evaluation (T0) and revaluation (T1) of the two groups: GEC (T0: 2.8 ± 1.7; T1: 2.0 ± 1.2) and GEM (T0: 5.0 ± 1.8; T1: 3.3 ± 2.3). The error bars indicate the standard deviation. The asterisk indicates a significant difference ($p < 0.05$) relative to T0. (Repeated measures ANOVA with Bonferroni post-hoc).

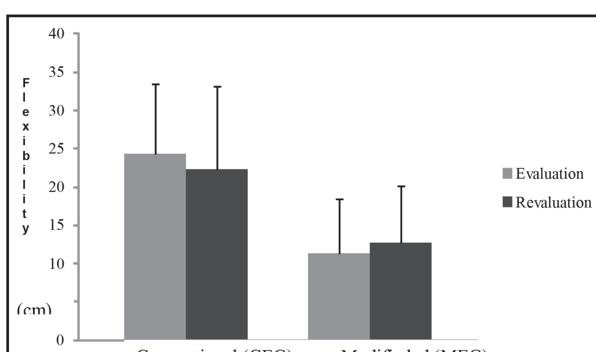

Figure 3. Flexibility obtained with the Bench of Wells. The bars represent the average obtained in the evaluations (T0) and revaluation (T1), CEG (T0: 24.4 ± 8.9; T1: 22.2 ± 10.9) and MEG (T0: 11.3 ± 7 1; T1: 12.7 ± 7.4) the error bars indicate the standard deviation.

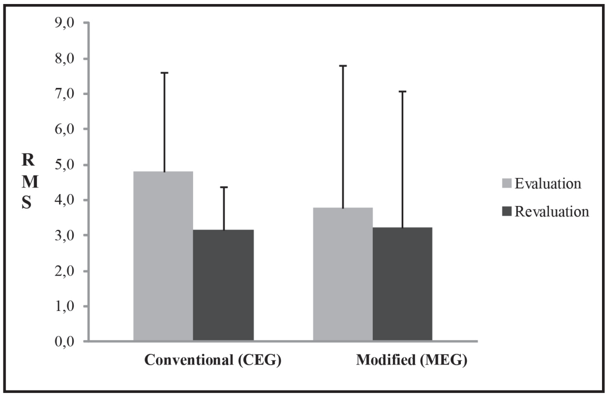

Figure 4. RMS (Root Mean Square) of the Cervical Region of the Conventional Experimental Groups (GEC) and the Modified Experimental Group (MEG). The bars indicate the average of standardization between activity and rest (activity/rest) in the assessment (T0) and revaluation (T1) of the RMS values obtained by surface electromyography of the Cervical Region, GEC (T0: 4.8 ± 2.8; T1: 3.2 ± 1.2) and GEM (T0: 3.8 ± 4.0; T1: 3.2 ± 3.8). Error bars indicate the standard deviation.

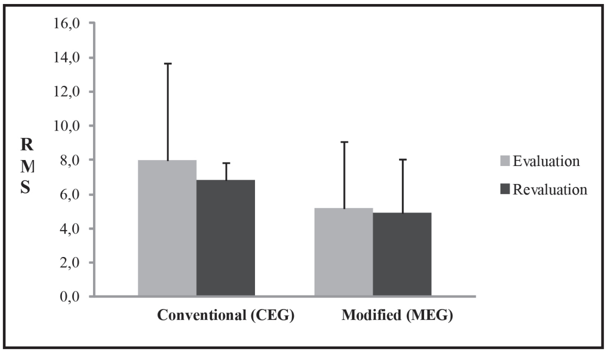

Figure 5. RMS (Root Mean Square) of the lumbar region of the Conventional Experimental Group (CEG) and the Modified Experimental group (MEG). The bars indicate the average of standardization between activity and rest (activity/rest) in the assessment (T0) and revaluation (T1) of the RMS values obtained by surface electromyography of the Cervical Region, CEG (T0: 8.0 ± 5.7; T1: 6.8 ± 2.3) and MEG (T0: 5.2 ± 3.9; T1: 4.9 ± 3.1). Error bars indicate the standard deviation.

who were evaluated by Schober test and lifting the extended leg (TEMIE) (bilaterally) and measuring the flexibility of posterior muscle chain Bench of Wells. Another study[26] compared the efficacy of Maitland techniques Mulligan and segmental stabilization with respect to gain range of motion in flexion and extension stem 21 volunteers with chronic low back pain, also observed a significant improvement in the flexibility of the three groups.

Another parameter was investigated muscle function through the electromyographic record. In the cervical region there was a trend to a better activation of the muscles in the MEG; already in the lumbar region there were no changes in muscle response when compared to baseline (T0) and revaluation (T1). In the research of Harvey & Descarreaux[27] was observed an increase in muscle electrical activity of paraspinal muscles during flexion-extension movements in the control group, what disagree with our finds that the extension movement, once finalized the spinal manipulation.

According to Kawano et al[28] a little fatigue strength of these muscles is common in patients with chronic low back pain and that individuals limit mobility for fear of increasing pain. The results obtained in our study may be due to this fact, despite the pain has decreased after treatment. Researches[9,29] concluded that muscle atrophy present even after the symptoms regression allows compensatory movements of the trunk and the installation of postural changes.

Heydari et al[30] with electromygraphics studies revealed the important role of the paraspinal muscle pains in the column, since people with back pain showed an activation asymmetry and fatigue compared with healthy people.

The magnitude of the effects of mobilization/manipulation of the spine, as well as their application form, their physiological mechanisms of pain, flexibility, muscle function need to be better clarified.

CONCLUSION

The volunteers in both groups had positive results even if not statistically significant. The effects of reduced time and time recommended by Maitland (1 minute) in the sessions have proved effective for reduction of symptoms (pain and restriction of joint motion), but we consider it important to continue further studies in this area of knowledge and physiotherapy praxis.

REFERENCES

1. Helfenstein Junior M, Goldenfum MA, Siena C. Lombalgia ocupacional. Rev Assoc Med Bras. 2010;56(5):583-9.
2. Caraviello EZ, Wasserstein S, Chamlian TR, Masiero D. Evaluation of pain level and function on low back pain patients treated with back school program. Acta Fisiátr. 2005;12(1):11-14.
3. Lin PH, Tsai YA, Chen WC, Huang SF. Prevalence, characteristics, and work-related risk factors of low back pain among hospital nurses in Taiwan: a cross-sectional survey. Int J Occup Med Environ Health. 2012;25:41–50.
4. Torres GC, Garcia RR. Perfil do desempenho ocupacional de pacientes com algias vertebrais crônicas, atendidos em uma clínica-escola de fisioterapia. Ver. Bras. Ciênc. Saúd. 2009;19:38-44.
5. 5. Maher CG. Effective physical treatment for chronic low back pain. Orthop. Clin. North Am. 2004;35(1):57-64.

6. Holderbaum GG, Candotti TC, Christianu SJ, Pressi SA. Relação da atividade profissional com desvios posturais e encurtamentos musculares adaptativos. Rev. Mov. 2002;8(1):21-29.
7. Haas M, Spegman A, Peterson D, et al. Dose-response and efficacy of spinal manipulation for chronic cervicogenic headache: a pilot randomized controlled trial. Spine J. 2010;10(2):117-28.
8. Adams MA. Biomechanics of back pain. Acupunt. Med. 2004;22(4):178-188.
9. Costa D, Palma A. O efeito do treinamento contra resistência da síndrome da dor lombar. Rev Port Cien Desp. 2005;5(2):224-234.
10. Heydari A, Nargol AVF, Jones APC, Humphrey AR, Greenough CG. EMG analysis of lumbar paraspinal muscles as a predictor of the risk of low-back pain. European Spine Journal. 2010;19(7):1145-52.
11. Walker BF, French SD. Pain in the neck: many (marginally different) treatment choices. Ann Intern Med. 2012;156(1):52-53.
12. Lefebvre R, Peterson D, Haas M. Evidence-based practice and chiropratic care. J Evid Based Complementary Altern Med. 2012;18(1):75-79.
13. Maitland GD, Hengeveld E, Banks K, English K. Manipulação vertebral – Maitland. 7th ed. Rio de Janeiro: Elsevier; 2007. p. 552.
14. Corrigan B, Maitland GD. Transtornos musculoesqueléticos da coluna vertebral. 1ª ed. Rio de Janeiro: Livraria e Editora Revinter Ltda; 2005:246.
15. Geisser ME, Wiggert EA, Haig AJ, Colwell MO. A randomized, controlled trial of manual therapy and specific adjuvant exercise for chronic low back pain. Clin. J. Pain. 2005;21(6):463-70.
16. Bertolla F, Baroni B, Leal Júnior ECP, Oltramari JD. Efeito de um programa de treinamento utilizando o método Pilates ® na flexibilidade de atletas juvenis de futsal. Rev. Bras. Med. Esporte. 2007;13(4):222-226.
17. Tanaka TH, Leisman G, Mori H, Nishijo K. The effect of massage on localized lumbar muscle fatigue. BMC Complementary and Alternative Medicine. 2002;2:9-14.
18. Hermens HJ, Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol. 2000;10:361-74.
19. Jesus-Moraleida FR, Ferreira PH, Pereira LSM, Vasconcelos CM, Ferreira ML. Ultrasonographic analysis of the neck flexor muscles in patients with chronic neck pain and changes after cervical spine mobilization. Journal of Manipulative and Physiological Therapeutics. 2011;34(8):514-524.
20. Powers CM, Beneck GJ, KKulig K, Landel RF, Fredericson M. Effects of a single session of posterior-anterior spinal mobilization and press-up exercise on pain response and lumbar spine extension in people with nonspecific low back pain. Physical Therapy. 2014;88(4):485-493.
21. Aquino R, Caires P, Furtado F, Loureiro AV, Ferreira PH, Ferreira ML. Applying joint mobilization at different cervical vertebral levels does not influence immediate pain reduction in patients with chronic neck pain: a randomized. The Journal of Manual & Manipulative Therapy. 2009;17(2):95-100.
22. Ianuzzi A, Khalsa PS. Comparison of human lombar facet joint capsule strains during simulated high-velocity, low-amplitude spinal manipulation versus physiological motions. Spine J. 2005;5(3):277–290.
23. Couto I. Efeito agudo da manipulação em pacientes com dor lombar crônica: estudo piloto. Fisioterapia em Movimento, 2007;20(2):57-62.
24. Keller TS, Colocca CJ, Moore RJ. Incresed multiaxial lumbar motion reponses during multiple-impulse mechanical force manually assisted spinal manipulation. Chiropr Osteopat. 2006;14(6).
25. Zatarin V, Bortolazzo GL. Efeitos da manipulação na articulação sacro-ilíaca e transição lombossacral sobre a flexibilidade da cadeia muscular posterior. Ter Man. 2012;10(47):40-45.
26. Piran M, Aily SM, Araújo RO. Análise comparativa do tratamento da dor lombar crônica utilizando-se as técnicas de Maitland, Mulligan e Estabilização Segmentar. EFDeportes.com, Revista Digital. 2012;170(17).
27. Harvey MP, Descarreaux M. Short term modulation of trunk neuromuscular responses following spinal manipulation: a control group study. BMC Musculoskeletal Disorders. 2013;14:92.
28. Kawano MM, Souza RB, Oliveira BIR, Menacho MO, Cardoso APRG, Nakamura FY, Cardoso JR. Comparação da fadiga eletromiográfica dos músculos paraespinhais e da cinemática angular da coluna entre indivíduos com e sem dor lombar. Rev Bras Med Esporte. 2008;14(3):209-214.
29. Elfiving B, Dedering A, Németh G. Lumbar muscle fatigue and recovery in patients with long-term low-back trouble – electromyography and health-related factors. Clin Biomech. 2003; 18: 619-30.
30. Heydari A, Nargol AVF, Jones APC, Humphrey AR, Greenough CG. Emg analysis of lumbar paraspinal muscles as a predictor of the risk of low-back pain. European Spine Journal. 2010;19(7):1145-52.