Online Journal
Quarterly
Peer-Review

August - December

Volume 7
Number 3

Editorial – Original Articles

ISSN: 1886-9297
ISSN online: 2173-9242

European Journal of Osteopathy
& Related Clinical Research

English Edition

3 2012

Editorial:

Advances in Osteopathic Knowledge and their Clinical Applicability

Original Article:

Immediate Changes in the Peripheral Blood Flow after applying a T3-T4 Manipulation in Smoking Women

Muscle Tone: General considerations. Review

Pain and Disability Rating Scale and Test for the Measurement of the Range of Motion in Low Back Pains

Semidirect Techniques for FRS dysfunctions of C3

www.europeanjournalosteopathy.com

August – December 2012. Volume 7. Number 3.

SUMARIO

European Journal Osteopathy & Related Clinical Research

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European Journal of Osteopathy
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EDITORIAL

Advances in Osteopathic Knowledge and their Clinical Applicability

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a. Editor of the European Journal of Osteopathy & Related Clinical Research

On this occasion, we would like to provide a variety of selected articles, which analyse different interesting issues that concern Osteopathy, under different points of view. This may be useful for the advance of the clinical knowledge related to common problems among the population. These advances will represent the key elements for osteopaths and their professional and research careers. It is one of our goals to contribute to their international dissemination.

Our journal includes in this issue several articles of special interest,related to the application of osteopathic manipulative techniques in smoking women and their consequences on the peripheral blood flow.

We also provide several systematic reviews related to the muscle tone and to the pain and disability rating scale on the one hand, and to the tests for measuring the range of motion in low back pains on the other hand.

Finally, we include a technical report on the technique of cervical manipulation for FRS dysfunctions.

We truly hope the content will meet your expectations.

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European Journal of Osteopathy
& Related Clinical Research

ORIGINAL ARTICLE

Immediate Changes in the Peripheral Blood Flow after Applying aT3-T4 Manipulation to Smoking Women

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Received: August 12th, 2012; accepted: August 20th, 2012

Keywords:
Smoking habit;
Spinal manipulation;
Doppler ultrasonography;
Autonomic nervous system.

ABSTRACT

Introduction: Our research is focused on smoking women, in order to evaluate thrust´s effects in female gender and verify if nicotine could represent a factor of varying the blood flow of this population.

Objectives: Verify if using Manipulation with Dog Technique (MDT) in extension of the vertebral segment T3-T4, there is a change produced in the heart rate, blood pressure and/or the blood flow of the radial, carotid or the dorsalis pedis artery.

Material and methods: 25 smoking women were analysed, aged between 18 and 50, with no previous cardiovascular disease. They were divided into two groups, the Experimental Group(n=13; average age 36.15 ± 8.34 years) and the Control Group (n=12; average age 34.67 ± 6.95 years). A thoracic manipulative technique (Dog technique) was applied in bilateral extension of the spinal segment T3-T4, and heart rate, blood pressure and blood flow of the radial, carotid and dorsalis pedis artery were measured.

Results: There are significant intergroup differences between the CG and the EG with regard to the systolic velocity (p=0.034) and the mean velocity (p=0.038) of the right radial artery. As for the heart rate and the systolic and diastolic pressure, we obtained an immediate decrease of their values after applying the experimental technique, but there were no significant differences between groups (p>0.05).

Conclusions: Applying the MDT technique in extension of the vertebral segment T3-T4, on smoking women, obtains a significant increase of the flow in the right radial artery and a significant tendency in the left carotid artery. There are no significant changes, neither in the flow of dorsalis pedis artery, nor in the values of the heart rate and systolic and diastolic pressure.

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INTRODUCTION

One of the most important principles of Osteopathy is Still´s “rule of artery”. This rule is essential for the concept of self-healing, because the artery is the one in charge of nourishing the tissues. A proper nutrition of the tissues is very important for their healing and regeneration[1].

There are few scientific articles that value the effects of the vertebral manipulation with thrust, concerning the blood flow. For this reason, we strongly believe Still´s “rule of artery” could be considered as a hypothesis to confirm. Karason[2], Howard[3] and Lombardini[4] are the few studies we found in that regard.

Our research is focused on smoking women, in order to evaluate thrust´s effects in the female gender, and verify if nicotine could be a varying factor in this population´s blood flow, related to gender, since there are researches carried out for genders, smoking and non-smoking, with no significant results obtained[5].

The fact of smoking and especially nicotine seems to be an important factor which influences blood flow, since it injures the vascular endothelium and facilitates vessels to become narrow and clogged[6], since smoking facilitates cholesterol deposits on the vessels[7],and alters this way, the blood flow by stimulating the sympathetic nervous system.Smokers´ blood tends to clot more easily[8, 9] than the non-smokers´ blood.

The effects of the nicotine last between[5] and 10 minutes, provoking phases of stimulating action and depressant action of the central nervous system.

Firstly, nicotine stimulates some sensitive receptors and produces a discharge of adrenaline that accelerates the heart rate and increases the blood pressure; next, it depresses all the autonomous ganglions of the peripheral nervous system[10].

Smokers were chosen according to the trials of Karason[2], whom investigated about applying a manipulation with thrust at L5, applied to 20 smokers of both genders, finding a significant improvement in the blood flow.

Our research is focused on the vertebral level T3-T4, in order to analyse if there are effects over the blood supply of the upper limbs, since there exist previous studies done over the lower limbs[2], but their effects are unknown over the upper limbs, and our intention is to distinguish if there are effects over the arterial or cardiac orthosympathetic system.

To measure the blood flow, we use as measurement device the Doppler, based on previous trials[11-14], taking into account the flow of the radial, carotid and dorsalis pedis artery. Also, we will control the values of heart rate and blood pressure, to observe the possible cardiac and arterial effects.

HYPHOTESIS

Manipulation with Dog Technique (MDT) in extension of the vertebral segment T3-T4 causes immediate changes in blood pressure, heart rate and the blood flow of the radial, carotid and dorsalis pedis artery, bilaterally after the manipulation of the mentioned smokers.

OBJECTIVES

The goal is to verify whether applying a MDT in bilateral extension of the vertebral segment T3-T4 produces immediate changes in heart rate, blood pressure and/or the blood flow of the radial, carotid and dorsalis pedis artery.

MATERIAL AND METHODS

Study design

It is a randomised clinical trial, double-blind, with no relation between the evaluator and the controller[15].

Study population

25 (n=25) women were included in this trial (13 in the Experimental Group, with an average age of 36.15 ± 8.34 years old, and 12 in the Control Group, with an average age of 34.67 ± 6.95).

Randomisation

The allocation of subjects to one study group or the other, meaning to the Control Group (CG) or the Experimental Group (EG), was made using a table of random numbers. Smoking women were allocated randomly to those groups, and did not receive any information neither about the trial´s objectives, nor about the assignment to the groups CG and EG. The random sequence was hidden to participants and was protected by a collaborator external to the research.

Study variables

The variables which were taken into account in our trial are age (years), gender, presence of cardiovascular disease, systolic, mean and diastolic velocity (cm/sg), heart rate (pul/min) and blood pressure(mmHg).

Variables like the systolic, mean and diastolic velocity were measured with Doppler (Bidop Es-100V3, Hadeco, Arima, Japan) [16-21] (Figure1).

Heart rate and blood pressure were evaluated with a digital pressure gauge (R6, Omron Healthcare, Kyoto, Japan)[22-24] (Figure1).

FIGURE 1. Tension gauge and Doppler.

Selection criteria

We selected smoking women according to WHO´s criteria, which considers a “smoker” to be someone who has been smoking daily for the last month, no matter how many cigarettes, even one[25]. The study population was chosen between the attendants at the Delfín Campos´ clinic (Ourense, Spain).

Inclusion criteria: a) women aged between 18 and 50 years 26; b) no diagnosed cardiovascular disease; c) more than 10 daily cigarettes smoker for more than a year;

Exclusion criteria: women with high blood pressure; medical history of angina; medical history of acute myocardial infarction; coronary atheromatosis; stroke; temporal arteritis; mitral insufficiency; arterial thrombosis; arterial aneurysm; Barré-Lieou´s syndrome; epilepsy; Ménière´s disease; balance disorders; Arnold Chiari; disc prolapse; visceral and bone cancer; osteoporosis; infectious or inflammatory rheumatism; fracture; patient´s rejection to manipulations.

Study protocol

We carry out the following sequence of actions: we verify criteria of inclusion/exclusion and signing of the consent; random allocation of women in the treatment groups; measurement of the heart rate at rest and in supine position, after waiting for 5 minutes to normalise the blood pressure; measurement of systolic and diastolic pressures at rest and in supine position; measurement of the systolic, mean and diastolic velocity with Doppler at rest and in supine position; applying thrust at the experimental group and placebo to the control group; measurement of the heart rate 5 minutes after applying the technique; measurement of systolic and diastolic pressure 5 minutes after the technique; measurement of the systolic, mean and diastolic velocity also 5 minutes after the technique.

Procedures applied

To the Experimental Group (EG): An MDT, in extension of T3-T4, was applied to smoking women in supine position, with the lower limbs extended and the upper ones in an embrace position with flexed elbows. Once we establish contact with our hand over the vertebral level T3-T4, we perform a thrust on the patient, towards his head, which produced in all cases articular cavitation[27, 28] through an audible “pop” sound. MDT was applied by an experienced osteopath.

To the Control Group (CG): A placebo technique was applied through positioning in the same position, but without applying any thrust to the smoker, and with no articular cavitation with an audible “pop” sound obtained.

Assessments performed

All participants received their measurements of the different values in two different moments, pre-intervention and post-intervention, carried out by qualified health professionals (vascular surgeon) with wide experience in the mentioned measurements. Procedure of intervention, monitoring and data collection:

Smoking women were surveyed about their smoking habit and recent pathologies. They were generally informed about the trial they were about to be involved in, without details about its objective, and they received the informed consent form, in order to sign it previously.

To verify the exclusion criteria, all smoking women filled out an explicit statement, indicating they do not suffer from any diagnosed cardiovascular disease.

Once inside the examination room, participants were asked to lie down in supine position on a treatment table, in anatomical position (Before measuring, it is necessary to wait for 5 minutes, so that blood pressure can normalise after the change of position), where we also had a Doppler portable equipment (Bidop Es-100V3, Hadeco, Arima, Japan) and a digital tension gauge, as well as administrative material for data collection. The room was maintained to a stable temperature, between 18 and 24ºC, and with no noise pollution.

All women smoked a last cigarette before entering the treatment room. Pre-manipulative measurements with Doppler were carried out (radial, carotid, dorsal is pedis artery), and also with the digital tension gauge. The intervention was performed for the EG or CG, and after waiting for 5 minutes, a new data collection was taken.

All the time, the evaluator was completely unaware of what group the participants belonged to, and also what the objectives of the trial were.

Statistical analysis

Data were analysed using software SPSS V.18 (version 18.0)[29-32]. Averages, and also the standard deviation of each variable, were calculated.

The Kolmogorov-Smirnov test was applied to establish the degree of normality for the studied variables. The initial comparisons between groups were performed through the statistica IU of Mann-Whitney, for which there were compared the pre-post improvements between groups. The statistical analysis was performed with a confidence level of 95%. A p-value that was lower than 0.05 in all analyses was considered statistically significant.

ETHICAL STANDARDS

Our research fulfils the ethical standards of the Helsinki Declaration and its subsequent revisions[34, 35] (figure 2).

RESULTS

25 women were involved in this trial (13 in the experimental group with an average age of 36.15 ± 8.34 years and 12 in the control group, with an average age of 34.67 ± 6.95 years). All study variables presented an abnormal distribution ($p>0.05$). There were no differences between groups at the beginning of the trial, except for the heart rate ($p=0.005$) (table1).

An increase of blood flow was observed in basically all the measurements of flow of the carotid and radial arteries, in the case of the experimental group after 5 minutes, except for the systolic velocity of the of the left radial artery and left dorsalis pedis. The same thing happened with the diastolic velocity of the left radial artery and right dorsalis pedis (table1). There are significant inter group differences between the EG and the CG as for the systolic velocity ($p=0.034$) and the mean velocity ($p=0.038$) of the right radial artery (table1). As for the heart rate, and the systolic and diastolic pressure, we obtained an immediate decrease of their values after applying the experimental technique, but there were no significant differences between groups ($p>0.05$) (table1).

DISCUSSION

The obtained results are the same as those from other trials, where an increase of blood flow was observed at the segmentary level after applying a manipulation with thrust [2-4].

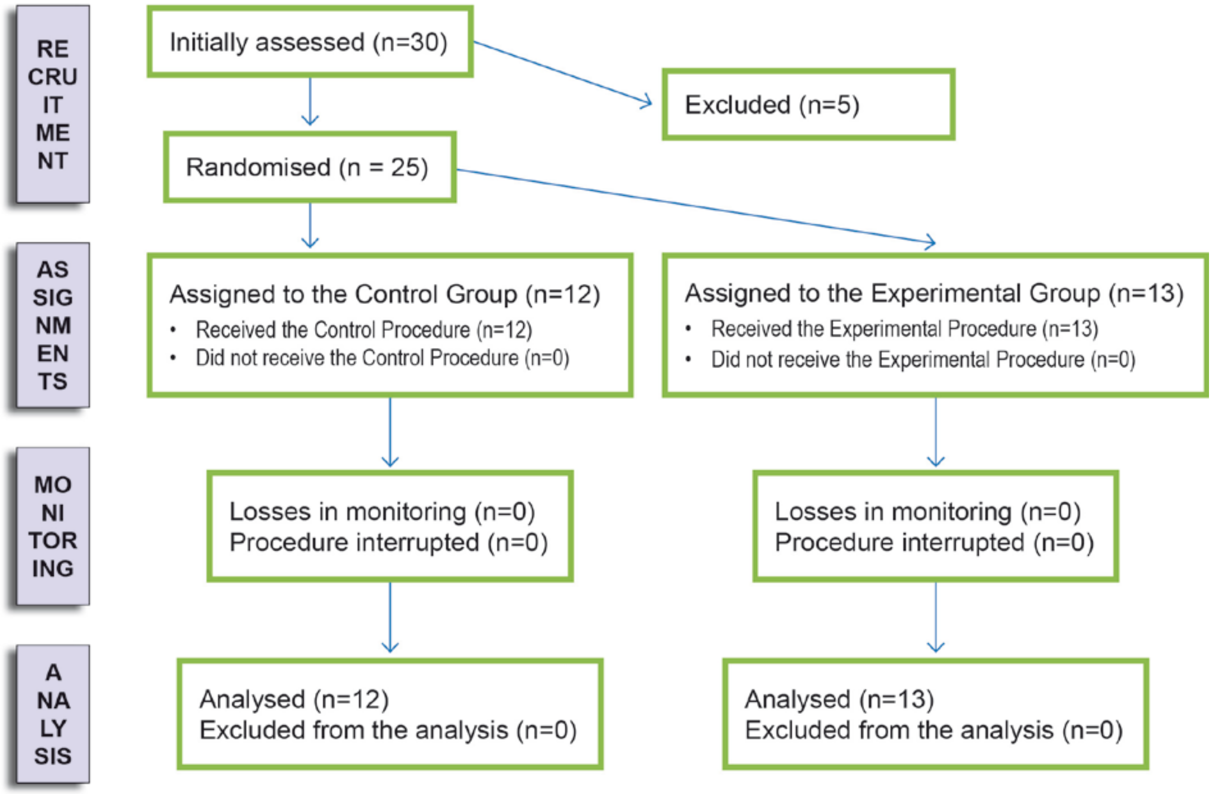

FIGURE 2. Flow chart according to the CONSORT[33] statement for the Report of Randomised Trials.

The involved action mechanisms could vary, including the influence of the segmentary orthosympathetic system at the arterial level, which could influence to a large extent than the orthosympathetic system at the central level, since we obtained immediate increases of flow of the radial artery, although for the carotid and dorsalis pedis artery was not the same significant situation. We believe that if the action mechanism shad been involved in the heart´s segmentary orthosympathetic system, heart rate would have changed significantly, and that was not the case, agreeing with Boscá[36] whom had not seen changes either. Budguell[37] did observed changes in the heart rate after applying a thoracic manipulation technique. Likewise, we believe that if the effect had an impact on the central orthoysimpathetic system at the level of the regulatory centres, there would be some changes of heart rate, blood pressure and blood flow. Budgell[37] described these findings, although other authors like Yates[38] or Boscá[36] did not agree with these statements.

Harris and Wagnon[39] observed that the skin´s temperature changes after applying a thrust technique, but not in the entire body, just in the area of the skin that shares the orthosympathetic nerve supply with the vertebral segment that receives the manipulation.

There are no significant changes neither in the flow of the dorsalis pedis artery, nor in the values of heart rate or the systolic and diastolic pressure between groups, which means that MDT is a safe technique at the cardiovascular level.

Other researches would be necessary with a greater sample size, to provide evidences of the changes in blood flow that the MDT can produce among smoking women. The foresight of this trial could head towards the MDT´s effects on other vascular pathologies that affect women´s upper limbs, such as the carpal tunnel syndrome.

	EG				CG				
	PRE		POST		PRE		POST		P
	Average	SD	Average	SD	Average	SD	Average	SD	Value
VSCAROTD (cm/sg)	6.73	2.60	8.52	2.88	6.44	2.82	6.96	3.68	0.253
VSCAROTI (cm/sg)	4.83	2.49	7.20	3.58	5.48	1.88	5.20	1.56	0.053
VMCAROTD (cm/sg)	1.96	1.35	2.38	2.18	1.49	1.12	2.32	2.33	0.399
VMCAROTI (cm/sg)	1.31	1.07	1.92	1.34	0.85	0.65	1.20	0.84	0.849
VDCAROTD (cm/sg)	0.38	0.58	1.46	1.26	0.85	0.86	1.33	2.21	0.880
VDCAROTI (cm/sg)	0.65	1.42	0.85	1.08	0.51	0.50	0.49	0.65	0.200
VSRADIALD (cm/sg)	3.95	2.13	5.89	5.50	6.26	4.47	4.42	2.49	0.034*
VSRADIALI (cm/sg)	4.98	2.20	4.30	2.02	5.72	3.16	5.74	1.75	0.480
VMRADIALD (cm/sg)	0.71	0.84	1.12	.81	1.64	1.77	0.63	0.43	0.038*
VMRADIALI (cm/sg)	1.07	1.01	1.45	2.10	1.22	1.03	1.26	1.22	0.623
VDRADIALD (cm/sg)	0.15	0.29	0.85	0.93	0.92	1.81	0.30	0.40	0.071
VDRADIALI (cm/sg)	0.72	1.32	0.52	1.16	0.28	0.36	0.26	0.46	0.452
VSPEDIAD (cm/sg)	4.25	2.55	5.22	5.73	4.99	2.87	5.09	3.72	0.978
VSPEDIAI (cm/sg)	4.61	4.19	4.37	2.87	5.41	2.12	4.50	1.93	0.683
VMPEDIAD (cm/sg)	1.05	1.19	0.53	0.40	1.27	1.65	1.06	1.51	0.978
VMPEDIAI (cm/sg)	1.05	2.02	0.98	0.96	1.03	1.15	0.93	1.53	0.114
VDPEDIAD (cm/sg)	0,38	0.67	0.27	0.51	0.14	0.29	0.22	0.47	0.445
VDPEDIAI (cm/sg)	0.27	0.39	0.65	1.42	0.53	0.87	0.53	0.67	0.640
FC (pul/min)	72.77	9.37	69.08	7.11	81.42	8.16	76.75	9.55	0.495
PAS (mmHg)	106.38	11.19	103.85	10.75	104.67	10.64	98.83	8.17	0.172
PAD (mmHg)	65.38	18.50	60.46	8.62	64.08	7.54	64.50	7.20	0.354

TABLE 1. Results of the Experimental and Control Group.

*VSCAROTD: right carotid artery systolic velocity; VSCAROTI: left carotid artery systolic velocity; VMCAROTD: right carotid artery mean velocity; VMCAROTI: left carotid artery mean velocity; VDCAROTD: right carotid artery diastolic velocity; VDCAROTI: left carotid artery diastolic velocity; VSRADIALD: right radial artery systolic velocity; VSRADIALI: left radial artery systolic velocity; VMRADIALD: right radial artery mean velocity; VMRADIALI: left radial artery mean velocity; VDRADIALD: right radial artery diastolic velocity; VDRADIALI left radial artery diastolic velocity; VSPEDIAD: right dorsalis pedis artery systolic velocity; VSPEDIAI: left dorsalis pedis artery systolic velocity; VMPEDIAD: right dorsalis pedis artery mean velocity; VMPEDIAI: left dorsalis pedis artery mean velocity; VDPEDIAD: right dorsalis pedis artery diastolic velocity; VDPEDIAI: left dorsalis pedis artery diastolic velocity; FC: heart rate; PAS: systolic blood pressure; PAD: diastolic blood pressure.SD: Standard Deviation. P-values are from the U of Mann- Whitney test.*It expresses statistical significance.*

Study limitations

Apart from the sample size, there are other limitations that can be taken into account for future researches, such as the application of MDT in patients with cardiovascular and lung diseases. It would be interesting to include men in future trials, since we are not familiar with the effects on them.

CONCLUSIONS

Applying MDT in extension of the vertebral segmentT3-T4in the case of smoking women means a significant increase of flow for the right radial artery, and a tendency in the left carotid artery. There are no significant changes, neither in flow for the dorsalis pedis artery, nor for the values of heart rate or systolic and diastolic pressure.

ACKNOWLEDGEMENTS

We would like to thank all those people who made this work possible, especially to the administrative and healthcare area from UPS of Fremap Ourense for their help and collaboration.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interests concerning this research.

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ISSN online:2173-9242

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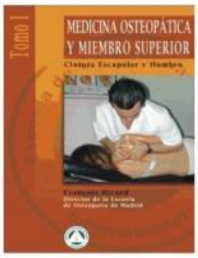
MEDICINA OSTEOPATICA Y MIEMBRO SUPERIOR

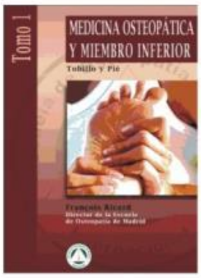


MEDICINA OSTEOPATICA Y MIEMBRO SUPERIOR
Tomo 1 Cintura escapular

MEDICINA OSTEOPATICA Y MIEMBRO SUPERIOR
Tomo 2 Codo

MEDICINA OSTEOPATICA Y MIEMBRO SUPERIOR
Tomo 3 Mano y Antebrazo

MEDICINA OSTEOPATICA Y MIEMBRO INFERIOR



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Tomo 1 Tobillo y pie

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Tomo 2 Rodilla

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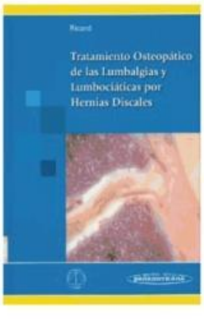

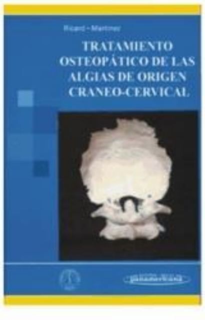

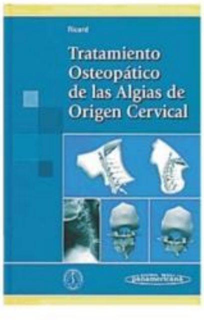

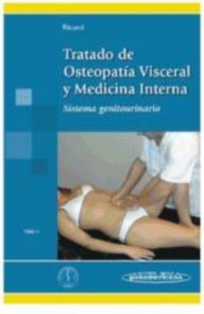

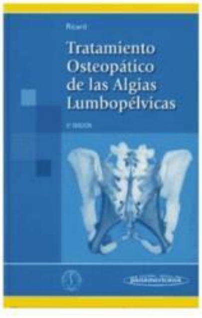

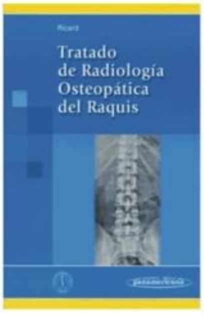

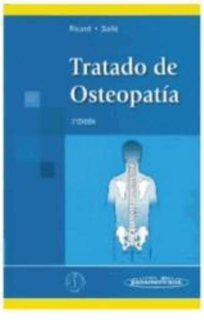

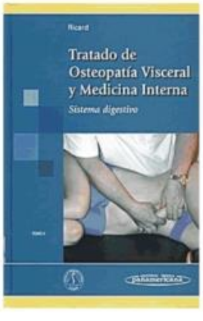

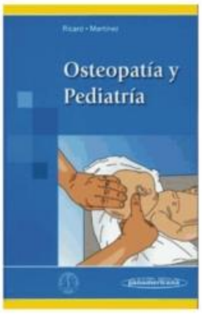

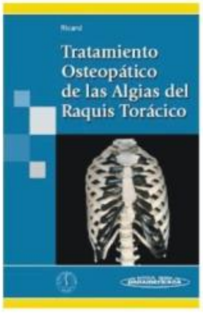

European Journal of Osteopathy
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SYSTEMATIC REVIEW

Muscle Tone: General considerations. Review

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Received: October 10th, 2012; accepted: November 14th, 2012

Keywords:
Muscle tone;
Musculoskeletal system;
Skeletal muscle;
Striated muscle;
Diagnosis.

ABSTRACT

Introduction: The measurement of the muscle tone provides important information, in order to render the differential diagnosis, prognosis and treatment of the musculoskeletal and neuromuscular disorders. It can be considered as an important prognostic factor in the evolution of certain pathologies.

Objective: To perform an actualised description of the different examination methods of the muscle tone.

Material and methods: A bibliographic research was performed in databases such as PubMed (MEDLINE), Sciencedirect (Scopus) and ISI Web of Knowledge, using terms like “muscletone”, “muscletonus”, “stiffness”, “measurement”, “myotonometer”, “reliability” and “validity”, alone or combined.

Results: Systematic review trial, retrospective, with a sample of bibliographic analysis, including 52 articles (n=52) that satisfied the selection criteria carried out in two phases of analysis, which meant 8.9% of all founded articles (n=578) and 17.50% of the articles which fulfilled the selection criteria (n=297) (inclusion and exclusion). Measurement of specific muscular areas, such as tone, elasticity and stiffness, provide relevant information about the functional state of the muscle. The devices used nowadays for the quantification of the muscle tone are varied and of latest technology, but without forgetting the traditional manual tests and nominal scales, such as Asworth´s.

Conclusions: The measurement of the muscle tone is an examination tool of great importance. The new devices that are used to examine muscle tone represent a forward step with regard to the traditional methods, since they are capable of measuring simultaneously three characteristics of the muscle, such as natural oscillation frequency, elasticity and stiffness.

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INTRODUCTION

Muscle tone is defined, from the clinical point of view, as the resistance to an external given strength, with the muscle in a voluntary relaxed state. Physically speaking, the resistance can also be explained like the increase of developed strength as a response to changes in the muscle length (muscular stiffness). One of the contributing factors to muscle tone is intrinsic stiffness, determined by the elastic and damping properties of the contractile device, as well as the inherent elasticity of the tendinous insertions and those of the muscle´s connective tissue. [1]

Measurement of the muscle tone provides important information for the differential diagnosis, prognosis and treatment of the musculoskeletal and neuromuscular disorders. It can be considered an important prognostic for the evolution of certain pathologies. [2]

MATERIAL AND METHODS

The bibliographic review was carried out using database such as PubMed (MEDLINE), Sciencedirect (Scopus) and ISI Web of Knowledge. The terms used for the search were “muscle tone”, “muscletonus”, “stiffness”, “measurement”, “myotonometer”, “reliability” and “validity”, alone or combined one to another, considering the same until 2012, and for publishings written in English or Spanish.

Selection criteria

Review was structured in two different phases of research. In the first phase, selection criteria were established (inclusion and exclusion)and in the second one, specific selection criteria were chosen.

Selection criteria. During phase 1 of the research, the following inclusion criteria were applied: articles published in scientific indexed magazines, in English or Spanish, related to every aspect concerning muscle tone and its evaluation in human beings.

During phase 2, selection criteria were applied to the chosen articles. The selection filter was made considering the title, summary, keywords, availability of the complete text and the bibliographic references of those articles included in phase 1 (figure1).

Data analysis

Phase1.- First, a general search was carried out in order to obtain the published results related to the muscle tone and its evaluation.

A total of 578 studies were obtained (n=578), once the duplicated articles were discarded, to which criteria of inclusion and exclusion were applied, fact that allowed an initial selection of 297 articles (n=297) (figure 1).

Phase2.- Later, it was established the objective of reviewing all articles that regarded the relationship of the muscle tone with pain, the different devices used for measuring tone, as well as its reliability and validity. This way, a selection was made considering title, summary and keywords, which excluded 104 (n=104) initially selected articles. After that, a selection of the whole text was applied, which gave as result a final inclusion of 52 trials (n=52). Finally, an analysis of bibliographic references was made, to verify if there was feasible to obtain additional information, and it was not the case, so no complementary trial was obtained (n=0). For this reason, the sample of this trial consisted of 52 articles, selected according to PRISMA criteria for systematic reviews (figure1).

From all the magazines we have used in order to develop this review, we highlight two of them: Archives of Physical Medicine and Rehabilitation and Physiological Measurement, which with ten (n=10) and seven (n=7) results respectively, are the publishings that most articles bring to the subject of the trial.

RESULTS

The sample of bibliographic analysis finally consisted of 52 articles (n=52), which fulfilled the selection criteria in two phases of analysis, which meant 8.9% of all founded articles and 17.50% of the articles that fulfilled the selection criteria (inclusion and exclusion).

In light of the performed search and once the different publishings were analysed with regard to the interest subject, the following aspects were emphasized, related to the muscle tone and their evaluation:

Definition

Measurement of specific muscular properties, such as tone, elasticity and stiffness, contributes with relevant information on the functional state of the muscle. Evaluation of the skeletal muscle´s properties is accepted clinically as a potential indicator of the effect of the applied treatment or the progression of the disease. [3]

Muscle tone, related to mechanical stiffness and elastical properties of the skeletal muscle, is considered as an essential factor in maintaining balance, stability and posture, since it allows an optimal postural control with energy efficiency. [4] Moreover, muscle tone is responsible for assuring an efficient muscular contraction in a static position, with no voluntary contraction. [5]

Between the mechanisms that contribute to maintaining muscle tone, we include reflex excitability, viscoelastic properties of the musculotendinous unity and intrinsic properties of the contractile elements. [6]

In literature, we can find different definitions related to muscle tone, such as the following: "passive muscular tension, as consequence of the intrinsic viscoelastic properties of the muscle with no contractile activity" [4, 5], "resistance to passive stretching that reflexes the relative influences of the mechanoelastic muscular properties" [7]; "resistance to passive stretching, as a result of several mechanisms such as reflex excitability, mechanical properties of the musculotendinous unity (viscoelasticity) and intrinsic properties or active resistance to contractile elements; [8] "interaction between the muscle´s viscoelastic properties, structures and neural regulation. [9]

Variations of the muscle tone

The increase of muscle tone(which is described in literature as "stiffness") is a frequent circumstance in musculoskeletal disorders, being its normalisation one of the most important goals of the osteopathic treatment. [10]

Muscular hardness or stiffness represents an objective parameter which is defined as the degree of muscular deformity at a given pressure. From a technical point of view, stiffness or muscular hardness is the mean of exchange rate in strength to change in length towards the main axis of the muscle. [11]

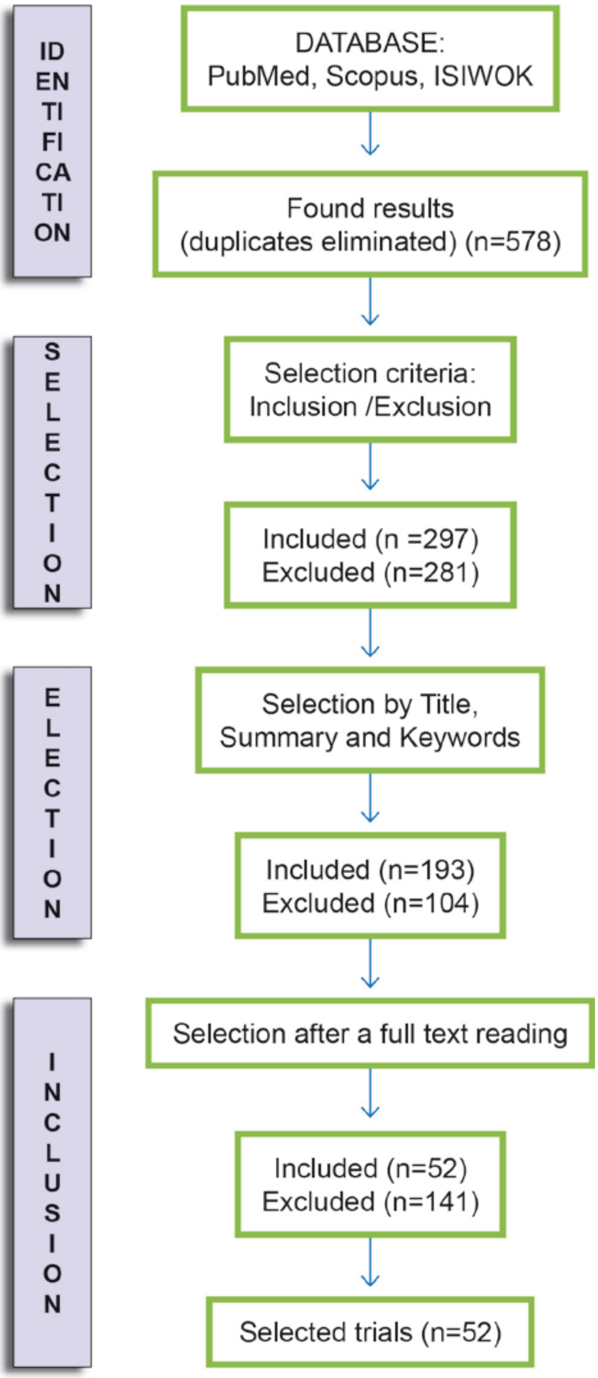

Figure1.- Flow chart of the articles´ selection, according to PRISMA declaration for systematic review reports and meta-analysis for healthcare trials.

Moreover, this muscular hardness increases as the contraction progresses, being affected by muscular alterations and according to trigger levels. [12] For example, patients with syndrome of myofascial pain have trigger points with tissue stiffness, feeling a tight band when palpating. Although chronic pathologies may induce physical changes in the muscle, causing it more stiffness when palpating, in general the increased muscular hardness is clinically associated with a neural activation of the muscle.

As an exception, we will mention the study of Andersen et al., in which when evaluating the trigger points of the trapezium through algometry, two of them revealed a low threshold under pressure (coinciding with typical locations for tender points or latent trigger points). However, these were the least stiffened areas with regard to the rest. [13] In any case, a palpable change in muscular stiffness produced in one day, one week or one month should be seen as a change in the amount of tension that the muscle exerts constantly. [14] This muscular hardness seems to depend of the muscular tension in the majority of the length ranges. [15]

Thus, the increase of muscle tone over normal conditions induces a sequence of alterations, such as muscular venous compression and alteration of the intramuscular movement, decreasing the volume of carried oxygen, which entails a painful state and damage of the motor function. [15]

Stiffness or hardness of the articular passive structures contributes very few to their mechanical stability, except for the last degrees of the range of motion. However, several trials determined that muscular properties of active stiffness are essential for dynamic stability. Optimal levels of musculotendinous stiffness are widely related to the significant improvements of the muscular function. This increase of the articular stiffness could limit the translation suffered at the articular level after an injury. [16]

There are some circumstances which can cause a pathologic increase in muscle tone. On the one side, we have the changes in mechanical and viscoelastic properties of the complex joint-tendon-muscle. On the other side, there are neurophysiologic alterations resulted from the activity of alfa motoneuron and/or disorders resulted from the local activity of the muscle spindles or gamma motoneurons. Between the last ones, there may be included an alteration of presynaptic inhibition, an inhibition of Renshaw´s interneuron and disorders of neuroplastic adaptation or hyperreflexia resulting from hypersensitivity to the sense of touch. [9]

Different trials have proven that muscle mechanical properties suffer alterations in certain neuromuscular pathologies, such as hyperthyroidism, Duchenne´s muscular dystrophy, multiple sclerosis, spasticity or myofascial pain syndrome. [17] For example, abnormalities in muscle stiffness are a characteristic aspect of a sequence of neurological alterations, and in other painful syndromes, they are related to repeated, sportive or occupational traumatisms. [18]

The used nomenclature for this pathologic muscular state varies, including terms such as "hypertonia", "stiffness", "hardness", "elasticity properties" and "viscoelasticity". [10]

Measurement of muscle tone

Measurement of muscle tone is considered one of the most common used methods in clinical practice as evaluator and prognostic factor. [1]

Evaluating muscle tone through direct palpation and resistance represents one of the most common methods to determine the muscular state in clinical practice. However, tone evaluations used nowadays are based on manual methods, which use ambiguous register scales that depend more of the examiner´s experience and subjectivity, so results can only be obtained using an ordinal scale. We must mention that for some authors, so far, manual palpation is the most important and precise method according to their experience, although they have a lack of objectives proves. [19] Clinical tests are like a prototype of this type of examinations, since they apply an ordinal scale to the resistance perceived by the examiner during a passive movement of the tested joint. A classic example of these types of tests is Asworth´s scale and modified Asworth´s scale, which basically evaluate the muscular tone and progressive stiffness. [20, 21] We must point out that even if the spasticity degree has been basically determined with this scale, new systems for its evaluation and for variations from the original scale are developed. [22, 23]

However, these measurements are not considered quantitative, since they do not own enough discriminative aspects, and the results are grouped in few degrees. [23] This testing is not sensitive enough to detect small or moderate changes. [2] Moreover, its reliability is not clearly defined. [20]

On the other hand, classic evaluation methods of the muscle mechanical properties imply the use of specific experimental devices, designed for a specific joint. As a result, changes in different muscles´ properties more or less affected by a specific pathology cannot be easily determined using the same procedure. [17] Moreover, measuring stiffness requires that the evaluated participants must make voluntary isometric contractions, maximum and submaximum, which can be painful and hard to carry out. We are talking about objective measurements that determine resistance to the present passive articular movement, while the evaluated limb moves under gravitational control or through an isokinetic dynamometer; an example of this type of measurements is Wartenberg´s sign or pendulum test, developed by this author firstly in 1951 for examining the knee joint. This system, although objective and reliable, has a limited use for certain muscle groups, such as in the case of quadriceps, and besides that, it only provides one force, the gravitational one. In order to carry out this test, the patient must be in a relaxed position, on the edge of the examination table, with his/her legs stretched out. The examiner lifts both of his/her legs until the horizontal position, and then drops them observing their oscillation, which will be different depending on the muscle, if healthy or spastic. [24-26]

Another measurement system founded in the bibliography is the magnetic resonance elastography, which specifies the measure of stiffness from the muscle tissues. [17] This technique has been used to evaluate the mechanical properties of the pathologic muscles in rest position. However, this system has different limitations that restrict its clinical use, mostly due to its complexity and cost. Also, certain trials limit its capacity to detect small structural changes in time. Progression in this last device can be observed in the supersonic shear imaging device that solves partially these problems; its reliability has been proved. [17]

Other researchers have developed another device more quantifier for the tone, the "twister". This device studies tone regulation from the axial and proximal muscles, while maintaining an active posture. The twister rotates axial areas of the body with regard to others rotating around a vertical axis. This rotation imposes length changes in axial muscles, without producing any change in the relation between body and gravity action. This system can be reconfigured in order to study several aspects of the muscle tone, such as co-contraction, tonic modulation with postural changes, tonic interactions through body segments, as well as perceptive thresholds to slow axial rotation. [27]

In the reviewed literature, there is a remarkable amount of articles centred in quantifying muscle tone through devices that study change in muscular hardness or stiffness, as a consequence of the applied forces through the axis of a given muscle. Several trial shave proven that this force perpendicularly applied is proportional to the changes in muscular hardness. [28, 29]

All mentioned devices measure the movement of a certain muscle to which a compressive strength was applied perpendicularly. The most relevant example of this type of devices is the Myotonometer ®. [30]

The Myotonometer ® is an electronic device that has been developed since 1993, whose most important function is to measure the force-displacement characteristics of the muscle and other tissues located beneath the measuring probe or the area under the curve (AUC).This means that it provides an evaluation of the muscular hardness at rest and during the contraction. Measurements are obtained when quantifying resistance (measured in millimetres of tissue displacement) by unit of a force applied perpendicular to the tissue. Myotonometer ® is formed by an inner metal probe (1 cm of diameter), surrounded by a plexiglass collar of 3.5 cm of diameter. Inside the probe, there are several transducers that monitor the applied downward pressure. Measurements are carried out in intervals of 0.25Kg, since 0.25 until 2.0Kg. Maximum applied force can be reduced to1kg in special cases (when dealing with children or in very painful situations). Probe sends the information concerning force and tissue displacement to the computer connected to the Myonometer ®. The examiner pressures gently downward and perpendicular to the muscle. It must be considered the fact that applying an external compression it increases the tissue´s stiffness. [31] While the pressure is applied, the probe dips into the muscle. As muscle tone is greater, less deepness is produced by unity of strength, in such way that a contracted muscle will allow less deepness than when relaxed. [30]

Obtained measurements with Myotonometer ® during a muscle contraction provide an indirect but valid measure of the muscle force [18, 32], since muscular hardness or stiffness increases proportionally to muscle activation and torque production. [33]

Values in rest position give an exact determination of the muscle tone and the muscle compliance. This is possible because a muscle fibre gets stiffer when stimulated. [29, 34]

The use of Myotonometer ® has certain advantages compared to surface electromyography (EMG), isokinetic test and dynamometer. The isokinetic and dynamometric tests can be influenced by muscular compensations and they only measure the joint torque, and not the muscle´s contributions to the joint torque.

On the contrary, time for setting up the Myotonometer ® is minimal and data can be obtained and interpreted quickly. [30]

Measurements of muscular stiffness made with Myotonometer ® show an increase approximately linear with the increase of electromyographic measures of the muscle activation and contractile strength during the voluntary isometric contraction, indicating the tissue displacement during contractile conditions, which provides an indirect measurement of the muscle force. [35]

Clinical trials have proven that measurements provided by this device can distinguish between injured and not injured muscles, even years later after the injury, as well as quantify muscular imbalances. [36] Also, the Myotonometer ® can quantify differences between subjects with alterations of the superior motoneuron and subjects without alterations, apart from distinguishing between homolateral and contralateral extremities to the injury. [7] Coon et al. [37] evaluated the effects of the manual technique of contraction-relaxation (in supine position) on the altered sensitivity and hardness (through Myotonometer ®), at the level of the trapezium in subjects with cervical pain compared to healthy controls. There was a significant decrease of muscle hardness in the group whom received manual technique, although it was not very different from the result obtained by the control group. Moreover, it has been used to measure the viscoelastic parameters for the muscles of triathletes [38], as well as to determine the possible relation between the changes of passive hardness of the brachial biceps after eccentric exercise. [39]

Leonard et al. [40] found the correlation between the measurements of muscular hardness obtained with the Myotonometer ® and the surface EMG during several degrees of voluntary isometric contraction of the brachial biceps. Data were obtained in rest position, with the subject holding 6.8Kg ballast, during a maximum voluntary isometric contraction. Measurements obtained with both instruments (AUC with Myotonometer ®) had correlation, especially between 1 and 2 kg.

Gubler-Hanna et al. [30] followed the same line of research, concluding that the obtained measurements with the Myotonometer ® proved a significant correlation with surface EMG and the production of knee-extensor torque during an isometric contraction.

Ditto et al. [41] proved the effectiveness of Myotonometerby finding changes in muscle compliance during a four-week programme of stretching for the calf muscle.

Myotonometer´s reliability and validity [7, 42, 43] have been proven, verified in muscle tone´s determination of children with PCI [44], and also in muscle properties after rehabilitation in subjects with stroke. [6]

Other very similar devices have been used for determining muscle tone, as for the case of Myoton. This is a device that provides objective measurements of three muscular mechanical properties: tone, hardness and elasticity. Frequency of oscillation indicates muscle´s tone in rest position. The logarithmic decrease of a muscle´s natural oscillation indicates its elasticity or capacity to recover its shape after contraction. Dynamic stiffness (N/m) describes the muscle´s resistance to contraction. There are several prototypes of Myoton, and the most frequent are Myoton-2 and Myoton-3, apart from the Myoton-Pro. The difference between the last device and the others is that this one has several updates, like a triaxial accelerometer, which makes it more versatile in terms of implementation. [45] Its reliability has been proved in the measurement of quadriceps´ tone in healthy elderly patients. [45] Myoton-2 can be used to make measurements in the live image, simultaneously and in non-invasive manner, of three parameters: natural oscillation frequency, which defines muscular tension, stiffness, like muscle´s capacity to handle changes in shape, and the logarithmic decrease of muscle elasticity, meaning muscle´s capacity to recover its initial shape after the co-contraction and/or deformity caused by external forces. Myoton-2 demonstrated a great reliability in measuring skeletal muscle´s properties. [5, 18] Moreover, it has been proved that measurements made by this device are more precise and sensitive if compared to the others, obtained through a nominal scale in subjects with spasticity. [46]

As an example of the use of Myoton-3 (Myometry AS; Tallinn, Estonia), we must point out its use for objectifying the degree of passive muscular stiffness in patients with Parkinson, greater than in healthy controls. [47] This discovery matches previous studies, such as Watts´ [48], which concluded similar issues by using dynamometry and electromyography. In the same line of research, it has been determined that the increase of stiffness observed in patients with Parkinson is associated to values of hardness or viscoelastic stiffness. [3] In addition, it is recommended the use of myometry for diagnosis and for monitoring the effectiveness of the therapy of deep brain stimulation. Through the use of myometry, it is concluded that antiparkinsonian medication reduces not only the pathognomonic stiffness of this pathology, but also the hardness related to muscle stiffness in rest position. According to these authors, myometry can be added to the neurological practice, since it provides an objective and reliable vision of the treatment for parkinsonian stiffness. [49] Its reliability and validity have been proved when quantifying muscle tone, elasticity and hardness of the brachial biceps and triceps in patients with subacute CVA, [4, 35] as well as when determining quadriceps´ stiffness of hardness. [16]

Jarocka et al. [10] compared measurements of tone and hardness of the brachioradial is muscle, using these two devices, Myoton-3 and Myotonometer ®. Muscle skeletal´s state was shown through the stiffness parameters ofMyoton-3 (N m-1), frequency, as well as through the AUC of the Myotonometer ®, with the muscle at rest and at 25%, 50%, 80% and 100% of voluntary maximum contraction in the elbow´s flexor muscles.

When comparing both results separately, the degree of correlation between both measurements depended on if the evaluated muscle was at rest or in contraction and besides, it varied between different parameters. One last device related to muscle tone´s evaluation is the tonometer (Medirehabook Ltd, Muurame, Finland), which quantifies the amount of muscle tissue displaced by the unity of force applied through a probe that is pressured against the tissue. [50] This device reads directly the muscle tone in normal conditions, and it can be used for diagnosis and treatment, motivating visual feedback. [50] Its reliability has also been proved. [2]

Finally, we point out the devices created to quantify muscular tension. [51, 52] For example,Đorđević et al. [52] are capable of measuring muscular tension through a sensor, using an innovating method during muscular contractions. Sensor is fixed on the skin over the muscle, and the sensor tip pressures the skin and provokes a light bleeding. Immediately afterwards, it applies pressure over the muscle. In that precise moment is when the strength on the sensor tip is measured. This strength is directly proportional to muscular tension. Measurement is non-invasive and selective.

DISCUSSION

From the reviewed literature, we can conclude that the quantification of muscle tone is a necessary tool when evaluating the muscular functional state, as well as for determining the effect of the applied treatment. [2] Muscle activity, muscle thickness and length must be taken into account when evaluating the muscle tone. [9]

Evaluating a specific muscle (fact that can suffer changes due to fatigue or to a pathologic process) is normally carried out through palpation. According to bibliography, this evaluation is subjective and unappropriated for a correct comparison of changes that can occur in different stages of the therapy, and according to different therapists. Myotonometry is proposed as a reliable tool to quantify the possible differences, as said before. [40]

Myotonometry is a useful system for supervising the mechanical changes of the muscles that depend on time, such as it occurs in case of chronic syndromes. The main difference between myometry and other way of evaluating the muscle tone is that this one can measure three characteristics of the muscle simultaneously: frequency of natural oscillation, elasticity and stiffness. Disproportion between stiffness and elasticity of the muscle tissue in its altered process of contraction and relax is proposed as a new indicator of pathologic changes in tissues. [5]

Myotonometric measures represent a new and valid approximation for an indirect evaluation of the muscle force. Speed and ease in obtaining data and in analysing the founded results give this system a clear advantage over electromyography.

Between the advantages of dynamometry, the capacity to quantify changes in muscle compliance of isolated muscles is mentioned, during measurements of joint strength and not only total joint strength. Muscle replacements are not possible and neither are device´s portability and easy handling. [43]

Another advantage of using Myoton and other devices is its capacity for measuring isolated muscles and also for avoiding co-contraction for antagonist muscles, which has a great influence on muscle stiffness. [6]

CONCLUSIONS

From this systematic review, we can conclude that measuring the muscle tone represents a relevant evaluation tool, until the point of becoming a prognosis factor in the progression of certain pathologies. The new devices used for the quantification of the muscle tone represent a forward step with regard to the traditional methods of evaluation, since they are capable of measuring simultaneously three characteristics of the muscle, such as natural oscillation frequency, elasticity and stiffness. Moreover, these measurements obtained with devices such as the Myotonometer ® represent a new valid approach to carry out an indirect evaluation of the muscle strength.

For all reasons exposed in the review many authors support the use of these devices and suggest to compare their reliability with the one obtained in the same participants in other classical measurements, such as the modified Asworth´s scale. [46]

CONFLICT OF INTEREST

Authors declare they had no conflict of interest.

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ISSN online:2173-9242

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SYSTEMATIC REVIEW

Pain and Disability Rating Scale and Test for the Measurement of the Range of Motion in Low Back Pains

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Received: September 26th, 2012; accepted: October 14th, 2012

ABSTRACT

Keywords:
Low back pain;
Disability examination;
Validity scales of the trials;
Range of joint motion.

Objectives: The purpose is to make a review of the validity of the pain and disability scales for the diagnosis of low back pain, as well as of the validity of the range of motion as a diagnostic criterion for low back pain in comparison to disability scales.

Material and methods: A bibliography research was carried out, according to the following database: Medline-PubMed and Pedro. There were included studies related with the trial. For this search, the following terms were used: "lowbackpain", "diagnosis", "validity", "disability scales, "range ofmotion". There were included a total number of 13 studies and were excluded 13.346.

Results: The consulted studies support the validity of the pain and disability scales for diagnosing low back pain (Roland Morris Disability Questionnaire, Oswestry Disability Index for Low Back Pain and VSA). Validity and high reproducibility of the test were observed to measure the range of low back pain motion [modified Schober, double inclinometer and fingertip-to-floor test (FTF)], obtaining a high correlation in comparison to an imaging test. On the other hand, the little relation between the range of motion and the functional disability indexes has been pointed out, which excludes it as diagnostic criterion for lumbar pathology.

Conclusions: Disability scales (Oswestry index and Roland Morris questionnaire) and pains (VSA) have proven their utility in diagnosing and in lumbar pathology´s monitoring, and are the most recommended measurements of the scientific bibliography. We found internal validity and high reproducibility of the measurement tests for the lumbar range of motion (modified Schober test, double inclinometer, FTF test) in relation to the imaging test for measuring mobility. However, range of motion is not a valid criterion for diagnosing lumbar pathology, because of its little relation with the disability indexes.

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INTRODUCTION

Epidemiologically speaking, "low back pain" is a very frequent pathology of medical consultation and work leave[1]. This pathology affects 70-85% of people at some point of their lives, from whom a 90% suffers recurrences. Great part of the back pathologies is due to low back pain, producing an important sanitary cost, direct and indirect[2].

Among the multiple causes of low back pain, such as mechanical alterations of the spine, disc diseases and inflammatory or degenerative processes, we can include elasticity[3] and strength[4-6] alterations of the erector spinae muscles, psoas and abdominals.

Similarly, alterations of posture and postural control[7-11] are important for postural chains, of which diaphragm is part[12, 13]. Biomechanically speaking, it is common to find alterations in low back motion. [14-16]

Assessment is very important for rendering a good diagnosis of this pathology and for making possible a good monitoring of its evolution.

For this reason, in this article we suggest a review of the questionnaires and of the most used manual methods of diagnosis, in order to compare them.

MATERIAL AND METHODS

Search strategy

A systematic search was made between January and August of 2012, in the following database: Medline-PubMed and Pedro.

Search was limited to the following languages: English, Spanish and French. The preferred terms were the following: "low back pain", "diagnosis", "validity", "disability scales" and "range of motion".

Articles not related to the objectives of this trial were excluded.

Results were structured in two sections: in the first section, we made a review of the disability scales that are normally used for diagnosis and low back pain monitoring.

In the second section, we point out tests that measure the most used range of motion in the consulted bibliography and also, its validity as diagnostic criterion for low back pain.

OBJECTIVES OF THE REVIEW

1. Verify the validity of the disability scales used for the diagnosis and assessment of low back pain.
2. Verify the internal validity of the tests that measure the range of motion and/or their relation regarding an imaging test.
3. Verify the validity of the range of motion as a diagnostic criterion for low back pain, when comparing it to the disability scales.

SELECTION CRITERIA

Inclusion criteria: The subject matter of the article must include diagnostic validity for low back pain pathologies. From this point, there are three possibilities:

- Disability scales and questionnaires.
- Internal validity of manual tests that measure the range of motion and/or their comparison to the imaging tests.
- Relation between the range of motion and the disability scales and questionnaires as a validity criterion.

The included languages are English, Spanish and French.

Exclusion criteria: Subject matter of these trials is different to the one included in the inclusion criteria; the language of the trials is different from the ones of the inclusion criteria.

REVIEW PROTOCOL

Database selection

Selected database for performing this article were PubMed-Medline and Pedro, for including a great amount of articles related to the object of the trial.

Identifying preferred terms

Preferred terms used for this matter were: "low back pain", "diagnosis", "validity", "disability scales" and "range of motion".

Searching in database

- First, these keywords were combined: "low back pain", "diagnosis", "validity" and "disability scales".
- Secondly, "low back pain", "diagnosis", "validity" and "range of motion" were combined.
- Thirdly, all preferred terms were combined.

Articles review and analysis

First, a review of the titles was performed and afterwards, of the articles overview, in order to exclude those that did not satisfy the inclusion criteria or those which are part of the exclusion criteria.

After performing the final selection, an analysis of the complete texts was carried out.

Subject matter classification

Articles were classified in three different subject matters:

1. Validity of the disability scales.
2. Internal validity of the range of motion tests and/or relation with imaging tests in order to measure motion.
3. Validity of the range of motion as diagnostic criterion for low back pain in comparison to the disability scales.

Characteristics of the selected trials

1. Trials that reveal the validity of the disability scales: to fulfill the first objective.
2. Trials that reveal the internal validity of the range of motion tests and/or their relation with the imaging tests: to fulfill the second objective.
3. Trials that relate the range of motion with disability scales: to fulfill the third objective and make sure these tests are valid for the diagnosis and monitoring of the lumbar pathology.

Data analysis

A data collection was created of all articles, which included the following categories:

1. General aspects: number of authors, year of publication.
2. Responding to objective 1: yes/no (validity of disability scales for diagnosing low back pain).
3. Responding to objective 2: yes/no (internal validity of the range of motion tests and/or regarding imaging tests).
4. Responding to objective 3: yes/no (validity of the range of motion tests as diagnostic criterion of low back pain in comparison to disability scales).

RESULTS

Statistical description of the sample size.

We found a total of 13,921 articles (n=13,921), from which 562 fulfilled the selection criteria (n=562).

After applying a classification by Title, Abstract and Keywords, we excluded 531 studies (n=531), thus including 31 articles in the end (n=31), which represents 0.22% of the initially founded articles.

Afterwards, we selected trials according to the content criteria (full text) and after the review, we excluded 18 (n=18), remaining our sample reduced to 13 articles (n=13).

Once we obtained the sample, we performed a secondary analysis of content and bibliographic references, from which we did not select any article (n=0); therefore, the final sample included 13 trials (n=13).

Authors	Year	Title
Honglei Yi., Xinran Ji, Xianzhao Wei, Ziqiang Chen, Xinhui Wang, Xiaodong Zhu, Wei Zhang, Jiayu Chen, Diqing Zhang, Ming Li[22]	2012	Reliability and validity of the simplified Chinese version of Roland Morris Questionnaire in evaluating rural and urban patients with low back pain.
Fritz, Irrqanq[20]	2011	A comparison of the Oswestry low back pain disability questionnaire and the Quebec back pain disability scale.
Hicks, Manal[21]	2009	Psychometric properties of commonly used low back disability questionnaires: are they useful for older adults with low back pain?
Van Nieuwenhuyse, Crombez, Burdorf, Verbeke, Masschelein, Moens, Mairiaux and the BelCoBack Study Group[29]	2009	Physical characteristics of the back are not predictive of low back pain in healthy workers: A prospective study.
Cuesta Vargas AI, Rodriguez Moya A[17]	2008	The frequency of the use of pain, disability and quality of life scales in the study of physiotherapy intervention on low back pain
Calmels, Bèthoux, Condemime, Fayolle[23]	2005	Low back pain disability assessment tools.
Rocchi, Sisti, Benedetti, Valentini, Bellagamba, Federici[18]	2005	Critical comparison of nine different self-administered questionnaires for the evaluation of disability caused by low back pain.
Bijur PE, Silver W, Gallagher PJ[19]	2001	Reliability of the visual analogue scale for measurement of acute pain.
Perret, Poiraudeau, Fermanian, Colau, Benhamou, Revel[25]	2001	Validity, reliability and responsiveness of the finger tip-to-floor test.
Poitras, Loisisel, Prince, Lemaire[28]	2000	Disability measurement in persons with back pain: a validity study of range of motion and velocity.
Sullivan, Shoaf, Riddle[27]	2000	The relationship of lumbar flexion to disability in patients with low back pain.
Saur, Ensik, Frese, Seeger, Hildebrandt[24]	1996	Lumbar range of motion: reliability and validity of the inclinometer technique in the clinical measurement of trunk flexibility.
Wiliams R, Binkey J, Bloch R, Goldsmith CH, Minuk T[26]	1993	Reliability of the modified Schober and double inclinometer methods for measuring flexion and extension.

Figure 1. Included articles.

Brief description of contents

General aspects: 46% of the articles have 5 or even more authors. 15% are publishings before 2000, 46% between 2000 and 2005, and 38% between 2006 and 2012.

Responding too bjective 1 of this review: 53% of the trials make possible responding to this objective; all authors agree in pointing out that pain and disability scales are valid for diagnosis and monitoring low back pain, and their use is recommended in the consulted scientific articles.

Cuesta Vargas[17] (2008) indicates that most used scales in scientific bibliography for evaluating low back pain are VAS, Roland Morris questionnaire and SF-36 to measure life quality. Rocchi[18] (2005) agrees and adds that questionnaires with most validity are Oswestry index, Roland Morris questionnaire and Quebec questionnaire.

Bijur[19] (2001) found good criteria of internal validity to measure pain from VAS. Fritz[20] (2011) points out that results of Oswestry index are better than those of Quebec questionnaire, and Hicks[21] (2009) states that both are valid to be used in elderly people.

Honglei[22] (2012) and Calmels[23] (2005) expose the validity of these questionnaires in their adaptions to other languages and cultures. Honglei[22] (2012) adds that Roland Morris questionnaire has good correlation with Oswestry index and VAS.

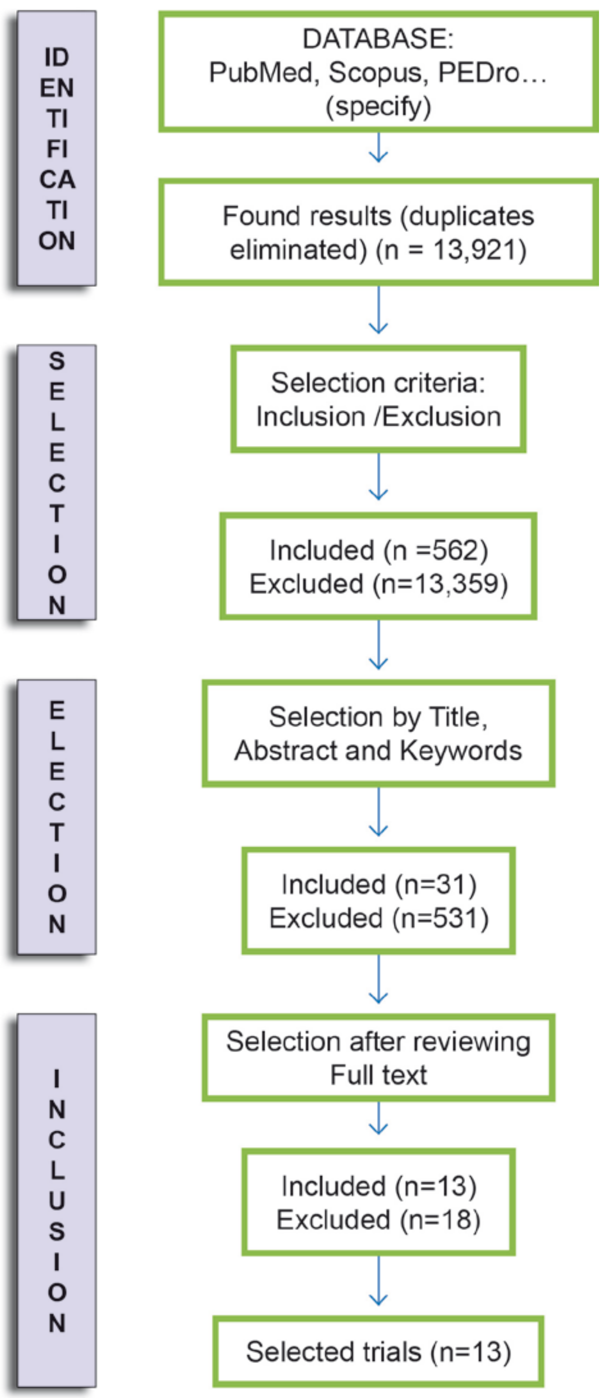

Figure 2. Flow chart of the articles selection, according to the PRISMA Declaration[30, 31] for reports of systematic review and meta-analysis in trials of health care.

Responding to objective 2 of this review: 23% of this trials allow responding to this objective; Saur[24] (1996) reveals a relation basically linear between the use of the double inclinometer and X-ray with an excellent correlation for total movement (r=0.97; P<0.001) and for the flexion movement (r=0.98, p<0.001) and less correlation for the extension movement (r=0.75; p=0.001). Perret[25] (2001) finds a good correlation between the trunk´s flexion in the FTF test (FTF) and X-ray (r=0.96; WHR=0.99). Williams[26] (1993) compares the modified Schober´s test and the inclinometer using internal validity criteria and finds a greater reproducibility in Schober´s test (flx 0.72, ext 0.76) than in the inclinometer (flx 0.60, ext 0.48).

Responding to objective 3 of this review: 23% of the trials allow responding to this objective; all authors Sullivan[27] (2000), Poitras[28] (2000) and Van Niewenhuyse[29] (2009) agree in pointing out that the range of motion has a poor correlation with the disability scales and therefore, conclude that the range of motion is not a valid criterion for diagnosing this pathology.

DISCUSSION

Lumbar pathology is one of the most common causes of medical consultation and work leave. Thus, it is important to have valid tools for its diagnosis and monitoring. The most common findings in the scientific bibliography are questionnaires and pain scales, to measure the range of motion and the imaging tests. In this trial, we carried out a review of the pain and disability scales and of the tests that measure the range of motion, due to its low economic cost, and the facility of using it during a consultation. Imaging and laboratory tests were excluded, since access to them is more difficult and economically more expensive.

The most mentioned scales in the consulted bibliography are VAS, Oswestry index and Roland Morris questionnaire[17, 18]. All these questionnaires are valid, reliable and of high reproducibility, validated in different countries and in different languages and cultures[22, 23]. These methods are used worldwide when performing scientific trials on lumbar pathology and their use is highly recommended[17-23]. The most frequently found tests for measuring the range of motion at the lumbar level in the consulted scientific bibliography are the FTF test; Schober´s modified test and the inclinometer test. FTF is a simple test, of high reproducibility and that needs few material resources[25]. Schober´s test has good reproducibility[26]. Inclinometer test has basically a linear correlation with the X-ray regarding the complete movements and trunk flexion, being less reliable for the extension movement[24, 26].

Authors	Ob-jec-tive	Con-trol	Pa-tients/ Group	Variables	Procedure	Conclusions
Bijur PE, Silver W, Gallagher PJ[19]	1	No	96	VAS	Cohorts. Repeated measurements of VAS for 2h	Relation between vertical and horizontal VAS r=0.99 Total r=0.97 (CI 0.96-0.98)
Camels, Bèthoux, Condemime Fayolle[23]	1	No	-	Scales and diagnostic processes	Bibliographic review	DPQ, RMQ, OSW, QUE showed validity, feasibility, linguistic adaptation and international use.
Cuesta Vargas AI, Rodriguez Moya A[17]	1	No	-	Assessment of the frequency rate of pain and disability scales in patients with low back pain	Bibliographic review	Most frequent methods for low back pain assessment were VAS, RMQ and SF-36
Fritz, Irrqanq[20]	1	No	67	OSW, QUE	Both scales were compared to the physical impairment index	Better levels of test-retest and reliability for OSW compared to QUE
Hicks, Manal[21]	1	No	107	OSW, QUE	Comparison with the psychometric properties	Reliability 0.92 OSW 0.94 QUE. Sensitivity p<0.0001 OSW; p<0.001 QUE Both questionnaires are valid for geriatric patients.
Honglei Yi., Xinran Ji, Xianzhao Wei, Ziqiang Chen, Xinhui Wang, Xiaodong Zhu, Wei Zhang, Jiayu Chen, Diqing Zhang, Ming Li[22]	1	No	187	RMQ, Chinese version	Comparison with the Chinese version of VAS and OSW	RMQ has high concordance with VAS and OSW and it is validated in intercultural adaption. WHR= 0.952-0.949 RMQ/VAS r= 0.685-0.666 RMQ/OSW r= 0.841-0.818, p<0.01
Rocchi, Sisti, Benedetti, Valentini, Bellagamba, Federici[18]	1	No	No	Self-assessment questionnaires of disability from low back pain	Bibliographic review	The most valid are OSW, RMQ and QUE, with high correlation between them. OSW WHR 0.94 RMQ WHR 0.93 QUE WHR 0.92
Perret, Poiraudeau, Fermanian, Colau, Benhamou, Revel[25]	2	No	114	FTF	Comparison with X-ray for reliability and validity	Good correlation between trunk flexion and X-ray (r=0.96) Very good intra-inter observer reliability (WHR=0.99)
Saur, Ensik, Frese, Seeger, Hildebrandt[24]	2	Yes	54	LRM, inclinometer	Comparison between the inclinometer and radiologic measurements	Correlation between inclinometer and X-ray results almost linear in total movement (r=0.97; p<0.001) and in flexion (r=0.98; p<0.001) Better correlation in extension (r=0.75; p<0.001)
Wiliams R, Binkey J, Bloch R, Goldsmith CH, Minuk T[26]	2	No	15	Schober´s modified test	Comparisons with inclinometer measuring. Searching for internal validity criteria	Schober´s test has a 0.72 in flexion and 0.76 in extension. Inclinometer 0.60 in flexion; 0.48 in extension
Poitras, Loisisel, Prince, Lemaire[28]	3	No	111	Range of motion in flexion and extension	Comparison with the kinematic results of OSW	No relation was found between the range of motion and disability tests.
Sullivan, Shoaf, Riddle[27]	3	No	34	Double inclinometer	Comparison of these results with RMQ	No relation was found between the measurement of range of motion and disability tests r=0.35; p>0.1
Van Nieuwenhuyse, Crombez, Burdorf, Verbeke, Masschelein, Moens, Mairiaux and the BelCoBack Study Group[29]	3	2 groups	692	Spinal aspects, range of motion test and questionnaires on low back disability	Cohorts study with annual measurement to find prognostic criteria for lumbar pathology	Disability tests represent an annual prognostic criterion. Spinal aspects and measurements of the range of motion are not related to the results of the disability scales; p>0.05
OSW Oswestry Index, RMQ Roland Morris Questionnaire, VSA Visual Analogue Scale, DPQ Dallas Pain Questionnaire, QUE Quebec Questionnaire						

Figure 3. Results of the review.

Consulted bibliography indicates us that the correlation between the range of motion and the disability questionnaires is very low, and for this reason it is not recommended to be used as diagnostic criteria for low back pain. It is not considered valid for this purpose[27-29].

Study limitations

This trial could have been limited by the fact of excluding articles published in languages different from English, Spanish or French. Equally, there might be biases in the articles selection and limitations for using only two databases.

It would be interesting to find valid diagnostic tests useful for the diagnosis and prognosis of this pathology. It is suggested to follow the research line over valid and reliable diagnostic tests for the diagnosis and monitoring of the lumbar pathology.

CONCLUSIONS

Pain and disability scales are valid, reliable and highly recommended tests in scientific bibliography for the diagnosis and monitoring of lumbar pathology[17-23]. They are translated and adapted to different languages and cultures[22,23]. These scales are also highly accepted to be used in scientific articles. Most used scales are Oswestry index, Roland Moris Questionnaire and VAS[17, 18].

Measurement tests for the range of motion are valid and reliable when detecting variations in the range of movement; they have high reproducibility and low economic cost. They have a good correlation with the imaging tests; therefore, they can be used to perform the mentioned measurement.

The most used ones are: modified Schober´s test[26], double inclinometer[24, 26] and FTF test[25].The range of motion is not a valid diagnostic criterion for lumbar pathology, since the relation between its results and the results of the disability scales is very poor[27-29].

CONFLICT OF INTEREST

Authors declare they had no conflicts of interest.

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TECHNICAL REPORT

Semidirect Techniques for FRS dysfunctions of C3

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Received: August 26th, 2012; accepted: September 10th, 2012

Keywords:
Neck pain;
Spinal manipulation;
Pain depth;
Cervical vertebrae.

ABSTRACT

Some of the recommendations based on the available scientific evidence establish that although there are many trials about the effectiveness of manipulation, there are few descriptions about cervical manipulation for dysfunctions in FRS, and their clinical considerations of being applied. The objective of our trial is to provide the basic generalities for the appropriate application of this therapeutic procedure.

INTRODUCTION

Cervical dysfunction in FRS (flexion, side-bending and homolateral rotation) of C3 corresponds to the second law of Fryette[1, 2], which describes the following: "When the spine is in a flexed or extended position (non-neutral), side-bending to one side will be accompanied by rotation to the same side". This cervical dysfunction of C3 can be primary (traumatic or physiologic) or secondary to a primary adaptation.

Adaptation can be reversible after correcting the primary injury. However, if this adaptation persists over time, it will become a compensation, which requires a specific treatment[3]. One of the most used techniques to treat this dysfunction in FRS is the semidirect thrust technique, since it allows eliminating the muscle spasm that fixes the dysfunction.

Cervical spine needs great mobility to be able to place the sensory organs in different ranges of motion.

The cervical osteopathic dysfunction is characterised by a restriction of motion in one or several physiologic parameters of that area. This dysfunction may be due to a sudden stretching (whiplash) or to a badly controlled movement.

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Osteoarticular mechanical factors and the occupational ones are the most important and common factors of cervicalgia, being able to point out the mechanical cervicalgia as the most frequent form of cervical pain and mobility restriction. This mobility restriction is caused by gamma hyperactivity in neuromuscular spindles that reject being stretched.

Due to this constant spasm in muscles around the neck area, such as the trapezium, sternocleidomastoid (SCM) and scalene among others, cervical pain can be accompanied by headaches, dizziness, nausea, vomiting, shoulder pain and even brachialgias, because of direct and external neuronal impairment, central and intraneural impairment, disc disease, etc.

As a result, there may be pain and sensory motor loss in the distribution of a spinal root.

Psychogenic states like depression and anxiety can cause around this area, among other symptoms, muscle fatigue, somatization and activation of trigger points. Those symptoms are common in patients with fibromyalgia, which is a frequent origin of chronic cervical pains.

Cervical pain can also be caused by alterations in adjacent organs or in vascular structures of the neck. Esophageal pathology, tracheal, carcinomas, polyps, infections, etc. can cause alterations in this area. Nowadays, there is a great variety of applicable treatments for mechanical cervicalgias. Recent studies have proven the effects of different therapeutic interventions for the treatment of cervicalgia such as exercise[4], manipulation and mobility[5], acupuncture[6], patient education[7] and pharmacologic treatment[8], concluding there is little evidence in the recommendation or contraindication of the mentioned treatments.

OBJECTIVES

With this technique, we eliminate the spasm that fixes the anteriority of the C3 facet joint, the elongation of intra and periarticular elements (joint capsule and intertransversal ligament),as well as of the nervous structures (Luschka´s sinuvertebral nerve) caused by the slippage of nucleus pulposus and maintained by the flexor muscles like intertransverse and spinous transverse that maintains desimbrication and the mentioned anteriority. This way, we can restore joint mobility.

IMPLEMENTATION PRINCIPLES

For a FRS dysfunction of C3, we find a restriction of vertebral movement in rotation to the opposite side of the injury, influenced by the profound muscles of the same side as the vertebral rotation. This pathologic situation creates a capsular tensional unbalance in the posterior interapophyseal joints that stimulate the appearance of local and distant symptoms, including pain and functional limitations.

Semidirect technique applied at C3 level for FRS dysfunctions must be applied to patients, after a careful diagnostic examination to determine the indications for the procedure in absence of risks and contraindications.

The osteopath must exclude the coexistence of other local or distant alterations that include risks during the application of the technique.

Patients whom receive this therapeutic procedure must remain calm and relaxed, so that the osteopath can apply the appropriate parameters in a safe way and without pain.

DIAGNOSTIC ASSESSMENT

Before applying this technique, several differential diagnostic tests must be carried out by the osteopath, such as vascular, imaging, neurological and orthopaedic tests:

- Klein´s test[9]: This test can be performed with the patient in sitting or supine position, with his/her head protruding on the edge of the table. The osteopath holds the patient´s head in his hands and must extend, bend and rotate it, maintaining the positions at the same time, from one side to another during 30 seconds, checking there are no symptoms such as nystagmus, dizziness, altered vision and hearing, altered perception of smells and tastes or unintelligible speech (See figure 1).

This test is used to cause neurologic and vascular symptoms. If these symptoms are awaken, then the test´s result is positive and manual treatment with thrust will be contraindicated.

- **Jackson´s test**[10]:We will use this test to exclude the cervical disc pathology. This test is considered specific for radiculalgia issues in the upper limb, and it can be explained with biomechanics of the nerve root compression[11] (See figure 2). To perform this test, patient will be sitting on the treatment table with his/her arms arranged along the body and forearms over the thighs in a relaxed position, with the feet on the ground. The osteopath will be standing behind the patient, supporting his/her thorax, in order to stabilise it and will take contact with his hands interlocked over the apex of the patient´s skull. The segment of the forearms is stabilised laterally, with the elbows sustained over the anterosuperior side of the patient´s shoulders, applying a pressure higher than 10Kg, with both hands in cranial-caudal direction.If there is presence of radicular pain towards the upper limb, it is a sign of positive test result and the existence of a disc compromise. If there is lack of pain, compression will be applied with the head bended to one side and the other. If there is homolateral pain in bending, it evidences a slipped disc, disc osteophyte or disc prolapse. If there is heterolateral pain in bending, it evidences root stretching or disc protrusion.

- **Quickscanning**[12]: This test is performed to confirm the existence of mobility restriction at C3; the patient will be in sitting position. The practitioner will be on one side of the patient, taking the patient´s forehead with the anterior hand, in order to support him, and with the posterior one grabs the spinous apophysis of C3 between his thumb and index, applying a posteroanterior movement. If there is restriction, it means that in that segment there is a limited joint mobility.

- **Lateral gliding test**[13, 14]:This osteopathic test is used to diagnose the dysfunctions of the C3 facet joint, and it was described by Greenman[13]; its validity for the osteopathic diagnosis of dysfunctions in the low cervical segment (C3-C7) is as good as any other radiologic tests. [14]

The patient will be in supine position and the practitioner will be at the head of the table. Practitioner´s index and middle fingers of each hand will approach the articular apophysis of the superior vertebra (C3), of the segment that will be examined. Thenar eminences and practitioner´s hand palms control the head and the superior cervical spine of the patient.

To determine if the dysfunction is in flexion, rotation or homolateral bending (FRS), the examiner extends the patient´s head until the explored segment, which is in this case C3. This segment is side shifted from right to left, examining the presence of articular resistance. If there is presence of resistance, it means that the mobility restriction is towards the extension, right bending and right rotation (left FRS). When facing this restriction, the right facet joint cannot be closed properly, and it remains in decompression or in a desimbrication state. To finish the test, a side shift from left to right is also performed afterwards. If in this case certain resistance is perceived, mobility restriction is given towards extension, left bending and left rotation (right FRS). In this case, the facet joint of the left side totally rejects to close and remains desimbricated.

Figure 1. Klein´s test

Figure 2. Jackson´s test

Figure 3. Semidirect Technique for FRS of C3

INDICATIONS / BENEFITS

Cervicalgias, cervicobraquial neuralgias, headaches, cervical disc protrusions; dizziness; cervical muscle spasms and diaphragmatic alterations, due to the innervation that this muscle receives from the level C3-C4.

CONTRAINDICATIONS /RISKS

This technique is not recommended in the following cases[15, 16]: traumatism, sequels of non-consolidated fractures, sprains of acute phase of third degree, vertebrobasilar insuffiency and cerebral vascular alterations, neurologic alterations, significant osteoporosis, osteophytosis, congenital malformations, basilar impression, Arnold-Chiari, syringomyelia, patient´s rejection to manipulation, tumours, infections and severe rheumatic alterations, congenital osteomalacia, iatrogenic dysplasia (long-term corticoids), rheumatoid arthritis, periarticular ossification, cervical myelopathy, medullar compression, nervous compression (neurological deficit).

TECHNIQUE DESCRIPTION

This technique[17] consists of applying a lever in homolateral lateroflexion-rotation, and then perform the thrust in lateroflexion to imbricate the C3 facet over C4. We will describe this impulse technique for a right FRS dysfunction.

Practitioner´s position: The osteopath will be standing in front of the patient´s head, with his right leg behind. His right hand will approach the radial-palm side of the interphalangeal joint of the index over the upper edge of the transverse apophysis of C3 vertebra, previously applying a tissue pull from top to bottom; thumb must be resting over the patient´s cheek and the free fingers must adapt to the area of the occiput. Osteopath´s forearm will be oriented towards the left hip of the patient. His left hand will control the patient´s head, with the osteopath´s palm over the patient´s ear, in such manner that the sternocleidomastoid´s centre is between the practitioner´s fingers (in the third interdigital area).

Patient´s position: He/she will be lying in supine position. The osteopath will regulate mobility in cervical flexion-extension, until the movement reaches the C3 vertebral level. Then, we apply a slight cervical rotation to the left (45º), and we also perform a slippage movement from the right side to the left side of the vertebra, apart from a slight right cervical lateroflexion, until the movement reaches at the C3 level. The practitioner must approach his elbows to the trunk now, in order to stabilise his position and transmit safety and confidence to the patient, without losing any of the acquired parameters, since in a different case, the tension acquired in tissues would decrease. Thrust is applied by contracting the right pectoral towards the patient´s left hip (figure 3), through an impulse of low-amplitude and high-velocity. If dysfunction occurred on the opposite side, meaning a left FRS, parameters would be inverted and the same technique would be applied towards the opposite side of the one described here previously.

PRECAUTIONS

Before applying the technique of cervical manipulation, the osteopath must make sure that the diagnosis assessment tests suggest applying this precise procedure, especially a negative result from Klein´s test and the imaging tests, and in lack of any morphologic alterations or coexistent pathologies that could contraindicate this therapeutic procedure of manipulating.

Moreover, the necessary movements in order to get the appropriate cervical tension that will obtain an effective manipulation force the osteopath to maintain a stable body position, avoiding painful movements for the patient. The final impulse to apply a thrust must be done in a controlled way[21] with a limited range of motion and high thrust velocity.

CONCLUSIONS

Semidirect technique at C3 for FRS dysfunctions should be applied in recommended situations, after carrying out first an appropriate diagnostic examination in order to avoid the known associated risks, and always when there are no contraindications.

The osteopath may include this procedure between all his available therapeutic resources for the benefit of his patients.

ACKNOWLEDGEMENTS

We would like to thank all those people who made the development of this technical report possible.

CONFLICTS OF INTEREST

Authors declare there were no conflicts of interest associated with this research.

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