

## Surface electromyography in manual therapy - categorization of purpose and quality of reporting: a systematic review protocol

Rui José Santiago <sup>a</sup>, J. Santos Baptista <sup>b</sup>, J. Torres Costa <sup>c</sup>

<sup>a</sup> PROA, Faculty of Engineering, University of Porto, Porto, PT (rui.santiago@gmail.com) ORCID: 0000-0002-8227-5707,

<sup>b</sup> LAETA, Faculty of Engineering, University of Porto, PT (jsbap@fe.up.pt) ORCID: 0000-0002-8524-5503, <sup>c</sup> PROA, Faculty of Engineering, University of Porto, Porto, PT (zecatoco@sapo.pt)

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### Abstract

**Introduction:** Manual therapy (MT) is widely used by several healthcare professions to treat musculoskeletal disorders (MSD's), still, there is little evidence to support its choice as a therapeutic approach to these kinds of problems. Researchers have been using surface electromyography (sEMG) to understand the effects and efficiency of MT. This study aims to present a protocol to evaluate the current literature using sEMG to assess muscle parameters within the scope of the use of MT. **Methods and Analysis:** The search will be performed in 26 electronic databases and journals using the PRISMA Statement. Selection of the studies, data extraction and validation will be performed independently by two reviewers. These studies shall be categorized towards their aims to capture what the authors have interest in. The overall quality will be assessed using Jadad Scale, and the quality of the reporting of EMG data will be assessed using the ISEK standards. This review is oriented towards identifying failure to report of methods in the studies selected, which directly affect their reproducibility. **Dissemination:** Outcomes of this review will be published in a peer-review journal. It may encourage future authors in this area of study to avoid failing to report all the relevant data in their studies.

## 1. INTRODUCTION

### 1.1. Background

Among the most common musculoskeletal disorders (MSD's), low back pain (LBP) is considered a global health issue affecting approximately 80% of the world population at some stage of their lives (Simson et al., 2017). Also neck pain is an important individual, social and economic health problem, affecting up to two-thirds of adults at some point of their lives (Groeneweg et al., 2017; Gudavalli et al., 2014). Manual treatment has showed favourable clinical effects (Cruz-Montecinos et al., 2016, Herzog et al., 1999, Pecos-Martina et al., 2017, Ribeiro et al., 2017) mainly for MSD's (Hu et al., 2014, Kamel et al., 2016). Particularly for LBP, Manual Therapy (MT) modalities as physical treatment and spinal manipulation are likely to be cost-effective options (Andronis et al., 2017; Licciardone, 2014). Evidence suggest that MT as mobilization, manipulation, and clinical massage are effective interventions for the management of neck pain

and reductions in intensity and frequency of chronic cervicogenic dizziness (Wong et al., 2016; Reid et al., 2014), still, according to Young et al. (2009), adding cervical traction to MT brings no significant additional benefit to pain, function or disability with patients with cervical radiculopathy. Armijo-Olivo et al. (2016) described some of the intentions of MT application to restore normal range-of-motion (ROM), reduce local ischemia, stimulate proprioception, break fibrous adhesions, stimulate synovial fluid production and reduce pain. It has been increasingly used by clinicians and researchers due to the positive outcomes in some conditions, particularly LBP and neck pain. MT was found to be effective in several other conditions. For carpal tunnel syndrome (CTS), it was effective for improving self-reported function, symptoms severity and pinch-grip force in women (Fernández-de-las-Peñas., 2017). Headache management is another area where MT can make a difference helping safe, effective and coordinated care (Moore et al., 2017). However, although several systematic reviews have been conducted to understand the effect of MT in temporomandibular disorders (TMD) and its positive effects have been highlighted, the quality of these studies is now considered low and more and better trials are needed (Armijo-Olivo et al., 2016). A scoping review aiming to understand the risks of manual treatment to the spine, found that benign adverse events following manual treatments were common while serious adverse effects are rare (Swait & Finch., 2017). Although there is some evidence of MT effectiveness, the evidence-informed primary care management of LBP states that there is some evidence to recommend MT as massage therapy and spinal manipulation for prevention and care of LBP (TOP., 2017). In terms of the clinical guidelines, the evaluation and management of LBP includes MT in the recommended modalities for spinal stenosis (Chou and Huffman., 2009). Although more research is needed, primary healthcare providers should be mindful of the use of this highly popular approach to musculoskeletal conditions when deciding the best course of action (Moore et al., 2017). Several authors chose surface electromyography (sEMG) as their elected technique to collect and interpret data from a MT intervention. sEMG is a non-invasive technique to measure the degree of myoelectric activity (Ko, 2015, Herzog, 1999), in use since 1960 for clinical research (Al-Mulla., 2011). sEMG can measure motor unit properties (as muscle fibre conduction velocity or location of innervation zones) which are more difficult to assess using the common invasive indwelling electromyography. Its use can also detect more motor units with respect to selective intramuscular recordings. When compared to other techniques, sEMG stands out as the most efficient in detecting and predicting muscle fatigue (Al-Mulla., 2011). sEMG seems to be an adequate technique to study the effects of MT. To date, no systematic review has been conducted on the use of instrumentation through sEMG to measure muscle contraction properties in MT interventions and thus seek evidence of possible effects of this therapy.

## 1.2. Review question/objective

The objectives of this review are to capture the intentions of the use of surface electromyography in MT and evaluate the quality of reporting and risk of bias of the included studies. More specifically:

- 1 – Identification of the objectives of these studies and present a qualitative categorization and comparison.
- 2 – Assessment and quantification of the Risk of Bias present across the included studies.
- 3 – Evaluation of the sEMG data reporting profile of all studies.
- 4 – Detection of which areas can be improved in future studies in terms of reporting sEMG and reporting an accurate description of the methods.

## 2. METHODS

### 2.1 Study registration

This protocol has been prepared using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols - PRISMA-P (Shamseer et al., 2015) and registered on PROSPERO database (Ref: CRD42018087499).

### 2.2 Eligibility criteria

#### *Studies characteristics/ participants*

All studies where surface electromyography was used to measure the alteration of electrical activity of muscles after MT intervention in adults will be included.

#### *Types of intervention(s)/phenomena of interest*

Any intervention that includes MT or the application of manual technique with a clinical purpose. Also accepted if used along other clinical techniques.

#### *Report characteristics*

The inclusion criteria for this review are:

- The study must include the application of MT.
- Must present objective measures with surface electromyography.
- Articles from 2014 was considered adequate as older, relevant articles would be referenced in the newer studies and will therefore be included after a reference and authors search.
- Participants: Adult Humans.
- Study must be approved by an Ethics Committee.
- Articles in English only.

### 2.3 Information sources

The following databases will be searched: SCOPUS, ScienceDirect, WebOfScience, PUBMED, Physiotherapy Evidence Database (PEDro), American Heart Association (AHA) Journals, Biomed CENTRAL, Directory of Open Access Journals (DOAJ), MEDLINE OVID, Sage Journals, Informaworld - Taylor and Francis, Springer Link, American Doctoral Dissertations, Library, Information Science & Technology Abstracts, Psyarticles, Wiley online library, IOPscience, Emerald insight, (American Institute of Physics) AIP Publishing and American Society of Civil Engineers (ASCE) Library. Search will also be conducted in 2 integrated search engines: B-ON and Academic Search Complete (ASC) and 4 scientific journals: Journal of the American Medical Association (JAMA), Proceedings of the National Academy of Sciences of the United States of America (PNAS), Journal of Electromyography and Kinesiology and Musculoskeletal Science and Practice. The reference list of papers will also be screened for older and relevant studies to be added to the included list of articles.

## 2.4 Search strategy

The terms to be used in the search strategy are:

"(((high AND density AND surface AND electromyography) OR (multichannel AND surface AND electromyography) OR (surface AND electromyography)) AND ((manual AND therap\*) OR (manual AND treatment) OR physiotherap\* OR osteopath\* OR chiro\* OR (occupational AND therap\*) OR orthop\* OR massag\*)) AND NOT (systematic AND review))"

This query will have to be adapted to the different database search engine specifications, listed in Appendix I.

## 2.5 Study records

### *Data management*

After retrieving search results, the records will be exported from the databases (when possible, the alternative is manually entering the data), entered and duplicated into EndNote X8 (Clarivate Analytics). Other literature, as from the references of the found citations will be manually entered. A DROPBOX shared folder will be created to allow reviewers access to the included studies. Summaries of all searches will be stored in the shared folder.

### *Selection process*

Two reviewers (RJS and JSB) will independently search the databases and journals and screen the titles and abstracts for eligibility and extract data using a standard data extraction form. This form was developed in a spreadsheet, by database, to organize the inclusion of articles. The reviewers will also manually search the references for articles to include. Full texts of the studies that meet the inclusion criteria will be obtained and screened by the same two reviewers. Another reviewer (JTC) will resolve disagreements of study selection. When reported data are insufficient or unclear, a researcher will contact the first author or author of the research reports by email or telephone to request missing or clarifying data. The selection of studies will be documented and summarised in Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram (Moher et al., 2009).

### *Data collection process*

Using a specifically designed Excel (Microsoft) spreadsheet containing tables to fill in with the relevant study and participant characteristics, intervention details and sEMG data for each included study. Data will be extracted by one reviewer and verified by another.

## 2.6 Data items

The variables or which data will be sought are divided in two areas, first a descriptive of the study, participant and intervention and a second on the sEMG data.

The descriptive data variables are: Number of Participants, Mean Age, Sex, BMI (kg/m<sup>2</sup>), Country, Recruitment Method, Assessment by Health Professional, Specific Physical Tests, Study Design, Other Measuring Methods, Symptoms, MT Used Techniques Used, Other Therapies along MT, Duration of MT Intervention, who applied the MT, Area of the body treated.

The sEMG data variables are: Surface Electrodes (material, shape, size, skin preparation, int. electrode distance, location), EMG detection (type of differential, input impedance, CMRR, SNR gain, Filter types, cut-off frequencies, slopes of the cut-off), Sampling (frequency, bits), Normalization (training of contraction, joint angle, conditions [angle of adjoining joint], rate of rise, velocity, ranges, load), Rectification and Amplitude process.

#### *Outcomes and prioritization*

Although all included studies must have sEMG readings as the outcome, the individual studies outcomes are outside of the scope of this review. The outcome of interest is the objective of the study for a categorization of these across all studies included. Another outcome is the defined data variables failure to report, a percentage of the incidence of non-reporting will be presented for most variables.

#### *Risk of bias in individual studies*

Quantitative papers selected for retrieval will be assessed by two independent reviewers (RJS and JSB) for methodological validity prior to inclusion. Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer (JTC). The risk of Bias for the included studies, at study level, will be assessed using the Jadad scale (Jadad et al., 1996) (Appendix II).

#### *Data synthesis*

Studies are anticipated to have high heterogeneity due to clinical and methodological diversity, therefore, no meta-analysis were planned, and a descriptive analysis of the data items will be presented. After extraction, the retrieved data will be summarized in a narrative synthesis and illustrated descriptively.

#### *Confidence in cumulative evidence*

The quality of evidence will not be assessed in this review as its main purpose is not a clinical recommendation.

### **3. DISCUSSION**

This protocol for a systematic review will provide a detailed summary of the current state of the use of Surface Electromyography in MT evaluation. Shall present a categorization of the objectives behind the studies, a description of the reporting profile for each study and specifically for the sEMG data and a risk of bias evaluation. This review should be useful to future authors in this area as to prevent failure to report information that ensures reproducibility of the study.

#### **Contribution of Authors**

"Authors` contribution: Development of study design and conduct: RJS, JSB. Coordination of study conduct: RJS, JTC. Title-/ abstract screening: JSB, JTC. Full text screening: RJS, JSB, JTC. Data extraction: RJS, JSB. Critical appraisal: RJS, JSB, JTC. Data analysis and interpretation: RJS, JSB. Support in data analysis and interpretation: RJS, JSB. Draft of the manuscript: RJS. Support in draft of the manuscript: RJS, JSB, JTC. All authors read and approved the final manuscript.

## Conflicts of interest

No competing interests.

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## Appendix I: Search Strategy

### SCOPUS

( TITLE-ABS-KEY ( ( surface AND electromyography ) AND ( ( manual AND therapy\* ) OR ( manual AND treatment ) OR ( occupational AND therap\* ) OR physiotherap\* OR osteopath\* OR chiro\* OR orthop\* OR massag\* ) AND NOT ( systematic AND review ) ) ) OR massag\* ) ) AND NOT ( systematic AND review ) )

### ScienceDirect

(TITLE-ABS-KEY ( ( ( surface AND electromyography ) ) AND ( ( manual AND therap\* ) OR (occupational AND therap\*) OR physiotherap\* OR osteopath\* OR chiro\* OR orthop\* OR massag\*) AND NOT (systematic AND review) )

### WebOfScience

(((( surface AND electromyography ) AND ( ( manual AND therap\* ) OR (occupational AND therap\*) OR physiotherap\* OR osteopath\* OR chiro\* OR orthop\* OR massag\* )) NOT (systematic AND review)))

### PUBMED

1. ("surface electromyography"[All Fields]) AND ("manual therapist"[All Fields] OR ("occupational"[All Fields] AND "therapist"[All Fields]) OR "physiotherapist"[All Fields] OR "osteopathic"[All Fields] OR "chiropractor"[All Fields] OR "orthopaedics"[All Fields] OR "massagist"[All Fields]) NOT "systematic review"[All Fields]
2. ("surface electromyography"[All Fields]) AND ("manual therapy"[All Fields] OR ("occupational"[All Fields] AND "therapy"[All Fields]) OR "physiotherapy"[All Fields] OR "osteopathy"[All Fields] OR "chiropractic"[All Fields] OR "orthopedics"[All Fields] OR "massage"[All Fields]) NOT "systematic review"[All Fields]

### PEDRO

surface AND electromyography and therapy

### AHA Journals

"surface electromyography"

### JAMA

surface electromyography

### Biomed CENTRAL

( surface AND electromyography ) AND ( manual AND therapy ) NOT (systematic AND review)

### DOAJ

( surface AND electromyography ) AND ( manual AND therap\* )



### **Informaworld**

[All: surface] AND [All: electromyography] AND [[[All: manual] AND [All: therap\*]] OR [[All: occupational] AND [All: therap\*]] OR [All: physiotherap\*] OR [All: osteopath\*] OR [All: chiro\*] OR [All: orthop\*] OR [All: massag\*]] AND NOT [[All: systematic] AND [All: review]]

### **Academic search complete**

(surface AND electromyography ) AND ( manual AND therapy ) NOT (systematic AND review)

### **MEDLINE OVID**

((surface and electromyography and (manual and therapy)) not (systematic and review))

### **B-ON**

AB ( surface and electromyography ) AND AB ( manual and therapy ) NOT AB ( systematic and review )

### **Sage Journals**

[All surface and electromyography] AND [All manual and therapy] AND NOT [All systematic and review]

### **Oxford Academic**

Full text: (surface AND electromyography) Full text: (manual and therapy )

### **PNAS**

surface electromyography THERAPY

### **Emeral Insight**

[Anywhere: surface electromyography] AND [Anywhere: manual therapy]

### **Springer Link**

(surface AND electromyography) AND ( manual AND therap\* ) NOT (systematic review)

### **Americal Doctoral Dissertations**

(surface AND electromyography) AND ( manual AND therap\* ) AND NOT (systematic review)

### **Library, Information Science & Technology Abstracts**

(surface AND electromyography) AND ( manual AND therap\* ) AND NOT (systematic review)

### **Psyarticles**

(surface AND electromyography) AND ( manual AND therap\* ) AND NOT (systematic review)

### **Wiley online library**

surface electromyography in All Fields AND manual therapy in All Fields NOT systematic review in All Fields

## **IOP science**

(surface electromyography) AND (( manual therapy) OR (occupational therapy) OR physiotherapy OR osteopathy OR massage OR Orthopedic OR chiropractic)

## **ASCE Library**

surface electromyography AND manual therapy

## **AIP Publishing**

surface electromyography AND manual therapy

## **Journal of Electromyography and Kinesiology**

surface electromyography in All Content AND Manual therapy in All Content NOT systematic review in All Content

## **Musculoskeletal Science and Practice**

surface electromyography in All Content AND Manual therapy in All Content NOT systematic review in All Content

## **Appendix II: Appraisal instruments** **Javad Scale for Risk of Bias**

Instrument to Measure the Likelihood of Bias in Pain Research Reports

This is not the same as being asked to review a paper. It should not take more than 10 minutes to score a report and there are no right or wrong answers.

Please read the article and try to answer the following questions (see attached instructions):

1. Was the study described as randomized (this includes the use of words such as randomly, random, and randomization)?
2. Was the study described as double blind?
3. Was there a description of withdrawals and dropouts?

Scoring the items:

Either give a score of 1 point for each "yes" or 0 points for each "no." There are no in-between marks.

### **Give 1 additional point if:**

For question 1, the method to generate the sequence of randomization was described **and** it was **appropriate** (table of

### **and/or:**

If for question 2 the method of double blinding was described, **and** it was **appropriate** (identical placebo. active placebo, dummy, etc.)

**Deduct 1 point if:**

For question 1, the method to generate the sequence of randomization was described **and** it was **Inappropriate** (patients were allocated alternately, or according to date of birth, hospital number, etc.)

**and /or:**

For question 2, the study was described as double blind but the method of blinding was **inappropriate** (e.g., comparison of tablet vs. injection with no double dummy)

## Guidelines for Assessment

### 1. Randomization

A method to generate the sequence of randomization will be regarded as appropriate if it allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which treatment was next. Methods of allocation using date of birth, date of admission, hospital numbers, or alternation should be not regarded as appropriate.

### 2. Double blinding

A study must be regarded as double blind if the word "double blind" is used. The method will be regarded as appropriate if it is stated that neither the person doing the assessments, nor the study participant could identify the intervention being assessed, or if in the absence of such a statement the use of active placebos, identical placebos, or dummies is mentioned.

### 3. Withdrawals and dropouts

Participants who were included in the study but did not complete the observation period or who were not included in the analysis must be described. The number and the reasons for withdrawal in each group must be stated. If there were no withdrawals, it should be stated in the article. If there is no statement on withdrawals, this item must be given no points.