Changes in sternocleidomastoid and descending portion of trapezius muscles in terms of electromyography and pressure pain threshold: women with chronic neck pain after acupuncture treatment

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OBJECTIVE: To evaluate the sternocleidomastoid and the descending portion of the trapezius muscles in terms of electromyographic activity and pressure pain threshold in women with chronic neck pain after acupuncture treatment.

METHODS: Twenty-five women, aged 18-50 years ([31±3] years), with chronic neck and temporomandibular disorder participated in the study. The electromyographic activity of the sternocleidomastoid muscle and the descending portion of the trapezius muscle were recorded at rest, during shoulder elevation, (left and right) rotation of the neck and crucifix position. Maximum voluntary contraction was used to normalize the electromyographic activity data. The points used for acupuncture were Jiache (ST 6), Xiaguan (ST 7), Quanliao (SI 18), Tinggong (SI 19), Yifeng (TE-17), Fengchi (GB 20), Renzhong (GV 26), Yangbai (GB-14), and points of the lower and upper limbs: Tai chong (LV 3), Zusanli (ST 36), Sanyinjiao (SP 6), Kunlun (BL 60), He Gu (LI 4) and Yanglingquan (GB 34). The treatment course was 10 sessions, 30 min long per session, and twice a week. The final electromyographic activity and pressure pain threshold data collection were performed 15 d after treatment completion.

RESULTS: The normalized electromyographic activity and pressure pain threshold data were tabulated and submitted to statistical analysis using t-test (P < 0.05). Significant difference was observed during shoulder elevation for the left trapezius muscle, during neck rotation from the right side to the left, and pressure pain threshold for the trapezius and sternocleidomastoid muscles, bilaterally, after the acupuncture treatment.

CONCLUSION: The acupuncture treatment improved the neck muscles in terms of electromyographic activity and increased the tolerance to chronic pain in women.

Keywords: Acupuncture; Chronic pain; Neck muscles; Electromyography; Pain threshold

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INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage, with the purpose of protecting the body.1 Some common types of pain include: nociceptive, which originates in the nociceptors, depending on their responses to mechanical, thermal, and/or chemical stimulation released by the injuries or the diseases in the central nervous system and by those with psychosomatic emotional origin.2

Chronic pain is considered destructive since it impairs quality of life and is exceedingly costly to the subject and society. It is also a worldwide public health concern.3 Chronic pain affects millions of Brazilians and compromises the activities of daily living of half of the subjects.4 In the United States, 76.5 million subjects develop chronic pain. Women consistently report a higher prevalence of chronic pain (34.3%) compared to men (26.7%), and is evolving over the years.5

The association between the cervical spine and craniofacial area lead to motor adaptations in cervical and masticatory muscles.6 The craniocervical mandibular disorders, with multifactorial etiology, compromise the quality of life of a large portion of the population and often affect the normal function of the muscles, leading to gradual changes in control and coordination of movement and loss of muscular strength.7

For at least 2500 years, acupuncture has been an integral part of Traditional Chinese Medicine. It is considered an effective therapeutic technique for alleviating the signs and symptoms of the craniocervical mandibular disorders.8 Moreover, it improves functional capacity and quality of life in people with chronic pain.9

Therefore, the purpose of this study was to evaluate, in terms of electromyographic activity and pain threshold, the effect of acupuncture treatment on the neck muscles in women with chronic neck pain, and to observe the functional response of the cervical muscle system.

MATERIALS AND METHODS

Sample

This study was approved by the Research Ethics Committee (protocol # 37033914.4.0000.5419) of the Ribeirão Preto School of Dentistry, University of São Paulo, Ribeirão Preto, Brazil. All subjects were informed about the experiment and agreed to participate by providing their free and informed consent according to resolution 466/12 of the Health National Council. The research followed evidence-based principles, multi-center and randomized controlled design. Ethical guidelines were strictly conducted in accordance with the Declaration of Helsinki and with local regulations.

The final sample determination of at least 25 subjects and the analysis of quantitative data were based on the calculation of the sample mean, 95% confidence level, standard error of 20% and a standard deviation of approximately 50%.10 The population size of this research was determined by the annual average attendance of 140 subjects diagnosed with chronic pain and temporomandibular disorder in the city of Ribeirão Preto, São Paulo, Brazil that were treated through the program Desmistificando Atendimento de Pacientes Especiais (DAPE) (Demystifying Treatment for Special Need Patients) of the Ribeirão Preto School of Dentistry, University of São Paulo.

Twenty-five women, between the ages of 18-50 years (31 ± 3 years) with temporomandibular disorder (RDC/TMD)11 and chronic pain in the right and left sternocleidomastoid muscles and in the descending portion of the right and left trapezius muscles were submitted to electromyographic activity and to pressure pain threshold in the clinical conditions of rest, shoulder elevation, (left and right) rotation of the neck and crucifix position, before and after acupuncture treatment.

The following items were used as exclusion criteria: use of mio-relaxing spline; no prior experience with acupuncture treatment; history of head and neck tumors; trauma, or surgery on the skull; cervical-chronic degenerative diseases; presence of neurological and psychiatric disorders; and use of any controlled drugs that could interfere with the myoelectric activity (tranquilizers, antidepressants, anticonvulsants). The anamnesis provided data regarding the subjects’ medical and dental history and any existing signs or symptoms of temporomandibular dysfunction.

Surface electromyography

The evaluation of the electromyographic activity changes of the right and left sternocleidomastoid muscles and the descending portion of the right and left trapezius muscles was performed by a single professional using the portable Myosystem Br-1 apparatus (DataHom- mis, Uberlandia, Minas Gerais, Brazil), coupled to a computer, including 8 channels for electromyographic activity and 4 auxiliary channels. Electromyography was conducted using surface active differential electrodes (two 10 mm-long × 2 mm-wide silver chloride bars 10 mm apart) with input impedance of 10^6 Ω/6 pf, bias current input of ± 2 nA, common-mode rejection ratio of 110 dB at 60 Hz and gain equal to 20x. The electromyographic activity signal was further amplified by 50 x (total gain 1000 x), bandpass filtered (20 Hz-1 kHz) and sampled at a frequency of 2 kHz with 16 bits resolution. A stainless-steel circular electrode (3 cm in diameter, 1.5 cm thick and 2m long) was fixed to the skin in the wrist region and used as a reference electrode (ground electrode) to minimize the risk of interference.12

The following postural conditions were analyzed: rest (4 s), maximum voluntary contraction (4 s), shoulder...
myographic activity showed higher values for the right •ture (Table 1). The analysis of mean normalized electromyographic rotation to the right side and for the left trapezius muscles.30

**Pressure algometry**

For the algometry pressure test, was used before and after acupuncture treatment a digital dynamometer (Kratos, model IDDK, Cotia, São Paulo, Brazil), with a 196.13N capacity, calibrated by the manufacturer. The algometer is a threshold and pain tolerance gauge, with a 12 mm stainless steel plunger applied perpendicularly to the surface of the neck muscles.31 The stimulation surface of the device was cleaned with alcohol. For the pressure pain threshold measurements, subjects sat in a dental chair. The investigator placed the algometer on the muscles following the sequence, right trapezius, right sternocleidomastoid, left trapezius and left sternocleidomastoid muscles and pressed against the tester in a vertical direction while increasing the force. The values were defined as soon as the pain was felt by subjects.

**Acupuncture technique**

Acupuncture therapy was performed by the same specialist in ancient Chinese technique, in 10 sessions, 30 min each session, twice a week.32 The needles were inserted into the skin in the points localized in the face region and in the upper and lower limb region. Prior to needle insertion, 70% alcohol was used for local asepsis. The Dong Bang Acupuncture Needles-0.25 mm × 30 mm (Dong Bang Acupuncture Inc., Chungcheongnam-do, South Korea) were inserted at tissue level33 in points of the face: Jiache (ST 6), Xiaguans (ST 7), Quan liao (SI 18), Tinggong (SI 19), Yifeng (TE-17), Fengchi (GB 20), Renzhong (GV 26), Yangbai (GB 14), and points of the lower and upper limbs: Tai chong (LV 3), Zusanli (ST 36), Sanyinjiao (SP 6), Kunlun (BL 60), He Gu (LI 4) and Yanglingquan (GB 34).16,17

**Statistical analysis**

The electromyographic activity data were normalized by maximal voluntary clenching (4 s). Data were tabulated and submitted to statistical analysis using the Statistical Package for the Social Sciences Version 21.0 for Windows, IBM Inc.; Chicago, IL, USA. Descriptive analysis was carried out (means, standard errors of means) for each variable. The values obtained were compared by t-test (P < 0.05), with a 95% confidence interval.

**RESULTS**

There were statistically significant differences (P < 0.05) for the left sternocleidomastoid muscle in neck rotation to the right side and for the left trapezius muscle in shoulder elevation after treatment with acupuncture (Table 1). The analysis of mean normalized electromyographic activity showed higher values for the right and left sternocleidomastoid muscles and lower values for the right and left trapezius muscles after treatment with acupuncture, at rest, during shoulder elevation and crucifix position. In neck rotation (right side), the values were higher for the right sternocleidomastoid, left sternocleidomastoid, left trapezius muscles and lower values for the right trapezius muscle after acupuncture. In neck rotation to the left, lower values were observed in normalized electromyographic activity mean for all analyzed muscles.

Table 2 shows the analysis of the pressure pain threshold values after acupuncture treatment of the sternocleidomastoid (right and left), right and left trapezius muscles. There were statistically significant differences (P < 0.05) and higher values for all analyzed muscles after acupuncture.

**DISCUSSION**

In the present study, the acupuncture points were applied to the region of the face and the upper and lower limbs, based on the premise that health is governed through the balance of Yin and Yang within our bodies.14,21

The sensitivity analysis of all muscles showed an increase in pain tolerance, after treatment with acupuncture, with significant differences for all the muscles evaluated. Reduction of painful symptoms as a result of efficient therapeutic treatment increases tolerance to skeletal striated muscle pressure.22,23

The evaluation of the electromyographic activity changes in the sternocleidomastoid and trapezius muscles (bilaterally) help understand the problems related to chronic pain, which may have a devastating impact on human life.24 The normalization of electromyographic activity data was used to compare different muscles of different subjects. Normalized electromyographic activity permits to access the relative level of activation of a given muscle by expressing the absolute amplitude and/or time of the signal measured during the exercise as a percentage of a meaningful reference electromyographic activity value. Therefore, it is a way to reduce the differences between the different records of subjects and to make the interpretation much more reproducible.25

Based on the results obtained, it was observed that after treatment with acupuncture, there was a decrease in the normalized electromyographic activity changes in the right and left trapezius muscles, and an increase in electromyographic activity changes in the right and left sternocleidomastoid muscles at rest, without significant differences. The presence of pain as a protective mechanism can affect the subject’s ability to function and when the therapeutic treatments are able to reduce symptoms, muscle relaxation occurs, improving functional performance.26

The present study showed that the right and left sternocleidomastoid muscles were hyperactive at rest, after the acupuncture treatment. The maintenance of posture of the head and neck is determined by the balance
Table 1 Muscle conditions in shoulder elevation after treatment with acupuncture

<table>
<thead>
<tr>
<th>Muscle condition</th>
<th>Period</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSCM</td>
<td>0.67±0.04</td>
<td>0.75±0.05</td>
</tr>
<tr>
<td>LSCM</td>
<td>0.77±0.04</td>
<td>0.79±0.04</td>
</tr>
<tr>
<td>RTRZ</td>
<td>0.93±0.04</td>
<td>0.85±0.05</td>
</tr>
<tr>
<td>LTRZ</td>
<td>0.92±0.04</td>
<td>0.82±0.05</td>
</tr>
<tr>
<td>SE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSCM</td>
<td>0.85±0.07</td>
<td>1.01±0.08</td>
</tr>
<tr>
<td>LSCM</td>
<td>0.97±0.07</td>
<td>1.02±0.06</td>
</tr>
<tr>
<td>RTRZ</td>
<td>5.38±0.66</td>
<td>4.98±0.61</td>
</tr>
<tr>
<td>LTRZ</td>
<td>5.53±0.61</td>
<td>4.24±0.46</td>
</tr>
<tr>
<td>RNR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSCM</td>
<td>0.80±0.07</td>
<td>0.86±0.06</td>
</tr>
<tr>
<td>LSCM</td>
<td>4.98±0.82</td>
<td>6.50±0.96</td>
</tr>
<tr>
<td>RTRZ</td>
<td>0.88±0.04</td>
<td>0.94±0.09</td>
</tr>
<tr>
<td>LTRZ</td>
<td>1.45±0.19</td>
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</tr>
<tr>
<td>RSCM</td>
<td>4.90±0.78</td>
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</tr>
<tr>
<td>LSCM</td>
<td>0.68±0.13</td>
<td>0.40±0.08</td>
</tr>
<tr>
<td>LNR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTRZ</td>
<td>1.67±0.33</td>
<td>0.96±0.19</td>
</tr>
<tr>
<td>LTRZ</td>
<td>0.67±0.13</td>
<td>0.33±0.06</td>
</tr>
<tr>
<td>CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSCM</td>
<td>1.09±0.10</td>
<td>1.19±0.09</td>
</tr>
<tr>
<td>LSCM</td>
<td>1.09±0.08</td>
<td>1.16±0.09</td>
</tr>
<tr>
<td>RTRZ</td>
<td>5.83±0.08</td>
<td>5.26±0.09</td>
</tr>
<tr>
<td>LTRZ</td>
<td>7.18±0.78</td>
<td>5.95±0.67</td>
</tr>
</tbody>
</table>

Notes: R: the clinical conditions of rest; SE: shoulder elevation; RNR: right neck rotation; LNR: left neck rotation; CP: crucifix position; RSCM: the right sternocleidomastoid; LSCM: the left sternocleidomastoid; RTRZ: descending portion of the right trapezius; LTRZ: the descending portion of the left trapezius. I : before acupuncture; II : after acupuncture. Data were expressed as mean standard error of mean. Compared with II , ’P < 0.05.

Table 2 Pressure pain threshold values of muscles after acupuncture treatment

<table>
<thead>
<tr>
<th>Muscle condition</th>
<th>Period</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSCM</td>
<td>13.23±0.14</td>
<td>17.65±0.13</td>
</tr>
<tr>
<td>LSCM</td>
<td>14.02±0.07</td>
<td>16.67±0.10</td>
</tr>
<tr>
<td>RTRZ</td>
<td>18.63±0.19</td>
<td>29.41±0.16</td>
</tr>
<tr>
<td>LTRZ</td>
<td>19.51±0.24</td>
<td>30.69±0.17</td>
</tr>
</tbody>
</table>

Note: RSCM: right sternocleidomastoid; LSCM: the left sternocleidomastoid; RTRZ: the descending portion of the right trapezius; LTRZ: the descending portion of the left trapezius. I : before acupuncture; II : after acupuncture. Data were expressed as mean standard error of mean. Compared with II , ’P < 0.05.

The muscles involved are the insertion of very thin needles, which involves the insertion of very thin needles through the patient’s skin at specific points located on...
meridians through which Qi vital energy runs and produces stimuli in nerve endings that affect the parts of the central nervous system. When an acupoint is needled, the cells are stimulated to release endorphins such as enkephalin and dynorphin, neurotransmitters serotonin and norepinephrine, beta-endorphin and adrenocorticotropic hormone, which in turn, activates the adrenal gland to release cortisol into the bloodstream. When these neurotransmitters are stimulated, there is an inhibition of the incoming pain sensation locally, a general pain-relieving effect throughout the body. Thus, the body response is faster, the sensation of pain decreases, the muscles relax, and blood flow increases to the local area promoting healing.

During neck rotation (right side), it was demonstrated that the left sternocleidomastoid muscle had greater normalized electromyographic activity compared to the right sternocleidomastoid muscle. This result was expected since it was based on the pattern of neuroanatomical muscular activity that showed increased electromyographic activity for the muscle that acts in the contralateral side of the rotation movement of the neck (working side) that occurs in the longitudinal axis of the body.

With regard to the normalized electromyographic activity changes in the neck muscles after treatment with acupuncture during neck rotation (right side), a hyperactivity of the left sternocleidomastoid muscle occurred with a statistically significant difference. This was an unexpected result because the acupuncture therapy was supposed to promote relaxation of the muscle fibers, resulting from reduced pain that promotes an increase in range of motion. However, if this amplitude is higher than usual; the muscle tends to contract as a protective measure to prevent muscle stretch leading to injury, increasing muscle activity. Thus, if the muscle is still tense, even with reduced pain, there will be an increase in the number of muscle fibers, promoting change in muscle activity.

During the rotation of the neck (left side), the right sternocleidomastoid muscle showed higher normalized electromyographic activity compared to the left sternocleidomastoid muscle. This was also an expected result since the correct pattern of neuroanatomical muscular activity was maintained, showing increased electromyographic activity for the sternocleidomastoid muscle in the contralateral side of the rotation movement of the neck (working side).

After treatment with acupuncture, the sternocleidomastoid and trapezius muscles (right and left) during rotation of the neck (left side) and the sternocleidomastoid muscles (right and left) in the exercise called “crucifix” with upper limbs abducted at 90 and the feet touching the ground, showed decreased normalized electromyographic activity. The restriction of body movements, associated with chronic pain, leads to impairment of functional capacity. When a patient is subjected to therapeutic treatments that reduce painful symptoms, the striated skeletal muscles respond immediately, producing relaxation, and consequently, decreasing the electromyographic activity.

The present study has some limitations. First, the postural position of head was not evaluated; second, the side of the neck with higher tension was not observed, and finally, the usual range of motion of the neck was not measured. However, it showed that the neck muscles responded positively to the treatment with acupuncture.

In conclusion, our findings suggest that the sternocleidomastoid muscle in women with chronic neck pain did not present functional changes after treatment with acupuncture, unlike the descending portion of the trapezius muscle, which showed remarkable improvement in pressure pain threshold and in electromyographic activity.

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