ABSTRACT

Background: The aim of the present study was to assess the short-term effects on mandibular dynamics [in terms of mouth opening (MO) and bite force (BF)] of the application of the therapeutic method of muscular inhibition of strain/counterstrain (SCS) on latent myofascial trigger points (MTrPs) of the masseter, temporalis and internal pterygoid muscles.

Methods: Ninety-nine subjects, 47 males and 52 females, aged between 18 and 24 and with at least one MTrP in each pair of muscles, were enrolled in the study. Subjects were randomly allocated to one of two groups: experimental (48 subjects), who received SCS therapy, and control (51 subjects), who received a placebo treatment. As outcome variables, we considered maximum active mouth opening (MO) and maximum bite force (BF), which were evaluated one minute before and five minutes after application of treatment by an external evaluator blinded to the random distribution of subjects to each study group.

Results: The results showed a significant improvement with respect to active MO (controls: 0.03mm ±0.65- experimental: 1.32mm±1; p< 0.01) and maximum BF (controls: 0.17N ± 1.33-experiments: 32.25 N ± 22.40; p< 0.001) after treatment of MTrPs with SCS.

Conclusions: Muscular inhibition methods through the application of strain/counterstrain (SCS) could be used in the treatment of the MTrPs of the masseter, temporalis and internal pterygoid muscles in order to improve maximum MO and maximum BF.

Key Words: Myofascial pain syndromes, Mouth Rehabilitation, Bite force, Temporomandibular joint.

HIGHLIGHTS

- SCS can be an effective tool to improve health status in patients with muscle disorders, especially in the chewing muscles.
- SCS increase mouth opening, and also get more strength in the bite.
- Patients with masticatory force problems and limited oral opening could improve their chewing quality in daily life.

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Background

Myofascial trigger points (MTrPs) are considered to be one of the sources of pain in many subjects with musculoskeletal alterations. A MTrP is a hyper-irritable area, lying within a taut band of a skeletal muscle, which is painful on compression and stretching [1].

An active MTrP produces clinical manifestations of spontaneous referred pain and movement restriction in the affected tissues, including autonomic phenomena, whereas a latent MTrP does not produce spontaneous pain but may evoke other muscular alterations such as fatigue, movement restriction and referred pain on palpation [1]. Lucas et al. have recently proven that a latent MTrP may alter the normal patterns of motor recruitment and movement efficacy [2].

The treatment of MTrPs aims at reducing pain and restoring normal function of the affected tissues and diminishing or eliminating restriction of movement. Several therapeutic techniques can be applied in the treatment of MTrPs: ischemic compression [1], stretch and spray [1], release through MTrP compression [3], ultrasound therapy [4], thermotherapy [5], laser therapy [6] and dry needling therapy [7].

MTrPs are normally associated with tender points in the literature [8]. A MTrP is a hyper-irritable area which always causes referred pain, either spontaneously or under compression, when the muscle stretches or when the tissues affected suffer from overload or fatigue. A tender point is also a hyper-irritable area but it does not cause referred pain [1]. Tender points are found in the muscles, joints, tendons, periosteum and bones [9], whereas MTrPs are usually located in the muscles and/or their fascia [1].

Jones found that certain body positions, which modified the degree of tension in the tissues, reduced tender point sensitization and he consequently developed the so-called strain/counterstrain method [10]. Dardzinski et al. proved that the strain/counterstrain method described by Jones may be useful in reducing pain and improving muscle function in subjects with myofascial pain syndrome [11]. Other reports confirm the use of the strain/counterstrain method to reduce musculoskeletal pain [12, 13] to improve mobility of affected musculoskeletal tissues [11] and to improve recovery of subjects undergoing surgery of the temporomandibular joint (TMJ) [14, 15].

In our clinical practice, we apply several therapeutic techniques to reduce pain, increase tissue mobility and achieve relaxation and/or inhibition of hypertonic muscles with MTrPs in a variety of musculoskeletal alterations. Among these techniques is the strain/counterstrain (SCS) method described by Jones. In a review of the literature stored in the ISI database and of other journals with quality and peer review indices, we have not found any blind and randomized controlled trials assessing the effects of the SCS method on mandibular dynamics, with regard to increased mouth opening (MO) and bite force (BF), when applied to all the muscles of the mandibular closure (masseter, temporalis and internal pterygoid muscles).

The aim of the present study was to assess the response of the masticatory muscles, in terms of improvement in active MO and increased BF, after application of the SCS method to the latent or active MTrPs in those muscles.

Material & Methods

Ninety-nine subjects (47 males and 52 females with an average age of 21 years, range: 18–24) of a population of volunteer students of the University of Seville (Spain) were enrolled in the study.
Muscular Inhibition in Masticatory Trigger Points

From an initial study carried out to determine the improvement rate in each group, we calculated the sample size required to conduct a blind and randomized-controlled study of continuous variables and normal distribution, assuming a Type I error rate of 5% ($\alpha = 0.05$), a Type II error rate of 10% ($\beta = 0.1$) and a variability of 20%. As inclusion criteria we took those established by Simons and Mense [29] and Gerwin et al [16] to detect the latent MTrPs present in the masseter, temporalis and internal pterygoid muscles bilaterally:

1. Presence of a palpable taut band in a skeletal muscle.
2. Presence of a sensitive, hyper-irritable foci lying within the taut band of a muscle.
3. Local twitch response or fasciculation provoked by palpation of the taut band.
4. Referred pain as response to compression of the MTrP.

The subject lies in supine decubitus position on a soft surface and the evaluator sits next to him. Using a pinching grip (with the thumb and index finger) the evaluator locates the MTrPs of the masseter muscle and the MTrPs of the internal pterygoid muscle. With the subject seated to allow the inferior maxillary to open in a relaxed way, the evaluator gains access to the MTrPs of the temporalis muscle by means of flat palpation using the index finger.

We also measured pain threshold to compression of the latent MTrPs in the above mentioned muscles by means of a digital algometer /Lutron FG100, Lutron, Taiwan) [13, 17, 18] (Figure 1).

Subjects showing at least one MTrP in every pair of muscles were enrolled in the study. Those who did not meet this requirement were excluded as well as those subjects presenting with evident signs of craniomandibular alterations and/or subjective signs of local pain and/or spontaneous referred pain. Also excluded were those with a diagnosis of fibromyalgia syndrome (FMS) (according to the diagnostic criteria established by the American College of Rheumatology) [19], those with a previous history of cervical trauma, craniocervical surgery, previous diagnosis of craniomandibular alterations, bruxism, cephalgia, cervicalgia, occlusion and / or masticatory muscle alterations. We also excluded those subjects who had received myofascial therapy in the craniocervical region the month prior to the study.

The physical evaluation the subjects would undergo was explained to them so that they could indicate whether the palpation of the MTrPs produced local and referred pain and so that they could indicate to the operator the area of evoked pain.

Subjects were also informed of the aim of the study and gave informed consent to participate. We obtained the approval of the ethics committee of the University of Seville. In adition, the present research complied with the ethical standards for human research, according to the Helsinki Declaration, considering its last modification.

Then the subjects were allocated into two groups using a list previously designed by a computer programme. The experimental group comprised 48 subjects who received strain/counterstrain therapy, as described by Jones [10]. With the subject in supine decubitus position on a soft surface and once the MTrP of the masseter and internal pterygoid muscles had been located using a pinching grip and the MTrP of the temporalis muscle using flat palpation, a steadily increasing pressure was exerted on the MTrP until the subject complained of local and referred pain in the regions previously mentioned. Then the position of the jaw and/or spine was slowly
modified, without reducing palpatory pressure, in order to modify the tension of the tissues under the fingers and to significantly reduce the subjective sensation of pain reported by the subject. This position of ease was maintained for at least 90 seconds before slowly returning to neutral.

The control group (51 subjects received a placebo treatment in place of the strain/counterstrain method. With the control subjects in supine decubitus position, the evaluator compressed their clavicles with both hands for at least 90 seconds (placebo procedure).

One minute before and five minutes after treatment, maximum MO and maximum BF were evaluated by an external evaluator (intraobserver reliability; confidence interval= 0.90-0.98 [20, 21]) blinded to the random distribution of subjects in each study group. Maximum MO was measured using a digital caliper (Digimatic Caliper, Mitutoyo, China) and maximum BF using a load cell adapted to the bite-opening device of a digital dynamometer (Lutron FG100, Lutron, Taiwan). For each variable we obtained three consecutive measurements one minute apart.

To test our hypothesis, we used Student’s t test for quantitative variables and the chi-squared test for qualitative ones in each study group.

The clinical effects in each group were calculated by means of Cohen’s test, according to which a clinical effect > 0.8 is large, between 0.5 and 0.2 is moderate and < 0.2 is small [22].

The data obtained were analyzed using descriptive statistic analysis of quantitative variables using the statistical package SPSS with a confidence interval of 95% (p <0.05).

**Results**

The mean age of our study groups was 20 years (range 18 to 24) in the control group and 21 years (range 18 to 24) in the experimental group. The distribution by sex is shown in Table 1. No significant differences were observed between the groups as regards these two variables. Table 1 also shows the mean of trigger points found in the masseter, internal pterygoid and temporalis muscles, as well as the mean pain threshold in each of these muscles. The positions achieving a greater ease for the subjects in the experimental group were mandibular drop between 7 and 10 mm and ipsilateral deduction to the MTrP, combining sidebending and ipsilateral rotation of the cervical spine to the MTrP together with flexion, for the masseter and temporalis muscles, while it was combined with cervical extension in the case of the internal pterygoid muscle (Table 2). The experimental group showed greater MO after treatment (1.32mm ± 1) in comparison with the control group (0.03 mm ± 0.65 ) (p< 0.001). As regards the size of the clinical effect, it was classified as large according to Cohen’s test (d= 1.26) in the experimental group and as small in the control group (d= 0.05) (Table 3). In relation to BF, it showed a greater increment in the experimental group after treatment (32.25 N ± 22.40) in comparison with the control group (0.17 N ± 1.33) (p < 0.001). As regards the size of the clinical effect, it was classified as large according to Cohen’s test (d= 1.43) in the experimental group and as small in the control group (d= 0.12) (Table 3).

**Discussion**

Our results showed a significant improvement with respect to active MO (controls: 0.03mm ±0.65- experimental subjects: 1.32mm±1; p< 0.01) and maximum BF (controls: 0.17N ±
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1.33- experimental subjects: 32.25 N ± 22.40; p<0.001) after treatment of MTrPs with SCS.

This suggests that muscular inhibition methods by the application of strain/counterstrain (SCS) could be used in the treatment of MTrPs of the masseter, temporalis and internal pterygoid muscles in order to improve maximum MO and maximum BF.

A systematic review of manual therapies in the treatment of MTrPs concluded that only a few reports have dealt with the treatment of MTrPs using such therapies [23]. Our study approaches one of the causes of pain in subjects with musculoskeletal alterations: myofascial trigger points (MTrPs) and helps to broaden scientific knowledge of the treatment of such muscle dysfunctions using manual therapies, a topic scarcely studied so far [23].

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Age</th>
<th>PPT (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Masseter</td>
</tr>
<tr>
<td>Control</td>
<td>22</td>
<td>29</td>
<td>20 (1)</td>
</tr>
<tr>
<td>Experimental</td>
<td>25</td>
<td>23</td>
<td>20 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>52</td>
<td>20 (1)</td>
</tr>
</tbody>
</table>

Table 1. Descriptive data of Control and Experimental Groups. No significant differences were observed. Data expressed as mean and standard deviation (in brackets). PPT: Pressure Pain Threshold; N: Newtons.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>N</th>
<th>PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masseter</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Temporalis</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Internal Pterygoid</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2. Most common position of greater ease for each pair of muscles; N: Number of Subjects; PE: Position of Ease; PE(1): Flexion and Homolateral Rotation together with homolateral sidebending to the MTrP; PE (2): Flexion and Contralateral Rotation together with homolateral sidebending to the MTrP; PE(3): Extension and Homolateral Rotation together with homolateral sidebending to the MTrP

<table>
<thead>
<tr>
<th>Group</th>
<th>MO (mm)</th>
<th>BF (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Control</td>
<td>48 (4.7)</td>
<td>48 (4.8)</td>
</tr>
<tr>
<td>Experimental</td>
<td>44.4 (5)</td>
<td>45.7 (5)</td>
</tr>
</tbody>
</table>

Table 3. Improvement achieved in mouth opening and bite force after treatment. MO: Mouth Opening; BF: Bite Force; Pre: Preintervention; Post: Postintervention; Dif: Pre-Post Differences; (* p<0.001); d: Effect Size (Cohen); N: Newton; mm: millimeters. Data expressed as mean and standard deviation (in brackets).
The method analyzed in our study has proved useful to treat other instances of musculoskeletal pain, as shown by a wide array of reports published [12, 13, 14, 15, 23], which justifies its use to treat MTrPs. Besides, the methods employed, apart from complying with the standards of current science, incorporate the necessity to evaluate the changes in the mobility of the affected tissues after treatment [23].

As regards the results of our study, the subjects included in the experimental group showed greater increment of MO than those in the control group (p< 0.001).

Kropmans et al claim that the minimum increment in active MO required in order to establish clinical improvement is 9mm [24], which is clearly greater than our results (1.32 mm ±1).

However, we must consider that our subjects had no severe mobility impairment of the TMJ as the aim of our study is not to assess the effects of SCS in subjects with temporomandibular alterations.

The analysis of the size of the clinical effect in our study proves that SCS methods could be useful to treat latent MTrPs in the muscles of the mandibular closure in order to obtain immediate improvement in MO, with a large clinical effect (d= 1.26) in comparison with the control group where it had a non-significant clinical effect (d= 0.05).

Previous studies have shown that compression techniques, for instance ischemic compression, are effective and reduce sensitization of latent [25] and active [12] MTrPs. In this sense, Fernández de las Peñas et al. described an increment of active MO of 3.5 mm after application of ischemic compression on the MTrP of the masseter muscle [14]. Rodríguez Blanco et al. reported a greater increment of MO using post-isometric relaxation techniques than applying CSC methods to the masseter muscle. They did not mention in their studies the temporalis or the internal pterygoid muscles [15].

Our study has some advantages in comparison with these previous studies, as it does include the temporalis and internal pterygoid muscles and as it is based on a larger study sample. Also, while previous studies assessed post-intervention effects after a fixed period of time, our study analyzes immediate post-intervention effects. Such immediate effects, which we have described, using CSC methods, match those reported by García using the ischemic compression technique [25].

In our opinion, SCS methods offer some advantages in comparison with ischemic compression techniques. The latter require the muscle to be in a pre-tension (or stretched) position, whereas SCS methods are usually applied on relaxed muscles. Also, ischemic compression is usually painful [26, 27] whereas SCS does not normally cause pain (with the exception of the period of evaluation of the MTrP).
As regards BF, subjects included in the experimental group showed a mean increase of 32.2 N ± 22.4 and those in the control group a mean increase of 0.17 N ± 1.3 (p < 0.001). From a clinical point of view, the size of the effect was large in the experimental group (d = 1.43) and not significant in the control group (d = 0.12).

Rodríguez Blanco describes significant increments in BF in subjects with TMJ alterations after application of post-isometric relaxation techniques and SCS methods [28]. This increment in BF can be explained by the degree of relaxation achieved, due to the fact that, after the inhibition is attained, the muscles can develop a greater contraction force. Bakke and Michler report greater increments in the muscular tone of the jaw closure muscles as well as weakness in such muscles in subjects with craniomandibular alterations and their association with alterations of occlusal contacts. These authors point to the fact that the increment of occlusal stability could improve the force of these muscles and reduce the risk of TMJ alterations [29]. Kogawa et al studied 200 women with TMJ alterations reporting a greater BF among controls than among subjects. They also revealed the effects of masticatory muscle alterations on maximum BF [30], as did Burdette and Gale, who confirmed that the mandible elevator muscles showed greater muscle tone in subjects with TMJ alterations [31].

It seems logical that, from the data obtained in our study, SCS methods should be applied to increase the muscular force of the mandibular closure muscles. This hypothesis will be valid if we take into account the characteristics, conditions and shortcomings of our study carried out in a population of subjects without known TMJ alterations and with response or volunteer effect bias, as the cooperation of subjects was necessary both before and after the treatment.

In order to improve our knowledge of the benefits of SCS methods in the treatment of musculoskeletal alterations, further studies should be conducted to assess the long-term effects of the changes observed. This way, we could compare the effects achieved by ischemic compression techniques with those obtained through the application of SCS methods during non-immediate post-intervention periods.

We believe that further studies are necessary to the effects of SCS methods on subjects with TMJ alterations, as, from the results of our study, we cannot make any accurate conclusion in this respect. In addition, a comparison with other techniques of treatment is required.

Conclusions

Muscular inhibition methods through the application of strain/counterstrain (SCS) could be used in the treatment of the MTrPs of the masseter, temporalis and internal pterygoid muscles in order to improve maximum MO and maximum BF.

Acknowledgments

The authors would like to thank the participants in this study, and those who have collaborated in its development.

Conflict of Interest

The authors state that there are no conflicts of interest associated with this research.
Ethical Approval and Informed Consent

The present research complied with the ethical standards for human research, according to the Helsinki Declaration, considering its last modification. In addition, we obtained the approval of the ethics committee of the University of Seville.

All participants signed an informed consent form, where they were informed of all aspects related to the research, and they were able to resolve all their doubts.

Funding

The authors state that there are no external sources of funding associated with this study. All costs of this research were assumed by the authors.

Clinical Implications for Practice

Muscle inhibition methods, through SCS, can be an effective tool to improve health status in patients with muscle disorders, with trigger points, especially in the chewing muscles. These patients could achieve increased mouth opening, and also get more strength in the bite, so that chewing could be facilitated in daily life.

References


