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SYSTEMATIC REVIEW WITH META-ANALYSIS

Strain counterstrain technique to decrease tender point palpation pain compared to control conditions: A systematic review with meta-analysis

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KEYWORDS
Osteopathic manipulative treatment;
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Trigger points;
Patient positioning;
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Summary *Background:* Strain counterstrain (SCS) is an indirect osteopathic manipulative technique that uses passive positioning to relieve tender point (TP) palpation pain and associated dysfunction.
Objective: The purposes of this systematic review with meta-analysis were to 1) determine the pooled effect of SCS on TP palpation pain compared to a control condition and 2) assess the quality of the overall evidence.
Data source: A search conducted using the MEDLINE with AMED, PUBMED, CINAHL, and SCOPUS databases for publications from January 2002 and April 2012 yielded 29 articles for eligibility screening.
Study selection: Included studies were limited to randomized control trials comparing TP palpation pain after isolated SCS treatment compared to control conditions assessed with a visual analog scale. Other study designs or manipulative treatments were excluded.
Data extraction: Two reviewers adhered to a predetermined study protocol following current Cochrane Collaboration recommendations to independently extract the data with standardized extraction forms and assess studies for methodological quality and determine risks of bias.
Results: Five randomized control trials were included for qualitative and quantitative analysis. The pooled effect of SCS was a reduction of TP palpation pain ($p < 0.001$, 95% CI −0.291 to

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−0.825). The overall evidence quality was low: while all studies met at least 8 of 12 methodological quality criteria, most were low quality.
Conclusions: This systematic review and meta-analysis found low quality evidence suggesting that SCS may reduce TP palpation pain. Future studies with larger samples of better quality studies with patient populations that assess long-term pain, impairment, and dysfunction outcomes could enrich the literature.

Background

Strain Counterstrain (SCS), also known as positional release therapy (d'Amborgio and Roth, 1997), is a passive positional technique aimed at relieving musculoskeletal pain and dysfunction through indirect manual manipulation (Jones, 1995). Compared to direct osteopathic manipulation techniques, such as high velocity low amplitude thrust that has a long documented history (Greenman, 2003), the history of indirect osteopathic manipulation using techniques such as SCS has been comparatively short spanning several decades (Jones, 1964). Since the first randomized controlled trials investigating the effects of SCS were published in 2004, a number of studies have examined the effects of SCS on palpation tenderness (Lewis et al., 2010a; Meseguer et al., 2006; Nagrale et al., 2010; Perreault et al., 2009; Wong and Schauer, 2004), pain (Lewis et al., 2011), range-of-motion (Birmingham et al., 2004; Blanco, 2006; Ibáñez-García et al., 2009), strength (Wong and Schauer-Alvarez, 2004; Wong et al., 2011), and functional disability (Lewis et al., 2011).

The most common outcome variable has been tender point (TP) palpation tenderness. Instruction in SCS technique focuses on TP palpation tenderness, as the technique utilizes TP tenderness to diagnose dysfunction and guide treatment (Jones, 1995; d'Ambrogio and Roth, 1997; Chaitow, 2007). Treatment strategy is based on identifying TPs and relieving TP tenderness in regions related to the symptoms (Wong, 2012). Tenderness of the TPs guides the practitioner to the position of release. After the position is held for 90 s, the body position is returned to neutral and the TP is reassessed with relief of the tenderness the desired outcome (Jones, 1995; d'Ambrogio and Roth, 1997; Chaitow, 2007). The underlying assumption is that the TPs are associated with musculoskeletal/osteopathic dysfunction which when relieved can speed recovery (Jones, 1995; d'Ambrogio and Roth, 1997; Chaitow, 2007).

The characteristics of TPs compared to corresponding asymptomatic points on the same people and asymptomatic control participants have been documented, but it remains unclear whether TPs can be consistently identified by cutaneous signals (Lewis et al., 2010b). Although the concept that cutaneous tissue can be affected by the shortening produced in SCS has been documented, by what mechanism this is achieved remains to be determined. It is possible that although TPs are palpated through skin, the TPs may reside in deeper tissues such as ligament or joint capsules sensitized by strain applied by related body segments (Chaitow, 2009). This theory also remains untested. There is some indication, however, that shortening tissues may affect local cellular healing adaptations (Meltzer and Standley, 2007).

Regardless of the physiologic characteristics of TPs, the mechanism by which SCS achieves a release of TPs or the underlying physiologic changes that occur after SCS, a number of studies have documented changes in TP tenderness after SCS treatment. The most frequently observed change has been palpation tenderness; with a few studies measuring effects on range-of-motion and strength impairments (Wong, 2012); and even fewer random control trials exploring effects on dysfunction in painful conditions (Lewis et al., 2011; Meseguer et al., 2006). Determining whether SCS has a treatment effect on the palpation pain of TPs, which are the focus of treatment, is a first step towards future research exploring potential relationships among SCS treatment and musculoskeletal impairment, function, and disability.

The dual aims of the systematic review with meta-analysis were to: 1) determine the pooled effect of SCS on TP palpation pain compared to a control condition and 2) evaluate the strength of the evidence for relief of TP tenderness.

Methods

This systematic review and meta-analysis adhered to a predetermined study protocol following the Cochrane Collaboration recommendations (Higgins & Green 2011).

Inclusion and exclusion criteria

Inclusion criteria

1) Randomized control trial study design from the past 10 years (January 2002—April 2012)
2) Adult participants over 18 years of age who reported TP pain or tenderness upon palpation
3) Isolated intervention using SCS. For studies that included 3 different intervention conditions, only the SCS and control conditions were included for comparison
4) TP palpation pain assessed with Visual Analog Scale (VAS) or numeric pain rating scale

Exclusion criteria

1) Case studies, case series, cohort, crossover, and case—control study designs
2) Study participants concurrently received any other type of osteopathic manipulative treatment or manual therapy
3) Mixed interventions including osteopathic manipulative or manual therapy

4) Assessments of general pain, pain during functional activity

Data sources and searches

The following databases were searched to identify relevant studies within the literature: MEDLINE including AMED, CINAHL, PUBMED, and SCOPUS. All databases and the Cochrane database for previously published systematic reviews on strain counterstrain without time limits. The following search terms were then used to identify relevant peer-reviewed randomized control trials in the databases from the past 10 years (January 2002 and April 2012): "strain counterstrain", "counterstrain", "strain and counterstrain", "positional release technique", "positional release therapy", "osteopathic manipulation", and "indirect osteopathic manipulation". All reviews, cases, surveys, letters, comments, or invited responses were excluded, as were dissertations and other unpublished data. Citations were retrieved from all databases, aggregated, and then duplicates were removed. The reference lists of the one identified narrative review (Wong, 2012) and all primary randomized control trials were also reviewed to identify references not found using the electronic search that could be included in the review.

Study selection and data extraction

Two reviewers screened the list of citation titles to identify citations for eligibility screening and reviewed the potentially relevant articles to determine eligibility for the systematic review and meta-analysis. The two reviewers then extracted the data using the standardized GATE-lite form for randomized control trials, adapted from the Graphic Appraisal Tool for Epidemiological studies (GATE), for each reviewed full-text article to ensure consistent documentation of relevant study design data in PICOT format (Participants, Intervention, Control condition, Outcome, and Time) and potential bias data in the RAMBO format (Recruitment, Allocation, Maintenance, Blinding, and Objective outcomes) (Jackson et al., 2006). The process of this systematic review with meta-analysis was reported following the PRISMA statement for reviews that evaluate health care interventions (Moher et al., 2009) and the Cochrane Collaboration guidelines (Higgins and Green, 2011). Study sample and outcome data including sample size and VAS data were input into a Microsoft Excel (Microsoft http://www.microsoftstore.com/store/msusa/en_US/list/Office-suites/categoryID.62685900, accessed July 29, 2013) spreadsheet for later analysis.

Methodological quality assessment

While numerous numeric scales and checklists exist for the simple quantitative assessment of study quality including the Cochrane Back Review Guidelines, the Cochrane Collaboration handbook explicitly discourages numeric rating of study quality due to the arbitrary nature of scale item weighting, the difficulty in separating incomplete reporting from study bias, and unreliable assessments of validity (Higgins and Green, 2011). Thus, following the current Cochrane Collaboration recommendations, each study was graded as a high, moderate, or low quality randomized control trial based on the Cochrane back review guideline assessment of methodological quality (Furlan et al., 2009) and then potentially downgraded or double downgraded based on study biases assessed with the Cochrane Risk of Bias tool (Higgins and Green, 2011).

Reviewers first independently graded the randomized control trials using the Cochrane Back Review Guidelines as one methodological quality assessment for this review (Furlan et al., 2009). Two independent reviewers performed the methodological study quality assessment, following the current Cochrane Collaboration guidelines and using a consensus method to resolve any disagreements (Higgins and Green, 2011). An additional reviewer was available to help resolve disagreements if consensus could not be reached. The Cochrane Collaboration Risk of Bias tool was then used to assess each study in multiple domains for potential bias: selection, performance, detection, attrition, reporting, and other bias. Each domain of bias was assessed as at high, low, or unclear risk of bias—such as if reporting left unclear whether the study had addressed specific potential biases. Rating of the randomized control trial methodological quality in this way also allowed a level of evidence for each study to be assigned according to the 2001 Oxford Levels of Evidence chart for comparison to other studies rated in this way (OCEBM, 2009).

The PEDro Scale, which produces a numeric grade on a scale of 0—10 based on similar study methodological quality issues as the RAMBO method, was used solely to determine the quantitative level of agreement between raters as an indication of inter-rater reliability. Reliability and validity of the PEDro Scale has been previously reported (Maher et al., 2003; deMorton, 2009). Separate reviewers rated each study and agreement between their scores was calculated (excellent agreement when $k > 0.80$) using the kappa statistic with quadratic weighting, a stringent weighting that penalizes nonadjacent disagreements (Landis and Koch, 1977).

Finally, overall quality of the evidence was assessed using the Cochrane GRADE system (Higgins and Green, 2011) which recommends assessment of the combined evidence as high, moderate, low, very low quality, or even no evidence based on the quality of the included randomized control trials with consideration given to overall limitations in 5 domains: study design, indirectness of the evidence, unexplained study heterogeneity or inconsistency, and imprecise results (wide confidence intervals), and high probability of publication bias (Higgins and Green, 2011).

Data synthesis and analysis

Meta-analysis was performed with Comprehensive Meta-Analysis software (Biostat, Inc., 14 North Dean Street, Englewood, NJ 07631, accessed at meta-analysis.com on June 1, 2012) which first determined between-group difference in change of pain and then adjusted the values for variance and weight. The software calculated study weights based on sample size, standard differences of the means and standard errors, effect sizes (Cohen's d), and significance ($p < 0.05$) for the pooled results and formulated a forest plot to reflect the results. Effect sizes with

values of $d \leq 0.49$ were considered small, values of 0.5–0.79 were considered moderate, and values ≥0.8 were considered large. Heterogeneity statistics, including Cohen's *Q*, *p* value ($p < 0.05$), and I-squared (50%), were calculated for the combined studies.

Results

Description of studies

The initial search identified 3192 records from the specified databases with 2 additional records included from the hand search. After screening for relevance and excluding duplicates among the overlapping database search results, 3165 records were excluded. Of the 29 remaining articles, 24 were excluded because they did not meet the inclusion criteria. Reasons for exclusion included studies that were not randomized control trials, did not specify or isolate SCS intervention, and did not include a VAS as a pain outcome measure. (See Fig. 1) The remaining 5 were included by consensus in the systematic review and their results included in the meta-analysis. (See Fig. 1)

Methodological quality of included studies

In total, 5 studies were included in the qualitative and quantitative synthesis of this systematic review with meta-analysis. Using the Cochrane Back Review Guidelines for methodological study quality, all 5 studies met 8 or more of the 12 methodological quality criteria. No study had a blinded care provider, which would be challenging to arrange for a manual therapy intervention. The other most common methodological criteria not met were treatment allocation concealment (Meseguer et al., 2006; Wong and Schauer, 2004) and participant blinding (Meseguer et al., 2006; Ibáñez-García et al., 2009). Inter-rater agreement for the 5 studies reviewed was good with $k_w = 0.79$. (See Table 1)

Risk of bias in included studies

Assessment with the Cochrane Collaboration Risk of Bias tool, as with the Cochrane Back Review Guidelines for methodological quality, revealed that the most common domains at high risk of bias found in 2 of the 5 studies were selection (e.g. concealed allocation) and performance bias (e.g. participant blinding). (See Table 2) Four studies were judged to be at unclear risk of reporting bias because mean group improvement was reported but the number or percentage of participants that improved was unspecified. One study had no domains at high risk for bias and one had 3 domains at high risk of bias, while the rest were at high risk of bias in 2 domains. Three studies had high risk of other potential sources of bias beyond the primary domains. Control groups that received no intervention in Meseguer et al. (2006) and Ibáñez-García et al. (2009) do not account for a possible placebo effect from receiving treatment of any kind and were considered at high risk of other source of bias. In Perreault et al. (2009) it was considered a high risk of other bias that the inclusion criteria depended on difficult to control subjective self-report information with incomplete information about the recruitment and screening process and 100% inclusion of a small participant sample. This study also had a high risk of bias due to incomplete outcome data due to the lack of pre-intervention group comparison and analysis (Perreault et al., 2009).

Assessment of individual included studies

Assessment of the included studies was based on both the methodological study quality and consideration of the Risks of Bias tool following the Cochrane Collaboration handbook recommendations (Higgins and Green, 2011). The Cochrane Back Review Guidelines recommend rating studies that meet at least 6 criteria as at low risk of bias (Furlan et al., 2009) suggesting a high or moderate quality rating for such studies (Liddle et al., 2007; Clarke et al., 2011). The largest most recent study had the fewest criteria at risk of bias and was not downgraded (Lewis et al., 2011). Consideration of the Risk of Bias tool led to the other studies being downgraded: One study was downgraded to moderate quality due to potential performance and other sources of bias domains (Ibáñez-García et al., 2009). Three studies were double downgraded to low quality due to high risk for allocation concealment (Meseguer et al., 2006; Perreault et al., 2009; Wong and Schauer, 2004), detection bias due to lack of outcome assessor blinding (Wong and Schauer, 2004), lack of subject blinding combined with a no treatment control (Meseguer et al., 2006), and other sources of bias (Perreault et al., 2009). (See Table 3) None of the included studies reported any adverse effects resulting from SCS treatment.

Effect sizes for individual included studies

The effect size for reduction in TP pain after SCS compared to a control intervention as calculated as Cohen's *d* varied from 1.15 to 0.14. Two studies had large effect sizes (Meseguer et al., 2006; Ibáñez-García et al., 2009), one had moderate (Lewis et al., 2011), and two had small effect sizes (Wong and Schauer, 2004; Perreault et al., 2009). The effect size calculation helped determine the magnitude of the difference in pain between the SCS group and comparison control group in each study.

Meta-analysis of pooled effect of SCS

A meta-analysis was undertaken to investigate the narrow question of whether SCS in the pooled studies had an immediate effect on TP palpation tenderness compared to non-manual therapy control conditions. Some heterogeneity was expected given inclusion of studies that examined different body segments with some patient and non-patient populations. Since the outcome to be investigated was limited to tender point palpation tenderness and not pathologic conditions, impairments, or dysfunctions, the studies were considered homogenous enough to be pooled for meta-analysis. After calculating the standardized difference of means for each study, the pooled results show that the SCS interventions resulted in lower TP palpation pain scores of −0.558; 0.136 cm (mean; SD) on a VAS in comparison to control groups ($p < 0.001$) with 95%

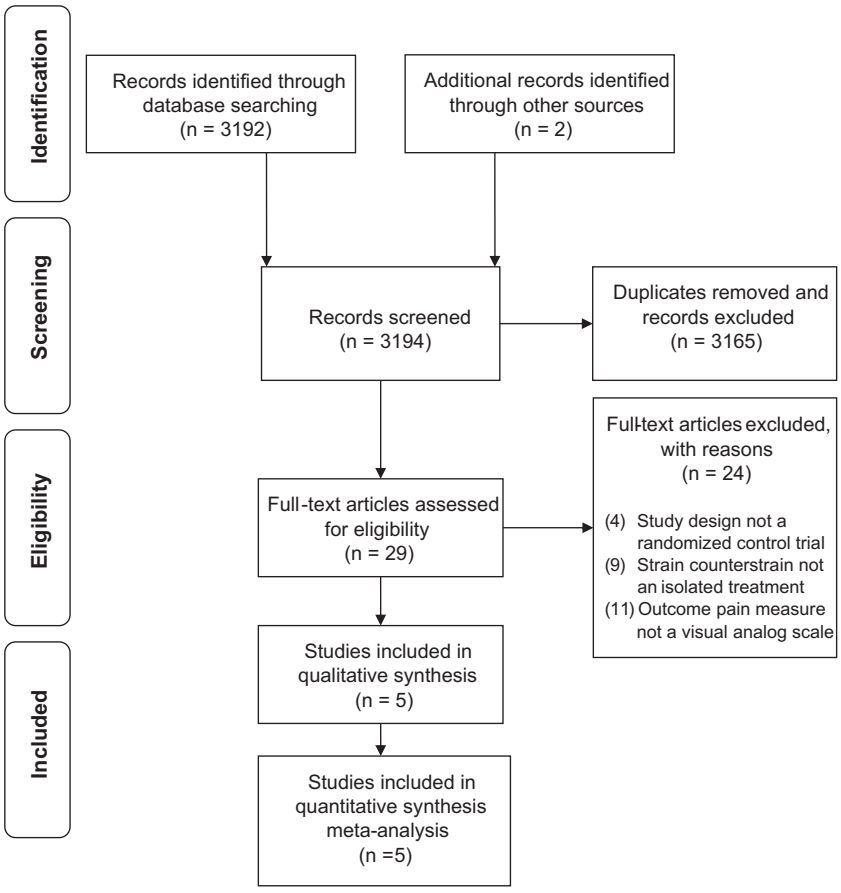


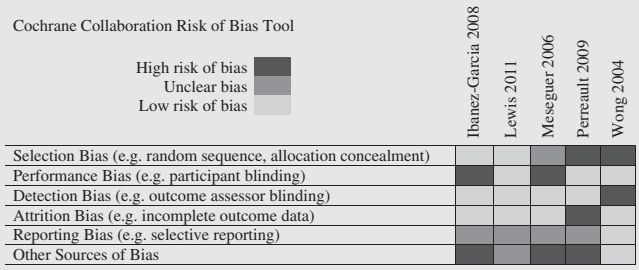
Figure 1 PRISMA study flow diagram.

confidence interval (−0.825 to −0.291). (See Fig. 2) The means and standard deviations for each of the five studies vary in position on the forest plot with three studies (Ibáñez-García et al., 2009; Meseguer et al., 2006; Wong and Schauer, 2004) supporting the intervention and two studies (Lewis et al., 2011; Perreault et al., 2009) showing no difference between SCS intervention and control groups not receiving manual therapy. The pooled effect suggests

Table 1 Methodological study quality criteria summary.

Methodological study quality criteria	Ibáñez-García et al., 2009	Lewis et al. (2011)	Meseguer et al. (2006)	Perreault et al. (2009)	Wong and Schauer-Alvarez, (2004)
1.A. Was the method of randomization adequate?	Yes	Yes	Yes	Yes	Yes
2.B. Was the treatment allocation concealed?	Yes	Yes	No	Yes	No
3.C. Was the patient blinded to the intervention?	No	Yes	No	Yes	Yes
4.C. Was the care provider blinded to the intervention?	No	No	No	No	No
5.C. Was the outcome assessor blinded to the intervention?	Yes	Yes	Yes	Yes	No
6.D. Was the drop-out rate described and acceptable?	Yes	Yes	Yes	Yes	Yes
7.D. Were all randomized participants analyzed in the group to which they were allocated?	Yes	Yes	Yes	Yes	Yes
8.E. Are reports of the study free of suggestion of selective outcome reporting?	Yes	Yes	Yes	Yes	Yes
9.F. Were the groups similar at baseline regarding the most important prognostic indicators?	Yes	Yes	Yes	No	Yes
10.F. Were co-interventions avoided or similar?	Yes	Yes	Yes	Yes	No
11.F. Was the compliance acceptable in all groups?	Yes	Yes	Yes	Yes	Yes
12.F. Was the timing of outcome assessment similar in all groups?	Yes	Yes	Yes	Yes	Yes
Criteria met	**10**	**11**	**9**	**10**	**8**

Table 2 Cochrane risk of bias tool summary.



that SCS intervention across all five studies led to an overall decrease in palpation pain of between 0.00 cm and 1.00 cm on the VAS scale.

Assessment of the body of evidence

The body of evidence was at risk for heterogeneity, as suggested by Cohen's $Q = 9.102$, p-value $= 0.059$, and I-squared $= 56.05\%$. A p-value >0.05 and I-squared value $>50\%$ is suggestive of heterogeneity. Using the Cochrane GRADE approach, which includes consideration of study heterogeneity, the body of evidence to support SCS use in reducing TP palpation pain was downgraded to low quality, because of the heterogeneity of the compiled studies, which included mostly double-downgraded randomized trials (Higgins and Green, 2011).

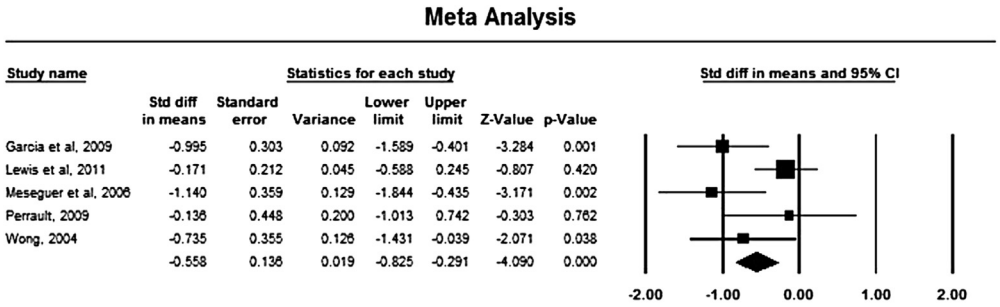
Discussion

The systematic review included 5 studies that resulted from what was deemed a comprehensive search of the English language literature. This systematic review with meta-analysis analyzed the effect of SCS on TP palpation pain compared to the control conditions and evaluated the strength of the randomized control trials from which the evidence was drawn. The meta-analysis of the pooled results of the 5 included studies revealed that SCS produced a significant reduction in TP palpation pain as measured with by VAS compared to control conditions. The overall TP palpation pain reduction after SCS was apparent when data were pooled, although 3 studies had reported significant pain reduction with moderate (Wong and Schauer, 2004) to large effect sizes (Ibáñez-García et al., 2009; Meseguer et al., 2006). The 5 randomized control trials included 1 rated as high, 1 rated as moderate, and 3 rated as low quality studies based on both methodological study quality and potential bias risks.

That the 5 studies used different control conditions and examined different TPs in different areas of the body including the head, spine, upper and lower extremity explained the risk of heterogeneity in the meta-analysis. As the control condition, 2 studies used no treatment (Ibáñez-García et al., 2009; Meseguer et al., 2006), 2 used light exercise (Lewis et al., 2011; Wong and Schauer, 2004), and 1 used a sham touch and positioning (Perreault et al., 2009). In addition to using different areas of the body, 2 studies used patients referred with regional pain while 3 studies used non-patients. The outcome measure considered for this meta-analysis was limited to the effect on TP

Table 3 Summary description of included studies.

Study	Participants		Intervention	Comparison	Outcome			Study assessment	
Author year	Patient sample	Mean age Years; SD *N* (% Female)	Intervention, areas treated	Control type	Measure mean change time	*p* value	Cohen's *d*	Cochrane quality rating	Oxford level of evidence
Ibáñez-García et al., 2009	No	36.0; 14.7 71 (52)	SCS, Masseter	No treatment	VAS −1.6 cm 1 week	<0.001	0.99	Moderate	1B
Lewis et al., 2011	Yes	40.0; 10.5 89 (62)	SCS, Ambrogio Lumbar spine	Exercise	VAS 0.3 cm 2 weeks	>0.05	0.17	High	1B
Meseguer et al., 2006	Yes	40; 12 54 (76)	SCS, Upper trapezius	No treatment	VAS −2.6 cm 2 min	<0.001	1.15	Moderate	1B
Perreault et al., 2009	No	22.4; 2.6 20 (45)	SCS, Upper trapezius	Sham touch treatment	VAS −0.3 cm 24 h	=0.276	0.14	Low	2B
Wong Schauer-Alvarez, 2004	No	25.0; 4.4 49 (69)	SCS, Hip muscles	Exercise	VAS −1.48 cm 2 weeks	<0.05	0.74	Low	2B



Note: Meseguer and Lewis used patients with regional pain that had painful tender points; Garcia, Perrault, and Wong used non-patients with painful tender points.

Figure 2 Meta-analysis of pooled results with forest plot. Standard difference in means measured in cm. A negative number represents reduced palpation pain.

palpation pain measured by VAS, however, not a regional pain condition. The VAS data for TP palpation pain were similar across TPs in all included studies. Confidence intervals were all within 1 cm of the mean in each direction, and widest for the smallest study while narrowest for the largest study (see Fig. 2). Given the data similarity despite investigations of different body areas, heterogeneity among the reviewed studies did not preclude pooling of the results.

The Cochrane GRADE approach allows downgrading of the overall evidence based on unexplained study heterogeneity, study design limitations, indirectness of the evidence, imprecise results, and high probability of publication bias of the whole body of evidence (Higgins and Green, 2011). Study design weaknesses were accounted for in the within-study methodological quality downgrading. Outcome inclusion criteria had been defined narrowly and all studies reported TP palpation pain using a VAS. However, the total number of participants was small with 283 included participants so conclusions must be guarded. Inclusion of 2 studies that reported no change with the 3 studies that did report significant pain reduction suggests that publication bias had been avoided. Using the GRADE system, the quality of the combined evidence supporting the effectiveness of SCS for reducing TP palpation pain was downgraded to low quality, because of the heterogeneity of the compiled studies that included mostly double-downgraded randomized trials (Higgins and Green, 2011).

The benefit of multiple treatments for healthy volunteers or patient populations was unclear. 2 studies included patients; the other 3 studies included healthy volunteers with investigator diagnosed TPs. Analyzed separately, studies including patients demonstrated decreased TP palpation pain on VAS in comparison to the control groups (95% confidence interval -0.780 to -0.064, $p = 0.021$); studies including non-patients also showed decreased palpation pain (95% confidence interval -1.099 to -0.316, $p < 0.001$).

Two studies utilized one single 90-s SCS treatment with reassessment within the first 24 h: one involving patients with mechanical neck pain reported a significant decrease in pain (Meseguer et al., 2006) while the other which involved healthy volunteers did not (Perreault et al., 2009). Three studies provided multiple SCS treatments over a period of a week or more: one involving patients with low back pain reported no change (Lewis et al., 2011) while the other 2 involving healthy volunteers reported reductions of palpation pain (Ibáñez-García et al., 2009; Wong and Schauer, 2004). While multiple SCS treatments may reduce TP palpation pain, even one SCS treatment may yield benefits.

The benefits for healthy volunteers may be limited compared to those with known dysfunction or pathology who might be considered to have greater impairment. Further, the fact that people without diagnosed pathology have TPs suggest that TPs may occur normally. It cannot be assumed that the TPs of people without pathology respond in the same way as those in people with diagnosed pathology. One study that involved participants with diagnosed pathology demonstrated a TP palpation pain relieving effect of SCS (Meseguer et al., 2006) and one did not (Lewis et al., 2011).

In addition, any benefit derived from SCS treatment may depend on the impaired body segment to which SCS treatment would be directed. In the 5 compiled studies, TPs were treated in the upper trapezius, masseter muscle, hip and lower back muscles. Since TP palpation pain reductions in the included studies were documented within 24 h of the SCS treatment with one study reporting follow-up data beyond 2 weeks (Lewis et al., 2011), the long-term effects of SCS on TP palpation pain remain unknown.

While this systematic review and meta-analysis showed that SCS can be an effective intervention to immediately reduce TP palpation pain, the pooled results do not provide insight into the relative benefits for single vs. multiple treatments, healthy volunteers or patient populations, specific TPs or body segments, long term effects, or general ratings of pain, symptoms, and disability.

Limitations of the review

This comprehensive systematic review of English language studies did not include studies in other languages nor was a capture-mark-recapture process (Stelfox et al., 2013) included in the methodology. None of the studies presented specific participant data and this meta-analysis was restricted to mean and standard deviation data. In

addition, this meta-analysis reported only the primary results of all studies; only the 2-week follow-up data were used in the meta-analysis for one study that had follow-up for up to 28 weeks because the results from different time points were not significantly different (Lewis et al., 2011). Results of the meta-analysis should also be viewed with caution because the studies involved different areas of the body, various treatment durations and control conditions. While the review of the literature and assessment of methodological study quality was conducted independently, the research of the senior author of this article was included in this review and meta-analysis. In sum, the results of this systematic review and meta analysis pertains only to the narrow question of short-term reduction of TP tenderness after SCS intervention and does not address long-term results or any effect on general pain, myofascial impairment, or physical dysfunction.

Implications for practice

The evidence that has emerged to support the effectiveness of SCS on reducing TP palpation pain provides clinicians an evidence-based approach to palpation pain. That palpation pain reduction has been noted after one or multiple sessions, in different areas of the body, for healthy volunteers and patients in pain suggests that SCS may be an effective treatment in a variety of clinical applications. This systematic review and meta-analysis supports SCS as a clinical option available to the practitioner working with patients with TP tenderness. The effectiveness of SCS on associated musculoskeletal disorders, however, remains unknown.

Implications for research

There is a definite need for more high quality randomized clinical control trials to add to the current literature pertaining to SCS treatment. To increase the value and reliability of study results, new studies should have larger sample sizes determined a priori using results from existing studies. Longer follow-up periods than are common in the current literature should be employed to provide insight on the lasting effects of SCS treatment. While the effectiveness of SCS for reducing TP palpation pain has been documented, studies assessing measureable improvement in patient general pain levels, orthopedic impairments, physical dysfunctions, or pathologic conditions are needed to explore potentially clinically relevant effects of SCS treatment.

Because the implications of SCS in treating TPs are just emerging, future reviews should be performed when more studies have investigated the short- and long-term effects of SCS on pain, impairment, and dysfunction in a larger sample of specific patient populations.

Conclusion

Within the search parameters described in this review, this is the first systematic review with meta-analysis to investigate the effects of SCS. The evidence supports the immediate effect of SCS on decreasing TP palpation pain with a low grade for the quality of the evidence. The heterogeneity and paucity of studies investigating SCS in patient populations limited the outcome investigated and thus the breadth of the conclusions that can be drawn.

Conflict of interest statement

The authors have no conflict of interest to report.

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