Immediate Changes in Neck Pain Intensity and Widespread Pressure Pain Sensitivity in Patients With Bilateral Chronic Mechanical Neck Pain: A Randomized Controlled Trial of Thoracic Thrust Manipulation vs Non–Thrust Mobilization

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Abstract

Objective: The purpose of this study was to compare the effects of thoracic thrust manipulation vs thoracic non–thrust mobilization in patients with bilateral chronic mechanical neck pain on pressure pain sensitivity and neck pain intensity.
Methods: Fifty-two patients (58% were female) were randomly assigned to a thoracic spine thrust manipulation group or of thoracic non–thrust mobilization group. Pressure pain thresholds (PPTs) over C5-C6 zygapophyseal joint, second metacarpal, and tibialis anterior muscle and neck pain intensity (11-point Numerical Pain Rate Scale) were collected at baseline and 10 minutes after the intervention by an assessor blinded to group allocation. Mixed-model analyses of variance (ANOVAs) were used to examine the effects of the treatment on each outcome. The primary analysis was the group * time interaction.
Results: No significant interactions were found with the mixed-model ANOVAs for any PPT (C5-C6: $P > .252$; second metacarpal: $P > .452$; tibialis anterior: $P > .273$): both groups exhibited similar increases in PPT (all, $P < .01$), but within-group and between-group effect sizes were small (standardized mean score difference [SMD] < 0.22). The ANOVA found that patients receiving thoracic spine thrust manipulation experienced a greater decrease in neck pain (between-group mean difference: 1.4; 95% confidence interval, 0.8-2.1) than did those receiving thoracic spine non–thrust mobilization ($P < .001$). Within-group effect sizes were large for both groups (SMD > 2.1), and between-group effect size was also large (SMD = 1.3) in favor of the manipulative group.
Conclusions: The results of this randomized clinical trial suggest that thoracic thrust manipulation and non–thrust mobilization induce similar changes in widespread PPT in individuals with mechanical neck pain; however, the changes were clinically small. We also found that thoracic thrust manipulation was more effective than thoracic non–thrust mobilization for decreasing intensity of neck pain for patients with bilateral chronic mechanical neck pain. (J Manipulative Physiol Ther 2014;37:312-319)
Key Indexing Terms: *Manual Therapy; Neck Pain; Spine; Pressure*

Neck pain is a common musculoskeletal complaint with a point prevalence around 15% in males and 23% in females.[1] Studies examining the course of neck pain have shown that symptoms usually decrease over the first few weeks and months, but complete resolution of symptoms is not attainable for all, even after years.[2] The economic burden associated with neck pain should not be underestimated because many participants will continue

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Fig 1. *Thoracic spine thrust manipulation. (Color version of figure is available online.)*

Fig 2. *Thoracic spine non–thrust mobilization. (Color version of figure is available online.)*

to use health care resources for up to 10 years after the initial onset.[3] In fact, there has been a consistent increase in the medical costs associated with the management of spinal pain conditions between 1997 and 2005.[4]

Participants reporting neck pain often seek manual therapy for the management of their symptoms. In fact, physical therapy is generally the first management option for patients with mechanical neck pain. Physical therapists treat mechanical neck pain with a number of interventions including joint mobilization and/or manipulation, therapeutic exercises, soft tissue massage, electrotherapy, or education. Manual therapies targeted to the neck and deep neck flexor musculature exercises are probably the most accepted therapeutic interventions for the management of this population. In fact, clinical practice guidelines for manual therapy management of patients with neck pain suggest use of treatment approaches including cervical spine manipulation or mobilization and training of the deep neck flexors.[5,6]

The use of cervical spine thrust manipulations is still controversial based on the fact that all potential risks cannot be avoided.[7] Hence, the use of thoracic spine thrust manipulations in individuals with neck pain has increased in recent years. Two recent systematic reviews concluded that individuals with mechanical neck pain benefit from thoracic spine thrust manipulation;[8,9] however, the exact neurophysiologic mechanism by which thoracic manipulation exerts it effects remains to be elucidated.[10,11] Segmental and central theories have been proposed as the most likely hypotheses for spinal thrust manipulation to act through the stimulation of descending inhibitory mechanisms, particularly the periaqueductal gray matter.[12,13] This assumption is mainly based on the premise that spinal thrust manipulation exerts a mechanical hypoalgesic effect, thereby increasing pressure pain thresholds (PPTs). Several studies demonstrated that cervical spine manipulation induces this hypoalgesic effect in healthy people,[14–16] individuals with mechanical neck pain,[17] and patients with lateral epicondylalgia.[18] However, few studies had investigated if thoracic spine thrust manipulation can exhibit a hypoalgesic effect. A small clinical trial compared changes on PPT over the elbow after the application of either cervical or thoracic thrust in individuals with lateral epicondylalgia and reported that the cervical manipulation produced a greater increase in PPTs than thoracic spine manipulation.[19] A recent randomized clinical trial found that cervical and thoracic thrust manipulation induces similar changes in widespread PPTs in individuals with chronic mechanical neck pain; however, these changes were small and did not surpass their respective minimal detectable change (MDC) values.[20]

To date, only 2 studies have compared the effects of thoracic thrust manipulation and non–thrust mobilization in reducing pain for individuals with mechanical neck pain. Cleland et al[21] found that those patients with mechanical neck pain who received thoracic manipulation had greater pain reduction at a 2-day follow-up period than did patients who received thoracic mobilization. Conversely, Suvarnnato et al[22] did not find a significant difference in pain reduction between individuals with neck pain who received thoracic thrust manipulation or non–thrust mobilization. Perhaps the difference is related to the fact that the participants in the study by Cleland et al[21] exhibited symptoms for less than 2 months, whereas those in the study by Suvarnnato et al[22] had to have symptoms greater than 3 months to be included in the trial. Considering these discrepancies and the fact that the physiological effects of thoracic thrust manipulation remain to be elucidated, the purpose of this randomized clinical trial was to examine the widespread effects of thoracic spine thrust manipulation and thoracic non–thrust mobilization on pressure pain sensitivity and intensity of neck pain in patients with chronic mechanical neck pain.

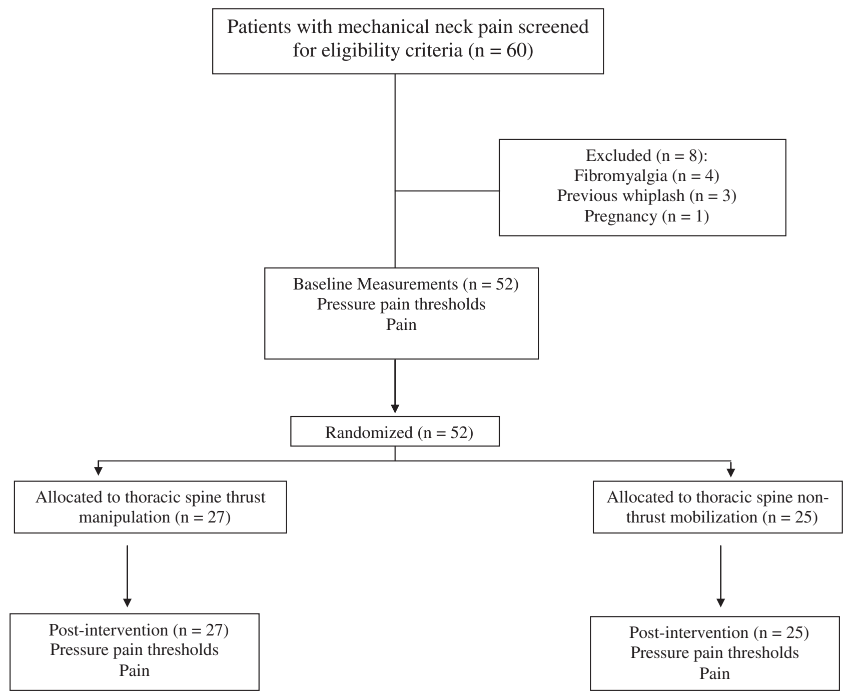

Fig 3. *Flow diagram of patients throughout the course of the study.*

Methods

Participants

A randomized single-blind clinical trial was conducted (clinical trial registry number NCT02051478). Consecutive individuals with bilateral chronic mechanical idiopathic neck pain referred by their primary care physician to physical therapy were screened for eligibility criteria from September 2012 to June 2013. In the current trial, *mechanical neck pain* was defined as neck-shoulder pain with sensory symptoms provoked by neck postures, neck movement, and/or palpation of the cervical musculature. Patients were included if they exhibited the following: (1) neck pain symptoms of mechanical nature, (2) age from 18 to 60 years, (3) bilateral symptoms, and (4) symptoms for at least 6 months of duration.

Potential participants were excluded if they exhibited any of the following criteria: (1) whiplash injury, (2) previous spine surgery, (3) diagnosis of cervical radiculopathy or myelopathy, (4) diagnosis of fibromyalgia,[23] (5) having undergone any physical therapy intervention in the previous year, or (6) pregnancy. The protocol for this study was approved by the local human research committee of the Universidad Rey Juan Carlos (Spain), and all participants signed an informed consent form prior to participation in the study.

Outcome Measures

The primary outcome in this trial was *PPT*, defined as the amount of pressure applied for the pressure sensation to first change to pain.[24] An electronic algometer (Somedic AB, Farsta, Sweden) was used to measure PPT levels. The algometer consists of a 1-cm^2 rubber tipped plunger mounted on a force transducer. Participants were instructed to press a switch when the sensation changed from pressure to pain. The mean of 3 trials was calculated and used for the main analysis. A 30-second resting period was allowed between each measure.

Pressure algometry over the cervical spine has shown excellent intrarater (intraclass correlation, 0.94-0.97) and good-to-excellent interrater (intraclass correlation, 0.79-0.90) reliability in individuals with acute neck pain.[25] This study reported that the MDC for PPT over the cervical spine and tibialis anterior muscle in patients with acute neck pain was 47.2 and 97.9 kPa, respectively.[25] To determine changes in widespread pressure pain sensitivity, PPTs were assessed bilaterally over the C5-C6 zygapophyseal joint, second metacarpal, and tibialis anterior muscle. A previous study had reported that patients with mechanical neck pain exhibit pressure hypersensitivity in these areas.[26]

The secondary outcome was neck pain intensity. Participants rated the intensity of their neck pain at rest on an 11-point Numerical Pain Rate Scale (0: no pain, 10: maximum pain).[27] Cleland et al[28] reported that the MDC and minimal clinically important difference (MCID) were 2.1 and 1.3 points, respectively, in patients with mechanical neck pain.

Table 1. *Baseline Demographics for Both Groups* [a]

	Thoracic Manipulation (n = 27)	Thoracic Mobilization (n = 25)	*P*
Sex (male/female)	17/10	13/12	.302
Age (y)	32 ± 7	34 ± 9	.324
Time duration (y)	2.2 ± 1.1	2.4 ± 1.3	.424
Pain intensity (0-10)	6.0 ± 1.4	5.8 ± 1.2	.497
PPTs (kPa)			
C5-C6 dominant	133.2 ± 36.8	141.7 ± 35.8	.404
C5-C6 nondominant	133.9 ± 36.0	148.3 ± 34.7	.350
Second metacarpal dominant	261.8 ± 57.8	244.5 ± 81.1	.376
Second metacarpal nondominant	263.3 ± 60.1	257.5 ± 71.1	.752
Tibialis anterior dominant side	430.8 ± 106.7	407.7 ± 129.8	.485
Tibialis anterior nondominant	434.2 ± 109.5	412.6 ± 134.7	.527

PPTs, pressure pain thresholds.
[a] Data are mean ± SD, except for sex.

Middle Thoracic Spine Thrust Manipulation

A high-velocity, end-range, anterior-posterior thrust applied through the elbows to the midthoracic spine was applied.[29] Patients were supine with upper extremities crossed over the chest and hands placed over the opposite shoulder. The manipulating hand of the therapist stabilized the inferior thoracic vertebra of the motion segment targeted. The other clinician's hand cradled the patient's head and introduced a gentle flexion of the upper and midthoracic spine. Finally, the clinician's body pushed down through the patient's arms, to perform a distraction thoracic spine thrust manipulation in an upward direction (Fig 1). The thoracic thrust manipulation was focused on T3-T6 segments; however, because thoracic thrust manipulation reportedly lacks segmental sensitivity,[30] no specific segment was targeted. If no audible cavitation was heard on the first attempt, then the therapist repositioned the participant and performed the thrust manipulation again. A maximum of 2 attempts were made.

Middle Thoracic Spine Non–Thrust Mobilization

Patients received 20-second bouts of grades III to IV of central posterior-anterior non–thrust mobilization from T3 to T6 spinous process, as described by Maitland et al,[31] for an overall intervention time of approximately 2 minutes (Fig 2). This procedure was chosen to establish a similar amount of time to complete the thoracic manipulation and non–thrust mobilization techniques, minimizing the potential for an attention effect.

Treatment Adverse and Side Effects

Patients were asked to report any adverse event that they experienced after the intervention and during a 1-week follow-up. In this study, an *adverse event* was defined as sequelae of medium term in duration with any symptom perceived as distressing and unacceptable to the patient and required further treatment.[32] In addition, *side effects*, defined as short-term, mild in nature, nonserious, transient reversible consequences of the treatment, were also monitored. Adverse and side effects were self-reported by the patients and collected by a clinician not involved in the study.

Randomization

Following the baseline examination, patients were randomly assigned to receive either thoracic spine thrust manipulation or thoracic non–thrust mobilization. Concealed allocation was performed using a computer-generated randomized table of numbers created prior to start of data collection by a researcher not involved in the recruitment of or treatment for the patients. Individual and sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. A second therapist, blinded to baseline examination findings, opened the envelope and proceeded with treatment according to the group assignment. Outcome measures were assessed before and 10 minutes after each intervention by an assessor blinded to group allocation.

Statistical Analysis

Statistical analysis was performed using SPSS statistical software, version 18.0 (SPSS, Chicago, IL). Mean, SDs, and/or 95% confidence intervals (95% CIs) were calculated for each variable. The Kolmogorov-Smirnov test showed a normal distribution of the data ($P > .05$). Baseline demographic and clinical variables were compared between both groups using independent Student *t* tests for continuous data and χ^2 tests of independence for categorical data. For the primary outcome of the study, a 2 × 2 × 2 mixed-model analysis of variance (ANOVA) with time (pre-post intervention) and side (dominant or nondominant) as the within-participant factor and group (thoracic spine thrust or non–thrust manipulation) as the between-participant factor was used to examine the effects of the intervention on PPT. A 2 × 2 mixed-model ANOVA with time (pre-post) as the within-participant factor and (thoracic spine thrust or non–thrust manipulation) as the between-participant factor was used to determine the effects of the intervention on neck pain intensity. For each ANOVA, the hypothesis of interest was the 2-way interaction (group * time). To enable comparison of effect sizes, standardized mean score differences (SMDs) were calculated by dividing mean score differences between groups by the pooled SD. An SMD greater than 0.8 is considered large; between 0.3 and 0.79, moderate; and less than 0.3, small.[33]

Table 2. *Outcome Data for Pressure Pain Sensitivity and Neck Pain*

	Pretreatment [a]	Posttreatment [a]	Within-Group Change Score [b]	Between-Group Difference in Change Score [b]
Pain intensity (0-10)				
Thoracic manipulation	6.0 ± 1.4	2.5 ± 1.7	−3.5 (−3.9 to −2.9)	1.4 (0.8 to 2.1) [c]
Thoracic mobilization	5.8 ± 1.2	3.7 ± 1.5	−2.1 (−2.4 to −1.6)	
PPTs (kPa)				
C5-C6 dominant side				
Thoracic manipulation	133.2 ± 36.8	168.1 ± 41.8	34.9 (28.5 to 41.3)	21.5 (13.3 to 29.6)
Thoracic mobilization	141.7 ± 35.8	155.1 ± 39.4	13.4 (8.2 to 18.6)	
C5-C6 nondominant side				
Thoracic manipulation	133.9 ± 36.0	171.7 ± 42.9	37.8 (30.8 to 44.8)	29.7 (17.7 to 41.7)
Thoracic mobilization	148.3 ± 34.7	156.4 ± 40.1	8.1 (−2.2 to 18.4)	
Second metacarpal dominant side				
Thoracic manipulation	261.8 ± 57.8	280.4 ± 61.1	18.6 (14.8 to 22.4)	1.2 (−21.1 to 23.6)
Thoracic mobilization	244.5 ± 81.1	264.3 ± 70.5	19.8 (−3.7 to 43.4)	
Second metacarpal nondominant side				
Thoracic manipulation	263.3 ± 60.1	283.7 ± 66.0	20.4 (15.2 to 25.7)	7.9 (−1.5 to 17.3)
Thoracic mobilization	257.5 ± 71.1	270.0 ± 72.9	12.5 (4.3 to 20.8)	
Tibialis anterior muscle dominant side				
Thoracic manipulation	430.8 ± 106.7	445.9 ± 110.2	15.1 (7.8 to 22.6)	5.2 (−2.9 to 13.4)
Thoracic mobilization	407.7 ± 129.8	417.6 ± 128.2	9.9 (6.6 to 13.3)	
Tibialis anterior muscle nondominant side				
Thoracic manipulation	434.2 ± 109.5	437.3 ± 132.1	3.1 (−20.3 to 26.6)	4.9 (−19.3 to 29.0)
Thoracic mobilization	412.6 ± 134.7	420.6 ± 134.2	8.0 (3.4 to 12.2)	

PPTs, pressure pain thresholds.
[a] Data are means ± SDs.
[b] Data are means (95% CIs).
[c] Significant group * time interaction (ANOVA test, $P < .001$).

Sample Size Calculation

The sample size was calculated using Ene 3.0 software (Autonomic University of Barcelona, Spain). The calculations were based on detecting differences of 49 kPa in PPT levels at postdata,[14,15,20] assuming an SD of 49 kPa, a 2-tailed test, an α level of .05, and a desired power (β) of 90%. The estimated desired sample size was calculated to be at least 22 participants per group.

Results

Sixty consecutive patients were screened for eligibility criteria. Fifty-two patients (mean ± SD age, 33 ± 9 years; 58% female) satisfied the eligibility criteria, agreed to participate, and were randomized into a thoracic thrust manipulation group (n = 27) or a thoracic non–thrust mobilization group (n = 25) group. The reasons for ineligibility are found in Figure 3, which provides a flow diagram of patient recruitment and retention. Baseline features between both groups were similar for all variables (Table 1).

The mixed-model 2 × 2 × 2 ANOVA revealed no statistically significant interaction for PPT at any location: C5-C6 (group * time: $F = 1.320$, $P = .252$; side * time: $F = 0.114$; $P = .736$; group * side: $F = 0.035$, $P = .852$; group * time * side: $F = 0.173$, $P = .678$), second metacarpal (group * time: $F = 0.302$, $P = .584$; side * time: $F = 0.202$; $P = .640$; group * side: $F = 0.074$ $P = .787$; group * time * side: $F = 0.571$, $P = .452$), and tibialis anterior (group * time: $F = 0.001$, $P = .977$; side * time: $F = 1.216$; $P = .273$; group * side: $F = 0.875$, $P = .352$; group * time * side: $F = 0.630$, $P = .429$). However, there was a main effect for time, with both groups experiencing similar PPT increases after the intervention at all locations (all $P < .01$) Within-group and between-group effect sizes were small (SMD < 0.22) for changes in PPT. Table 2 provides baseline and postintervention data as well as within-group differences with their associated 95% CI for PPTs data.

The 2 × 2 mixed-model ANOVA revealed a statistically significant group * time interaction for neck pain ($F = 21.609$, $P < .001$): patients receiving thoracic spine thrust manipulation experienced a greater decrease in neck pain than did those receiving thoracic spine non–thrust mobilization. Within-group effect sizes were found to be large for both groups (SMD > 2.1), and between-group effect size was also large (SMD = 1.3) in favor of the manipulative group. Table 2 provides baseline and postintervention data as well as within-group differences with their associated 95% CI for neck pain intensity.

In this study, 1 patient who received thoracic spine thrust manipulation reported a minor side effect by experiencing cervicothoracic discomfort the day after the thrust intervention. This posttreatment symptom resolved spontaneously within 12 hours.

Discussion

The results of the current study demonstrated that there was no difference in PPT between individuals with chronic mechanical neck pain receiving either thoracic spine manipulation or thoracic non–thrust mobilization. However, individuals who received thoracic thrust manipulation experienced significantly great reductions in neck pain as measured by the Numerical Pain Rate Scale at the 1-week follow-up. The effect size for the between-group differences was large, suggesting a clinical effect of thoracic spine thrust manipulation; however, the between-group difference score surpassed the reported MCID of 1.3 points, but it did not surpass the MDC of 2.1.[28]

Although there was not a statistically significant difference between groups for PPT, both groups experienced improvements regardless of the intervention received; however, a cause-and-effect relationship cannot be inferred because we did not have a control group. In addition, although both groups' exhibited improvements in PPT, the values did not exceed the MCID, as identified by Walton et al[25] for the cervical spine and the tibialis anterior muscle. It should be noted that these patients only received one session of the intervention. Perhaps extra sessions are necessary to experience a cumulative effect when dealing with manual therapy techniques directed at the thoracic spine. For example, it has been demonstrated that in a population with acute mechanical neck pain, thoracic spine manipulation does not lead to tolerance in regard to pain and active range of motion.[34] However, future studies are needed to examine if this same phenomena is true with changes in PPT.

A small trial had previously found that individuals with lateral epicondylalgia experienced greater reductions in PPT if they received cervical spine manipulation as compared with thoracic manipulation.[19] However, a more recent trial compared the effects of cervical spine manipulation to thoracic spine manipulation for improving PPT in patients with chronic mechanical neck pain.[20] The results demonstrated that there were no significant differences between the 2 groups. Patients in that study experienced considerably greater changes in PPT with thoracic manipulation than did those patients in the current study. Future studies should continue to examine the physiological effects of thoracic spine manipulation and mobilization in patients with mechanical neck pain.

The current study identified a greater reduction in neck pain after thoracic thrust manipulation compared with thoracic mobilization. Both groups reported significant and clinically meaningful neck pain intensity that met or exceeded the MDC and MCID; however, the between-group difference score met the MCID but not the MDC.[28] This was an unexpected because it is not normal that the MDC score would be higher than the MCID (readers are referred to the study by Cleland et al[28] for further discussion on this). Our results are similar to Cleland et al,[21] who also identified a greater pain reduction in pain after thoracic manipulation. The reason for the difference between studies might be because Cleland et al included a group of patients with neck pain and symptoms less than 2 months, whereas the current study included patients with chronic symptoms. Interestingly, our results differed from that of Suvarnnato et al,[22] in that they experienced no differences in pain reduction between thoracic thrust manipulation and non–thrust mobilization in individuals with chronic neck pain. These authors used the visual analog scale in the study, making direct comparisons difficult to do.

Limitations

A number of limitations should be considered in this clinical trial. First, we only included a short-term follow-up period, and we do not know if the findings would be the same at long-term follow-up periods. Second, we did not include a control group; hence, a cause-and-effect relationship cannot be inferred. Third, it is possible that the sample size was unpowered to detect changes in PPT over all points because estimation was only based on available data for the cervical spine. This could explain why the current study observed changes in neck pain intensity but not in PPT. Another reason maybe that both outcomes assess different aspects of the pain experience because PPT is considered as a neurophysiological outcome, whereas neck pain is a self-reported outcome. Fourth, the thoracic manipulation was done without using manipulation indicators for determining the site of manipulation. Nevertheless, it should be recognized that thoracic spine thrust manipulation lacks segmental sensitivity.[30] Fifth, only 1 clinician treated all patients in the current study, which limits the generalizability. Furthermore, we did not collect a measurement of function, so we cannot say if this was different between groups after the intervention. Futures studies should include pain and function as outcome measures and include a long-term follow-up.

Conclusion

The results of this randomized clinical trial suggest that thoracic manipulation resulted in similar changes in PPT as thoracic mobilization in patients with chronic neck pain. However, those who received thoracic manipulation had a greater reduction in pain than did those who received thoracic non–thrust mobilization. Future studies should continue to compare the effects of mobilization vs manipulation and continue to investigate the physiological mechanisms that result in the beneficial effects of manipulation.

Practical Applications

- This study suggests that thoracic manipulation resulted in similar small changes in pressure pain sensitivity to thoracic mobilization in chronic neck pain.
- Patients with mechanical neck pain receiving thoracic manipulation had a greater reduction in pain than did those who received thoracic non–thrust mobilization.
- Future studies should continue to compare the neurophysiological effects of mobilization vs manipulation

Funding Sources and Potential Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): JSM, ROS, JAC, MPC, STD, CFP.

Design (planned the methods to generate the results): JSM, ROS, JAC, MPC, STD, CFP.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): JAC, STD, CFP.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): JSM, ROS, MPC.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): JSM, ROS, JAC, MPC, CFP.

Literature search (performed the literature search): JSM, ROS, JAC, MPC, STD, CFP.

Writing (responsible for writing a substantive part of the manuscript): JSM, ROS, JAC, MPC, STD, CFP.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): JSM, ROS, JAC, MPC, STD, CFP.

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