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Effectiveness of craniosacral therapy in the human suboccipital region on hamstring muscle

A meta-analysis based on current evidence

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Abstract

Background: Craniosacral therapy (CST) has remained controversial in the treatment of musculoskeletal disorders. To our knowledge, there is no larger sample size of research to demonstrate the effectiveness of craniosacral therapy in the human suboccipital region on hamstring muscle.

Methods: To study whether the CST in the human suboccipital region could have a remote effect on the flexibility of the hamstring muscles, the Cochrane Library, Medline/Pubmed, CNKI, Embase, and Google Scholar were searched. Clinical trials assessing the effects of CST in short hamstring syndrome patients were eligible. Mean differences (MD) and 95% confidence intervals (CI) were calculated for the straight leg raise test (primary outcomes). The quality of the included studies was assessed using the Newcastle-Ottawa Scale. RevMan 5.3 software was used for data analysis.

Results: Five controlled trials with a total of 238 participants were included. CST could effectively relieve the symptoms of short hamstring syndrome patients [the overall MD −9.47, 95% confidence interval (CI) −15.82 to −3.12, $P < .000001$]. The CST was better than the proprioceptive neuromuscular facilitation technique (MD 3.09, 95% CI 1.48–4.70, $P = .0002$). Sensitivity analysis shows that the frequency of treatment and who did the experiment might be the main sources of impact results.

Conclusion: CST could change the flexibility of the hamstring muscles. CST had a better curative effect when compared to proprioceptive neuromuscular facilitation technique on the hamstring muscles.

Abbreviations: CI = confidence intervals, CSF = cerebrospinal fluid, CST = craniosacral therapy, MD = mean differences, MDBC = myodural bridge complex, PNF = proprioceptive neuromuscular facilitation, SHS = short hamstring syndrome, SIT = suboccipital muscle inhibition technique, SLR = straight leg raise test.

Keywords: craniosacral therapy, meta-analysis, myodural bridge complex, short hamstring syndrome

1. Introduction

Osteopathic manipulative treatment usually involves a series of manual techniques,[1] which was a method that emphasizes the role of the musculoskeletal system in health.[2] According to the clinical judgment of doctors, osteopathic manipulative treatment could be applied to many areas and tissues of the body. The characteristic of treatment was to take a holistic approach to patients, sometimes far away from the symptomatic areas.[3] Among these, craniosacral therapy (CST) comes from the special medical practice of osteopathy. CST is considered to be a noninvasive, mindfulness-based therapeutic strategy that releases fascial limitations between the cranium and the sacrum using gentle manual techniques.[4] The theory of CST is based on the negative effect of fascial limitations within the craniosacral system on the rhythmic impulses transmitted from the skull to the sacrum through cerebrospinal fluid (CSF).[5,6] This rhythmic impulse was named craniosacral rhythm.[7] The CST aims to restore sympathetic nerve activity,[8,9] which is commonly exacerbated in chronic pain sufferers, by changing craniosacral rhythms, besides releasing myofascial structures. It has been demonstrated that decreasing physiological arousal and entering the parasympathetic mode[10] improve the body's capacity for physiological regulation and tissue relaxation,[11] as well as reduce chronic pain.[12]

However, the specific mechanism of craniosacral medicine,[13] and the mechanism of how the CSF is affected by manipulation to improve patients' symptoms in particular, is still unclear. Therefore, there have been and still remain, continued calls for it to stand up to the rigors of evidence-based medicine. To date, no higher quality methodological study to demonstrate the effectiveness of CST in the human suboccipital region on

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hamstring muscle[14] (also named the suboccipital muscle inhibition technique, SIT shown in Fig. 1). The effectiveness of this technique has been reported in literatures for the treatment of tension-type headaches,[15] cervical headaches,[16] and temporomandibular joint disorders.[17] Therefore, the effect of CST on shortening hamstring was explored, and explained its mechanism combined with existing literature reports in this paper. Shortening of the hamstring could be examined by straight leg raise (SLR) tests. The short hamstrings syndrome (SHS) defined by Ferrer et al[18,19] means that a patient cannot touch the floor with the fingertips in the bent-forward position or the SLR is lower than 80°.[20]

2. Methods

Two researchers separately identified all studies by searching for "*(Atlas occipital joint) OR Atlanto Occipital Joint) OR Atlanto-Occipital Joints) OR Joint, Atlanto-Occipital) OR Joints, Atlanto-Occipital) OR Atloido-Occipital Joint) OR Atloido Occipital Joint) OR Atloido-Occipital Joints) OR Joint, Atloido-Occipital) OR Joints, Atloido-Occipital)) OR Suboccipital) AND ((Rehabilitation) OR Habilitation)) AND hip motion) OR* Short hamstring syndrome*) OR Sacroiliac joint)) Filters: Clinical Trial*" keywords in the Cochrane Library, Medline/Pubmed, CNKI, Embase, and Google Scholar from September 2018 to November 2020. The search content was recorded in Table 1.

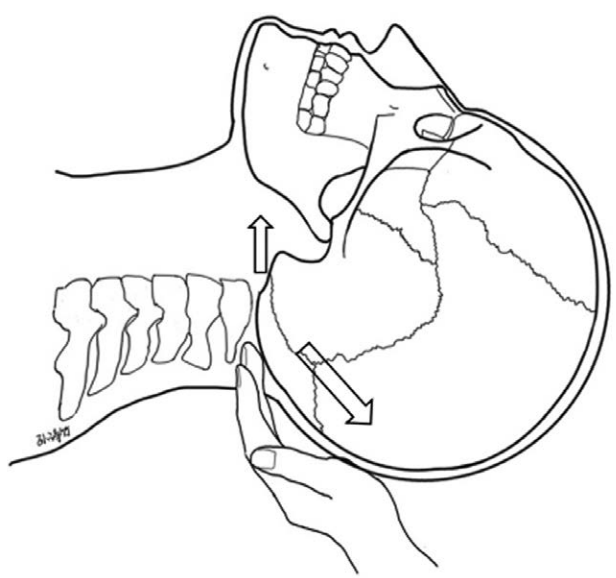

Figure 1. SIT diagrammatic drawing. The patient in a supine position with the neck in a neutral position, and closed his eyes, and the therapist sits behind the subject's head, places the palm of his hand below the head, and places the finger pad on the projection of the posterior arch of the atlas. Gradually increased the pressure. Black arrow: Directions of pressure. SIT = suboccipital muscle inhibition technique.

2.1. Ethical review and informed consent of patients

Meta-analysis was on published research data and does not involve patients. So ethical approval was not applicable.

2.2. Selection criteria

This study only includes the relationship between SIT and SHS. While ensuring that the treatment method, treatment area, patients age range of the final selected studies must be consistent, which must contain a consistent control group. The duration of each treatment was no more than 10 minutes.

2.3. Types of participants

Participants included in the studies are adult patients (age ≥ 18 years) with SHS only.

2.4. Types of interventions

SIT or used several different forms of intervention including SIT.

2.5. Types of comparators

Acceptable comparators of any type of intervention or no treatment.

2.6. Types of outcomes

We considered as primary outcome, the straight leg raise (SLR).

2.7. Types of studies

Randomized controlled trials (RCTs) or controlled clinical trials (CCTs) written in English language or Chinese.

2.8. Study identification

Two investigators (WJ, OCS) applied selection criteria to independent reviewed titles and abstracts. At the end of the screening process, the full text was retrieved and evaluated for other eligibility. Discrepancies were resolved by consensus after discussion, otherwise a third author (CW) made the final choice.

2.9. Quality of selected studies

The methodological quality of the selected studies was assessed using the Newcastle–Ottawa Scale based on 3 main items with a maximum score of 9: the selection of study groups (0–4 points), the comparability of study groups (0–2 points), and the determination of either the exposure or outcome of interests (0–3 points).

Table 1

Search content.

Participants	Short hamstring syndrome) OR Sacroiliac joint) OR hip motion
Interventions	Atlas occipital joint) OR Atlanto Occipital Joint) OR Atlanto-Occipital Joints) OR Joint, Atlanto-Occipital) OR Joints, Atlanto-Occipital) OR Atloido-Occipital Joint) OR Atloido Occipital Joint) OR Atloido-Occipital Joints) OR Joint, Atloido-Occipital) OR Joints, Atloido-Occipital)) OR Suboccipital) AND ((Rehabilitation) OR Habilitation)
Comparators	No restrictions
Outcomes	No restrictions
Studies	Clinical Trial

2.10. Data extraction

Two reviewers (WJ, OCS) performed data extraction separately using a predefined standardized electronic table. One reviewer extracted the data from the selected studies, and the other reviewer verified the extracted data. When the published data for the outcome measures were inadequate for the meta-analysis, the authors were emailed and adequate information was requested. The reviewers extracted eligible studies whose characteristics include Author, year, participants (sample type, number of participants recruited, drop-outs), interventions (treatment and control), Test time, outcome measures, and results of interventions. Disagreements regarding extracted data was resolved through discussion between the 2 reviewers, otherwise, a third author (CW) was consulted.

2.11. Statistical analysis

Data analysis was performed using RevMan software version 5.3. $P < .05$ was considered to be statistically significant. The continuous outcomes used Mean differences (MD) and 95% confidence intervals (CI) to represent the magnitude of the effect. Relative risk (RR) and 95% CI were calculated for dichotomous outcomes.[11] Chi-square test was used to detect heterogeneity between studies, the significance level was set to $P < .10$[21]; I^2 statistic was used to quantify the degree of heterogeneity,[22] value > 50% means significant heterogeneity. When heterogeneity was not detected, a fixed effect model was used; otherwise, a random effect model was applied. Subgroup analysis and sensitivity analysis were performed when the heterogeneity is > 50%. If a study did not provide appropriate outcome measures, it was included in the review, but excluded from the meta-analysis. Funnel plot asymmetry was used to assess publication bias.

3. Results

3.1. Characteristics of identified studies

Figure 2 shown the detailed screening process. An initial search identified 237 titles and abstracts from the electronic databases. After reading the abstract and title, 191 records were excluded. After reading the full-text articles and references by the inclusion and exclusion criteria, 3 published RCTs[23–25] and 2 CCTs[26,27] with a total of 238 patients met all of the inclusion criteria. The 5 included studies were published between 1997 and 2016 and were published in English. The age of the subjects ranged from 19 to 40 years. The patients were treated only once for 2 minutes, and all the evaluation indexes were completed within 5 minutes. The frequency of treatment in 1 of the articles was 5 days per week for 2 weeks and each treatment lasted for 2 minutes.[27] The general characteristics of the studies was recorded in Table 2.

3.2. Methodological quality assessment

The outcomes of methodological quality assessment were as follows: 2 studies had a score of 6,[26,27] 2 studies had a score of 7,[24,25] 1 studies had a score of 8.[23]

3.3. Meta-analysis

3.3.1. SLR. Five articles used the SIT technique to treat SHS.[23–27] SLR was used to check the efficacy of the treatment (Fig. 3).

Meta-analysis shown: The studies shown no statistically significant heterogeneity between pretreatment versus post-treatment ($P < .00001$, $I^2 = 92\%$). A random-effects model was applied to the meta-analysis, and results indicate that the mean SLR was significantly increased in post-treatment when compared with pre- treatment (MD −9.47, 95% CI −15.82 to −3.12, $P = .003$). This means that SIT treatment was effective in treating SHS.

Two articles used the proprioceptive neuromuscular facilitation (PNF) technology to treat SHS. SLR was used to check the efficacy of the treatment.[23,24]

Meta-analysis shown: Acceptable heterogeneity was identified for pretreatment versus post-treatment ($P = .24$, $I^2 = 27\%$). A fixed-effects model was applied for meta-analysis, and the result shown that the mean SLR was significantly increased in post- treatment compared to pre- treatment (MD −2.34, 95% CI −3.82 to −0.86, $P = .002$). This means that PNF treatment was effective in treating SHS.

Figure 4 shown the efficacy of SIT and PNF techniques compared to control groups.

Meta-analysis shown: Statistically significant heterogeneity was identified in SIT versus control ($P < .00001$, $I^2 = 96\%$). A random-effects model was applied to the meta-analysis, and the impact of SIT on enhancing SLR was demonstrated in the SIT versus control group (MD 9.66, 95% CI 0.95–18.38, $P = .03$).

No statistically significant heterogeneity was identified in PNF versus control ($P = .5$, $I^2 = 0$). A fixed-effects model was

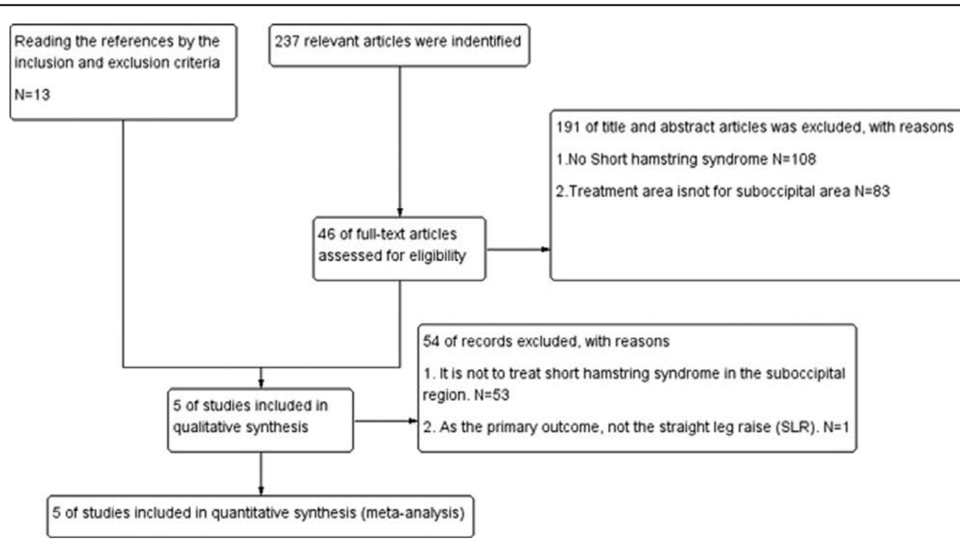

Figure 2. Screening process.

Table 2

Characteristics of included studies.

Author,yr	Participants	Interventions	Time	Outcome measures	Results
Aparicio,2009[25]	SHS 70 (47 male) Drop out:0	SIT N = 36 PT N = 34	Pre- Post-	FFD SLR PA	SIT Effective
Henry a,1997[23]	SHS 60 Drop out:0	SIT N = 20 Hip stretch N = 20 PT N = 20	Pre- Post-	ROM SLR	SIT Effective
Henry b, 1998[24]	SHS 52 Drop out:0	SIT N = 18 Hip stretch N = 18 PT N = 16	Pre- Post-	ROM SLR	SIT Effective
Vakhariya, 2016[27]	SHS #128;	SIT N = 20 NDS N = 20 SST N = 20 Control N = 20	Pre- Post-	SLR AKE SRT	All Effective NDS more
Sung, 2015[26]	SHS 50 (19 male) Drop out:0	SIT N = 25 SMFR N = 25	Pre- Post-	SLR FFD PA	SIT more Effective

AKE = active knee extension test, FFD = forward flexion distance, ICR = cervical spine isometric contract-relax technique, NDS = neurodynamic sliding, PA = popliteal angle, PKE = passive knee extension, PT = placebo technique, SHS = short hamstring syndrome, SIT = suboccipital muscle inhibition technique, SLR = straight leg raise test, SMFR = self-myofascial release techniques, SRT = sit and reach test, SST = static stretching technique, ROM = flexion range of motion.

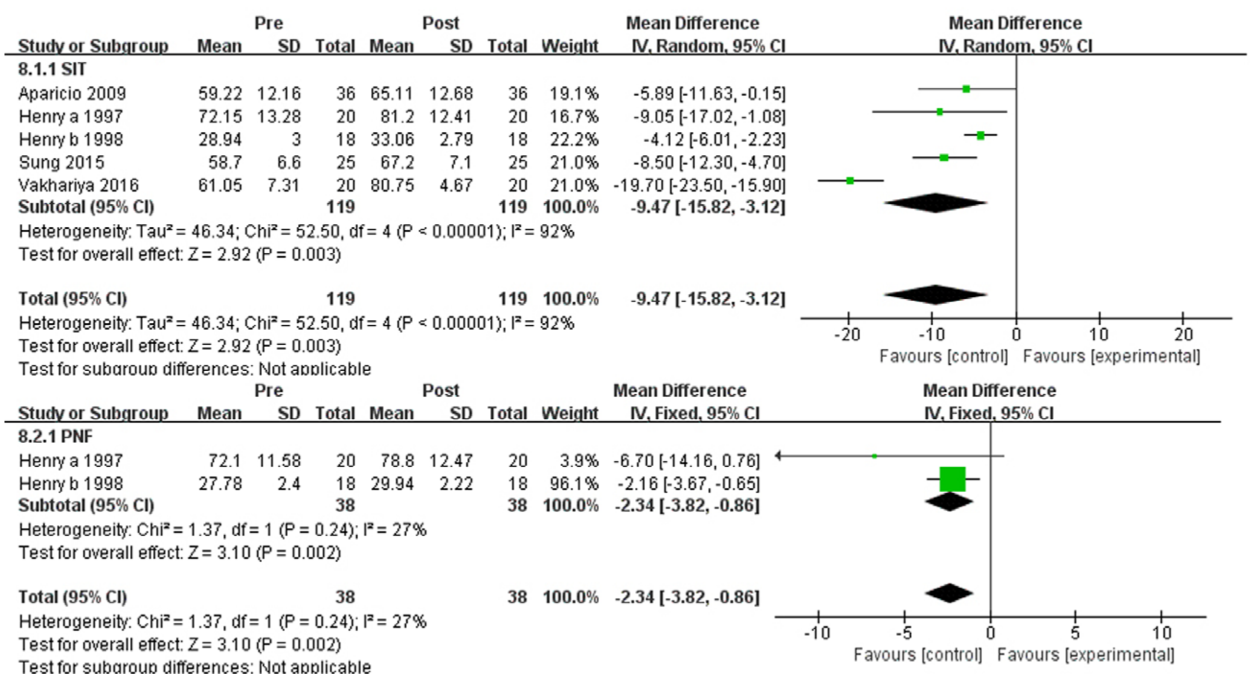

Figure 3. Comparison before and after treatment.

applied to the meta-analysis and the results reveal that SIT could increase SLR angle (MD 6.15, 95% CI 4.33–7.97, $P < .00001$).

The effectiveness of SIT and PNF techniques in the treatment are shown in Figure 5.[23,24] This meta-analysis identified no statistically significant heterogeneity in SIT VS PNF ($P = .86$, $I^2 = 0$). The fixed-effects model was applied and the results show that SIT was more effective than PNF (MD 3.09, 95% CI 1.48–4.70, $P = .0002$).

3.4. Sensitivity analysis

Due to heterogeneity $I^2 = 92\%$ and 96% in Figures 3 and 4. Sensitivity analysis was performed by excluding CCTs. The I^2, 95% CIs, and P values for change in SLR (SIT vs Control) were still similar to the results obtained before the exclusion of CCTs (Table 3). Thus, the inclusion of CCTs did not bias the results of our meta-analyses of the effect of osteopathic medicine in the human suboccipital region on hamstring muscle. After this procedure, the article-by-article exclusion method in conducting sensitivity analysis was revised, and the results were used to reevaluate the analysis.

In Table 4, we found that Vakhariya et al[27] might be the source of heterogeneity ($I^2 = 41\%$ MD −6.07, 95% CI [−8.74, −3.4]). In the study by Vakhariya et al,[27] the patients received treatments for the duration of 5 days per week for 2 weeks, after which the SLR was measured. Although each treatment also lasted for 2 minutes, this was different from other studies where the patients were treated only once for 2 minutes.

After excluding the study of 2 non-homologous authors, Vakhariya et al[27] and Aparicio et al[25] might be the source of heterogeneity ($I^2 = 0$, MD 9.19, 95% CI 7.23–11.15) in Table 5.

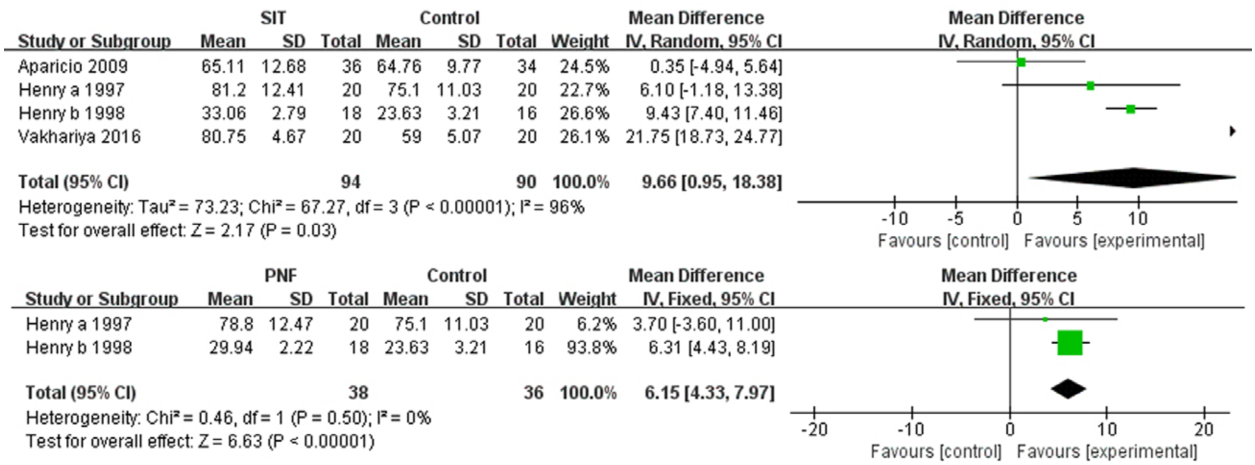

Figure 4. The experimental group was compared with the control group.

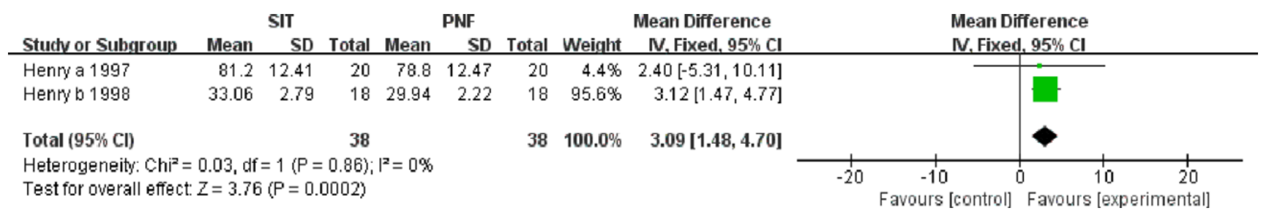

Figure 5. Which technology is more effective.

Table 3

Sensitivity analysis of the merged results.

	All eligible trials (RCTs and CCTs)					Only RCTs included				
Outcome	**No.**	**Patients**	**I^2**	**95% CI**	***P***	**No.**	**Patients**	**I^2**	**95% CI**	***P***
SLR (Pre vs Post)	5	238	92%	−9.74 (−15.82, −3.12)	.003	3	148	0	−4.52 (−6.28, −2.77)	<.00001
SLR (SIT vs Control)	4	184	96%	9.66 (0.95, 18.38)	.03	3	144	80%	8.12 (6.29, 9.96)	<.00001

CCT = controlled clinical trial, CI = confidence interval, RCT = randomized controlled trial, SIT = suboccipital muscle inhibition technique, SLR = straight leg raise test.

So, the results might be different from other studies when comparing between groups.

3.5. Publication bias

Considering the small sample size (<10) in our meta-analysis, funnel plot analysis was not applicable for the determination of publication bias.

4. Discussion

4.1. Main findings

According to the meta-analysis results, physical therapy at the suboccipital region could effectively relieve hamstring shortening syndrome, and physical therapy at the suboccipital region was better than direct physical therapy on the hip with regards to hamstring shortening syndrome. Although great heterogeneity (92% and 96%) was found in Figures 3 and 4, we conducted a sensitivity analysis according to the article-by-article exclusion method. Compared with the other 3 studies, the frequency of treatment[27] and who did the experiment[25] might be the main sources of heterogeneity in this paper.

4.2. Interpretation of the results

Increased activity of fascial nociceptors within restricted connective tissue has been found to contribute to inflammation and fibrosis remodeling processes, increased tissue stiffness, muscle tension, and persistent pain.[28] Suboccipital muscles are known to be associated with maintaining body posture as well as head rotation.[29,30] The suboccipital muscles spindles have high-density large diameter fibers that transmit proprioceptive information.[30,31] Suboccipital muscle inhibition technique was used to relax tension in the suboccipital muscles, which help to regulate the proprioceptive information. These fibers transmit proprioceptive signals that effectively inhibit damage perception signals from reaching the spinal cord and higher centers.[31] Which lowers the activation of sympathetic nerves. The expansion range of motion and the release of tense muscles were benefits of less harmful stimulation. This was consistent with previous research showed that CST could

Table 4

Sensitivity analysis result in pre versus post by article-by-article exclusion.

Excluding documents	Meta result
Aparicio 2009	I^2 = 94% MD −10.32, 95% CI [−17.99, −2.65]
Henry a 1997	I^2 = 94% MD −9.55, 95% CI [−16.84, −2.26]
Henry b 1998	I^2 = 87% MD −11.01, 95% CI [−17.98, −4.04]
Vakhariya 2016	I^2 = 41% MD −6.07, 95% CI [−8.74, −3.4]
Sung 2015	I^2 = 94% MD −9.72, 95% CI [−18.33, −1.10]

CI = confidence intervals, MD = mean differences.

Table 5

Sensitivity analysis result in SIT/PNF versus control by article-by-article exclusion.

Excluding documents	Meta result
Aparicio 2009	I^2 = 96% MD 12.72, 95% CI [3.15, 22.29]
Henry a 1997	I^2 = 97% MD 10.69, 95% CI [0.29, 21.10]
Henry b 1998	I^2 = 96% MD 9.56, 95% CI [−5.44, 24.56]
Vakhariya 2016	I^2 = 80% MD 5.60, 95% CI [−0.52, 11.71]
Vakhariya 2016 + Aparicio 2009	I^2 = 0 MD 9.19, 95% CI [7.23, 11.15]
Vakhariya 2016 + Henry a 1997	I^2 = 90% MD 5.23, 95% CI [−3.64, 14.10]
Vakhariya 2016 + Henry b 1998	I^2 = 36% MD 2.66, 95% CI [−2.87, 8.18]

CI = confidence intervals, MD = mean differences, PNF = proprioceptive neuromuscular facilitation, SIT = suboccipital muscle inhibition technique.

regulate hyperactivation of sympathetic nerves and reduce muscle tension.[8,9]

Previous studies have shown that cervical spine flexion triggers the movement of the spinal cord in the lumbar region, which was greater when the leg was flexed at the hip in cadavers.[32] Anatomically, it has been reported that the hamstrings and suboccipital muscles were believed to be connected by the so-called superficial back line[25] which was described by Meyers.[33] Therefore, an increase in suboccipital muscle tone results in a concomitantly reduced hamstrings extensibility. Recently scholars have noted that a new anatomical link was named myodural bridge complex (MDBC, Fig. 6). This link means that the rectus capitis posterior minor, rectus capitis posterior major, and obliquus capitis inferiors sends out fibers that converge to spinal dura mater (SDM).[34] Some scholars thought that MDBC could modulate the compliance of SDM.[35,36] The SDM is attached to the periphery of the foramen magnum and the internal aspects of the posterior C1 and C2 vertebral bodies, and to the coccyx through the filum terminale. The SDM also invests on the spinal nerve roots as far as the level of the intervertebral foramen. These sites reduce the compliance of the SDM and limit the range of motion of the SDM. Obstruction of dura movement tenses the peripheral nerve roots in movements of the lower limb such as SLR. The release of the suboccipital muscles which attach to the dura via the MDBC was believed to cause dura stretch and therefore increases the lower limb range of motion.[23,24]

The latest research shows that the contraction of the suboccipital muscles significantly changed both CSF flow and pressure.[37,38] Among CST theory, the craniosacral system including the membranes, CSF surrounding the spinal cord and brain, the bones to which membranes are attached to and the connective tissue related to these membranes.[39] Upledger thought[2] the slow flow of cerebrospinal fluid in the spinal canal produces little friction. If a force is applied in the epidural window of the epidural system, the same amount of force is transmitted from the cerebrospinal fluid to other parts of the system. This alteration in mechanical afferent transmission of CSF might activate the cerebrospinal fluid contacting neurons,[40] resulting in a series of physiological processes that relax the tight muscles.

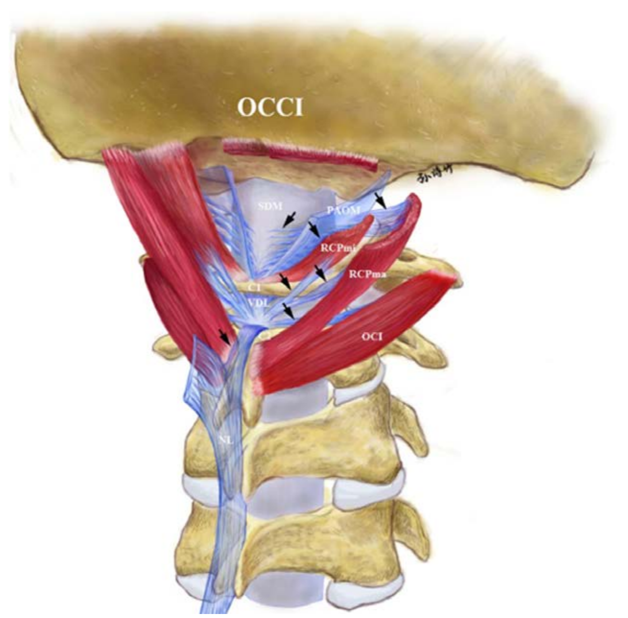

Figure 6. Myodural bridge complex structure diagrammatic drawing. The fibers originating from the ventral part of RCPmi, RCPma and OCI, passed through the atlanto-occipital interspaces and atlanto-axial space in a oblique direction. These fibrous gradually merged into the spinal dura mater, formed a part of the spinal dura mater. C1 = Atlas, C2 = Axis, NL = nuchal ligament, OCI = obliquus capitis inferior, OCCI = occipital bone, PAOM = posterior atlanto-occipital membrane, RCPma = rectus capitis posterior major, RCPmi = rectus capitis posterior minor, SDM = spinal dura mater, VDL = vertebral dura ligament, Black arrow = MDB fibers. Re: Zheng Nan,Chung Beom Sun,Li Yi-Lin et al The myodural bridge complex defined as a new functional structure. [J]. Surg Radiol Anat, 2020, 42: 143–153.

But this effects of the CSF change in the human body need to be further studied.

In summary, CST in the human suboccipital area could change the elasticity of the hamstring muscle, and this technique might cause changes in CSF via the MDBC.

4.3. Implications for further research

This study shows that the time of treatment and the person doing the experiment are the main sources of heterogeneity of this topic, so a clinical trial with large sample size and the same intervention time should be involved in the future. And the relationship between suboccipital region and other structures should be noted.

4.4. Implications for clinical practice

The results of this paper suggest that manipulative therapy on the suboccipital region might through the MDBC affect the degree of lower limb movement at the hip. Moreover, this paper might be helpful to study the mechanism of the CST.

5. Limitations

Due to few published articles and clinical trials on this subject, few articles were included in this meta-analysis. In the future, more experiments would be included to obtain more realistic results.

6. Conclusion

Despite these limitations, CST in the suboccipital region is very effective for changes the flexibility of the hamstring. Furthermore, CST had a better curative effect on hamstring when compared with direct hamstring muscle treatment.

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Writing – review & editing: Wei Chen, Hong-Jin Sui.

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