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Efficacy of suprascapular nerve blocks for management of hemiplegic shoulder pain: a systematic review and meta-analysis

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Abstract. – OBJECTIVE: To compare the efficacy of suprascapular nerve block (SSNB) with other treatment modalities for management of HSP in terms of relieving pain and improving range of motion of shoulder joint.

MATERIALS AND METHODS: An electronic search was carried out in PubMed, CENTRAL, SCOPUS and EMBASE databases using a series of relevant keywords, along with a manual search. Randomized clinical trials comparing the efficacy of SSNB with placebo injections, intra-articular injections (IAI), ultrasound and Pulsed RF were identified. The outcomes assessed were pain relief measured with visual analogue scale and improvement in the range of motion (ROM) at the end of the follow-up period. The meta-analysis was carried out for quantitative analysis of outcome data.

RESULTS: Eight randomized clinical trials were included. The quality of the included trials was low to moderate. SSNB showed improved pain relief at the end of 1 month, compared to placebo (normal saline injections) with mean difference (MD) 1.20 95% CI [0.59,1.80], $p<0.0001$. When compared to Pulsed radio-frequency (RF), the pain relief at the end of 1 month and 3 months was greater for patients treated with Pulsed RF than SSNB. No significant improvement in the range of motion for flexion, external and internal rotation was observed between SSNB and inter-articular injections.

CONCLUSIONS: SSNB is more effective in pain relief than placebo injections and ultrasound, but similar to pulsed RF. Similar effectiveness in ROM improvement was observed with SSNB and intra-articular injections.

Key Words:
Supra-scapular nerve block, Local anaesthesia, Hemiplegic shoulder pain, Systematic review, Meta-analysis.

Introduction

Hemiplegic shoulder pain (HSP) is one of the most common complications after cerebrovascular incident, such as stroke[1]. The incidence of HSP among stroke patients varies, with almost 72% of the patients complaining of shoulder pain within the first 12 months after stroke, and around 20% of the patients affected with HSP immediately[2]. The persistence of HSP causes lifestyle distress due to reduced range of movements (ROMs, pain, and subsequent disability in upper limb function[3].

HSP significantly affects the recovery of stroke patients and may hinder their rehabilitation at a very early stage. According to a study by Roy et al[4], HSP was strongly associated with prolonged hospital stay and poor recovery of arm function during the first 3 months after stroke. The aetiology of HSP is multi-factorial and can be broadly classified into neurological (paralysis, spasticity, altered sensation and neuropathic pain) and mechanical (shoulder subluxation, soft tissue injuries such as rotator cuff tears, bicipital tendonitis, muscle imbalance, weakness and altered scapula position)[5].

The main goal of HSP management is to reduce pain and to increase the ROM of the shoulder with an effective rehabilitation regiment[6]. Functional shoulder motion is fundamental for effective hand use during daily activities. While best nursing practice aims to improve functionality by handing, positioning, physiotherapy, strapping, physical therapy modalities or by acupuncture, high pain levels often interfere with the rehabilitation process[7]. Therefore, pain management strategies, such as shoulder intra-articular injection (IAI), supras-

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capular nerve blocks (SSNB), ultrasound (US) and pulsed radio-frequency (Pulsed RF) are common treatment modalities that can be applied at all stages in hemiplegic patients with shoulder pain and contribute to the rehabilitation of the patient.

To date several trials have compared outcomes of SSNB with various treatment modalities. However, to the best of our knowledge, no systematic review and meta-analysis has been attempted to provide level-1 evidence. Thus, the aim of this meta-analysis is to explore the clinical efficacy of SSNB compared to various treatment modalities for management of patients with HSP.

Material and Methods

This systematic review and meta-analysis was carried out with strict adherence to Preferred reporting of systematic review and meta-analysis (PRISMA) guidelines[8]. Methodology of the study was pre-determined and delineated for smooth conduction of the review.

Research Question

What is the clinical efficacy of SSNB when compared to other treatment modalities in reducing pain and improving range of motion in patients with HSP?

PICO Criteria

Population: Patients with hemiplegic shoulder pain.

Intervention: Treated with Supra-scapular nerve block (SSNB).

Comparison: Treated with standard care, ultra-sound, radiofrequency, intra-articular injections or placebo.

Outcomes: Pain assessed with Visual Analogue Scale (VAS) and Range of Motion.

Search Strategy

The search for relevant reports was conducted electronically in digital databases and manually in relevant peer reviewed indexed journals. The electronic search was carried out in PubMed, CENTRAL, SCOPUS and EMBASE database from inception to April 2021, using a series of relevant keywords combined using Boolean operators. The search string was developed using the following keywords: Hemiplegic shoulder pain, post-stroke shoulder pain, stroke, cerebro-vascular incident, supra-scapular nerve block, pain, range of motion. The manual search was carried out in all issues of *Stroke, International Journal of Stroke, Journal of Stroke, Journal of Rehabilitation Medicine, Clinical Rehabilitation.* References of previously conducted relevant systematic reviews and other relevant articles were also screened to identify any potentially eligible articles. Trial registries were also searched for any protocols registered in these databases.

Study Selection

The reports identified through various digital databases were imported into the citation manager (ENDNOTE) to eliminate duplicates. The titles and abstracts of the retrieved reports were then screened based on relevancy by two independent reviewers. Potentially eligible articles were subjected to full text assessment to match the inclusion and exclusion criteria.

Inclusion criteria:

1. Randomized clinical trials comparing the efficacy of SSNB with other treatment strategies for HSP.
2. Studies with an experimental group treated with SSNB with anaesthetic agent alone and control group treated with any other treatment modality like standard of care, intra-articular injections, placebo or ultra-sound.
3. Studies reporting the efficacy in terms of alleviating pain or improvement in the range of motion.

Exclusion criteria:

1. Studies not reporting relevant outcomes.
2. Studies published in languages other than English.
3. Studies which are not randomized.

Data Extraction

The data from the included reports were extracted and entered into the Excel spreadsheet by two independent reviewers. The following data were retrieved: study design; study groups; nature of control treatment; demographic characteristics (such as age, gender, sample treated); interventional characteristics, such as type of anaesthetic agent and needle used, site of injection and outcomes reported, such as pain and range of motion. The authors were contacted via electronic mail in cases of any missing or unclear information.

Data Analysis

The data were subjected to both qualitative and quantitative analysis. Study demographic and in-

terventional characteristics were tabulated and summarized as a part of qualitative analysis. A detailed qualitative report was provided for the studies or outcomes which could not be combined for a quantitative pooling of data. A pairwise meta-analysis was carried out to compare the treatment efficacy between SSNB and other treatment modality for a particular outcome, if 2 studies were found similar. The continuous outcomes like pain and range of movement were expressed as mean and standard deviation (SD) and the mean difference (MD) between the baseline and post-intervention results were compared. A random effect model was used to plot the studies, taking into account the heterogeneity among the included trials. The heterogeneity among the included trials was assessed using I^2 statistics. The I^2 value of <40% was considered less, and a value ranging between 40-70% was considered moderate, and >70% was considered high.

Risk of Bias Analysis

The risk of bias analysis for included RCTs was carried out using Cochrane risk of bias tool by two independent reviewers. The included trials were analyzed for bias in selection of participants by evaluating randomization process and allocation concealment methods; bias in blinding of participants and personnel; bias in blinding of outcome assessors; bias in selective reporting of results and lost to follow-up. The studies were graded as low, moderate and high risk based on adequacy of above-mentioned domains.

Results

A pool of 245 reports retrieved from electronic and manual database searches were screened for relevancy based on title and abstract. Eleven reports were then subjected to full text assessment, based on predefined inclusion and exclusion criteria. Of them, 3 reports[9-11] were excluded as 2 of the reports were non-randomized pilot studies and one report was a cross-sectional study. Finally, 8 trials[12-19], assessing the efficacy of SSNB compared to various treatment modalities in management of HSP, were included. The study selection process is summarized in Figure 1.

Two of the RCTs compared SSNB with placebo[14,18], two[13,15] with intra-articular injections (IAI), two[16,19] with pulsed radiofrequency (Pulsed RF), one with ultra-sound, and another with botulinum toxin injection[12]. A total of 267 patients (154 males and 113 females) were included in these 8 trials. Out of 267, 127 patients with HSP were treated with SSNB by administering local anaesthesia in supra-scapular notch, and the remaining 140 patients received alternative treatment modalities. All included trials assessed relief in pain after intervention, and only 5 trials[12,13,15,16,19] assessed various degrees of improvement in basic range of motion, such as flexion, abduction, internal rotation and external rotation. The follow-up of included trials ranged from 1 hour immediately after intervention to a maximum of 3 months. The demographic characteristics of included studies are provided in Table I.

SSNB was performed using both local anaesthetic agents alone and in combination with corticosteroid. Two trials[12,16] used lignocaine or lidocaine alone, one used bupivacaine[15] and the other used prilocaine[13]. A combination of methylprednisolone with bupivacaine was reported in one trial[14], and one trial used a combination of lignocaine with triamcinolone hex acetonide[17]. All the injections were given in the supra-scapular notch in supra-spinous fossa after regional pre-anaesthesia, with a 21-gauge to 25- gauge needle guided either manually or by ultra-sound. The details of the interventions in the SSNB and control groups of the included trials are provided in Table II.

The outcomes assessed were pain relief and improvement in the range of motion (ROM) of the shoulder post intervention at various follow-ups. The details of outcomes assessed with main statistical findings and author conclusions are provided in Table III.

The meta-analysis was carried out when at least two or more trials with similar comparisons and similar outcomes were found. Seven trials were included in the meta-analysis. One study which compared SSNB with botulinum toxin was not included in the meta-plots as the data represented was in median and interquartile range. However, it was found that Botulinum toxin injection into the pectoralis major and teres major muscles for HSP was equal in the short term and more effective in the middle term compared with SSNB treatment in improving pain, ROM, and function.

Pain Relief at 1 and 3 Months

The subgroup analysis carried out according to the comparative treatment modality showed improved pain relief in the SSNB group at the end of 1 month, compared to placebo (normal saline injections) with MD 1.20 95% CI [0.59,1.80],

$p<0.0001$, with moderate heterogeneity (i2 = 48%). SSNB group also showed similar improved pain relief when compared to ultrasound, with MD 2.94 (Figure 2).

When compared to pulsed RF, the pain relief at the end of 1 month and 3 months was greater for patients treated with pulsed RF than SSNB with MD -2.32 95% CI [-2.73, -1.90], $p<0.0001$ and MD -1.58 95% CI [-3.05, -0.11], $p=0.04$, respectively (Figures 2 and 3).

Improvement in ROM

The meta-plots for the four ROMs, flexion, abduction, internal and external rotation of shoulder arms, are provided in Figures 4-7 respectively. The sub-group analysis was conducted for all plots based on the comparative treatment modality provided along with SSNB.

When compared to pulsed RF, no significant difference was observed in the SSNB group for flexion and abduction (Figures 4 and 5). However, data from two studies[16,19] comparing SSNB with pulsed RF showed that SSNB resulted in significant improvement in the range of motion for internal and external rotation with MD -2.84 and MD -7.10 respectively (Figures 6 and 7).

One study[12] assessed the difference in the degree of improvement in ROMs for flexion and abduction of shoulder and arms, and reported no significant difference between SSNB and ultra-sound for treatment of HSP.

No significant difference in the range of motion for flexion, external and internal rotation was observed between the SSNB group and patients

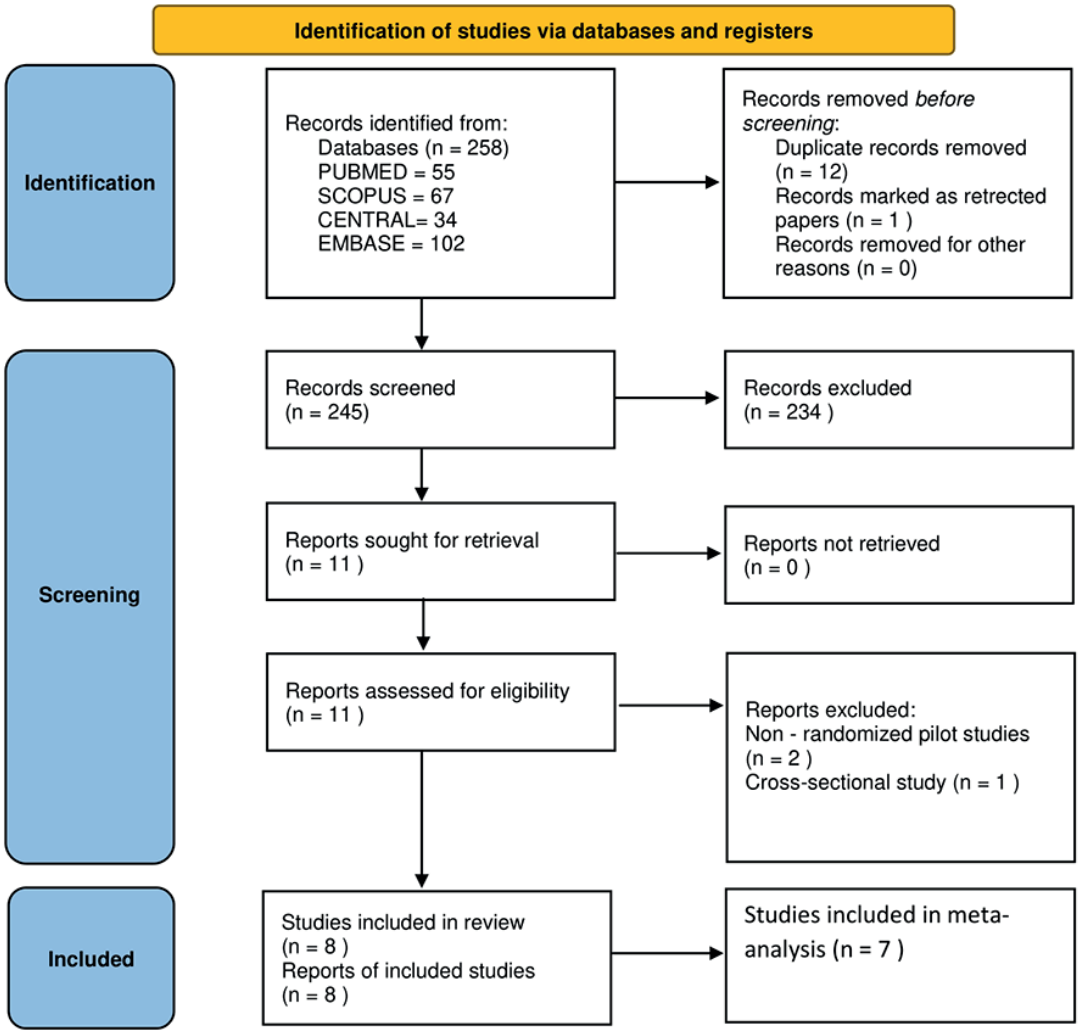

Figure 1. Study selection flow chart.

Table I. Characteristics of included studies.

Author	Year	Study Design	Experimental	Control	Sample size	Gender	Recruited Exp	Recruited Control	Analysed Exp	Analysed Control	Follow-up
Boonsong	2009	RCT	SSNB	Ultra-sound	10	6/4	5	5	5	5	2 weeks 4 weeks
Yasar et al[13]	2011	RCT	SSNB	Intra-articular injections	26	17/9	15	11	15	11	1 hour 1 week 1 month
Adey-wakeling et al[14]	2013	RCT	SSNB	Normal Saline (Placebo)	64	36/28	32	32	29	28	1 week 4 weeks 12 weeks
Sencan et al[15]	2019	RCT	SSNB	Intra-articular injections	30	17/13	10	20	10	20	1 hour 2 weeks 2 months
Alanbay et al[16]	2020	RCT	SSNB	Pulsed RF	30	18/12	15	15	15	15	1 month 3 months
Terlemez et al[18]	2020	RCT	SSNB	Placebo	30	15/15	10	20	10	20	1 hour 1 week 1 month
Kasapolglu-Aksoy et al[17]	2020	RCT	SSNB	BoNT-A	57	35/22	30	30	30	27	2 weeks 6 weeks
Yang et al[19]	2020	RCT	SSNB	Pulsed RF	20	10/10	10	10	10	10	4 weeks 16 weeks

RCT–Randomized clinical trial, SSNB–Supra-scapular nerve block, RF–Radiofrequency, BoNT-A-Botulinum Toxin A

treated with inter-articular injections. On the other hand, patients treated with IAI showed significantly greater improvement in the degree of arms abduction, with MD -8.88 95% CI [-15.15, -2.61], p=0.005 and very low heterogeneity i2=0% (Figure 5).

Risk of Bias Assessment

The quality of the included trials was low to moderate. Two studies[13,18] were found to achieve low risk in all the domains for assessing risk. Two studies[12,19] did not provide information on blinding. One of the studies[16] did not provide in-

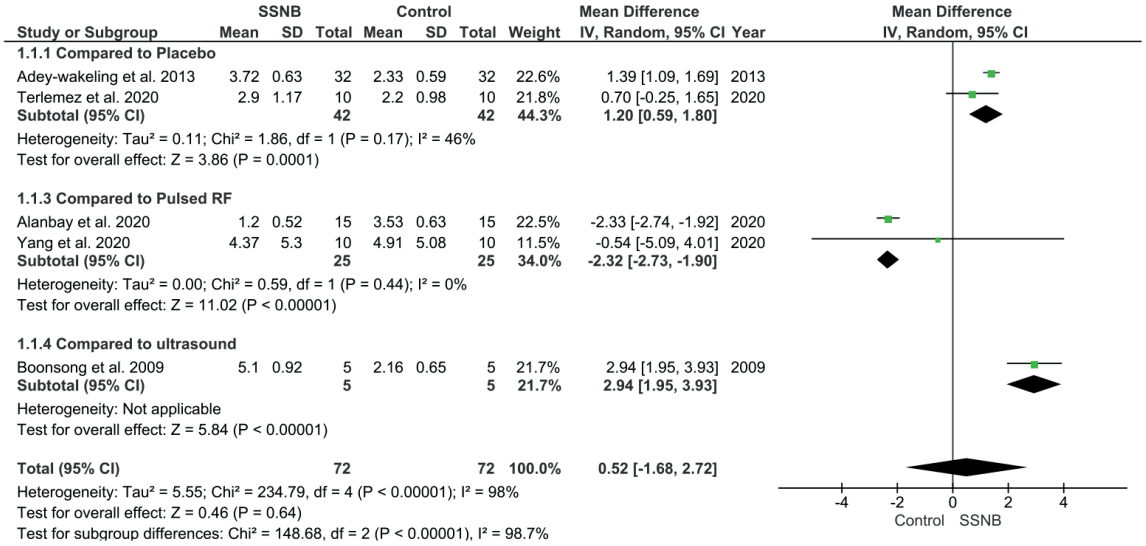

Figure 2. Forest plot showing comparison of pain relief after 1 month between SSNB and other treatment modalities.

Table II. Interventional characteristics.

Author	Year	SSNB			Control
		Injection	Needle	Site	
Boonsong et al[12]	2009	10 mL of 1% lidocaine without adrenaline	25G x 1.5" needle	Needle was introduced through the skin 2 cm cephaloid to the midpoint of the spine of the scapula	1.0-2.0 watt/cm^2 around shoulder joint 10 min every official day (5 times/week) x 4 weeks
Yasar et al[13]	2011	10 mL of prilocaine (Citanest 2%)	NR	The needle was inserted at the suprascapular notch point about 2 cm lateral and 1.5 cm superior to the intersecting point of the horizontal and perpendicular lines	Triamsinolone acetonide 40 mg (1 mL Kenacort A) and 6 mL of prilocaine (Citanest 2%) were used for the injection.
Adey-wakeling et al[14]	2013	suprascapular nerve block injection with 1 mL of 40 mg/mL methylprednisolone and 10 mL 0.5% bupivacaine hydrochloride.	10 mL syringe and a 21-gauge 38-mm needle	Supra-spinous fossa	Normal saline injection
Sencan et al[15]	2019	Two cubic centimetres of saline, 3 cc (0.5%) bupivacaine mixture	21-G 0.8 × 100-mm peripheral nerve stimulation needle	Supra-scapular notch	1 cc (0.5%) bupivacaine mixture was injected after 1-2 cc of contrast agent (300 mg/ 50 ml iohexol)
Alanbay et al[16]	2020	5 mL 2% lidocaine hydrochloride and 5 mL 0.9% sodium chloride isotonic saline solution	21-gauge x 3.5-inch spinal needle	Supra-scapular notch	A computerized radiofrequency (RF) pain management lesion generator and electrode system were used to apply pulsed radiofrequency to the suprascapular nerve.
Terlemez et al[18]	2020	5 ml of 2% lidocaine	23-gauge spinal needle	Supra-scapular notch	normal saline injection
Kasapolglu-Aksoy et al[17]	2020	2% (9 mL) lidocaine + triamcinolone hexacetonide (1 mL)	Ultra-sound guided needle	Supra-scapular notch	100–150 units of BoNTA-ONA (BOTOX® 2 ml saline) were injected into the pectoralis major from two points, and 40–60 units of BONTA-ONA were injected into the teres major under ultrasound guidance
Yang et al[19]	2020	8 mL of a mixture of 5 mL of 2% lidocaine 7 mg of Diprospan	7-gauge, 80 mm needle was ultra-sound guided near the arteriae suprascapularis,	Supra-scapular notch in the supraspinous fossa	22-gauge, 100 mm, 5 mm active-tip radiofrequency needle with 50 HZ, 1 ms, 0.3 V sensory stimulus and appropriate muscular response to a 2 HZ, 1 ms, 0.3 V stimulus, pulsed radiofrequency treatment was applied at 42 °C, 600 s, 100 V, 10 ms, and 1 Hz

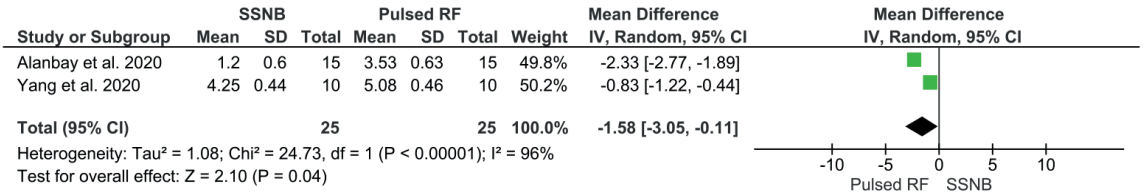

Figure 3. Forest plot showing comparison of pain relief after 3 months between SSNB and pulsed RF.

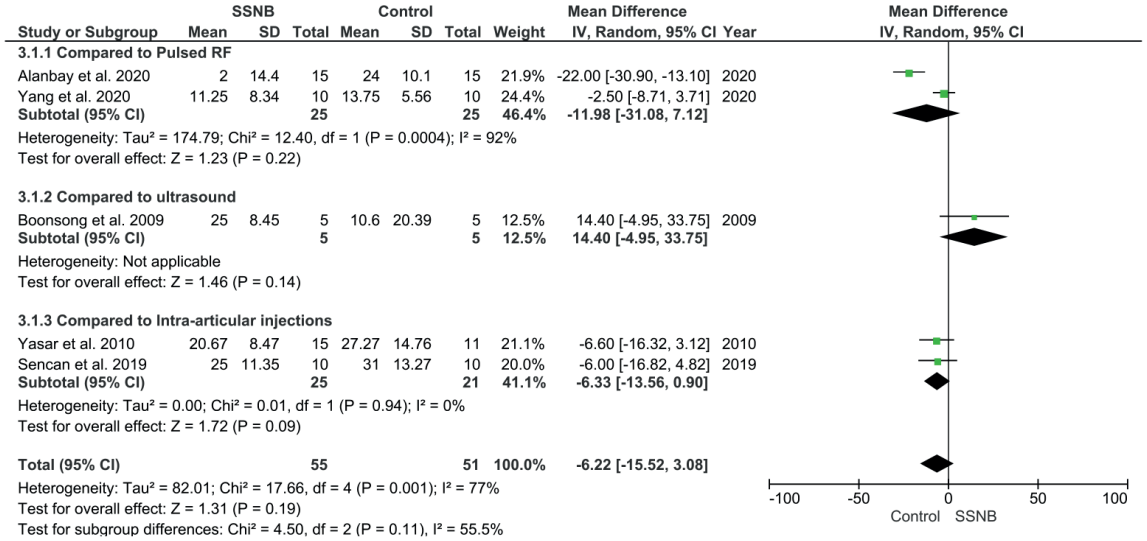

Figure 4. Forest plot showing comparison of improvement in ROM-flexion after 1 month between SSNB and other treatment modalities.

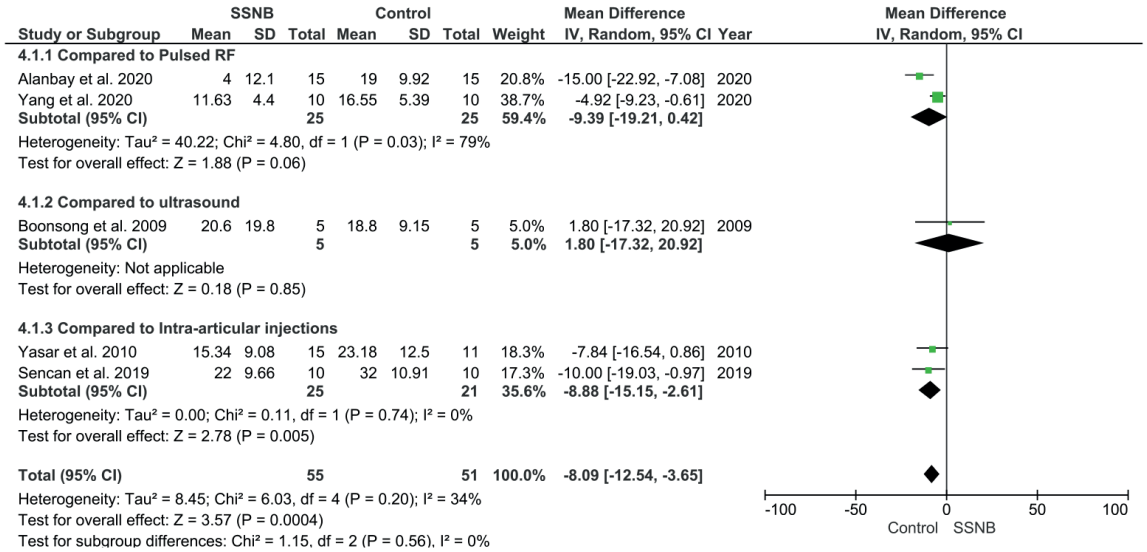

Figure 5. Forest plot showing comparison of improvement in ROM-abduction after 1 month between SSNB and other treatment modalities.

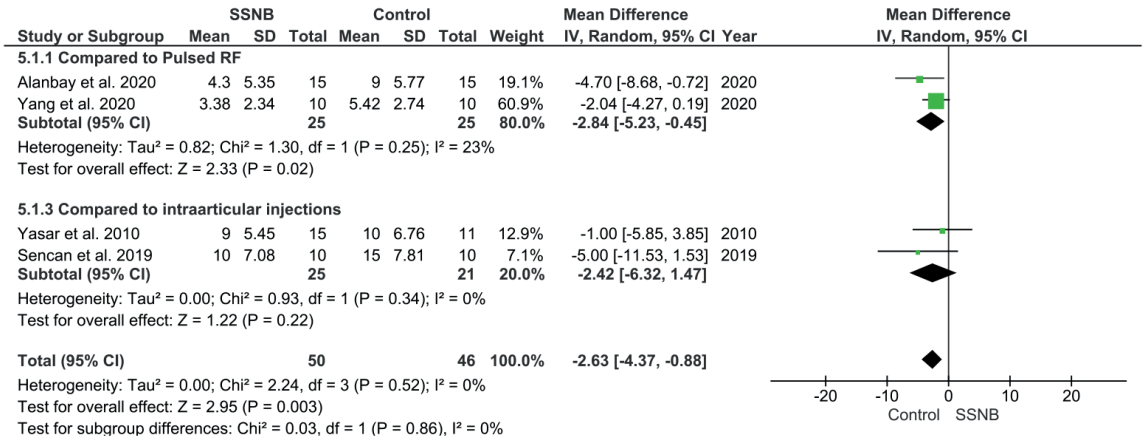

Figure 6. Forest plot showing comparison of improvement in ROM-internal rotation after 1 month between SSNB and various treatment modalities.

formation on random sequence generation and six of the trials[12,14-17,19] could not provide sufficient information on allocation concealment, for which the respective domains were marked at unclear risk. (Figure 8)

Discussion

This systematic review and meta-analysis compared the efficacy of SSNB and other treatment modalities in management of HSP, more specifically, in their abilities to relieve pain and improve the range of motion of shoulder and arms. Eight included randomized clinical trials assessed the efficacy of SSNB compared to placebo, ultrasound, intra-articular injections or pulsed radiofrequency. The evaluated outcomes included pain relief, measured by visual analogue scale, as well as various degrees of motion, such as flexion, abduction, internal and external rotation, measured during follow-up.

To our knowledge, this is the first systematic review assessing the efficacy of SSNB in patients with HSP. Previous studies looked at the effect of SSNB pain relief in patients with chronic shoulder pain. A comprehensive review by Chan et al[20] concluded that SSNB provided more pain relief in patients with

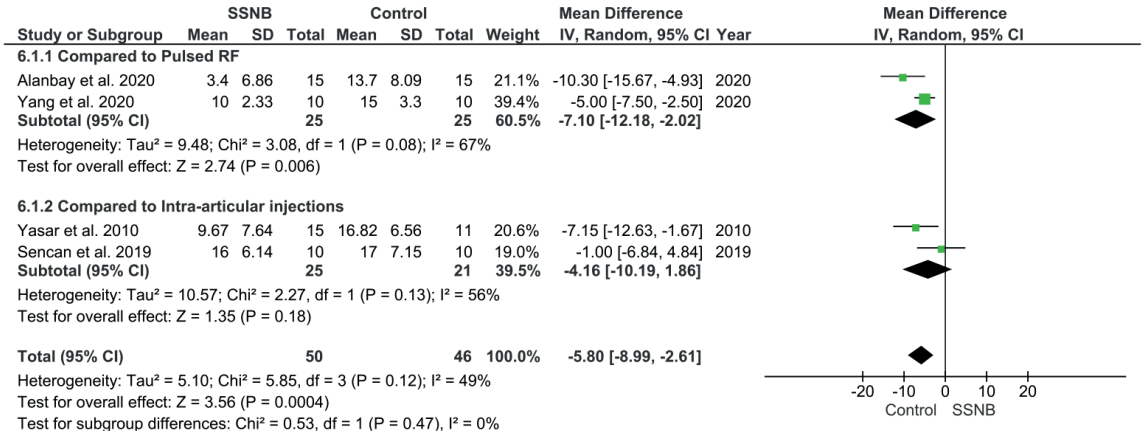

Figure 7. Forest plot showing comparison of improvement in ROM-external rotation after 1 month between SSNB and other treatment modalities.

long-standing rheumatoid arthritis as compared to intra-articular injection of corticosteroid, as well as short-term pain reduction in persistent rotator cuff lesions. While the review explored on efficacy, different anatomical variation and procedures of SSNB on different categories of patients, it did not perform any quantitative analysis.

Another systematic review and meta-analysis by Chang et al[21] assessed SSNB efficiency as compared to physical therapy, placebo, and intra-articular injections in patients with chronic shoulder pain. The review included eleven RCTs and demonstrated that SSNB was superior to placebo and physical therapy, but had similar efficacy as intra-articular injection for treatment of chronic shoulder pain.

SSNB with local anaesthetics alone or combined with corticosteroid resulted in significantly greater pain relief at the end of 1 month when compared to placebo and ultrasound, but not when compared to pulsed RF. Local anaesthetics that provide immediate blocking of the supra scapular nerve with both short acting and long-acting anaesthetic agents such as lignocaine and bupivacaine, are able to immediately alleviate neuropathic pain, allowing the patients to undergo physical therapy and perform repetitive shoulder movements, necessary for effective rehabilitation. Combination of corticosteroids and anaesthetic agents reduces the inflammatory component of the shoulder muscles and joints, further improving pain relief in the shoulder region.

SSNB involves the injection of anaesthetic agents into the supra-scapular notch in supra-spinous fossa. The 30-100mm long 21–25-gauge needle is inserted to access the area for the nerve block. Most of the included trials in our study used surface anatomical landmark to locate the supra-scapular notch, while two trials used ultrasonic guidance that allowed the physicians to locate the supra-scapular nerve more accurately, resulting in consistently improved outcome of the SSNB.

Our systematic review also assessed the functional improvement by evaluating the improvement in the range of shoulder motion. Basic motions, such as flexion, abduction, internal and external rotation were assessed. We found no significant difference in the ability of SSNB and inter-articular injections to improve flexion, and external and internal rotation of shoulder. Our findings agreed with the previous results reported by Chang et al[21] that showed that SSNB and IAI were equally effective in functional management of glenohumeral joints.

Pulsed RF was more efficient than SSNB in pain relief and function improvement in HSP patients, which is consistent with the results of a previous RCT that included patients with chronic shoulder pain[22]. In the randomized, placebo-controlled, double blind study, which investigated the effect of Pulsed RF applied to the suprascapular nerve on chronic shoulder pain, significant improvements in pain, disability, and functional assessment lasting as long as 6 months were observed in patients treated with PRF, but not in those who received SSNB with lidocaine only. Pulsed RF application has been reported to be a safe and repeatable method of pain reduction, with each application having 4 to 5 months of sustained efficacy. Our systematic review included two trials which assessed the outcomes of pulsed RF over SSNB, and demonstrated its efficiency in providing superior pain relief at 1- and 3-month follow-ups.

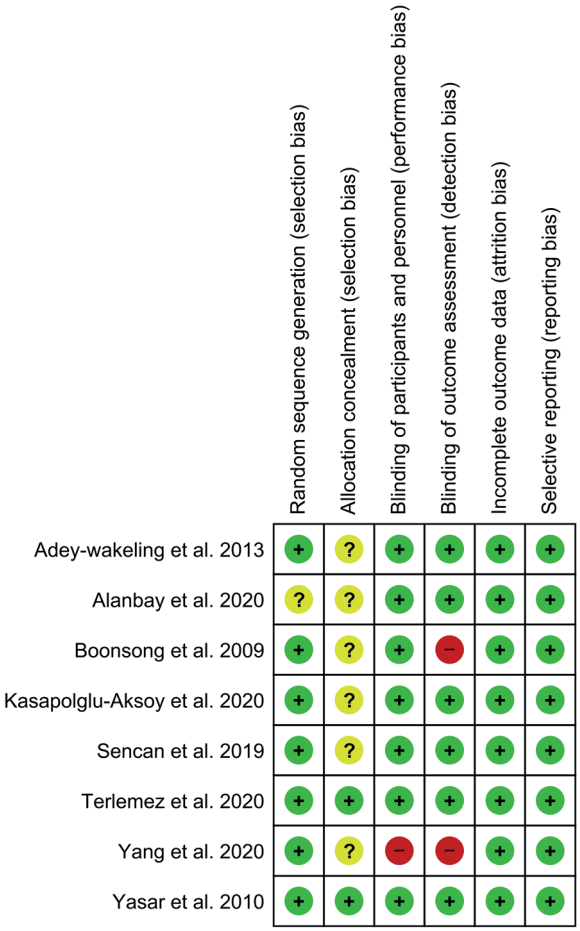

Figure 8. Risk of bias assessment summary of all included trials.

Table III. Outcome characteristics.

Author	Year	Outcomes Assessed	Main findings	Conclusions
Boonsong et al[12]	2009	Pain (VAS), ROM-flexion, abduction	There were significant improvements of VAS score at the 2nd and 4th week in the SSNB group with mean decreasing VAS scores of 40.6 + 25.4 and 51.0 + 20.7, respectively. For ROM outcome of the SSNB group, the increase of flexion at the 2nd and 4th week was 17.0 + 6.3 and 25.4 + 10.4 and abduction was 13.2 + 11.3 and 20.6 + 12.5, respectively. Statistically significant increase was detected at the 4th week in flexion motion ($p = 0.026$).	suprascapular nerve block is a safe and effective treatment for hemiplegic shoulder pain. It was more rapid and effective than therapeutic ultrasound in reducing pain score but there is a similar result for improvement of ROM.
Yasar et al[13]	2010	Pain (VAS), ROM-flexion, abduction, internal rotation, external rotation	Range of motion A and range of motion B were changed statistically in repeated measures. There were important differences in repeated measures of pain intensity levels at these two ranges of motion values ($p <0.05$). However, no significant differences were determined in all measurements between intra-articular steroid injection and suprascapular nerve block groups ($p <0.05$).	The results showed that Intra-articular steroid injection or suprascapular nerve block injection technique are safe and have a similar effect in stroke patients with hemiplegic shoulder pain.
Adey-wakeling et al[14]	2013	Pain (VAS)	Pairwise contrasts between groups were statistically significant at all follow-up time points, with the SSNB group consistently demonstrating greater mean VAS reduction when compared with placebo (p=0.02 at week 1, p =0.01 at week 4, p =0.02 at week 12).	Suprascapular nerve block is a safe and effective treatment for patients with hemiplegic shoulder pain.
Sencan et al[15]	2019	Pain (VAS), ROM-flexion, abduction	Significant decrease in the VAS and increase in shoulder passive ROMs were detected at all follow-ups in groups. In comparison, there was no significant difference in VAS scores. Change in the internal rotation at the moment that pain started was found to be higher in the patients treated with the combined method than the other methods. Change in maximum passive ROMs was similar between treatment groups.	IAI, SSNB, and the combination treatments are reliable and effective treatment modalities that provide pain relief and an increase in shoulder passive ROMs in HSP.
Alanbay et al[16]	2020	Pain (VAS), ROM-flexion, abduction, internal rotation, external rotation	Between the groups, comparison revealed that decrease in the VAS score was statistically significantly higher at the first (3.5 1.9 *vs.* 1.2 1.0) and third month (4.2 1.7 *vs.* 1.2 0.9) in the PRF group compared with the NB group ($p < 0.01$). The PRF group had significantly higher increases in shoulder ROM compared with the SSNB group ($p < 0.05$).	The combination of PRF applied to the suprascapular nerve and physical therapy was superior to the combination of SSNB and physical therapy.
Terlemez et al[18]	2020	Pain (VAS)	There were significant decreases in the VAS scores with both injections at all follow-up time points (p: 0.001 for the placebo group, $p <0.001$ for the SSNB group. When changes in VAS scores were compared between the groups, the SSNB group demonstrated a higher decrease in VAS than the placebo group.	The use of an SSNB with or without CS, to increase the range of motion in the affected shoulder, especially during the rehabilitation period.
Kaspolglu-Aksoy et al[17]	2020	Pain (VAS)	In BoNT-A, statistically significant improvement was found in all evaluation parameters on 2th and 6th week. SSNB showed significant improvement in all parameters on week 2 ($p < 0.05$), and significant improvement was observed pain in abduction in the 6th week ($p < 0.05$).	BoNT-A injection into the pectoralis major and teres major muscles for HSP was equal in the short term and more effective in the middle term compared with SSNB treatment in improving pain, ROM, and function
Yang et al[19]	2020	Pain (VAS), ROM-flexion, abduction, internal rotation, external rotation	Significant improvements in the VAS score were observed in both groups at T1 (4 week) and T2 (16 week). However, a significant difference was not observed between the two groups (T1: p=0.43; T2: p=0.23). In the PROM of shoulder abduction and external rotation, statistically, significant differences were observed between the two groups at T1 (p=0.02, & p=0.04) and T2 (p=0.02, & p=0.00). Statistically significant differences in shoulder flexion and extension were not observed between the two groups at T1 (p=0.23, & p=0.35) and T2 (p=0.14, & p=0.14).	Pulsed radiofrequency of SSN and AN achieves similar therapeutic effects to the nerve block. Pulsed radiofrequency modulation is superior to nerve block in improving the PROM of shoulder abduction and external rotation.

VAS – Visual Analogue Scale, ROM – Range of motion, SSNB – Supra-scapular nerve block, IAI – Intra-articular injections, PRF – Pulsed radiofrequency, BoNT-A – Botulinum toxin A.

Autologous platelet concentrates like PRP are currently used for alleviating pain in HSP patients[23] due to their anti-inflammatory effect[24]. However, further research is needed to compare the efficiency of PRP to SSNB or standard of care in management of HSP.

The majority of stroke patients care is provided by neuroscience nurses, and includes transferring, positioning and assisting in activities of daily living. Nurses, therefore, are an essential part of the therapy process[26]. The mobility of the recovering stroke patient is dependent on the assistance of nurses, therapists, doctors and other ancillary staff. Pain relief and improved ROM of HSP patients as a result of SSNB therapy may allow the nurses to provide the best of the standard care.

The main limitations of this review are inability to assess the influence of the type of anesthetic agent or corticosteroid used, duration of action of anesthetics, guidance method of the needle, and longer follow-up on outcomes due to limited availability of the data. This systematic review was not registered with any registry, however, a strict adherence to PRISMA guidelines was maintained to ensure quality. Lack of high quality randomized clinical trials in this area demands future research with larger sample sizes and longer follow-ups to provide stronger evidence.

Conclusions

Within the limitations of the study, the present meta-analysis demonstrated that SSNB had better effectiveness in pain relief as compared to placebo injections and ultra sound, but not to pulsed RF. SSNB and IAI demonstrated similar effectiveness in ROM improvement. Interestingly, SSNB was more efficient than ultra-sound in pain relief and improving ROM. Pulsed RF was superior to SSNB in alleviating pain and improving ROM in the long term.

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Availability of Data and Materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' Contributions
YW conceived and designed the study. YF and NZ collected the data and performed the literature search. YW was involved in the writing of the manuscript. JY edited the manuscript. All authors have read and approved the final manuscript.

Ethical Approval
Not applicable.

Patients Consent
Not applicable.

Conflict of Interest
The authors declare that they have no competing interests.

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