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ORIGINAL ARTICLE

Effects of fluoroscopy-guıded intraartıcular injectıon, suprascapular nerve block, and combınatıon therapy ın hemıplegıc shoulder paın: a prospective double-blınd, randomızed clınıcal study

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Abstract

Objective To investigate the effect and superiority of fluoroscopy-guided intraarticular shoulder injection (IAI), suprascapular nerve block (SSNB), and combination treatment in hemiplegic shoulder pain (HSP).

Design We included 30 patients diagnosed with HSP. Patients were divided into three groups: IAI, SSNB, and combination treatment. Patients were assessed using a visual analogue scale (VAS) prior to the injection and at hour 1, week 2, and month 2 after the injection, with goniometry at two angles at the moment that pain started and maximum passive range of motion (ROM) of the shoulder and Modified Barthel Index prior to the injection, at week 2 and month 2 after the injection.

Results 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.

Conclusion 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.

Keywords Hemiplegia · Shoulder pain · Nerve block · Intraarticular injection

Introduction

Hemiplegic shoulder pain (HSP) is one of the most common complications after stroke and is the most common post-stroke painful condition [1]. The prevalence was reported as 16–84% [2]. Its etiology is not clear. The underlying pain mechanisms are complex and multifactorial [3]. The cause of major pain was thought to be frozen shoulder [4]. HSP causes decreases in shoulder range of motion (ROM) and functional use of the arm. It affects the performance of the patient and its participation in rehabilitation in negative direction [5]. It limits activities of daily life and reduces the quality

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of life and associated with prolonged hospital stay [2, 6]. Early diagnosis and appropriate treatment lead to relief of symptoms in most patients [7].

The goal of treatment is to reduce pain and with an effective rehabilitation process to increase the ROM of the shoulder. Therefore, many treatment modalities such as shoulder straps, physiotherapy, analgesic drugs, physical therapy modalities, and botulinum toxin injections are used [8–10]. Shoulder intraarticular injection (IAI) and suprascapular nerve blocks (SSNB) are accepted as treatment modalities that can be applied at all stages in hemiplegic patients with shoulder pain and contribute to the rehabilitation of the patient [11]. In the literature, recent studies have demonstrated the effectiveness of IAI and SSNB to treat HSP [9, 11–18]. However, there are few studies examining the superiority of the two treatment modalities or the combined treatment of both treatment modalities, and the superiority of treatments to each other could not be demonstrated [11, 16]. In these studies, injections were applied either under USG guidance or blind technique. To the best of our knowledge, there are no studies that compared the efficacy of fluoroscopy-guided IAI, SSNB, and combination of both injection techniques in patients with HSP.

The aim of this study is to investigate the effect of interventional shoulder pain treatments, which are performed by fluoroscopy-guided IAI, SSNB, and both injection techniques, and their superiority to each other in the objective HSP treatment.

Materials and methods

The study was performed between June 2014 and June 2018 with patients admitted to Marmara University, School of Medicine, Rehabilitation Service with HSP. Inclusion criteria were (1) age, 18–80 years, (2) time since stroke onset < 1 year, and (3) severity of pain based on visual analogue scale (VAS) ≥ 4. Exclusion criteria were: (1) Mini-mental Status Test (MMST) score ≥ 24, (2) presence of complex regional pain syndrome (**t**ype I), (3) **h**istory of IAI or SSNB, (4) Modified Ashworth **S**cale (MAS) ≥ 3, (5) presence of infection in the shoulder region, presence of bleeding diathesis, (6) presence of neglect syndrome, (7) presence of fracture at the affected site, (8) unstable medical condition (uncontrolled diabetes mellitus, respiratory distress, etc.), (9) glenohumeral degeneration (grade 4), and excessive osteoporotic appearance, (10) Brunnstrom stage 1 and stage 6, and (11) patients with cardiac pacemaker.

Eighty patients were evaluated in terms of the screening criteria listed above and 32 were included in the study. Patients were assigned to three groups (10 IAI, 11 SSNB, 11 IAI + SSNB) by a nurse external to the study by simple randomization generated by a computer software program. Two patients (1 SSNB, 1 IAI + SSNB treatment group) were excluded from the study because they did not show up for follow-ups. After admission to the hospital, injections were administered by the pain medicine section. The shoulder rehabilitation program was initiated 24 h after injection therapy. In the context of hemiplegic shoulder rehabilitation, passive- and active-assistive ROM, stretching, and neurophysiologic exercises were applied in a total of ten sessions for 2 weeks guidance of an experienced physiotherapist.

A physiatrist who was unaware of which injection therapy was administered to the patient was responsible from completing the patient evaluation form, including detailed physical examination findings, demographic characteristics including age, sex, the follow-up process, and evaluation of treatment outcomes. Injection therapy was performed under fluoroscopy by a pain medicine specialist who was unaware of the clinical situation of the patients. Details of injection were not shared with the patient in order not to create bias.

The ethics committee of Marmara University approved the study. Patients were informed about the study and written, and verbal forms of acceptance were taken from all the patients included in the study.

Procedures

Patients were formally informed about the possible complications and benefits of the procedure by the physician in charge. The patients were transferred to the interventional procedures unit for injection therapy. The patients were monitored, and vascular access was established. Injections were administered at the supine position. The skin was cleaned **three** times with povidone-iodine and was covered with a sterile sheet. Short-acting local anesthetic (3 cc 2% lidocaine) was injected to provide anesthesia to the skin and subcutaneous tissue.

IAI The shoulder joint on the side to be treated was anteroposteriorly imaged by fluoroscopy. A 22-G 3.5-in. spinal needle was inserted into the shoulder joint under intermittent fluoroscopic imaging. Forty cubic centimeters of methylprednisolone acetate, 2 cc saline, 1 cc (0.5%) bupivacaine mixture was injected after 1–2 cc of contrast agent (300 mg/50 ml iohexol) (Fig. 1).

SSNB The patients were placed in supine position. SSNB was applied by the method defined by Kang et al. [19]. Fluoroscopy was medially angled to obtain the best view of the scapular notch and caudally angled to have a coracoid process and scapular spine in the same line. A 21-G 0.8 × 100-mm peripheral nerve stimulation needle was advanced to the scapular notch with 1-cm steps under intermittent fluoroscopic imaging. Paresthesia was observed along

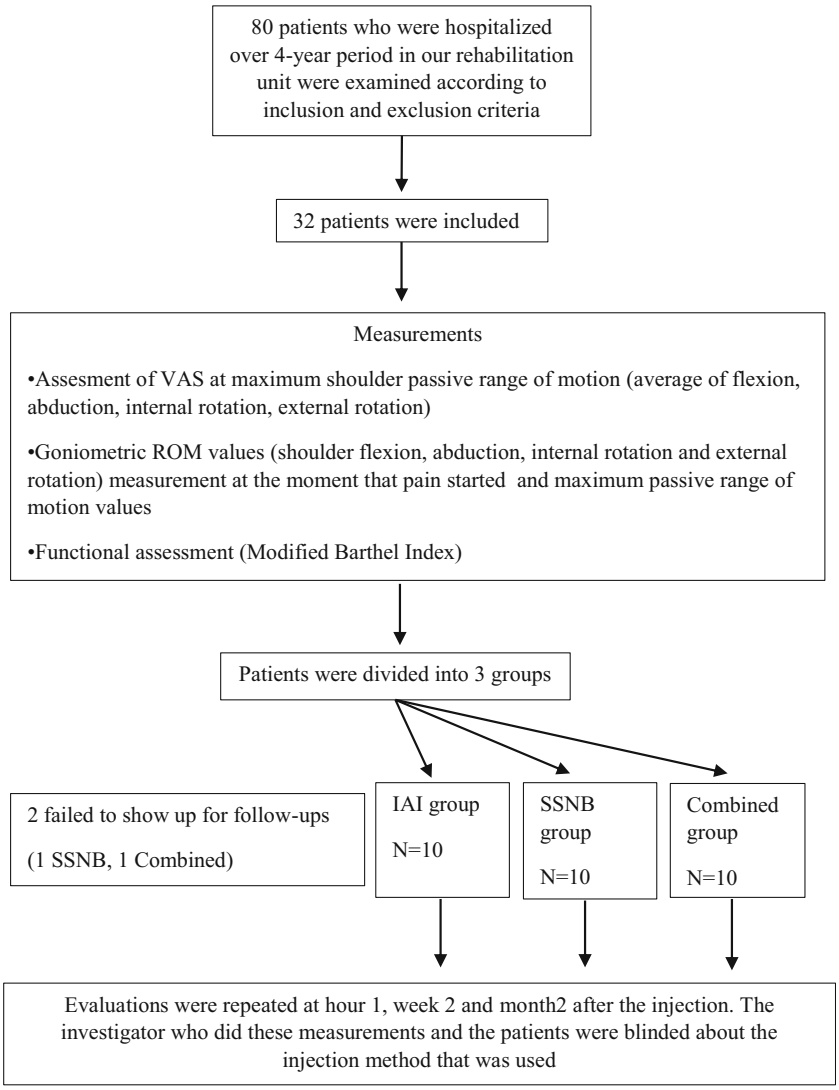

Fig. 1 Flow diagram showing how patients progressed through the study. IAI, intraarticular injection; SSNB, suprascapular nerve block; Combined, intraarticular injection + suprascapular nerve block. VAS, visual analogue scale, ROM, range of motion

suprascapular nerve dermatome, and abduction movement at arm was observed after a contraction in supraspinatus muscle. Two cubic centimeters of saline, 3 cc (0.5%) bupivacaine mixture was injected after 1–2 cc of contrast agent (Fig. 2).

Outcome measures

VAS was used prior to the injection and at hour 1, week 2, and month 2 after the injection to determine pain severity. The severity of pain was calculated with the average of VAS values of maximum passive flexion, abduction, internal rotation (IR), and external rotation (ER). The shoulder ROM (flexion, abduction, IR, and ER) was assessed by goniometry in two different ways, at the moment that pain started and maximum ROM. Activities of daily living were evaluated prior to the injection, at week 2, and month 2 after the injection with Modified Barthel Index (MBI). Brunnstrom grading system

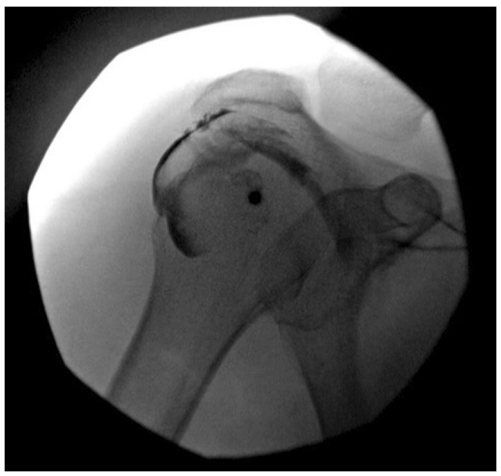

Fig. 2 Spread of radiopaque agent in shoulder joint in anteroposterior view

was used for motor evaluations of the patients. MAS was used to assess spasticity. Shoulder magnetic resonance imaging and direct X-Ray were used to assess joint stability, osteoporosis, fracture, and glenohumeral degeneration. MMST was used for cognitive evaluation. A flow diagram showing how patients progressed through the study was shown in Fig. 3.

Statistical analysis

In the study, the descriptive categorical data were presented as *n*, (%), continuous data as the mean ± standard deviation or median (interquartile range). Shapiro-Wilk test was used for the assumption of normal distribution. Fisher's exact test was used in the analysis of categorical data. One-way ANOVA test and ANOVA for repeated measures was used for normally distributed data. Kruskal Wallis test was used for comparison of the nonparametric data. For statistical significance, $p < 0.05$ was considered. Analyzes were carried out with SPSS 15 program.

Results

The study was completed with 30 patients, 17 of whom were males and 13 were females, with an average age of 62.9 ± 8.1 years. Symptom duration of shoulder pain was 5.5 ± 1.81 months. Sixteen of the patients (53%) had right, and 14 (47%) had left-sided involvement. In 5 of the patients (16%), etiology was hemorrhagic and in 25 (84%) ischemic. Demographic (sex, age) and clinical features (symptom duration, etiology) were similar according to the study groups. There was no difference between the groups in the upper limb proximal, and distal Brunnstrom stage, spasticity, and MMST scores (Table 1).

The decrease in VAS scores in all three treatment groups was significant in all controls ($p < 0.001$). The change in MBI scores was not significant in all three treatment groups (Table 2). Increase in both passive range of motion at the moment that pain started and the maximum passive range of motion was found to be significant at all controls (Table 3).

There was no significant difference in the time-dependent changes of the VAS and MBI scores among the treatment groups (Table 2).

When the changes in the passive ROM at the moment that pain started were compared among the treatment methods, the change in IR was significantly higher in the combined treatment group and lower in the SSNB treatment group ($p = 0.003$) (Fig. 4). When the change in the maximum passive range of motion is examined according to time flexion, abduction, IR, and ER were similar among the treatment groups (Table 3).

Discussion

In our study, all the treatment groups showed improvement in pain scores and shoulder passive ROMs at all control visits. Although there was no significant difference between the groups, improvement of the pain scores especially in the combined treatment group at 2 weeks was remarkably higher than the other two treatment methods. In addition, improvement in the passive IR at the moment that pain started in the combined treatment group was significantly higher at the second week and second month than the other two treatment modalities.

IAI and SSNB are effective and reliable treatment modalities commonly used in the treatment of shoulder pathologies such as rotator cuff disease and frozen shoulder [19–21]. The major cause of shoulder pain in HSP is adhesive capsulitis and it is observed in 50% of hemiplegic patients [4]. Steroid injection exerts its effects with powerful anti-inflammatory and pain-relieving properties [20]. Suprascapular nerve is a mixed motor and sensory peripheral nerve originating from the upper trunk of the brachial plexus (C5, C6). It supplies motor innervation of supraspinatus and infraspinatus muscles. It is the major sensory nerve providing to sensory innervation of 70% of the shoulder joint, coracohumeral and coracoacromial ligaments, and glenohumeral joints [22]. SSNB may block the sensory fibers and temporarily interrupt the transmission of nociceptive information from the shoulder to the central nervous system [11, 17]. Although there was no significant difference in our study, pain scores at 1-h postinjection control were higher in the SSNB and combined treatment group than

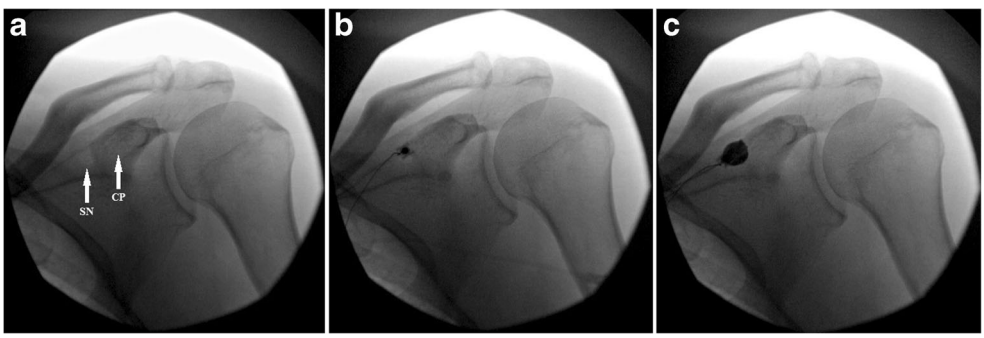

Fig. 3 This figure shows fluoroscopic images of the anterior approach for SSNB. **a** Optimum fluoroscopic image for SSNB. **b** Coaxial view of the needle in suprascapular notch. **c** Contrast agent suffusing through the suprascapular notch. SN suprascapular notch, CP coracoid process

Table 1 Demographic and clinical features of patients according to study groups

	IAI		SSNB		Combined		*p*
	n	(%)	*n*	(%)	*n*	(%)	
Sex							
Male	6	(60)	5	(50)	6	(60)	> 0.999
Female	4	(40)	5	(50)	4	(40)	
Age (years)	61.4	± 6.3	64.5	± 8.6	62.9	± 9.8	0.71
Symptom duration (month)	5.8	± 2.0	5.3	± 1.4	5.4	± 2.1	0.819
Etiology							
Ischemic	8	(80)	9	(90)	8	(80)	> 0.999
Hemorrhagic	2	(20)	1	(10)	2	(20)	
MMST	26.7	± 3.8	28.3	± 6.0	25.6	± 2.4	0.393
Brunnstrom							
UEP	3	(2.0–3.0)	3	(2.0–3.0)	3	(2.0–3.0)	0.93
UED	3	(2.0–3.0)	3	(2.0–4.0)	3	(2.0–3.0)	0.946
MAS							
UEP	2	(1.0–2.0)	2	(1.0–2.0)	2	(1.0–2.0)	0.89
UED	2	(2.0–2.0)	2	(1.0–2.0)	2	(1.0–2.0)	0.67

UEP, upper extremity proximal; *UED*, upper extremity distal; *MAS*, Modifiye Ashworth Scale, *MMST*, Mini Mental Status Test

in the IAI group, which may be related to the effect of the local anesthetic agent on the peripheral nerve. The long duration of the treatment effect suggests that other potential mechanisms are involved. This effect may be related to decreased sensitization secondary to reduced nociceptive stimuli [15].

Snels et al. compared intraarticular steroid injection with placebo (saline injection) in their study with 37 HSP patients in 2000 and found that the reduction in pain caused by intraarticular steroid injection of the shoulder and functional improvement was not superior to placebo. They did not recommend steroid injection in HSP treatment [23]. In this study, injections were carried out blinded. There are studies in the literature that emphasized that the rate of penetration into the joints in image-guided injections was higher than that of blinded injections, thereby reducing pain and improving functional healing [24–26]. The lack of significance in pain in this study may be due to the blinding of injections. In our study, different from Snels et al. study, reduction of pain and improvement in passive shoulder ROM were observed in patients who received IAI. Therefore, the results of our study support the results of current studies reporting that shoulder IAI is effective in the treatment of HSP [11, 12, 16].

Recent studies evaluating the efficacy of SSNB in the treatment of HSP in the literature have reported that SSNB reduces

Table 2 Comparison of VAS and MBI scores according to treatment methods

	IAI		SSNB		Combined		*p**
	Median	(IQR)	Median	(IQR)	Median	(IQR)	
VAS							
Before	8.5	(8.0–10.0)	8.5	(8.0–9.0)	9.0	(8.0–9.0)	0.720
1 h	4.0	(0.0–5.0)	2.0	(0.0–4.0)	2.0	(0.0–3.0)	0.568
2 week	3.0	(1.0–4.0)	3.5	(2.0–4.0)	2.5	(2.0–4.0)	0.569
2 month	3.5	(3.0–5.0)	4.0	(3.0–7.0)	3.5	(2.0–6.0)	0.868
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
MBI							
Before	65	(60 −70)	65	(60 −70)	70	(65 −70)	0.638
2 week	68	(65 −70)	65	(60 −70)	70	(65 −75)	0.715
2 month	68	(65 −70)	65	(60 −70)	70	(65 −75)	0.715
*p***	0.051		0.135		0.135		

Italic values: $p < 0.05$ statistically significant

VAS Visual Analog Scale, *MBI* Modified Barthel Index

Table 3 Comparison of passive range of motions according to treatment methods

	IAI		SSNB		Combined		*p**
	Mean	± SD	Mean	± SD	Mean	± SD	
PSPROM - Flexion							
Before	108 ± 25		102 ± 26		109 ± 28		0.322
2nd week	145 ± 30		137 ± 21		157 ± 18		
2nd month	139 ± 31		127 ± 22		148 ± 18		
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
PSPROM–Abduction							
Before	99 ± 17		88 ± 20		98 ± 35		0.527
2nd week	135 ± 25		119 ± 20		139 ± 25		
2nd month	131 ± 28		110 ± 21		127 ± 27		
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
PSPROM–IR							
Before	47 ± 15		46 ± 14		49 ± 10		*0.003*
2nd week	67 ± 15		62 ± 15		79 ± 9		
2nd month	62 ± 18		56 ± 16		73 ± 12		
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
PSPROM–ER							
Before	50 ± 10		39 ± 12		48 ± 16		0.829
2nd week	69 ± 18		60 ± 14		68 ± 16		
2nd month	67 ± 19		55 ± 14		63 ± 18		
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
MPROM–Flexion							
Before	137 ± 25		128 ± 24		139 ± 29		0.937
2nd week	170 ± 12		157 ± 20		172 ± 8		
2nd month	163 ± 19		149 ± 20		165 ± 13		
*p***	*< 0.001*		*0.008*		*0.003*		
MPROM–Abduction							
Before	124 ± 27		117 ± 22		130 ± 30		0.757
2nd week	157 ± 29		145 ± 19		161 ± 13		
2nd month	151 ± 30		135 ± 20		153 ± 14		
*p***	*< 0.001*		*0.001*		*0.004*		
MPROM–IR							
Before	66 ± 17		63 ± 16		66 ± 12		0.265
2nd week	86 ± 5		76 ± 15		83 ± 6		
2nd month	83 ± 9		71 ± 15		80 ± 7		
*p***	*< 0.001*		*< 0.001*		*< 0.001*		
MPROM–ER							
Before	66 ± 18		55 ± 8		66 ± 14		0.546
2nd week	85 ± 10		75 ± 11		80 ± 8		
2nd month	83 ± 13		70 ± 10		77 ± 8		
*p***	*0.002*		*< 0.001*		*< 0.001*		

PSPROM moment that pain started range of motion, *MPROM* maximum passive range of motion, *IR* internal rotation, *ER* external rotation

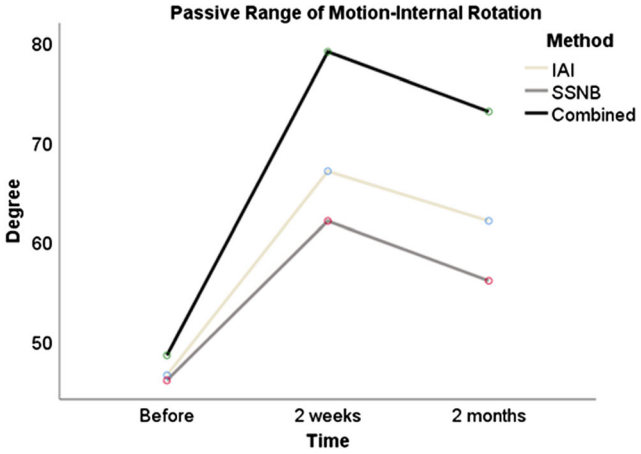

Fig. 4 Change according to time in the shoulder passive range of motion. IAI, intraarticular injection; SSNB, suprascapular nerve block, Combined, intraarticular injection + suprascapular nerve block

pain and improves shoulder passive ROM and is a safe and effective treatment [11, 13, 15, 17]. Our results in this regard are compatible with the literature. Wakeling et al. compared SSNB and placebo in 64 HSP patients and found SSNB superior to placebo at the decrease in pain scores in the third-month follow-up [15]. In our study, SSNB had similar efficacy when compared to IAI. For this reason, SSNB may be considered prior to intra-articular steroid injection because it does not have side effects that can be caused by steroids, but in order to evaluate it clearly, studies with a larger group of patients and longer follow-up are needed.

SSNB may be applied with fluoroscopy, USG, or blinded. US guidance is usually preferred because of the lack of radiation exposure, high accuracy rate, and low risk of complications [22]. We also do it with USG but we performed fluoroscopic-guided procedures in our study because fluoroscopically guided SSNB is reliable and effective and also fluoroscopic-guided procedures are performed more commonly in our clinical practice. Patient position and fluoroscopic angle in fluoroscopically guided SSNB have not yet been optimized [27]. Kang et al. emphasized that the anterior approach they described has advantages such as effective block with low volume local anesthetic, more accurate positioning of the needle tip in the scapular notch, and low complication rate [19]. Due to these advantages in clinical practice, the anterior approach is preferred. In addition, hemiplegic patients may have difficulty in injection because of change of the shoulder biomechanics and variations in the suprascapular notch [13, 27]. For this reason, it is combined with sensory and motor stimulation of the nerve and electrical stimulation which helps to determine the localization of the suprascapular nerve [28]. Furthermore, the process is performed in supine position, which is especially important for comfort in hemiplegic patients.

In the literature, there are very few studies evaluating the superiority of IAI, SSNB, and combined treatment in the treatment of HSP [11, 16]. Yasar et al. compared IAI and SSNB treatment efficacy in their study with 26 HSP patients. Both treatments reported that pain scores, passive ROM at the moment that pain started, and maximum passive ROM improved on 1-month follow-up [11]. In this study, injections were performed blinded and included a short follow-up period. Jeon

et al. compared effectiveness of IAI, SSNB, and combination of both treatments in their study with 30 HSP patients. They reported improvements in pain scores and passive ROM of shoulders at 2-months follow-up in all three treatment modalities but failed to show the superiority of treatment methods to each other [16]. In this study, injections were made with USG guidance. Although these results seem to be consistent with our study, in the combined treatment group, the improvement in shoulder passive IR at the moment that pain started was significantly higher at the second week and second month than the other two treatment modalities. In addition, although the treatment methods for pain scores were statistically similar, improvement in pain scores especially in the second week was remarkably higher in the combined treatment group. The effect of the combined treatment method was found to be similar to the other two treatment methods; this may be related to the fact that both studies were performed with a small number of patients.

Our study has some limitations such as small sample size, short-term follow-up, and lack of control groups. On the other hand, prospective design, being the first study with fluoroscopic guidance in patients with HSP, and its results are the strong aspects of this study.

In conclusion, IAI, SSNB, and the combination of both treatments are effective and reliable treatment methods that decrease pain and increase joint ROM. These may increase the participation of patients in the rehabilitation in the early stages. Although their effectiveness seems similar, there is a need for larger groups of patients and longer follow-up studies to clearly understand the effectiveness of the combined treatment method.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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