

Ultrasound-Guided Interscalene Versus Pericapsular Nerve Group (PENG) Block in Shoulder Surgery - Randomized Controlled Study

Original
Article

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ABSTRACT

Introduction and Aim: This study was conducted to determine whether Pericapsular Nerve Group (PENG) block is comparable to interscalene block in providing postoperative analgesia after shoulder surgery.

Methods: Patients over 18 years of age, ASA 1-2, and undergoing elective shoulder surgery were included in the study. After general anesthesia, patients were divided into Interscalene and Pericapsular Nerve Block Groups. Analyzed parameters were: age; gender; ASA grade; presence of additional disease; total anesthesia time; total surgery time; duration of block application; presence of motor block and, if any, return time of motor block; time of first additional analgesic administration; satisfaction at discharge; visual pain scores (VAS) at 10 minutes, and at the first, fourth, eighth, twelfth, sixteenth, twentieth, twenty fourth hour at rest and with movement; Ramsay sedation score; momentary and total tramadol amount; additional analgesia need; and complications.

Results: Forty patients were recruited with a mean age of 58.6±20.1 years. A significantly shorter pain-free period and lower satisfaction levels were observed in the PENG group (both $p<0.05$). There was no significant difference between PENG and interscalene block in terms of resting and moving VAS values up to 16 hours, but at the sixteenth hour, both resting and moving VAS values were significantly higher in the PENG group.

Conclusion: PENG block was as effective as interscalene block in providing postoperative analgesia but was less acceptable to patients.

Key Words: Interscalene block, Pain, Pericapsular Nerve Group (PENG) Block, Shoulder, Ultrasound.

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INTRODUCTION

Shoulder pain is a very common musculoskeletal disorder that frequently affects people of working age due to occupational and/or recreational risk factors. The economic burden of shoulder pain in industrialized countries is large^[1]. Delays in pain control increase the risk of chronicity, absenteeism, loss of productivity, and the economic burden associated with repeated medical consultation. Therefore, obtaining quick pain relief is essential to prevent further chronicity. Early postoperative pain after shoulder surgery is a major concern and causes distress for patients and orthopedic surgeons^[2].

Adequate pain control is vital to all aspects of a patient's recovery, including mental state, nutrition, cost of care, rehabilitation, patient satisfaction, and overall post-operative outcomes. Single analgesic regimens are not always effective in controlling moderate to

severe postoperative pain. Therefore, multimodal pain management is preferred and is currently recommended for early postoperative pain control. Regional anesthesia (RA) is increasing in use in shoulder surgery as an effective way of providing anesthesia and postoperative analgesia^[2]. In order to provide adequate postoperative pain control, nerve innervation to the synovium, capsule, joint surfaces, ligaments, periosteum and shoulder muscles should be blocked^[2-4]. Interscalene blocks are a well-studied and established means of providing analgesia following shoulder surgery and are considered the gold standard mode for RA^[3]. The glenohumeral joint is innervated by the suprascapular nerve, the posterior branch of the axillary nerve, the superior branch of the subscapularis, and the main branch of the axillary nerve, and mainly includes sensory branches^[5]. The recently described pericapsular nerve group (PENG) block provides a pericapsular

distribution with local anesthetic infiltration around the glenohumeral joint and provides analgesia by reaching the sensory nerve branches of the glenohumeral joint without motor blockade in this region^[4].

The aim of this study was to compare clinical outcomes and patient satisfaction between interscalene block and pericapsular nerve group block in patients undergoing shoulder surgery.

MATERIALS AND METHODS

This was a prospective, randomized, controlled trial. The study was approved by XXXXXXXXXXXXXXXXXXXX Medical Faculty Clinical Research Ethics Committee (decision number 2020/121-09). Written informed consent was obtained from the cases. The study was registered at ClinicalTrials.gov ID: NCT04718090. <https://clinicaltrials.gov/ct2/show/NCT04718090>. Date of registration: January 17, 2021. Patient enrollment date: February 1, 2021.

Inclusion criteria were patients over 18 years of age, at low risk of mortality (American Society of Anesthesiologists (ASA) grade 1-2), and who would undergo elective shoulder surgery. Surgical procedures included shoulder arthroscopy, rotator cuff repair, acromioplasty, bankart repair, and superior labrum anterior posterior repair. Exclusion criteria were patients with: advanced bronchopulmonary disease; known phrenic nerve pathology; existing chronic pain disorders or daily opioid consumption of ≥ 30 mg oxycodone or equivalent; existing neurological deficits or neuropathy involving the brachial plexus on the surgical side; contraindications to nerve blocks such as infection, bleeding diathesis, or allergy to local anesthetics; contraindications to any component of multimodal analgesia; or pregnancy. In addition patients were excluded if they declined to participate in the study or had a history of a significant psychiatric conditions that could affect patient evaluation.

After standard monitoring which included NIBP, electrocardiogram (ECG) and peripheral oxygen saturation measurement, general anesthesia was applied with routine anesthesia induction. The patients were divided into two groups through randomization using the closed envelope method. Group 1 would receive the interscalene block and Group 2 who would receive the PENG block. After general anesthesia and before surgical incision, ultrasound guided interscalene block with 20mL of 0.25% bupivacaine + saline mixture was given to Group 1. In Group 2, PENG block was applied with 20mL of 0.25% bupivacaine + saline mixture under ultrasound guidance after general anesthesia and before the surgical incision (Figure 1). Both blocks were performed as previously described^[4,6].

After the surgery was completed, patients were awakened and taken to the postoperative care unit, where

they were asked to judge their pain and transferred to the ward if their Aldrete score was ≥ 9 .

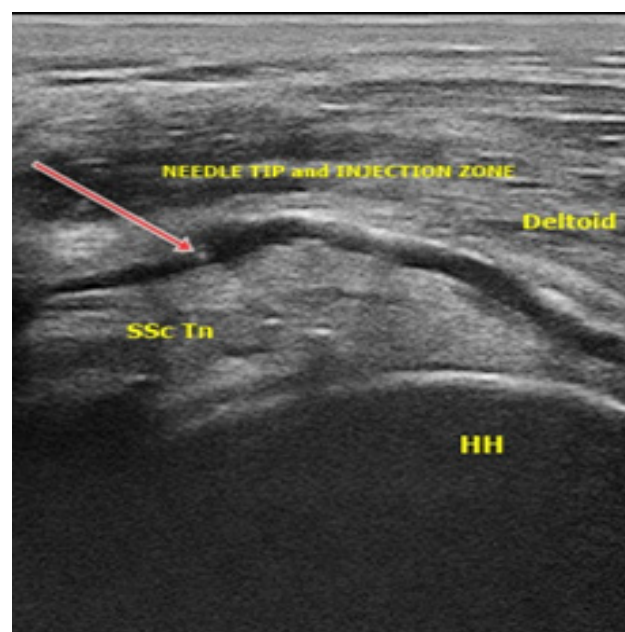


Fig. 1: HH: humerus head, SSc Tn: subscapularis tendon, deltoid: deltoid muscle.

Tramadol infusion was started with a patient-controlled analgesia (PCA) device in all patients in the postoperative period. Analgesic solution was prepared with 400mg tramadol diluted with 92cc normal saline and adjusted to contain 4mg/cc. PCA settings were without loading and basal infusion, 20 milligrams intravenous bolus, lock time was 15 minutes and a maximum application of 200 milligrams in 4 hours.

Parameters collected, monitored and analyzed included; age; gender; ASA grade; presence of additional disease; total anesthesia time; total surgery time; block application time; presence of motor block and return time of motor block, if any; time to first additional analgesic requirement; satisfaction at discharge; visual pain scores (VAS) at 10 minutes, and at the first, fourth, eighth, twelfth, sixteenth, twentieth, twenty fourth hour at rest and with movement; Ramsay sedation score; momentary and total tramadol amount; number of PCA requests and doses taken; need for additional analgesia; and complications. The satisfaction status of the patients was evaluated with a 5-point evaluation, scored as follows: 1= not at all satisfied; 2= not satisfied; 3= neither satisfied nor unsatisfied; 4= satisfied; and 5= very satisfied.

In patients who needed additional analgesics 2mcg/kg fentanyl were administered.

The aim of the study was to investigate if PENG block was comparable to interscalene block for providing postoperative analgesia after shoulder surgery. Therefore,

the primary outcome measure of the study was postoperative pain scores measured by VAS at 0, 1, 4, 8, 12, 16, 20 and 24 hours postoperatively.

Statistical analysis

The power analysis of the study was based on the meta-analysis of Nasir *et al.*, (Hussain *et al.*, 2020). These authors reported that the mean (standard deviation) VAS at 12 hours after interscalene block was 1.54(1.43) at rest. We assumed that the 12 hour VAS score after PENG block would be 2.5. Thus the power calculation showed that the required sample size was 40 for the margin of error to be 0.05 and the power to be 85%.

Categorical variables as presented as numbers and percentage. Continuous variables are shown as mean $\pm$ SD. Comparison of the categorical variables between groups was done using Chi-square or Fisher's exact test. For

comparison of independent continuous variables between two groups, the Student's *t*-test was used. The statistical level of significance for all tests was considered to be 0.05. Statistical analysis was performed using the IBM SPSS, v. 19 (IBM Software, Armonk, NY, United States).

RESULTS

Forty patients (10 females) were included in the study with a mean age of 58.6 $\pm$ 20.1 years. There was no significant difference between Group 1 and Group 2 in terms of any demographic parameter examined (Table 1). In the whole cohort, total anesthesia time was 125.13 $\pm$ 30.8 minutes, total surgery time was 100.50 $\pm$ 42.4 minutes, mean block application time was 7.43 $\pm$ 3.2 minutes, the mean time to first analgesia was 666.25 $\pm$ 323.2 minutes and discharge satisfaction was 3.60 $\pm$ 0.5 (out of 5).

Table 1: Demographic data for Group 1, Group 2 and for the whole cohort:

	Group			P
	Interscalene Group 1 (n= 20)	PENG Group 2 (n= 20)	Whole cohort (n= 40)	
	Mean $\pm$ sd	Mean $\pm$ sd	Mean $\pm$ sd	
Age	59.7 $\pm$ 18.2	57.6 $\pm$ 20.3	58.6 $\pm$ 20.1	0.812
Sex (female / male)	6/14	4/16	10/30	0.716
ASA (I/II)	13/7	7/13	20/20	0.060
Additional disease, n (%)	7(35)	10(50)	17(42.5)	0.500
Total anesthesia time (min)	136.25 $\pm$ 34.1	114.00 $\pm$ 22.9	125.13 $\pm$ 30.8	0.020*
Total surgery time (min)	123.75 $\pm$ 36.7	77.25 $\pm$ 34.7	100.50 $\pm$ 42.4	<0.001*
Block Administration Time (min)	8.75 $\pm$ 3.0	6.10 $\pm$ 2.9	7.43 $\pm$ 3.2	0.009*
First analgesic time (min)	756.5 $\pm$ 368.4	576.0 $\pm$ 248.0	666.25 $\pm$ 323.2	0.039*
Discharge satisfaction	3.80 $\pm$ 0.4	3.40 $\pm$ 0.6	3.60 $\pm$ 0.5	0.032*

Compared to the interscalene block (Group 1), the PENG group (Group 2) had significantly shorter anesthesia, surgery, and block application times. However, Group 2 also reported a shorter pain-free period and lower satisfaction levels (Table 1).

When the primary outcome measure of the study (postoperative VAS values) was investigated, no significant difference was found between PENG and interscalene block up to the sixteenth hour after surgery. However, at the 16th hour, both resting and moving VAS values were significantly higher in the PENG group. This difference disappeared at the twentieth hour while at the twenty-fourth hour patients in Group 2 reported significantly higher VAS with movement but not at rest. Although there was a trend

for the PCA requests, PCA intake, and momentary and total tramadol amounts at all hours to be higher in the PENG group, the difference with the interscalene group was not significant, with the exception of momentary tramadol intake and PCA intake at the twentieth hour (Table 2).

Although there was no statistically significant difference in motor block rates and additional analgesic needs were generally similar between the groups, there was again an exception at the sixteenth hour post-operatively in terms of need for additional analgesics in the PENG group (Table 3).

No complications were observed in any of the patients.

Table 2: Comparison of the intergroup comparisons over time:

	interscalene	PENG	<i>p</i>
1 st h VAS (rest)	1.65±0.8	1.70±0.9	0.857
1 st h VAS (with movement)	1.90±0.7	2.05±0.5	0.479
1 st h momentary tramadol (mg)	27.10±13.2	36.00±19.0	0.095
1 st h total tramadol (mg)	29.00±13.7	39.00±21.9	0.094
1 st h PCA requests (times)	3.20±2.0	4.05±2.1	0.206
1 st h PCA intakes (times)	1.50±0.6	1.80±0.9	0.261
4 th h VAS (rest)	2.20±1.1	2.45±0.6	0.395
4 th h VAS (with movement)	2.70±1.5	3.00±0.9	0.464
4 th h momentary tramadol (mg)	53.0±33.2	51.0±21.0	0.821
4 th h total tramadol (mg)	82.0±40.4	90.0±38.1	0.524
4 th h PCA requests (times)/alim	7.1±3.0	6.3±2.1	0.380
4 th h PCA intakes (times)	3.9±2.0	4.5±1.9	0.380
8 th h VAS (rest)	2.0±1.1	2.3±0.8	0.358
8 th h VAS (with movement)	2.3±1.3	3.1±1.4	0.080
8 th h momentary tramadol (mg)	57.0±39.0	59.0±28.6	0.855
8 th h total tramadol (mg)	135.0±65.4	149.0±59.2	0.483
8 th h PCA requests (times)	11.5±4.4	9.9±3.6	0.207
8 th h PCA intakes (times)	6.3±3.0	7.4±2.9	0.256
12 th h VAS (rest)	2.6±1.1	2.5±0.7	0.871
12 th h VAS (with movement)	2.8±1.2	3.4±0.9	0.100
12 th h momentary tramadol (mg)	57.0±26.9	60.0±15.8	0.671
12 th h total tramadol (mg)	193.0±75.4	209.0±70.6	0.493
12 th h PCA requests (times)	16.4±5.1	14.0±3.8	0.114
12 th h PCA intakes (times)	9.2±3.5	10.4±3.5	0.290
16 th h VAS (rest)	2.4±1.0	3.4±1.4	0.018*
16 th h VAS (with movement)	2.8±1.4	4.0±1.4	0.009*
16 th h momentary tramadol (mg)	58.0±35.4	77.0±46.0	0.152
16 th h total tramadol (mg)	250.0±97.4	286.0±95.6	0.246
16 th h PCA requests (times)	21.3±6.8	23.2±6.9	0.377
16 th h PCA intakes (times)	12.1±4.7	13.8±4.6	0.276
20 th h VAS (rest)	2.6±1.2	2.5±0.6	0.875
20 th h VAS (with movement)	2.8±1.2	3.2±0.9	0.209
20 th h momentary tramadol (mg)	51.0±32.1	76.0±30.1	0.015*
20 th h total tramadol (mg)	303.0±112.4	362.0±100.2	0.088
20 th h PCA requests (times)	26.0±8.5	25.7±4.5	0.908
20 th h PCA intakes (times)	14.7±5.5	18.1±5.0	0.049
24 th h VAS (rest)	2.2±0.7	2.4±0.8	0.347
24 th h VAS (with movement)	2.3±0.8	3.3±1.4	0.013*
24 th h momentary tramadol (mg)	43.0±37.9	58.0±36.0	0.208
24 th h total tramadol (mg)	346.0±132.5	420.0±117.5	0.070
24 th h PCA requests (times)	29.0±9.7	31.9±7.8	0.299
24 th h PCA intakes (times)	16.8±6.56	20.8±6.1	0.056

*: Student's *t* test.

Table 3: Number of motor blocks and need for additional analgesics by group:

	GROUP		<i>P</i>
	Interscalene (<i>n</i> = 20)	PENG (<i>n</i> = 20)	
Motor blocks (<i>n</i>)	6	2	0.235
Need for additional analgesics (post-op hour)			
1	1	0	0.987
4	3	4	0.976
8	1	5	0.091
12	2	7	0.064
16	4	10	0.048*
20	4	5	0.956
24	1	5	0.091

DISCUSSION

In this study, interscalene block, the gold standard in postoperative pain control in patients undergoing shoulder surgery, was compared with the newly described PENG block. In general the PENG block was as effective as interscalene block in providing postoperative analgesia.

Shoulder pain is a common musculoskeletal disorder with a prevalence of up to 67% in the general population, and it significantly affects daily living activities, such as working, playing sports, driving, dressing, brushing and even eating^[7]. After open or arthroscopic surgery, shoulder pain is felt very intense and postoperative analgesia is needed^[8]. Inadequate pain management causes prolonged hospital stay and recovery times, and even permanent impairment as a result of not participating in the necessary rehabilitation programs. This situation creates a serious burden for health systems and leads to poor quality of life for patients^[9]. Providing pain relief by avoiding motor block, besides providing an early rehabilitation program in the postoperative period, also allows controlling chronic nociceptive activation secondary to pain-related movement^[10].

Cervical root nerve blocks, such as the interscalene brachial plexus block, are considered the gold standard for providing optimal analgesia in shoulder surgery. However, it can cause complications ranging from accidental epidural anesthesia to vertebral artery injection, phrenic nerve palsy, pneumothorax, brachial plexus injury, and extended motor block^[11]. For this reason, researchers have begun to investigate peri-articular injections (PA), locally injected anesthesia (LIA), and other alternative techniques^[6]. Although the PENG block is a newly described block for shoulder surgery, it has been a remarkable advance in anesthetic and analgesic technique^[4,12]. A shoulder PENG block involves an injection reaching the pericapsular space between the glenohumeral ligaments (GHLs) on the anterior wall of the capsule of the shoulder joint and is

focused on blocking all the terminal sensory branches of the shoulder joint in a single procedure^[13].

In this study, which compared interscalene block with PENG block in shoulder surgery, it was found that the PENG block provided effective analgesia up to the first 16 hours, similar to interscalene block, and there was no need for additional analgesia and the PENG procedure caused less motor block. However, it should be noted that the interscalene block provided longer analgesia time.

It was also demonstrated that the application time of PENG block was shorter than the application time of interscalene block. In an interscalene block, especially in people with thick necks, finding the appropriate area and directing the needle is challenging, especially for novices. However, the PENG block is easier to implement because the coracoid and subscapularis myotendinous junction is easy to recognize on ultrasound and therefore does not require a long learning process, and anatomical structures can be easily recognized, even by less experienced sonographers. Another advantage of the PENG technique is that the needle is placed in a "safe zone", far enough away from any structure that could be inadvertently injured. In our study, it was found that the rate of motor block was lower in PENG block (10% vs 30% in interscalene block) and no complications were observed in either group.

The level of patient satisfaction, which can prompt a hospital to review and reorganization of processes, is an important indicator of health service quality. Postoperative opinions and comments of patients who underwent surgery provide important information about improving the quality of anesthesia care and health services^[14,15]. Capuzzo *et al.*, found that the type of anesthesia administered significantly affected satisfaction, and those who received regional anesthesia were more satisfied^[16]. Again, in previous studies, it was found that the satisfaction of patients who underwent peripheral block was 100%^[17]. In our study, although the satisfaction rates were significantly higher in patients who underwent interscalene block, high levels of satisfaction were also reported in the PENG block group.

A few points stand out in our findings that need to be taken into account. In our study, both the duration of total anesthesia and the duration of surgery were shorter in PENG block. Since this may depend on the type of surgery, it is reasonable to assume that these short-term types of surgery may cause less pain. However, pain comparison between surgical types was not performed and we suggest that further research with larger specific surgical procedure groups is necessary. A further limitation of the study was the small group sizes. We hope that our findings prove intriguing enough for other researchers to investigate the effectiveness of PENG block compared to interscalene block in shoulder surgery in the future.

CONCLUSION

In this study, in which interscalene block and PENG block in shoulder surgery were compared, it was found that PENG block provided effective analgesia up to the first 16 hours post-operatively, similar to interscalene block, and did not require additional analgesia. PENG block also caused less motor block. We conclude that PENG block, which is uncomplicated, safe, effective, easy to apply and takes a short time to perform, can be an alternative to interscalene block in suitable patients, although further, larger studies are required to confirm our findings.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Onur Koyuncu], [merve yazıcı kara] and [ilke Dolgun]. The first draft of the manuscript was written by [ilke Dolgun] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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