



Erector spinae plane block versus intraarticular injection of local anesthetic for postoperative analgesia in patients undergoing shoulder arthroscopy: A randomized controlled study

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ABSTRACT

Background: To improve the outcome after shoulder arthroscopy, effective pain control is needed. We aimed to compare the efficacy of ultrasound (US) guided erector spinae plane block (ESPB) versus the intraarticular injection (IAI) of bupivacaine in managing postoperative pain in patients undergoing shoulder arthroscopy.

Methods: This prospective randomized, double-blind, parallel-controlled trial was conducted on sixty patients aged 18–60 years of either gender, BMI < 40 kg/m², American Society of Anesthesiologists physical status I–II, posted for elective shoulder arthroscopy. Patients were randomly allocated into two equal groups. Group IA: received IAI using 20 ml of bupivacaine 0.25% done through the surgical port by the surgeon after closure of the shoulder capsule and sham ESPB. Group ES: received US guided ESPB at the T2 level using 20 ml bupivacaine 0.25% after the end of surgery and sham IAI.

Results: Postoperative visual analogue scale (VAS), heart rate and mean arterial blood pressure were significantly decreased at 30 min, 1 h, 2 h, 8 h, 12 h and 24 h in group ES compared to group IA. VAS increased at 4 h, 6 h in group ES compared to group IA. The time of first postoperative analgesic requirement was significantly increased in group ES compared to group IA. The total diclofenac consumption over 1st 24 hrs postoperatively was decreased in group ES compared to group IA.

Conclusion: US-guided ESPB controlled postoperative pain effectively in patients undergoing shoulder surgeries with superiority over IAI of bupivacaine.

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1. Introduction

Shoulder arthroscopy is a common procedure done in orthopedics for many surgical indications as rotator cuff tears, stiffness and instability [1]. This procedure has a well-documented postoperative pain. To improve the outcome after surgery, effective pain control is needed [2].

There are many postoperative pain management modalities after shoulder arthroscopy including non-steroidal anti-inflammatory drugs, intraarticular injection (IAI), regional nerve blocks, patient controlled analgesia and cryotherapy [3].

gglAI of local anesthetics is a simple technique and preserves the motor function but carries a potential risk to chondrolysis [4].

The erector spinae plane block (ESPB) is one of the emerging regional techniques for managing postoperative pain. ESPB has been used successfully in many surgeries such as mastectomy [5], thoracotomies [6], percutaneous nephrolithotomies [7], lumbar fusions [8], hernia repair [9], cesarean delivery [10] and even in total hip arthroplasty [11]. However, there is paucity in the literature about the use of

ESPB in shoulder surgeries [12]. Also, no previous study, to our knowledge, compared ESPB with IAI of bupivacaine in shoulder arthroscopy.

Therefore, our aim was to compare the efficacy of ultrasound (US) guided ESPB versus the IAI of bupivacaine for managing acute postoperative pain in patients undergoing shoulder arthroscopy.

2. Materials and methods

2.1. Patient population and eligibility criteria

This prospective randomized double-blind parallel-controlled study was carried out after obtaining approval from the ethical committee (ID: 33,097/04/19), registration on clinicaltrials.gov (ID: NCT04483323) and written informed consent from all cases. We enrolled 60 patients aged 18–60 years of either gender, BMI < 40 kg/m², American Society of Anesthesiologists (ASA) physical status I–II, posted for elective shoulder arthroscopy from August 2020 to March 2021. The design of trial and pain score [visual analogue scale (VAS)] were clarified for participant during the preoperative anesthesia visit.

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The actual work was done at Tanta University, Tanta 31,511, Egypt.

Patients with opioids chronic use, local anesthetics allergy, coagulopathy, and the need for postoperative drain were excluded.

2.2. Randomization

Computer-generated randomization numbers were used to randomly allocate patients into two equal groups. The sealed envelope was opened by another investigator (who had no other roles in the trial). Group IA: patients received IAI using 20 ml of bupivacaine 0.25% and sham ESBP. Group ES: patients received US guided ESPB using 20 ml bupivacaine 0.25% and sham IAI.

Both patients and outcome assessors were blinded. A dedicated anesthetist, who had no subsequent participation in the trial, prepared the study solutions and performed ESBP and IAI. Intraoperative and postoperative measurements were evaluated by another anesthetist who was blinded to assignment of groups.

2.3. Study design

After canula insertion, all patients were premedicated with intravenous (IV) midazolam 2 mg. For all case, the standard technique of general anesthesia was used. We used the standard monitoring (pulse oximetry, temperature probe, noninvasive blood pressure, 5-lead ECG, and capnography). Induction of general anesthesia was done by IV propofol 2–2.5 mg/kg and IV fentanyl 1ug/kg. After IV cisatracurium 0.15 mg/kg, endotracheal intubation was done. Maintenance of anesthesia was isoflurane (1–1.5%) with 50% oxygen. Incremental doses of IV cisatracurium 0.03 mg/Kg was given.

Insufficient analgesia was considered if there was heart rate (HR) or mean arterial blood pressure (MAP) increase > 20% than baseline values and IV fentanyl 1 ug/kg was administered.

In group IA (n = 30): IAI of 20 ml bupivacaine 0.25% was done through the surgical port by the surgeon after closure of the shoulder capsule. Sham ESBP (by 20 ml saline) was received.

In group ES (n = 30): Sham IAI (by 20 ml saline) was done. After the end of surgery, the position of patient was in the lateral one. After disinfection of skin, the counting started from the spinous process of C₇ and down. The level of T₂ transverse process was identified. A 2–5 MH₂ curved probe (Philips CX50 Extreme edition) was positioned transversely to visualize the lateral tip of T₂ transverse Process. A longitudinal para sagittal orientation was obtained over the transverse process using a 22 – gauge 8 cm block needle (visioplex, Vygon, France) was inserted in plane to US beam in a caudal to cranial direction to place the needle tip between the posterior fascia of the erector spinae (ES) muscle and the T₂ transverse process. The needle tip position was deep to the ES muscle was confirmed using hydrodissection with 0.5–1 ml of normal saline and visualization of the linear fluid spread deep to the ES muscle following which 20 ml of 0.25% bupivacaine was injected. (Figure 1).

At the end, all anesthetics were stopped. Extubation was performed when spontaneous breathing is adequate and following prompt reversal. Patients were transferred to the post-anesthesia care unit (PACU).

Postoperative pain (using VAS at admission), HR and MAP were measured at PACU, 30 min, 1 h, 2 hr, 4 hr, 6 hr, 8 hr, 12 hr, 18 hr, and 24 hrs postoperative. All patients in both groups were scheduled to receive paracetamol 1 gm/8 hrs. Rescue analgesia in the form of diclofenac sodium 75 mg intramuscularly (IM) was given if the VAS ≥ 40. Time to the 1st rescue analgesic request was recorded. Total amount of rescue analgesic (Diclofenac sodium) in 24 hrs. Recording of adverse events was done [e.g., nausea, vomiting, hypotension (MAP < 20% of baseline value) and bradycardia (HR < 60)].

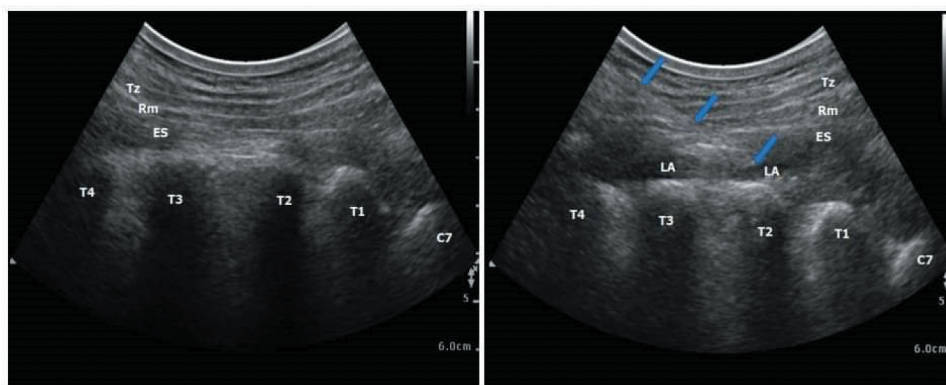


Figure 1. Ultrasound-guided erector spinae plane block. (a) before local anesthetic injection (b) after local anesthetic injection. Tz: trapezius muscle, Rm: rhomboid major muscle, ES: erector spinae muscle, T: transverse processes of the thoracic vertebrae, C: transverse processes of the cervical vertebrae, LA: local anesthetic.

The primary outcome was the total 24 hrs postoperative rescue analgesic consumption. Secondary outcomes were postoperative VAS along the study time as well as the time to first request of rescue analgesia.

2.4. Sample size calculation

G*Power 3.1.9.2 (Universitat Kiel, Germany) was used to calculate the sample size. We recruited 10 cases in each group and performed a pilot study. The mean difference of total 24 hrs postoperative rescue analgesic consumption was 37.5 and the common SD was 33.9. The following parameters were used: 1.10 effect size, 95% confidence limit and 95% power of the study, group ratio 1:1. Seven cases were added to each group to overcome dropout. Therefore, we recruited 25 patients in each group.

2.5. Statistical analysis

Statistical analysis was done by SPSS v25 (IBM Inc., Chicago, IL, USA). Normality of data was checked with Shapiro–Wilks test and histograms. Quantitative parametric variables were described as mean and SD and compared by unpaired student's T test. Quantitative non-parametric variables were described as median and interquartile range (IQR) and compared between

the two groups by Mann Whitney (U) test. Qualitative variables were described as frequency and percentage (%) and compared by the Chi – Square test or Fisher's exact test when appropriate. A two tailed P value less than or equal 0.05 was adopted for the level of statistical significance.

3. Results

For enrollment, 79 patients were evaluated; 13 patients didn't match the inclusion criteria and six patients refused to participate in the study. Randomization of 60 patients were done into two equal groups. All patients were followed up and statistically analyzed (Figure 2).

Demographic data (age, sex, body mass index and ASA physical status) and duration of surgery were comparable among the two studied. (Table 1)

Postoperative VAS was significantly decreased at 30 min, 1 h, 2 h, 8 h, 12 h and 24 h ($P < 0.001$, <0.001 , 0.007 , <0.001 , <0.001 and 0.027 respectively) but increased at 4 h, 6 h ($P < 0.001$ and 0.039 respectively) in group ES compared to group IA. Postoperative VAS was insignificantly different between-group ES and group IA at PACU, 3 h and 18 h. (Table 2)

Postoperative HR and MAP were significantly lower in group ES at 30 min, 1 h, 2 h, 8 h, 12 h and 24 h but increased at 4 h, 6 h compared to group IA.

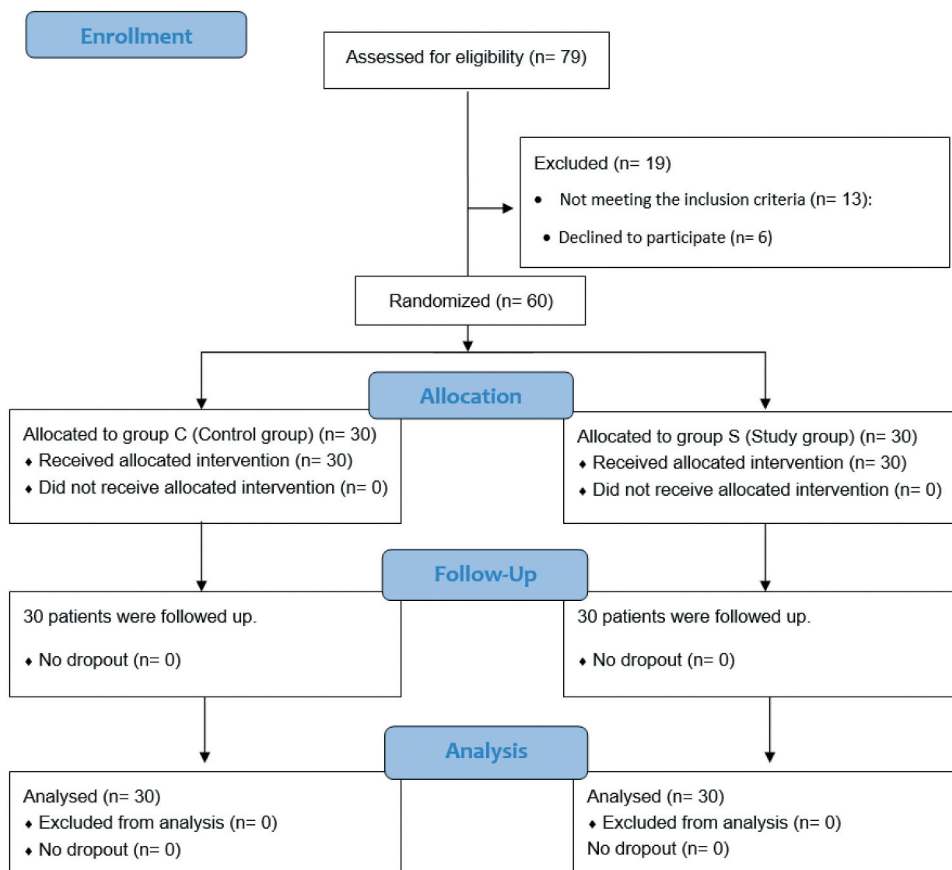


Figure 2. CONSORT flow diagram of participants in each.

Table 1. Patient characteristics of both groups.

	Group IA (n = 30)	Group ES (n = 30)	P value
Age (y)	35.7 ± 9.52	33.3 ± 9.08	0.329
BMI (Kg/m ²)	26.3 ± 5.34	25.27 ± 3.89	0.41
Sex	Male	17 (56.7%)	0.196
	Female	13 (43.3%)	
ASA physical status	I	23 (76.7%)	0.77
	II	7 (23.3%)	
Duration of surgery (min)	82.9 ± 18.1	80.8 ± 17.2	0.652

Data are presented as mean ± SD or frequency (and percent), ASA: American Society of Anesthesiologist

Table 2. Postoperative visual analog scale (VAS) in both groups.

	Group IA (n = 30)		Group ES (n = 30)		P value
	Median	IQR	Median	IQR	
PACU	10	0–20	10	0–10	0.158
30 min	20	10–20	10	0–10	<0.001*
1 h	30	22.5–47.5	10	2.5–20	<0.001*
2 h	30	20–47.5	20	10–27.5	0.007*
3 h	20	20–30	20	10–30	0.199
4h	10	10–20	30	20–40	<0.001*
6 h	20	10–30	40	10–50	0.039*
8h	30	20–30	20	10–20	<0.001*
12 h	40	30–57.5	15	10–20	<0.001*
18 h	30	20–37.5	20	12.5–30	0.149
24h	50	40–60	30	30–50	0.027*

PACU: Post-anesthesia care unit, IQR: interquartile range * significant as P value <0.05

Postoperative HR and MAP were insignificantly different between-group ES and group IA at PACU, 3 h and 18 h. (Figures 3 and 4)

The time of first analgesic requirement was significantly prolonged in group ES compared to group IA [median (IQR): 5 (4–6 h) vs 2 (1–2.75hrs), $P < 0.001$]. The total diclofenac consumption over 1st 24 hrs postoperatively was lower in group ES compared to group IA [median (IQR): 150 (75–150 mg) vs 225 (168.75–225 mg), $P < 0.001$]. (Table 3)

As regards complications, postoperative nausea and vomiting occurred in two patients in group ES and four patients in group IA ($P = 0.389$), hypotension occurred in one patient in group ES and two patients in group IA ($P > 0.99$).

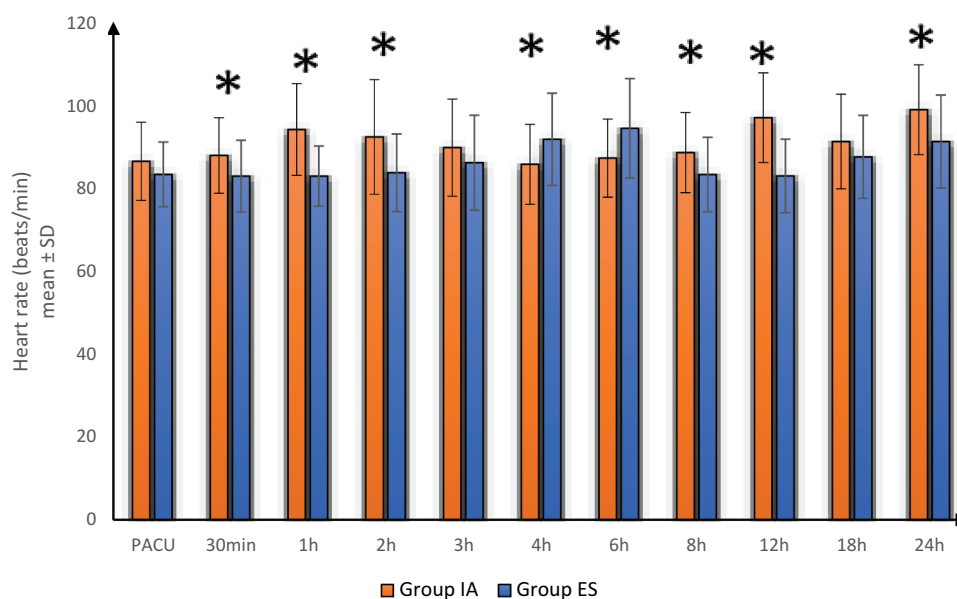
4. Discussion

ESPB has established itself as a useful technique for regional anesthesia in a variety of thoracic, abdominal, and lower limb operations. ESPB became popular because it is an easy technique with low incidence of severe adverse events.

ESPB has a role in effective multimodal analgesia regimens and Enhanced Recovery after Surgery (ERAS) [13].

There are only case reports regarding ESPB in managing postoperative pain after shoulder surgery without obvious guidelines or randomized clinical trials. Several factors may affect the outcome of block; block related (such as volume and concentration of local anesthetics), surgery related (such as type of surgery), patient related (such as individual variations of the anatomy) [14].

In our study, postoperative VAS, HR and MAP were significantly lower at 30 min, 1 h, 2 h, 8 h, 12 h and 24 h but were increased at 4h, 6 h in group ES compared to group IA and were insignificantly different between-group ES and group IA at PACU, 3 h and 18 h. The time of first postoperative analgesic requirement was significantly increased and the total diclofenac consumption over 1st 24hrs postoperatively was decreased in group ES compared to group IA. ES group had better analgesia; therefore, VAS, HR and MAP were significantly decreased at 30 min, 1 h, 2 h, 8 h, 12 h and 24h in group ES compared to group IA. However, VAS, HR and MAP increased at 4h, 6 h in group ES compared

**Figure 3.** Postoperative heart rate in both groups. PACU: Post-anesthesia care unit, * significant as p value <0.05

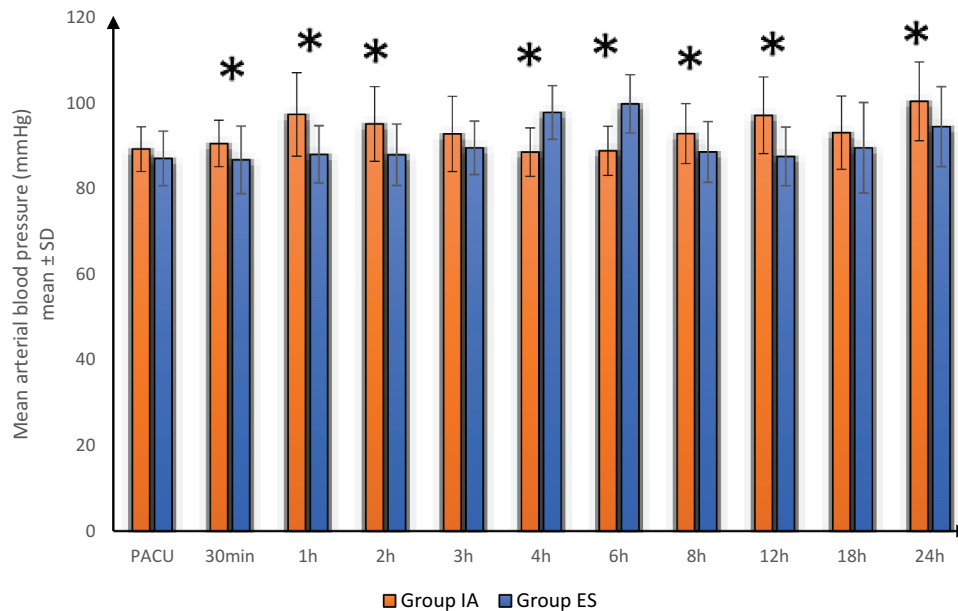


Figure 4. Postoperative mean arterial blood pressure in both groups. PACU: Post-anesthesia care unit, * significant as p value <0.05

Table 3. Time of first analgesic requirement and total diclofenac consumption at 1st 24 hours in both groups.

		Group IA (n = 30)	Group ES (n = 30)	P value
Time of first analgesic requirement (h)	Median	2	5	<0.001*
	IQR	1–2.75	4–6	
Total diclofenac consumption at 1st 24 hours (mg)	Median	225	150	<0.001*
	IQR	168.75–225	75–150	

IQR: interquartile range * significant as p value <0.05

to group IA as group IA required analgesia earlier and was covered by the effect of analgesia at 4h and 6 h resulting in higher VAS as group ES started to need analgesia.

Forero et al. managed chronic shoulder pain in one case by performing ESPB at T2/T3 level. After the block, range of motion improved with good control of pain. The motor function was preserved, and the sensory block was in the cervico-thoracic dermatomes. The radiocontrast spread up to the level of C3 as shown by computed tomography imaging [15].

In agreement with our results, Ciftci et al. [12] in a randomized prospective double-blind study demonstrated that ESPB at the T2 level can offer effective analgesia after shoulder arthroscopy. As ESPB decreased postoperative fentanyl consumption, the need for rescue analgesia and the pain score compared to sham block.

Also, a case report done by Selvi et al. [14] demonstrated that ESPB at T2 managed postoperative pain in shoulder surgeries effectively. Also, Papa et al. [16] case report showed that ESPB can be used for treating upper extremity cancer pain with preserving the motor power.

Moreover, many case reports [17–20] showed that high thoracic ESPB can be used in shoulder surgeries with phrenic nerve sparing.

In a study done on a cadaver, ESPB injection led to LA anterior penetration to the spinal nerves [21]. Mechanism of action of ESPB may be explained by placement of LA near the costotransverse foramina where the origin of both the dorsal and ventral e spinal nerves rami [22].

A recent metanalysis [23] stated that US guided ESPB decreased the postoperative 24 h opioid consumption.

Additional studies including a large number of patients are required for generalization of these results. Also, further studies are needed for assessment of using bupivacaine in different concentrations and with different additives.

Further studies are needed to compare thoracic with cervical ESPB. A cadaveric study [24] showed that US-guided ESPB at C6 and C7 stained the roots of the brachial plexus and dorsal rami. Also, a case report [25] demonstrated that ESPB at C7 controlled post-shoulder disarticulation acute pain. Moreover, a case report for forequarter amputation [26] showed that insertion of ESPB catheter threaded from the thoracic region to cervical region was an effective, method.

5. Conclusion

US-guided ESPB controlled postoperative pain effectively in patients undergoing shoulder surgeries with superiority over IAI.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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