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Original Research Article

Comparison of regional anesthetic techniques used in Awake Clavicle surgeries: A Prospective Observational study

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Abstract:

Background: Clavicle surgeries were traditionally done under general anesthesia due to its complex and multiple innervations, the upright beach chair position required for the surgery and discomfort to the patient. With the advent of ultrasound, peripheral nerve blocks are becoming increasingly selective, with less drug volume, longer duration of analgesia with adjuvants added and minimal side effects. This avoids the problems of general anesthesia, provides excellent surgical anesthesia, postoperative analgesia and more comfortable to the patient with minimal sedation, thereby decreasing the use of opioids.

Methods: This prospective observational study was done in a tertiary care academic institution over one year. All patients posted for clavicle surgery were given ultrasound guided peripheral nerve blocks. Three different blocks used were Group A - Interscalene block, Group B - Superior trunk block and Group C - Clavipectoral fascial block, all in combinations with superficial cervical plexus block. The three techniques were compared and evaluated for block efficiency, duration of analgesia and safety profile.

Results: All the three blocks provided complete nerve blockade adequate for surgical anesthesia and post operative analgesia. In the Interscalene group, the duration of analgesia was least ($P<0.001$) and transient side effects of hemi-diaphragmatic paresis, hoarseness of voice and Horner's syndrome were also significantly higher ($P=0.034$). The Superior trunk block and Clavipectoral group patients had longer analgesia without any of these side-effects.

Conclusion: For clavicle fracture surgeries, the ultrasound guided selective block of the Superior trunk of brachial plexus and the Clavipectoral fascial block both combined with the Superficial cervical plexus block provided excellent surgical anesthesia, prolonged post operative analgesia and better safety profile with negligible side effects than the Interscalene block.

Keywords: Interscalene, Superior Trunk, Clavipectoral, Clavicle Fractures.

Introduction

Clavicle fractures make up 44% of all shoulder girdle fractures 3-5% of all adult fractures and impact men more often than women [1]. Most clavicle fractures occur in the midshaft accounting for about 80% of all clavicle fractures, followed by distal and medial clavicle fractures [1].

Clavicle surgeries are usually performed in the supine or modified beach chair position. Traditionally general anesthesia is preferred for absolute immobility during surgery near major neurovascular structures, uncomfortable positioning and difficult airway access. In resource limited settings with high patient numbers and rapid turnover rate, general anesthesia is not feasible or economical. Hence the research for safe, cost-effective, reliable regional anesthetic techniques feasible with limited resources is essential.

Regional anaesthesia yields superior patient-reported outcomes compared to general anaesthesia for clavicle surgery [2]. Also, the side effects of general anesthesia like nausea, vomiting, use of opioids and airway instrumentation are avoided. Regional anesthesia techniques for the clavicle focuses on site-specific nerve blocks to minimise the drug volume, prevent unnecessary nerve block, and reduce complications [2].

Innervation of the clavicle: The clavicle is a unique bone in the body due to its intricate and complex

innervation from both the cervical and brachial plexus. Tran Q, in a comprehensive anatomical review, stated that four nerves, namely the supraclavicular nerves (SCN) from superficial cervical plexus and nerve to subclavius, suprascapular and long thoracic nerve from the brachial plexus (BP), are responsible for pain transmission from the clavicle.[3]

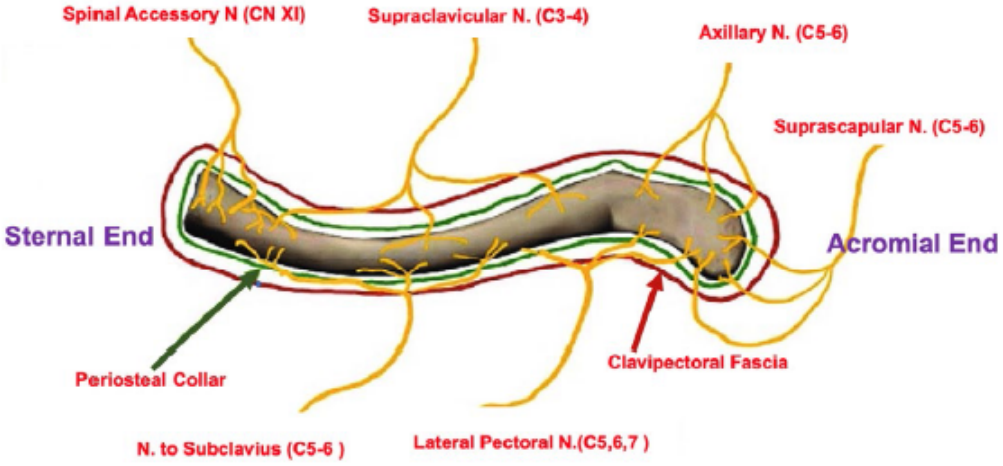

Figure 1: Innervation of the clavicle (Courtesy: Copyright © 2023 Das S, et al [5])

The supraclavicular nerves of the superficial cervical plexus innervate the cephalad and ventral aspects of the clavicular bone and the skin above the clavicle. The caudal and dorsal aspects of the clavicle are innervated by the subclavian nerve (middle and medial thirds). The lateral pectoral nerve supplies the caudad aspect of the clavicle (middle and lateral thirds). The sternoclavicular joint derives its innervation solely from the supra-clavicular nerves whereas the acromioclavicular joint is supplied by the supraclavicular and lateral pectoral nerves. [4] The brachial plexus innervates [5] the deep muscle of the clavicle. Distal branches of all the above nerves pierce the clavipectoral fascia and supply the clavicle (Figure 1).

So, the combination of Superficial Cervical Plexus Block (SCPB) and Inter-scalene block (ISB) can meet the needs of clavicle fracture surgery [6,7,8,9]

Inter scalene block: Interscalene brachial plexus block provides reliable anesthesia for clavicle fracture fixation with a low incidence of conversion to GA, with multiple studies describing excellent success along with Superficial cervical plexus block. Reverdy et al [6] Fugelli et al [7], Banerjee et al [8] have all described 100% success in providing surgical anesthesia by combining SCPB with an ISB.

Ultrasound guided regional anaesthesia: The ultrasound-guided technique visualising the needle tip and solution injected reduces the risk of side effects, accidental intravascular or intra neural injection, and possible trauma to surrounding tissues. The ultrasound has also reduced the volume needed to gain effective block [10]. The widespread availability of ultrasound-guided regional anaesthesia has led to newer blocks, such as the Clavipectoral fascial plane block [13] (CPB) and Superior or Upper Trunk block [11] of brachial plexus block (C5, C6).

Superior trunk block (STB): The nerve to subclavius, suprascapular nerve and two thirds of the fascicles to long thoracic nerve arise from the upper trunk (UT) of Brachial plexus. The superior trunk block (STB) is a variation of the ultrasound-guided interscalene block (ISB), with similar sensory distribution, non-inferior analgesia and significantly less phrenic nerve involvement [10].

The superior trunk block targets its namesake—formed by the fusion of the C5 and

C6 nerve roots, with an injection site more distant from the phrenic nerve compared to

the traditional ISB approach—and has good results with significantly reduced hemi-diaphragmatic paresis compared to the ISB [11,12].

Clavipectoral fascial plane block (CPB): There is a very clear relationship between the pectoral fascia, which covers the anterior surface of the pectoralis major muscle, and the investing layer of the deep cervical fascia, which envelops the sternocleidomastoid muscle [13]. Valdés-Vilches originally described the Clavipectoral fascial plane block (CPB) in 2017 at the 36th European Society of Regional Anesthesia & Pain Therapy (ESRA) Symposium as an injection of 10-15 cc of local anesthetic under ultrasound guidance in between the clavipectoral fascia and the periosteum on the medial and lateral aspects of the area of clavicular

injury [13] which is at the superior aspect of the clavicle aiming at the sensory nerves penetrating the clavipectoral fascia before supplying the clavicle.

However, the supraclavicular nerve which innervates the skin above the clavicle is spared and hence must be supplemented [14] for anaesthesia and postoperative analgesia for clavicle fracture surgerywith SCPB.

We hypothesised that the Superior Trunk Block and Clavipectoral Fascia block with the Superficial Cervical Plexus block would provide adequate anesthesia in patients undergoing clavicle fracture surgery with fewer adverse effects.

Materials and Methods

The aim of this study was to prospectively evaluate the efficacy of the three anesthetic techniques in terms of anaesthesia, analgesia and side-effects of the selective blocks like Superior trunk block (STB) or Clavipectoral fascial (CPF) block with superficial cervical plexus nerve block (SCPB) versus Interscalene block plus SCPB for anesthesia in clavicle surgeries.

The primary objective was to compare and evaluate the block characteristics. The secondary outcomes were the side-effects and analgesia duration.

Approval was obtained from the Institutional Ethics committee (IEC) for this prospective observational study. (IEC/RIMS/154/2024) on 12th June, 2024.

Inclusion Criteria: Adult consenting patients with American Society of Anesthesiologists (ASA) physical status I and II, aged 18-75 years scheduled for Clavicle surgeries were enrolled for this study, performed at a tertiary care academic institution over a period of one year.

Exclusion Criteria: Patients with a history of pre-existing cardiac or pulmonary disease, renal or hepatic derangements, metabolic or neurological disorders and those who consumed opioids in the previous 2 weeks or with opioid dependance were excluded.

Written informed consent was taken, pre-anesthetic evaluation done with airway and spine assessment. The technique used was based on the choice of the duty Anesthesiologist.

Total dose of drug was 20ml of 0.5% Bupivacaine in all three groups.

Method of blinding: The block was performed by Senior Anesthesiologists in the Pre-anesthesia procedure room under Ultrasound guidance (Mindray DC30). The principal investigator, blinded to the block technique given, managed the patients and collected the data. Both the patient and the investigator were blinded.

Regional anesthesia technique: Selected patients were fasted for minimum eight hours. On the day of surgery, all patients were assessed, informed consent taken and shifted into the operation theatre. Pre-loading was done with 10-20 ml/kg of Ringer lactate solution before surgery to replenish the overnight fasting. Monitoring of heart rate, blood pressure, electrocardiography and pulse oximetry was commenced using multipara monitor.

The patient was placed supine with a towel under the neck and the head turned to the opposite side of the block. Skin prepped with betadine solution and the transducer wrapped in a sterile cover.

Superficial cervical plexus block (SCPB): Using a linear high-frequency ultrasound probe (6–13 MHz, Mindray DC30), the superficial cervical plexus was identified with the transducer over the midpoint of the posterior border of sternocleidomastoid muscle at level of cricoid cartilage and moved posteriorly till the interscalene groove. Then, the superficial cervical plexus (SCP) was visualized just superficial to the prevertebral fascia overlying the interscalene groove. A five-cm block needle was then introduced from lateral to medial using the posterior-in-plane technique until its tip was placed near the SCP above the prevertebral fascia and after careful negative aspiration to exclude intravascular placement, 5 ml of 0.5% bupivacaine was injected.

Inter Scalene Block (ISB): The sternocleidomastoid muscle was scanned laterally at the C6 cricoid cartilage level to visualize the carotid artery, internal jugular vein, anterior and middle interscalene muscles at the end of the SCM, and interscalene groove between them. After visualizing the typical "stoplight sign" of the C5-6-7 roots in the interscalene groove, 15 ml of 0.5% bupivacaine was administered and the spread of local anesthetic was seen.

Superior trunk block (STB): The nerve roots of C5 & C6 are traced from the interscalene groove downwards where they fuse to form the superior trunk, 8ml of 0.5% bupivacaine was instilled around the neural sheath and 2 ml of 0.5% bupivacaine was injected into the supra clavicular nerve region.

Clavipectoral fascial plane block (CPB): A 6- to 13-MHz linear array probe probe was placed on both the inner and outer one-third of the anterior surface of the clavicle. Using the in-plane technique, a 24-gauge needle was inserted and advanced into the space between the periosteum of the clavicle and clavipectoral fascia in a caudal to cephalad direction, and a total of 15 mL of 0.5% Bupivacaine was equally injected medially and laterally.

Nerve blockade assessment: Block was assessed after 15 min. Motor blockade was assessed of shoulder abduction and flexion, sensory blockade was tested for by loss of sensation to cold over

relevant dermatomes and pinprick sensation at the surgical site.[7] Also, the arm mobilized passively to assess further pain. A block was deemed successful if all the examinations, were present.

If uncontrolled pain occurred after starting surgery that required conversion to GA, the block was considered incomplete.

In the case of patient anxiety, 1 mg of Midazolam was and if pain, Butorphanol 1mg or Ketamine 30mg was administered intravenously. If respiratory rate less than 8, apnea of more than 15 s, and oxygen saturation of less than 93%, were observed, bag and mask ventilation done with 100% oxygen. Intra-operatively, patients were monitored for changes in blood pressure, heart rate, respiratory rate, oxygen saturation (SpO2). Episodes of hypotension, bradycardia, vomiting or nausea, desaturation and bradypnea were noted. At the end of surgery, patients were assessed for pain scores with VAS, sensory blockade and adverse effects.

Thoracic Ultrasound was used to diagnose diaphragm paralysis. The B-mode shows the diaphragm as a thick echogenic line. The M-mode shows the movement of the paralyzed diaphragm as no motion or a paradoxical movement with quiet breathing, voluntary sniffing, or deep breathing.[26] Diaphragmatic movement on both sides was assessed at T2, partial paresis was defined when there was 25% reduction of diaphragm movement and complete paralysis when there was 75-100% reduction when compared to the contralateral diaphragm [25]

Post operative analgesia was assessed by

a. The time to first request for analgesia.
b. The total duration of analgesia was noted from the time of complete sensory block upto the first request of analgesic or VAS ≥4 postoperatively.

Rescue analgesics given with Intravenous Paracetamol 1gm eighth hourly and Diclofenac 75mg added if VAS > 4 or patient had pain.

Statistical analysis: All data were entered in Microsoft Excel and analyzed using SPSS version 31 software (SSPS Inc., Chicago, IL, USA).

Analysis of variance ANOVA was used for three groups comparison on quantitative parameters. Pearson's Chi-square test was used for categorical parameters. Kruskal-Wallis test was used for non-parametric data. $P < 0.05$ was considered to be statistically significant.

Results

Over our study period of one year from August 2024 till July 2025, 134 patients were enrolled for the study after informed consent.

The block failed in 4 patients - 2 in the Interscalene group and 2 in the Clavipectoral group who were then administered general anesthesia. These four patients were not included in the statistical analysis.

The rest 130 patients were evaluated in three groups as

Group A - Interscalene block (ISB + SCPB) (N=72)

Group B - Superior Trunk Block (STB + SCPB) (N=30) and

Group C - Clavipectoral Fascia block (CPFB + SCPB) (N=32)

all alongwith Superficial Cervical Plexus block (SCPB).

Table 1: Demographic Variables

S. No.	Parameters	Group A - ISB + SCPB (N=70)		Group B - STB + SCPB (N=30)		Group C - CPFB + SCPB (N=30)		P value
1	**Age**	36.52 ± 12.6		38.1 ± 13.3		36.93 ± 11		**0.846**
2	**Gender**							
	Men	64		24		25		**0.24**
	Women	6		6		5		
3	**Site of Injury**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	
	Mid Shaft	29	19	8	13	11	13	
	Lateral Third	6	11	5	2	1	2	**0.608**
	Ac Joint	2	3	1	1	1	2	
4	**Surgery Done**							
	Locking Plate	45		18		21		
	Hook Plate	22		10		2		
	Clp Removal	3		1		2		**0.261**
	Endobutton	0		0		3		
	Tens / K-Wire	0		1		2		
5	**Surgery Duration**	93.9 ± 25.9		99.2 ± 27.3		89.5 ± 32		**0.4**

Demographic variables like age, gender, site of injury, duration of surgery and surgeries done were all comparable between the three groups (P>0.05) and statistically insignificant, thereby avoiding selection bias.

Table 2: Block Characteristics and Side Effects

S. No.	Parameters	Group A - ISB + SCPB (N=72)	Group B - STB + SCPB (N=30)	Group C - CPFB + SCPB (N=32)	P value
1	**Time For Onset of Complete Block**	12.5 ± 2.87	11.53 ± 3.1	11.8 ± 2.9	**0.261**
2	**Block Failure**	2	0	2	
3	**Total Duration of Analgesia (Hrs)**	8.37 ± 2.1	10.17 ± 3.7	10.8 ± 3.4	**<0.001**
4	**Analgesic Used**	14 (20%)	8 (24%)	6 (20%)	**0.082**
5	**Midazolam Used (MG)**	37 (52%)	15 (50%)	14 (47%)	**0.73**
6	**Side-Effects**				
	Hemi-Diaphragm Paresis	35 (50%)	2 (7%)	0	**0.034**
	Hoarse Voice	7 (10%)	0	0	
	Horner's	2 (3%)	0	0	
7	**Ul Motor Block**	63 (90%)	15 (50%)	NIL	
8	**Post Op Opioid Requirement**	NIL	NIL	NIL	

a. The total duration of sensory analgesia was least in the Interscalene group at 13hrs with a statistically significant P=0.024
b. The incidence of hemi-diaphragmatic paresis (57%), hoarseness of voice (10%) and Horner's syndrome (3%) were significantly higher in the Inter-scalene block group, (P=0.024). There were no such events with Clavipectoral block.
c. The time for onset of complete sensory and motor blockade, the number of patients who required additonal analgesia and sedation intra operatively were comparable in all the three groups and statistically insignificant with P>0.05.
d. None of the patients developed intraoperative intraneural injection or local anesthetic toxicity. Moreover, none of the patients developed postoperative neurological complications associated with the block.
e. Motor blockade of upper limb was seen in 90% of Interscalene group, 50% of Superior trunk and None in the Clavipectoral group.
f. No patients needed opioids for post-operative analgesia. Most of them were managed with IV Paracetamol 1gm and oral NSAIDs.
g. Most of the patients who had no residual sensory or motor blockade were discharged home a day earlier.

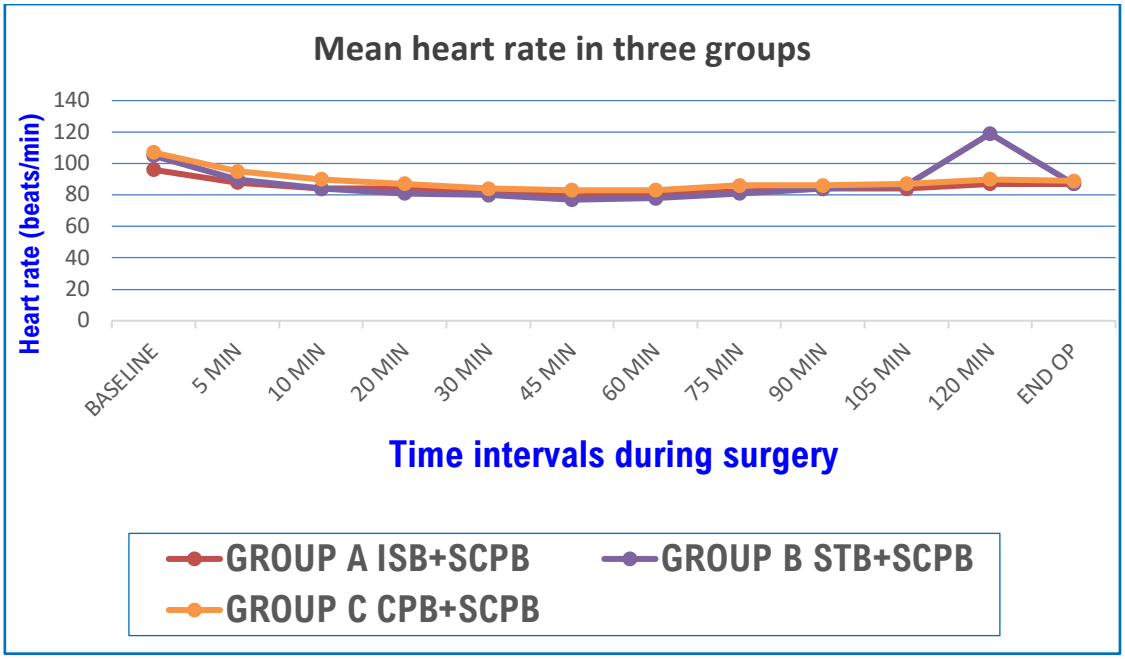

Figure 2: Mean Heart rate at various intervals after nerve block

The mean heart rate in all the three groups (Figure 2) was comparable at all intervals and not statistically significant

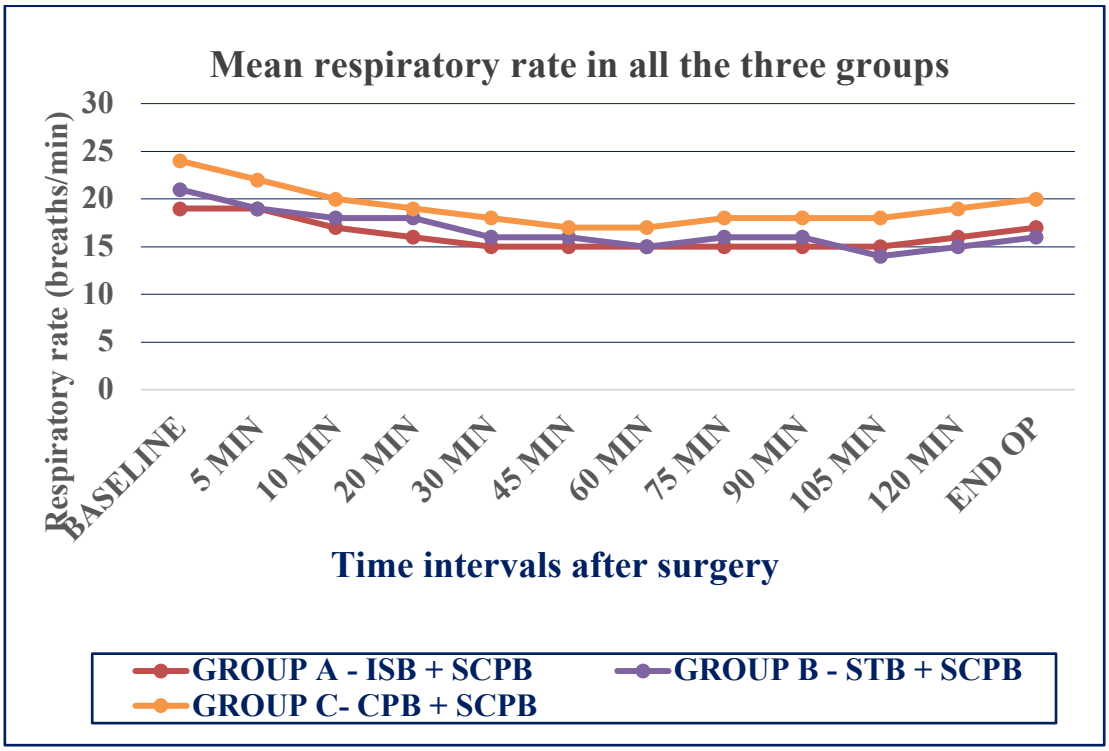

Figure 3: Mean Respiratory rate at various intervals after nerve block

The mean respiratory rate in all the three groups was comparable (Figure 3) at all intervals and not statistically significant. Among all the patients in all the three groups none had respiratory depression at any point.

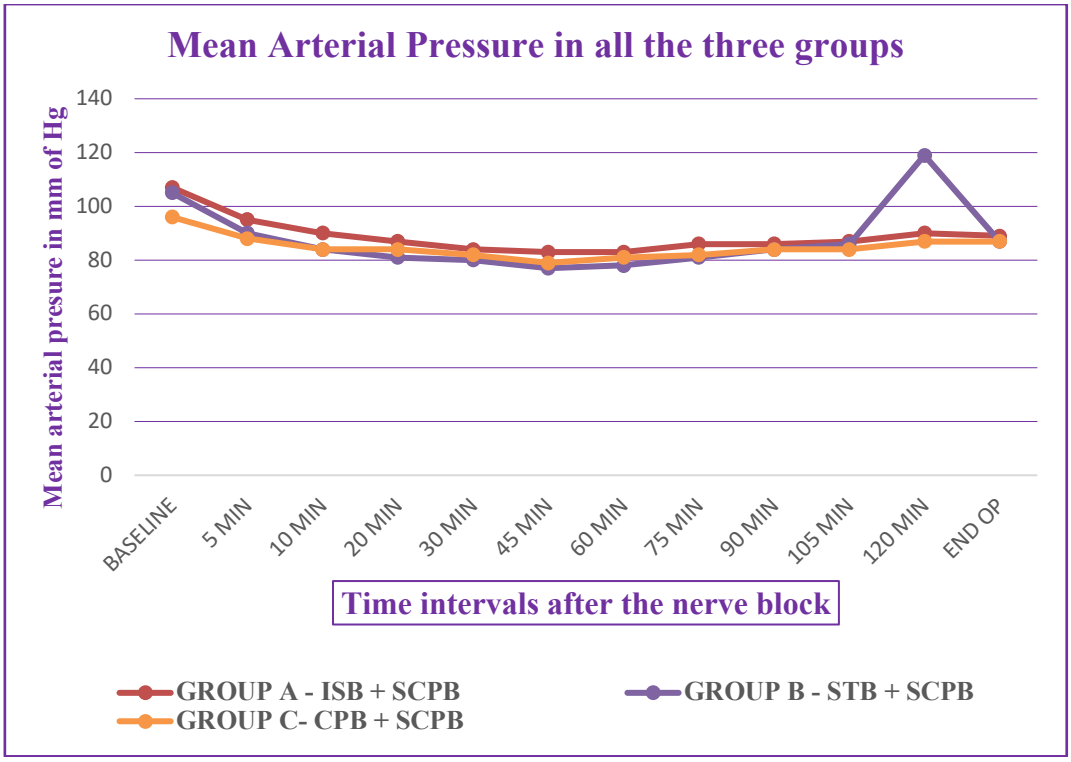

Figure 4: Mean Arterial pressure at various intervals after nerve block

The mean arterial pressure in all the three groups (Figure 4) was comparable at all intervals and not statistically significant

Discussion

Operative treatment of displaced midshaft clavicle fractures in adults has higher union rates, better early outcomes, allows for anatomic reduction of the bone to expedite healing, reducing the risk of nonunion and allowing for long term improvement in function, particularly with displaced, comminuted, and shortened clavicle fractures. Displaced lateral fractures with disruption of the coracoclavicular ligament complex may also benefit from operative repair.[17]

Peripheral nerve blocks are effective as the sole anesthetic technique in awake clavicle surgeries requiring minimal supplementation with analgesic or sedative [5,6,7,9]. However, complications have to be anticipated and all precautions must be taken to prevent and treat any such adverse event. Injecting large volume of local anaesthetic drug in Interscalene block with landmark technique can cause epidural spread of the drug, phrenic nerve palsy and neuronal damage.

Block failure: In our study, four patients had complete failure of both sensory and motor block till 45 minutes, even with repeat Ultrasound guided attempt of block, possibly due to prior history of multiple scorpion stings [16]. All the other 130 patients had 100% success rate of block with minimal requirement for additional analgesic and sedation.

Complete onset of block: In our study the time taken for complete nerve blockade (12.5, 11.8 and 11.5 minutes) was comparable in all three groups possibly as the same volume of 20ml was used in all patients.

The total duration of analgesia: The total duration of analgesia was significantly less in Interscalene group at 8 hours than 10hrs in the other 2 groups ($P<0.001$) but was managed with non-opioid analgesics.

Intra-operative sedation / analgesia: During manipulation near the medial end of clavicle and acromio-clavicular joint, few patients required minimal sedation and analgesia but were managed with 1mg Butorphanol, Midazolam 1-2mg and Ketamine 0.5mcg/kg.

Motor blockade of upper limb: In our study, motor blockade was seen in 90% of Interscalene group and in 50% of the Superior trunk group but none in the Clavipectoral group. The patients with no motor blockade were discharged home earlier.

The interscalene approach and other approaches which target the brachial plexus or its origin nerve roots (e.g., superior trunk and selective C5 or C6 often result in motor block and reduced shoulder mobility [7-9]. A paucity of motor blockade is desirable for the preservation of upper limb function and the prevention of respiratory compromise from phrenic or recurrent laryngeal nerve blockade, and

seeking techniques which are motor-sparing is, thus, of importance to facilitate recovery whilst providing good early postoperative analgesia [15]. Dobbie et al. [15] showed that interscalene block performed at the level C5-6 nerve root did not cause a motor block in hand movements.

Hemi diaphragmatic paresis: In our study, Hemi diaphragmatic paresis was noted only in 10% of patients in Superior trunk group as compared to 50% of patients in Interscalene group at 60 minutes after the block. This correlates with the results of Xu et al [18] and Zhuo et al [19] who noted incidence of hemidiaphragmatic paresis of 70 - 92% with Interscalene block.

This observation is of clinical significance where patients with compromised respiratory system or poor respiratory reserve will tolerate the block better when isolated superior trunk, supraclavicular and superficial cervical plexus is blocked instead of blocking the brachial plexus at the interscalene level, where phrenic nerve is also blocked [20]. Phrenic nerve sparing aids in better diaphragmatic and efficient respiratory function for early recovery, early mobilization and shorter hospital stay.

Interscalene brachial plexus block: Only drawback is the interscalene block always results in hemidiaphragm paresis because of the close proximity of the phrenic nerve (C3–C5) to the interscalene groove. Any patient who cannot tolerate a reduction in pulmonary function greater than 30% should not receive this block. [7]. Furthermore, blockade of brachial plexus outflow leads to an insensate, immobile limb that can potentially compromise function and delay recovery, requires protection from injury, and can affect surgical assessment of neurovascular function [8,9]

Superior trunk block: Kim et al [21] and Reverdy F [6] compared superior trunk with interscalene block and concluded that superior trunk block patients had better satisfaction and unaffected respiratory parameters [21]. Potential advantages when compared with interscalene block include lesser incidence of phrenic nerve palsy (~5% vs 70%) [20,31] a thicker nerve sheath reducing trauma to the nerves and also lesser vascular injuries [20] [23] lower risk of injury to the dorsal scapular and long thoracic nerves in the middle scalene muscle , often pierced by the block needle during an ISB) and avoidance of issues related to the anomalous course of C5. [23] During peripheral nerve blocks, low dose of local anaesthetic drugs when deposited under direct vision using ultrasound can significantly reduce the risk of complications [21].

Clavipectoral fascial plane block: Valdés-Vilches originally described the CPB in 2017 as an injection of 10-15 cc of local anesthetic under ultrasound guidance in between the clavipectoral fascia and the periosteum on the medial and lateral aspects of the area of clavicular injury [13]

Ultrasound-guided superficial cervical plexus block combined with clavipectoral fascial plane block can be used for clavicular surgery. It has a long postoperative analgesia time, can retain the motor function of the involved upper limb and does not cause hemidiaphragmatic paresis [14] with no risk of pneumothorax. The decision to use the CPB alone or in addition to SCPB depends on the site of clavicle injury and variations in innervation [18].

Tertiary academic government institutions like ours have more number of admissions and turnover rate. Hence the need for reliable, safe and efficacious regional anesthetic techniques in view of limited resources. Larger prospective studies with peri-operative sonographic and neuro-muscular monitoring are required to further clarify the distribution of sensory blockade and the efficacy and safety of the Superior trunk and Clavipectoral fascia block.

Conclusion

Regional anaesthesia for clavicle surgeries has the advantage of promoting non-opioid free anaesthesia. Effective pain control enhances patient satisfaction and reduces the length of stay in hospital.

For clavicle fracture surgeries, the ultrasound guided selective block of the Superior trunk of brachial plexus and the Clavipectoral fascial block both combined with the Superficial cervical plexus block provided excellent surgical anesthesia, prolonged post operative analgesia, better safety profile with negligible side effects.

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