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ULTRASOUND-GUIDED VERSUS CONVENTIONAL INTERSCALENE BRACHIAL PLEXUS BLOCK

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ABSTRACT

Background: Regional anesthesia can provide superior pain management and perhaps improve patient outcomes. Ultrasound guidance may be associated with better results of regional anesthesia block.

Objective: Detection of the important differences between conventional and ultrasound guided interscalene block.

Patients and methods: Following approval to enter the study and obtaining informed consents from the patients, sixty patients who scheduled for upper limb surgery were randomized into two equal groups:

- **Group A:** conventional interscalene brachial plexus block (ISBPB) using conventional landmark-guided interscalene block.
- **Group B:** Ultrasound-guided interscalene brachial plexus block guided by two dimensional ultrasonic images.

Results: Both groups were comparable as regard to patient demographics, surgical intervention and premedication. Ultrasound guided group had shorter time to detect the plexus, injection of local anesthesia, and shorter time of sensory blockage. However, the difference was statistically non-significant. On the other hand, ultrasound guided group had the advantages of significantly shorter time to reach motor blockade, and significant longer duration of both sensory and motor block. Finally, success rate was high in ultrasound guided group, but the difference was statistically non-significant.

Conclusion: Conventional and Ultrasound-guided guidance provided comparable sensory block onset times, complications, and success rates in patients undergoing interscalene block. Ultrasound guided block showed significantly shorter time to reach motor blockade and significant longer duration of both sensory and motor block.

Keywords: Interscalene, brachial plexus, ultrasound.

INTRODUCTION

With modern anaesthetic techniques, recovery after surgery can be rapid, smooth and complete. Regional anesthesia can reduce or avoid the hazards and discomfort of general anesthesia. This technique provides analgesia without sedation, prolonged postoperative analgesia, and allows earlier patient's discharge. Regional anesthesia reduces the requirements of opioids, reducing the incidence of postoperative nausea and vomiting. It can be used alone, in combination with sedation or as a part of balanced analgesia with general anesthesia **(Rawal, 2013).**

Regional anesthesia has the ability to precisely deliver to the target nerve exactly the right dose of local anesthetic without incurring any risk of damage to the nerve or its related structures **(Chakraborty et al., 2016).**

Interscalene brachial plexus block (ISBPB) is a well-established technique in anesthetic practice with high success rate. The technique was later modified by ***Meier and Colleagues (2001)***, who used a more cranial puncture site with a more tangential orientation of the needle **(Salinas & Hanson, 2014 and Senapathi et al., 2017).**

The study was designed to detect the important differences in parameters such as time taken for the procedure, onset time of sensory blockade, onset time of motor blockade, duration of the block, intensity of the block, awareness of block, success rate, patient satisfaction, and incidence of complications.

PATIENTS AND METHODS

After approval of the local ethical committee of Al-Azhar Faculty of Medicine, and obtaining informed consent from the patients, sixty patients who scheduled for upper limb surgery were randomized into two equal groups:

- **Group A:** conventional (ISBPB) using conventional landmark-guided interscalene block.
- **Group B:** Ultrasound-guided (ISBPB) **guided** by two dimensional ultrasonic image.

Inclusion criteria: Age group between 18 to 50 years, patients with upper limb surgery, and patients with American Society of Anesthesiologists (ASA) Grade I and II physical status.

Exclusion criteria: Hypersensitivity to local anesthetics, pre-existing neurological deficits, bleeding tendencies, skin lesions at the site of planned blocks, local sepsis, severe systemic disease, and patient incompliance.

Anesthesia procedure:

Most patients received 1-3 mg of midazolam to achieve a comfortable and cooperative state during nerve localization.

Group A: ISBPB was applied using conventional landmark-guided inter-scalene block. ISBPB represents the most cranial approach to the brachial plexus. In our study, the anterior approach was the access used for blocking the brachial plexus in the interscalene area **(Meier et al., 2001).**

Group B: ISBPB was guided by two-dimensional ultrasonic image. After sonographic identification of the brachial plexus, we injected glucose 5% to scan the fluid around the plexus, then we fixed the needle not to move. Deposition and spread of anesthetics can also be appreciated with real-time imaging during injection **(Brull et al., 2007).**

Drug solution used and dosage:

- Xylocaine 2% ampoule (Astra Zenca pharmaceutical industry Inc., Cambridge, England), 15 ml of it was diluted to 20ml with normal saline in a dose not exceeding 7mg/kg.

- Bupivacaine 0.5% ampoule (Astra Zenca pharmaceutical industry Inc., Cambridge, England), 15ml of it was taken in 20 ml syringe. It was used in the dose not exceeding 2mg/kg.

All patients were monitored for: signs of local anesthetic toxicity, respiratory difficulty, and hemodynamic change following brachial plexus anesthesia. In addition, assessment of the sensory and motor blockade was made following injection and the time was recorded.

Sympathetic block: By recording warming at the dermatomes blocked, and cold sensitivity were tested with a gel bag that was kept in a freezer, and was applied to a 5 cm diameter area for 3 seconds.

Sensory block was assessed by pin prick.

Motor block was tested by modified Bromage scale **(Bromage, 1965)** assessing shoulder flexion, extension, abduction and adduction as well as elbow and wrist extension (radial nerve), elbow flexion (musculocutaneous nerve), and wrist flexion (median nerve).

Statistical analysis of data: Statistical analysis was done using the statistical software SAS, version 9.1.3. The results were given at first descriptively as absolute or relative frequencies for categorical variables and as median, range (minimum, maximum) and standard deviation for continuous variables; separated for both groups. Differences between conventional landmark-guided interscalene block and ultrasound (US) groups were analyzed exploratively by the Fisher's Exact Test and the Mann-Whitney-U-Test. Statistical significance was accepted at a p-value of <0.05. Because of the pilot nature of this study, the significant level was not adjusted for multiple testing.

RESULTS

In the present work, there was no significant difference between groups as regard to age and weight. In addition, both groups had predominantly male patients. The most common operation performed was arthroscopic subacromial decompression (ASAD - Table 1).

In both groups, the right shoulder was operated upon in 16 patients. **The ASA score** and renal functions were comparable in both groups.

In the present study, there was no statistically significant difference between both groups as regard to premedication, time spent for detecting the brachial plexus and injecting the local anesthetic drug properly around the plexus, operative time, and times of onset of sensory blockade. The onset of motor block was within 14.56±3.85 min in Group B and 16.8 ± 3.42 min in group A. This difference is statistically significant. In addition, the duration of sensory blockade was significantly shorter in Group A. The duration of motor blockade was shorter in Group A when compared to Group B, and it was statistically significant. The block was successful in 90% in Group B and 73.33% of patients in conventional group (Table 2).

As regard complications in the present study, no severe complications have been

seen. All cases of neurological dysfunction resolved in the early postoperative period. No systemic toxicity from local anaesthetic and no hemodynamic complications were encountered. No significant difference in complication rate was noted between both groups (Table 3).

In a scale of 6 points, patients were asked about their satisfaction at the time of detecting the plexus and insertion of the pain relieving catheter during the operation itself and in the postoperative period**.** During insertion, 21 (70%) of patients in Group A and 23 (76.7%) in Group B were completely satisfied with the procedure (p=0.55). Intraoperatively, 29 (96.7%) of patients in Group A and 27 (90%) in Group B were completely satisfied with the block (p=0.30). In the postoperative period, 23 (76.7%) of patients in Group A and 13 (43.3%) in Group B were completely satisfied regarding the relief of postoperative pain (p=0.008). All patients in Group A agreed to have the same technique if they are going to be subjected to the same operation again, while 96.7% in Group B would accept it in future operation.

Table (1): Patient characteristics and surgical procedure.

Groups / **Characteristics**	**Group A**	**Group B**	**P value**
Age (years)	30.12±9.95	33.30±10.99	> 0.05
Weight (kg)	62.53±10.51	60.66±8.54	> 0.05
Sex (male/female)	25/5	23/7	> 0.05
Surgical procedure			
Lateral clavicular resection	14(46.7%)	11(36.7%)	
Removal of screws and plates	3(10.0%)	3(10.0%)	
Arthroscopic removal of shoulder calcifications	4(13.3%)	2(6.7%)	
Total shoulder replacement	1(3.3%)	2(6.7%)	
Shoulder hemiarthroplasty	2(6.7%)	2(6.7%)	
ORIF of fracture humerus	1(3.3%)	2(6.7%)	> 0.05
ORIF acromial fracture	2(6.7%)	2(6.7%)	
Change of screws	1(3.3%)	2(6.7%)	
Lateral clavicular resection	1(3.3%)	2(6.7%)	
Open biopsy for upper arm mass	1(3.3%)	1(3.3%)	
Excision of arm lipoma	0(0.0%)	1(3.3%)	

Table (2): outcome in both groups

Groups / Variables	Group A (C)	Group B (US)	P value
Premedication (dose)			
None	4 (13.3%)	7(23.3%)	
Midazolam 1mg	0(0.0%)	1(3.3%)	> 0.05
Midazolam 2mg	16(53.3%)	11(36.7%)	
Midazolam 3mg	8(26.7%)	4(13.3%)	
Midazolam 4mg	2(6.7%)	7(23.3%)	
Time to detect plexus and inject LA (min)	3.9±1.4	3.5±1.0	> 0.05
Operative time (minutes)	46±6	48±8	> 0.05
Onset of sensory blockade (min)	11.60±3.48	10.83±2.94	> 0.05
Time of motor blockade (min)	16.8±3.42	14.56±3.85	0.021*
Duration of sensory block (min)	352.22±87.50	397.93±67.32	0.032*
Duration of motor block (min)	305.19±60.08	343.44 ± 94.03	0.022*
Success rate			
Totally effective	22(73.33%)	27(90.0%)	
Partially effective	5(16.7%)	2(6.7%)	> 0.05
Failed	3(10.0%)	1(3.3%)	

Table (3): Complications in studied groups

Groups / Complications	Group A (C)	Group B (US)	P value
Bloody tape	1(3.3%)	0(0.0%)	
Horner's syndrome	3(10.0%)	2(6.7%)	
Recurrent laryngeal nerve palsy	1(3.3%)	1(3.3%)	
Phrenic nerve stimulation	1(3.3%)	1(3.3%)	
Parasthesia	2(6.7%)	0(0.0%)	

Total	6(20.0%)	2(6.7%)	> 0.05

DISCUSSION

The present study was designed to compare between conventional and ultrasound-guided interscalene block in upper limb surgery. It included 60 patients scheduled for elective upper limb surgery who were randomized into two equal groups according to block technique whether conventional or ultrasound guided.

Results of the study revealed that, both groups were comparable as regard to patient demographics, surgical interven-tion and premedication. Ultrasound guided group had shorter time to detect the plexus and injection of local anesthesia and shorter time of sensory blockage. However, the difference was statistically non-significant. On the other hand, ultrasound guided group had the advantages of significantly shorter time to reach motor blockade; and significant longer duration of both sensory and motor block. Finally, success rate was high in ultrasound guided group, but the difference was statistically non-significant. These results are comparable to those reported by **Kapral et al. (2008)** who reported that, ultrasound guided was found to enhance block success rate when performing interscalene block. In addition, **Liu et al. (2010)** reported that, US guidance has also been shown to improve peripheral nerve block onset times when compared with a neuro-stimulation technique, and others specifically addressed this issue for the interscalene block, and reported comparable results **(Dhir et al., 2007 and Chin & Handoll, 2011).** On the other hand, **Danelli et al. (2012)** reported that, sensory and motor block onset times were similar in patients undergoing interscalene block with 20 ml of 1% ropivacaine for coracoacromial ligament repair whether the block was placed using US guidance or not. These results comparable to the present study for sensory block but not for motor block, where it was significantly shorter in ultrasound guided group; and it may be due to better precision of placing local anesthetic with the use of ultrasound guidance.

Similar to the previous work by **Fredrickson et al. (2009),** results of the present study showed no significant difference in terms of block success rate between the two techniques. On the other hand, **Abrahams et al. (2009)** demonstrated significantly higher success rate and shorter procedural times and a reduced risk of vascular puncture using US guidance for nerve localization.

Regarding complications in the present work, it was comparable to those reported by **Park et al. (2016)** who reported that, an appropriate sensory and motor block was achieved in the upper extremities, including the ulnar nerve, fifteen minutes after interscalene block (ISB), and that there were no complications associated with the block. In addition, it was reported that, there is evidence to confirm that phrenic nerve blockade is almost always seen with traditional high volume (20 ml or more) interscalene blocks, including continuous infusions for postoperative analgesia, limiting its applicability to those who would normally benefit most

from a regional technique, namely those with significantly compromised respiratory function, the elderly and the obese. However, recent studies have demonstrated a lower incidence of phrenic nerve blockade and hemidiaphragmatic paresis to between 13 and 45% when administering a reduced dose of local anesthetic in a smaller volume **(Verelst and van Zundert, 2013).** Other reported adverse effects include Horner's syndrome (stellate ganglion block) and hoarseness (laryngeal hyperemia or recurrent laryngeal nerve block), which resolve on block regression **(Kumar et al., 2013).**

Real-time visualization with ultrasound has been proposed to improve the safety of peripheral nerve blocks due to the ability to avoid intraneural needle placement **(Chan et al., 2007),** whereas other techniques may often result in unintentional intraneural placement **(Jeng and Rosenblatt, 2011).** Despite this theoretical advantage, ultrasound was not associated with a significant reduction in postoperative neurological symptoms. A potential explanation is that we used a fixed two-dimensional cross-sectional image plane on the ultrasound, thus a similar rate of neural contact may have occurred due to the inability to fully visualize all three planes in real time. In addition, common clinical steps, such as monitoring for difficult injection or complaints of pain upon injection **(Benhamou et al., 2010),** were included for both techniques and may have narrowed a potential difference between groups **(Liu et al., 2009).**

In conclusion, results of the present study demonstrated that conventional and US guidance provided comparable sensory block onset times, complications and success rates in patients undergoing interscalene block. Ultrasound guided block showed significantly shorter time to reach motor blockade and significant longer duration of both sensory and motor block. As the sample of size of the present study is small, results of the present work should be handled in caution and future large scale studies are recommended.

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إحصار الضفيرة العصبية العضدية بين العضلات الأخمعية (إسترشاد بالموجات فوق الصوتية مقارنة بالطرق التقليدية)

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خلفية البحث: يمكن أن يقدم التخدير الموضعي نتائج أفضل في علاج الألم ويساعد علي جودة المآل لدي المرضي. والاسترشاد بالموجات فوق الصوتية من الممكن أن يحسن نتائج التخدير الموضعي.

الهدف من البحث: التعرف علي الفروق الهامة بين الطرق التقليدية وإستخدام الإسترشاد بالموجات فوق الصوتية في إحصار الضفيرة العصبية العضدية بين العضلات الأخمعية.

المرضي وطرق البحث: بعد أخذ الإذن من المريض للمشاركة في الدارسة، تم اشتراك 60 مريضا مقرراً لهم إجراء عملية جراحية بالطرف العلوي. وقد تم تقسيم المرضي بصورة عشوائية إلي مجموعتين متساويتين: الأولي إشتملت علي المرضي الذين تم التعامل معهم بالطريقة العادية، والثانية إشتملت المرضي الذين تم إستخدام الإسترشاد بالموجات فوق الصوتية أثناء إحصار الضفيرة العصبية العضدية بين العضلات الأخمعية.

النتائج: كشفت نتائج الدراسة أن كلا المجموعتين كانتا متقاربتين فيما يتعلق بالتركيبة السكانية للمرضي، وأسباب التدخل الجراحي، وأدوية ما قبل التخدير. وكانت مجموعة الإسترشاد بالموجات فوق الصوتية أقصر وقتا في التعرف علي الضفيرة العضدية وحقن التخدير الموضعي، كما إشتملت علي وقت أقصر للوصول للإنسداد الحسي. وكانت نتائج مجموعة الإسترشاد بالموجات فوق الصوتية أفضل بدرجة يعتد بها إحصائيا بالنسبة لوقت الوصول للانسداد الحركي، وفترة أطول في كل من الإنسداد الحسي والإنسداد الحركي. وأخيرا، فقد كان معدل نجاح التخدير الموضعي أفضل في مجموعة الإسترشاد بالموجات فوق الصوتية، ولكن الفرق لم يكن ذا أهمية من الناحية الإحصائية.

الاستنتاج: قدمت الطرق التقليدية والإسترشاد بالموجات فوق الصوتية نتائج متشابهة في وقت الإنسداد الحسي والمضاعفات ومعدلات النجاح. بينما كان الإسترشاد بالموجات فوق الصوتية أفضل في وقت الوصول للإحصار الحركي ومدة طويلة في الإحصار الحركي والإنسداد الحسي.