Stress response in shoulder surgery under interscalene block, randomized controlled study comparing ultrasound guidance to nerve stimulation

Hossam A. Elshamaa

Department of Anesthesia, Faculty of Medicine, Cairo University, Giza, Egypt

ABSTRACT

Background: Shoulder surgeries are known to cause moderate to severe pain. Many techniques have been used successfully to minimize that stress response including interscalene block. Ultrasound guided techniques are becoming widely spread and commonly used for regional anesthesia. The objective of the present randomized controlled study is to compare the ultrasound guidance with nerve stimulation for interscalene brachial plexus block (IBPB) regarding the effect on stress response. **Patients and Methods:** 50 patients, American Society of Anesthesiologists physical status I, II, and III, undergoing shoulder surgery were enrolled in the current study. Group U patients (n = 25) received ultrasound guided IBPB and Group N patients (n = 25) received IBPB using nerve locator. IBPB was done under ultrasound guidance using the linear 13-6 MHz transducer of the SonoSite M-Turbo ultrasonic device. In both groups, venous blood samples to measure cortisol level and assess stress response as a primary outcome were collected. **Results:** The current study demonstrated that the stress response, as indicated by the cortisol level in blood, showed no significant difference in the preoperative blood level between Group U and Group N, as well as blood level after block and before skin incision. However, it differed significantly between the two groups postoperatively. **Conclusion:** The current study concluded that the use of ultrasound guidance for IBPB in shoulder surgeries offered a significant suppression of the stress response intraoperatively and postoperatively as indicated by the low cortisol level with less complications and easier technique compared to nerve location.

Key words: *Cortisol, interscalene block, nerve stimulation, stress response, ultrasound*

Address for correspondence:
Dr. Hossam A. Elshamaa,
EBGH, King Fahad St., Alfaysaleia,
P.O. Box 6519, Jeddah 21452,
Saudi Arabia.
E-mail: hossamshamaa@yahoo.com

INTRODUCTION

Shoulder surgeries are commonly associated with moderate to severe degree of pain both intraoperative and postoperative which is comparable to the pain in some other major surgeries such as abdominal gastrectomy and thoracotomy necessitating a good control of pain and stress response.[1] Many techniques and procedures have been used successfully to minimize that stress response including: interscalene brachial plexus block (IBPB) both single injection as well as continuous infusion, local anesthetic infiltration, narcotic-based general anesthesia, suprascapular nerve block, and intra-articular injection of analgesics, however, it still remains a challenge that require more intense time and work of anesthesiologists to achieve a better patient care specially for elderly, cardiac or pulmonary compromised patients.[2] Adequate and efficient control of surgical pain in shoulder surgery is not only important for the patient's well-being but also facilitates a smooth stress-less recovery. IBPB is a widely spread technique to provide anesthesia and analgesia for shoulder surgery, but it is associated with a relatively high incidence of postoperative neurological symptoms that may reach up to 16%, the etiology of which is unclear. However, the use of ultrasound guidance minimized the incidence of such effects.[3]

Access this article online	
Quick Response Code:	Website: www.saudija.org
	DOI: 10.4103/1658-354X.159454

In the past few years, the ultrasound guided techniques became widely spread and commonly used for regional anesthesia facilitating the onset time and simplifying regional blocks.[4] Besides, other advantages of ultrasound guidance in regional anesthesia include: Fast performance of blocks, lower dose of local anesthetic, longer duration, less incidence of complications, e.g., arterial puncture, as well as a higher success rates.[5,6] Moreover, the better recovery with lower incidence of postoperative nausea and vomiting leads to a shorter hospital stay, resulting in a better cost effectiveness as well as patient satisfaction.[7] Furthermore, the progressive technical development of the ultrasonography devices as well as the high frequency and high-resolution transducers made it possible to see the small nerves and structures, and such devices made it even feasible to perform selective peripheral nerve or root blocks successfully.[8]

As a result of blocking the afferent impulses from the surgical site, decrease of the endocrinal stress response to the surgical procedure is observed. Furthermore, this decrease of such stress response is considered as an important indicator of a successful regional block. Normally, there is a circadian rhythm for stress hormones, the common of which is cortisol, with a gradual increase after night sleep to reach a peak at early morning wake up time, followed by a gradual decrease as the day goes by.[9] However, this rhythm may be interrupted by any stressful condition such as acute pain associated with surgery, which was proved to be accompanied by a progressive rise in cortisol level intraoperatively as well as in the early postoperative period.[9]

The objective of the present randomized, controlled study is to compare the ultrasound guidance with nerve stimulation for IBPB regarding the effect on stress response in patients undergoing shoulder surgery.

PATIENTS AND METHODS

After obtaining approval from the Clinical Research Ethics Committee of Erfan and Bagedo General hospital and obtaining informed consent. 50 patients, American Society of Anesthesiologists physical status I, II, and III, aged 18-60 years undergoing shoulder surgery were enrolled in the current study. The patients were randomly divided, using concealed envelope method, into two equal groups: Group U patients ($n = 25$) received ultrasound guided IBPB and Group N patients ($n = 25$) received IBPB using nerve locator. Inclusion criteria were as follows: age >18-year-old; ability to consent; and ability to understand and communicate, absence of the language barrier. Exclusion criteria were cardiovascular, hepatic or renal dysfunction, neuromuscular diseases, any coagulation defects or anticoagulant therapy, opioid or analgesic abuse, and history of chronic pain syndrome or brachial plexus injury.

All patients were premedicated with 5 mg midazolam I.M. and 4 mg ondansetron I.V. 30 min before shifting to OR. After admission to OR, the standard monitors including noninvasive arterial blood pressure, electrocardiography and pulse oximetry were applied. 500 ml of intravenous Lactated Ringer's solution was started. Patients were placed in a supine position with their faces directed to the contra-lateral side of surgery, and open facemasks of oxygen at 5 L/min were applied. Patient's neck was sterilized using iodine solution and sterile drapes were applied. In Group U, IBPB was done under ultrasound guidance as described by Liu *et al*.,[10] using the linear 13-6 MHz transducer of the SonoSite M-Turbo ultrasonic device (SonoSite™, Inc., Bothell, WA 98021, USA). With the probe parallel to the clavicle and the sonographic beam directed to the first rib, the subclavian artery was identified as an easy landmark with the brachial plexus divisions around it. From such position, the brachial plexus nerves were followed in a cephalic direction till the scalene muscles were visualized surrounding the trunks of the brachial plexus in the interscalene groove under sternocleidomastoid muscle [Figure 1]. Local anesthesia infiltration was given by 1 ml lidocaine 2% in the needle insertion site. A 50 mm 22-gauge insulated needle (Stimuplex® insulated B Braun Medical Germany) was introduced from lateral to medial parallel to the interscalene groove in an in-plane technique such that the entire needle was visualized. Once the needle tip was seen close to the plexus trunks 10 ml lidocaine 1% and 10 ml bupivacaine 0.25% was injected in divided doses with frequent aspiration and the local anesthetic spread was visualized with the ultrasound. If

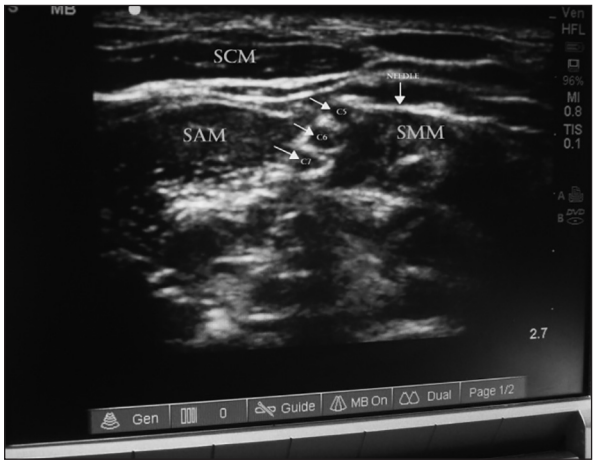

Figure 1: The scalene muscles (anterior and medius) surrounding trunks of the brachial plexus in the interscalene groove under sternocleidomastoid muscle

the resistance to injection was encountered, or intraneural injection was suspected the needle tip was repositioned under ultrasound guidance and local anesthetic was then injected. After block placement, the patient was placed in a sitting position for surgery, sensory block was assessed using ice pack with a scale of 2 (normal sensation), 1 (dysesthesia), and 0 (numbness), and motor block was assessed by evaluation of deltoid muscle function (deltoid abduction sign) such that 2 (normal movement), 1 (weak movement), and 0 (no movement). This assessment was repeated every 5 min and surgery was started only when the scale was 0.

In Group N, in the same position, insertion point was localized as the point of intersection of horizontal line drawn at the level of the cricoids cartilage laterally with a line 0.5 cm lateral and parallel to the lateral border of the sternocleidomastoid muscle. Superficial local anesthesia was done at this point using 1 ml lidocaine 2%. A 50 mm 22-gauge insulated needle was introduced (Echoplex® insulated echogenic needle with electro-neuro-stimulation port, Vygon, France) in a medial, posterior and slightly caudal direction. The needle was connected to the nerve locator (Fisher and Paykel Healthcare Ltd., Auckland, New Zealand) which was set at 0.8 mA at 2 Hz, once a motor response (deltoid muscle contraction) was elicited the current was reduced gradually with maintaining the best motor response possible till 0.3 mA was reached. Same type and dose of local anesthetic was injected in divided doses with frequent aspiration. In both groups, venous blood samples to measure cortisol level as a primary outcome were collected before surgery as a baseline, then after the application of the IBPB before skin incision as well as after skin incision. By the end of surgery, samples were taken immediately after surgery and at 3, 6, 12, 24 h postoperatively. The time to complete block placement in both groups (from needle insertion till final needle withdrawal), incidence of complications namely phrenic nerve block, as well as hemodynamic parameters namely, heart rate (HR), and mean arterial blood pressure (MAP) were assessed as a secondary outcome at the same time intervals as the blood samples.

Data were analyzed using computer statistical software system SPSS version 12.0 (SPSS Inc., Chicago, IL, USA). Descriptive data are expressed as mean (±standard deviation), statistical analysis was done using two-way analysis of variance, and paired or unpaired Student's *t*-test were used to compare data between the groups or within a group whenever appropriate. The power analysis was performed on the basis of the cortisol level as the primary outcome and indicated a sample size of 24 subjects per group, with an α error <0.05 and beta error 0.6 and power of 80%. Sample size calculation was done by PASS software program (Power Analysis and Sample Size calculation) by NCSS, LLC, USA. $P < 0.05$ were considered statistically significant.

RESULTS

The current study showed no significant difference in demographic data including age, sex, height, and body weight between patients of Group U and Group N as shown in patient data and flow chart [Table 1 and Figure 3]. Moreover, the duration of surgery, which was all done by the same surgeon, was not significantly different among both groups as indicated in Table 1. No significant difference was detected between the two groups as regards the various surgical procedures. One patient in Group U had failed block and was excluded from the study.

No significant difference was detected regarding time of block completion between Group U (8 ± 2.1 min) and Group N (9 ± 1.8 min). Only one patient (4%) in Group U developed phrenic nerve block which was significantly lower than Group N that showed five patients (20%). Hemodynamic parameters HR and MAP in the current study showed significant difference in the values measured immediately after application of IBPB whether before or after skin incision, being significantly lower in Group U, and this significant difference was also seen at postoperative, 3 h and 6 h assessment. Whereas, no significant difference was detected between the two groups as regards the baseline (control), 12 h as well as 24 h values as demonstrated in [Table 2].

Regarding the stress response as indicated by the cortisol level in blood, no significant difference was detected in the preoperative blood level between Group U (173 ± 21 ng/ml) and Group N (169 ± 18 ng/ml), as well as level after block placement before skin incision which was (169 ± 17 ng/ml) for Group U compared to (172 ± 19 ng/ml) for Group

Table 1: Demographic and operative data

Groups	Group U (*n* = 24)	Group N (*n* = 25)
Age (year)	52.6±2.1	49.9±1.3
Gender (male/female)	21/4	18/7
Body weight (kg)	78±18	77±11
Height (cm)	170±3	172±4
Duration of surgery (min)	149±25	153±27
Failed block	1	0
Type of surgery (%)		
Shoulder arthroscopy	14 (56)	15 (60)
Shoulder total arthroplasty	2 (8)	2 (8)
Rotator cuff repair	6 (24)	7 (28)
Shoulder stabilization	2 (8)	1 (4)

Values are expressed as mean ± SD. No significant differences between the two groups ($P > 0.05$). SD: Standard deviation

N. Indicating a comparable stress response in both groups during the application of IBPB.

Significant difference was detected between the blood levels of cortisol in the subsequent samples which was taken immediately after skin incision, after surgery, at 3, 6, and 12 h postoperatively as demonstrated in [Figure 2] where the cortisol level was significantly higher in Group N than Group U suggesting a lower stress response in Group U during surgery and in the first postoperative day. However, the cortisol level in Group N decreased to show no significant difference from Group U at 24 h postoperative sample [Figure 2].

DISCUSSION

In the present prospective randomized controlled study, the results demonstrated that the use of ultrasound guidance for IBPB can significantly reduce the stress response, hence, the cortisol level, both intraoperatively and postoperatively rather than nerve stimulation with a low failure rate. Besides the hemodynamic parameters, HR and MAP also showed a significant reduction intraoperatively as well as early postoperatively indicating a suppressed stress response to surgery. The ultrasonographic guidance facilitated the exact injection of the local anesthetic between the scalene muscles undercover the sternocleidomastoid decreasing the incidence of complications as phrenic nerve block and adding to the safety as well as the success of the block, resulting in a superior control of the stress response in patients of the present study with no difference in the time of completion of the block. Although no significant difference was detected after application of the block till the start of surgical skin incision, yet intraoperatively there was a significantly lower cortisol level, HR, and MAP with the ultrasound guided IBPB which was maintained in the first postoperative day. Such results, in addition to the lower incidence of phrenic nerve block, made the block under ultrasound guidance of value in compromised patients, as cardiac and chronic obstructive pulmonary disease (COPD) patients, as a result of its success in blunting the stress response and stress hormones release, hence all its deleterious effect.

Table 2: Hemodynamic parameters (secondary outcome)

Parameters	MAP (mmHg)		HR (beat/min)	
	Group U	Group N	Group U	Group N
Preoperative	84±7.1	87±1.0	87±6.2	89±6.4
Postblock	74±5.3*	83±2.2	79±3.5*	85±2.9
Postincision	71±3.3*	88±5.5	75±3.6*	87±2.5
Postoperative	74±4.1*	93±7.4	77±5.2*	86±3.9
3 h	76±7.6*	89±1.8	76±4.4*	88±1.9
6 h	75±6.8*	85±6.6	75±4.8*	89±6.5
12 h	83±3.3	84±3.1	84±6.3	85±4.1
24 h	82±5.0	85±6.2	85±7.3	86±9.2

Values expressed as mean ± SD. *Significant differences between the two groups $P < 0.05$. SD: Standard deviation; MAP: Mean arterial pressure; HR: Heart rate

Interscalene brachial plexus block is described as technique where local anesthetic is injected in the groove between scalenus anterior and scalenus medius muscles undercover of sternocleidomastoid muscle where the trunks of the brachial plexus are available, with recent trials to refine it to avoid phrenic nerve palsy.[11] This block is accused of high failure rate as well as prolonged application time; however, the use of ultrasound guidance minimized such disadvantages as a result of direct visualization of the brachial plexus trunks as well as the needle advancement and local anesthetic spread during injection, thus shortening application time with a higher success rate, improving safety. It also leads to lowering incidence of complications including phrenic nerve block, intraneural, intrathecal or intravenous injection of local anesthetic, and arterial injury, besides the use of a lower volume of local anesthetic that help avoiding toxicity.[12,13] All of which is consistent with the current study. Whereas, other studies suggested that other block techniques may commonly be associated

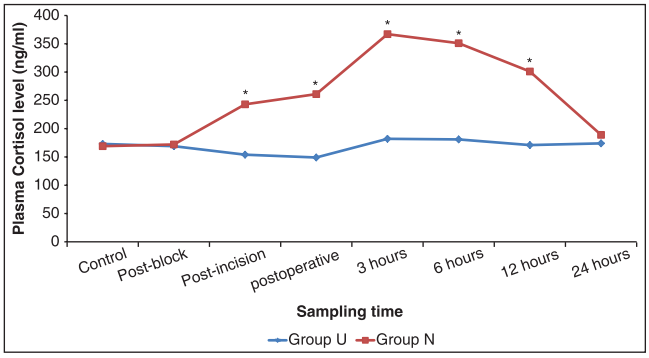

Figure 2: The plasma cortisol level in ng/ml (primary outcome) expressed in mean ± standard deviation. (*) indicates a significant difference

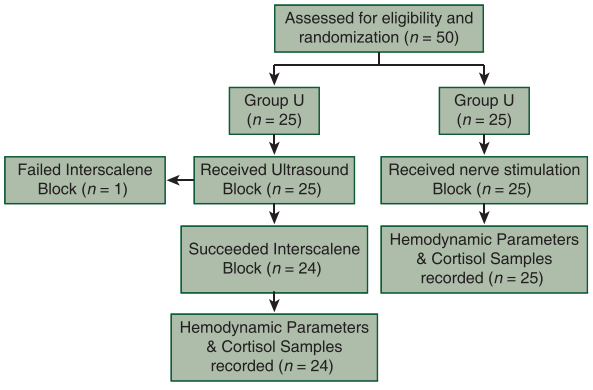

Figure 3: The patient selection, allocation, and analysis flow chart (Consort 2010)

with intraneural injection.[14] Circadian rhythm of steroid hormones secretion, namely cortisol, has been described and such rhythm is affected and disturbed by acute surgical pain, where a progressive rise in cortisol level was described in the early six postoperative hours, however, such effect was blunted by the block application.[15]

Supporting the result of the present study was Liu *et al*.[16] who studied the use of ultrasound guidance in the ambulatory shoulder surgery and concluded that the use of ultrasound to guide interscalene or supraclavicular blocks was very effective and minimized the incidence of complications. Furthermore, in the study done by El-Dawlatly *et al*.[17] they found out that the ultrasound guidance facilitated the exact injection of the local anesthetic in place leading to a better quality of analgesia compared to standard general anesthesia. Consistent with the current study, are results demonstrated by Thomas *et al*.[18] who compared ultrasound guided IBPB to nerve stimulation in residency training programs and concluded that it was associated with shorter procedure time and lower incidence of postoperative neurological complications. On the contrary, Liu *et al*.[10] compared ultrasound guidance with nerve stimulation in IBPB and concluded that ultrasound does not add superior results over the nerve stimulation. However, McNaught *et al*.[19] discussed the difference between the ultrasound-guided and nerve stimulation IBPB and summarized that the ultrasound decreased the number of needle passes indicating easier technique. Danelli *et al*.[20] compared ultrasound to neurostimulation IBPB and concluded that the ultrasound facilitated a shorter procedure time with less incidence of complications and fewer needle puncture.

In conclusion, the present study demonstrated that the use of ultrasound guidance for IBPB in shoulder surgery offered a significant suppression of the stress response as indicated by the low cortisol level, and better hemodynamic parameters both intraoperative and postoperative compared to nerve stimulation with less complications and easier technique suggesting its safety in cardiac or pulmonary compromised patients. However, further studies are required to assess effect on other stress hormones, optimal local anesthetic volume, as well as a longer postoperative follow-up period than 24 h, in addition to evaluate the effect of ultrasound guidance in other regional blocks with other surgical procedures.

ACKNOWLEDGMENTS

The author would like to thank Erfan and Bagedo General Hospital for financing the current study.

REFERENCES

1. Wilson AT, Nicholson E, Burton L, Wild C. Analgesia for day-case shoulder surgery. Br J Anaesth 2004;92:414-5.
2. Fredrickson MJ, Krishnan S, Chen CY. Postoperative analgesia for shoulder surgery: A critical appraisal and review of current techniques. Anesthesia 2010;65:608-24.
3. Liguori GA, Zayas VM, YaDeau JT, Kahn RL, Paroli L, Buschiazzo V, *et al.* Nerve localization techniques for interscalene brachial plexus blockade: A prospective, randomized comparison of mechanical paresthesia versus electrical stimulation. Anesth Analg 2006;103:761-7.
4. Koscielniak-Nielsen ZJ. Ultrasound-guided peripheral nerve blocks: What are the benefits? Acta Anesthesiol Scand 2008;52:727-37.
5. Kapral S, Greher M, Huber G, Willschke H, Kettner S, Kdolsky R, *et al.* Ultrasonographic guidance improves the success rate of interscalene brachial plexus blockade. Reg Anesth Pain Med 2008;33:253-8.
6. Marhofer P, Greher M, Kapral S. Ultrasound guidance in regional anesthesia. Br J Anaesth 2005;94:7-17.
7. Russon K, Sardesai AM, Ridgway S, Whitear J, Sildown D, Boswell S, *et al.* Postoperative shoulder surgery initiative (POSSI): An interim report of major shoulder surgery as a day case procedure. Br J Anaesth 2006;97:869-73.
8. Greher M, Scharbert G, Kamolz LP, Beck H, Gustorff B, Kirchmair L, *et al.* Ultrasound-guided lumbar facet nerve block: A sonoanatomic study of a new methodologic approach. Anesthesiology 2004;100:1242-8.
9. Katz FH, Romfh P, Smith JA. Diurnal variation of plasma aldosterone, cortisol and renin activity in supine man. J Clin Endocrinol Metab 1975;40:125-34.
10. Liu SS, Zayas VM, Gordon MA, Beathe JC, Maalouf DB, Paroli L, *et al.* A prospective, randomized, controlled trial comparing ultrasound versus nerve stimulator guidance for interscalene block for ambulatory shoulder surgery for postoperative neurological symptoms. Anesth Analg 2009;109:265-71.
11. Burckett-St Laurent D, Chan V, Chin KJ. Refining the ultrasound-guided interscalene brachial plexus block: The superior trunk approach. Can J Anaesth 2014;61:1098-102.
12. Chan VW, Brull R, McCartney CJ, Xu D, Abbas S, Shannon P. An ultrasonographic and histological study of intraneural injection and electrical stimulation in pigs. Anesth Analg 2007;104:1281-4.
13. Schafhalter-Zoppoth I, Zeitz ID, Gray AT. Inadvertent femoral nerve impalement and intraneural injection visualized by ultrasound. Anesth Analg 2004;99:627-8.
14. Bigeleisen PE. Nerve puncture and apparent intraneural injection during ultrasound-guided axillary block does not invariably result in neurologic injury. Anesthesiology 2006;105:779-83.
15. Engquist A, Brandt MR, Fernandes A, Kehlet H. The blocking effect of epidural analgesia on the adrenocortical and hyperglycemic responses to surgery. Acta Anaesthesiol Scand 1977;21:330-5.
16. Liu SS, Gordon MA, Shaw PM, Wilfred S, Shetty T, Yadeau JT. A prospective clinical registry of ultrasound-guided regional anesthesia for ambulatory shoulder surgery. Anesth Analg 2010;111:617-23.
17. El-Dawlatly AA, Turkistani A, Kettner SC, Machata AM, Delvi MB, Thallaj A, *et al.* Ultrasound-guided transversus abdominis plane block: Description of a new technique and comparison with conventional systemic analgesia during laparoscopic cholecystectomy. Br J Anaesth 2009;102:763-7.
18. Thomas LC, Graham SK, Osteen KD, Porter HS, Nossaman BD. Comparison of ultrasound and nerve stimulation techniques for interscalene brachial plexus block for shoulder surgery in

a residency training environment: A randomized, controlled, observer-blinded trial. Ochsner J 2011;11:246-52.
19. McNaught A, Shastri U, Carmichael N, Awad IT, Columb M, Cheung J, *et al.* Ultrasound reduces the minimum effective local anaesthetic volume compared with peripheral nerve stimulation for interscalene block. Br J Anaesth 2011;106:124-30.
20. Danelli G, Bonarelli S, Tognú A, Ghisi D, Fanelli A, Biondini S, *et al.* Prospective randomized comparison of ultrasound-guided and neurostimulation techniques for continuous interscalene brachial plexus block in patients undergoing coracoacromial ligament repair. Br J Anaesth 2012;108:1006-10.

How to cite this article: Elshamaa HA. Stress response in shoulder surgery under interscalene block, randomized controlled study comparing ultrasound guidance to nerve stimulation. Saudi J Anaesth 2015;9:359-64.
Source of Support: Nil, **Conflict of Interest:** None declared.