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Research Article

Comparison between continuous posterior and lateral interscalene brachial plexus blockades for major shoulder surgery

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Abstract *Background:* Postoperative pain relief after major shoulder surgery is extremely challenging. Continuous interscalene blockade is considered a well suited pain management technique for this type of surgery, but with technical difficulties. The aim of this study was to compare the efficacy and safety of continuous posterior and conventional lateral interscalene brachial plexus blockades.

Methods: This prospective randomized study included 40 patients who were radomally allocated into two equal groups ($n = 20$ patients), in the first group, continuous lateral interscalene blockade was done (Lateral Group), while continuous posterior interscalene was performed in the second group (Posterior Group). The measurement data were patient characteristics and surgical data, easiness of catheter insertion, onset of blockade, catheter insertion and total blockade times. Side effects encountered during blockade and postoperative efficacy of analgesia as well as patients satisfaction were also measured.

Results: There was no significant difference as regards the onset of anesthesia in both groups. Block procedure time and catheter placement times were faster in the posterior group

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(6.6 ± 0.64 vs 9.6 ± 1.1 min; $P < .05$ and 1.6 ± 0.7 vs 4.3 ± 0.7 min; $P < 0.05$ respectively). Successful catheter insertion was higher in the posterior group (19 patients vs 15 patients in the lateral group). Easy catheter insertion were significantly higher in the posterior group (16 patients vs eight patients In the lateral group; $P < 0.05$).Technical adverse effects related to catheter insertion were significantly higher in the lateral group (nine patients vs only one patient in the posterior group; $P < 0.05$). Complications were comparable in both groups. Postoperative efficacy of analgesia and Patient's satisfaction about catheter placement was higher in the posterior group.

Conclusion: In conclusion, we demonstrated a high success rate, low systemic and technical adverse effects, and better catheter compliance with continuous posterior interscalene blockade.

1. Introduction

Major shoulder surgery are known to be extremely painful [1]. Continuous interscalene brachial plexus blockade has been reported to be the technique of choice for postoperative pain management after this type of surgery [2].

The original approach for interscalene blockade was described by Winnie, this technique was associated with some rare but life-threatening complications as inadvertent subarachnoid spread, intra-arterial injection, and pneumothorax [3]. Catheter insertions were also technically challenging [4–7]. For these reasons, many investigators reported other approaches aiming at solving these complications. In 1990, Pippa et al. [8] reintroduced the paravertebral posterior approach of the brachial plexus using a single-injection blockade with the loss-of-resistance technique that was first described by Kappis in 1912, using a multiple injection technique [9]. Till now, the Pippa approach is infrequently used and only a few studies of this approach have been published [10–16].

To our knowledge, there is only one study compared the single injection posterior approach with the classic lateral approach [17]. Therefore, authors conducted this study to compare the reliability and efficacy of continuous interscalene blockade using the posterior and lateral approaches.

2. Methods

After approval by local ethics committee, written informed consent was taken from each patient. Forty American Society of Anesthesiologists (ASA) physical status I, II or III adult patients scheduled to undergo elective major shoulder surgery were prospectively enrolled in this study. Exclusion criteria included local infection, sepsis, coagulopathy, and other contraindications to the interscalene block as contralateral phrenic or recurrent laryngeal nerves paralysis.

Patients were then randomized using a sealed envelope into two equal groups: interscalene blockade was done using the Winnie approach in the first group (Lateral Group), while the Pippa approach was performed in the second group (Posterior Group).

All patients were premedicated with 3.75–7.5 mg oral midazolam 2 h preoperatively. In the induction room, standard noninvasive monitors including pulse oximetry, noninvasive arterial blood pressure in the non-operative arm, and five leads electrocardiogram were attached. O2 (2–4 L/min) was administered via nasal cannula and a peripheral intravenous access was inserted.

Patients in the lateral group were placed supine, with the head slightly turned away from the side to be blocked. In the posterior group patients were placed in the lateral recumbent position, the head is placed axially on a pillow, with the cervical spine flexed forwards. After skin disinfection, sterile covering and local anesthesia of the insertion site was done.

The insertion site for the lateral group as was reported by Winnie [18] (at the height of the superior thyroid notch at the posterior edge of the sternocleidomastoid muscle). The insertion site for the posterior group as was reported by Pippa et al. [8] (3 cm lateral to the midpoint between spinous process of the sixth and seventh cervical vertebrae). For lateral approach, 18-gauge, 38-mm insulated Tuohy needle was advanced caudad, slightly to the lateral and aims at the puncture site of the vertical-infraclavicular blockade. For the posterior approach, a 17-gauge insulated Tuohy needle advanced 5–10° laterally, towards the direction of the easily felt posterior edge of the sternocleidomastoid muscle at the level of the cricoids, once the transverse process of C7 is encountered, the direction of puncture is corrected just slightly to the cranial, until, after another 1–2 cm.

All blocks were performed using a nerve stimulator (Stimuplex HNS 11, B. Braun Melsungen AG, Melsungen, Germany). The electrical current of the nerve stimulator was initially set at 2 mA with a stimulation frequency of 2 Hz and pulse duration of 0.1 ms. Correct placement of the needle was defined as contractions of the deltoid, biceps, or triceps muscles at a current below 0.5 mA. The nerve stimulator was then attached to the proximal end of a stimulating 20 or 21 gauge catheter (StimuCath), and the catheter was advanced 3–5 cm beyond the tip of the needle using a Seldinger technique; muscle twitches should be maintained throughout the catheter advancement process, and the nerve stimulator output remained at 0.5 mA during catheter placement. Failed block was defined as the failure to threaten the catheter.

In both groups, catheters were secured with a transparent occlusive dressing. Lidocaine 2% and Bupivacaine 0.5% (20 mL of both) was injected after doing a test dose with repeated aspiration (5 mL each).

In the operating room, general anesthesia was induced for all patients with 1–2 μg/kg fentanyl, 1.5–2 mg/kg propofol, and 0.5 mg/kg atracurium IV 30 min after local anesthetic injection. Endotracheal intubation and mechanical ventilation were then commenced. Anesthesia was maintained with a mixture of nitrous oxide (50–70%) and isoflurane (1–1.5%) in oxygen, and incremental doses of atracurium. An infusion of 8–10 mL/h of bupivacaine 0.25% throughout the interscalene catheter was started postoperatively.

Sensory block (absence of cold and pinprick response in all dermatomes C3–C6) and motor block (inability to lift or abduct the arm) were assessed at 10, 20, and 30 min from the

end of local anesthetic injection. Difficulties in placement of the catheter were reported, easy insertion was defined as only one successful insertion attempt, while difficult insertion was defined as two or more successful insertion attempts. Block time (time from skin infiltration to securing the catheter), and catheter insertion time (time of catheter placement) were recorded. Clinical systemic complications as pnemothorax, intravascular, or neuraxial spread, Horner's syndrome, and dysphonia were recorded. Local adverse effects related to catheter placement as catheter occlusion, dislodgement, local signs of infection, or leakage of anesthetics was documented during the postoperative 48 h. Patient satisfaction with respect to catheter placement was assessed by a patient satisfaction score; this score graded as graded as excellent, satisfactory, or poor. Postoperative efficacy of analgesia was assessed at 12, 24, 48 h postoperatively using a 10-cm visual analog scale (VAS); this score graded (0 cm no pain; 10 cm worst). In case of inadequate analgesia, 50 mg pethedine was given intramusculary.

3. Statistical analysis

Data are presented as mean ± SD or percentage. Comparison of two means was performed using the Student test. Comparison of percentages was performed using the Fisher exact method. P value < 0.05 was considered significant.

4. Results

Forty adult patients were enrolled in the study. Failed catheter insertion attempts were reported in five patients in the lateral group and one patient in the posterior group and they were excluded from the study. Patient characteristics and surgical data were comparable in both groups (Table 1).

There was no significant difference as regards onset of anesthesia in both groups. Complete sensory and motor blockade were not achieved after 30 min from local anesthetic injection in two cases in the lateral group, and only one case in the posterior group. Block procedure time was faster in the posterior group (6.6 ± 0.64 vs 9.6 ± 1.1 min; $P < .05$). Catheter placement time was also faster in the posterior group (1.6 ± 0.7 vs 4.3 ± 0.7 min; $P < 0.05$) (Table 2). Easy catheter insertion attempts were significantly higher in the posterior group (16 patients "84%" in posterior group vs eight patients "53%" In the lateral group; $P < 0.05$) (Table 2).

Table 1 Patient characteristics and surgical data.

	Lateral group ($n = 15$)	Posterior group ($n = 19$)
Age (yrs)	38.3 ± 6.27	37.7 ± 5.9
Male sex	12 (80%)	15 (78%)
ASA class		
I	8	10
II	5	6
III	2	3
Type of surgery		
Shoulder arthoplasty	6	7
Rotator cuff repair	5	7
Bankert operation	3	4
Others	1	1
Operative time (min)	112 ± 22.3	111 ± 28.9

Data expressed as mean ± SD, and number (%).

Table 2 Procedure and catheter insertion data.

	Lateral group ($n = 15$)	Posterior group ($n = 19$)
Onset		
10 min	3 (20%)	5 (26%)
20 min	10 (66%)	16 (84%)
30 min	13 (86%)	18 (95%)
Procedure time (min)	6.6 ± 0.64	9.6 ± 1.1*
Catheter insertion time (min)	1.6 ± 0.7	4.3 ± 0.7*
Catheter insertion difficulties		
Easy insertion	8 (53%)	16 (84%)*
Difficult insertion	7 (47%)	3 (16%)*

Data expressed as mean ± SD, and number (%).
* $P < 0.05$.

Table 3 Adverse effects.

	Lateral group ($n = 15$)	Posterior group ($n = 19$)
Systemic adverse effects		
Epidural spread	1 (6%)	0 (0%)
Dysphonia	6 (40%)	5 (27%)
Horner's syndrome	5 (33%)	6 (31%)
Diaphragmatic palsy	2 (13%)	1 (5%)
Technical adverse effects (occlusion, dislodgement, leakage, infection)	9 (60%)	1(5%)*

Data expressed as number.
* P less than 0.05.

Technical adverse effects related to catheter insertion as (occlusion, dislodgement, leakage, infection) were significantly higher in the lateral group (nine patients vs one patient in the posterior group; $P < 0.05$). There were no reported cases of systemic complications apart from neuroaxial spread in one case in the lateral group. Minor complications in the form reversible phernic nerve palsy, dysphonia, and Horner's syndrome were comparable in both groups (Table 3).

Postoperative efficacy of analgesia was significantly higher in the posterior group as evident by the lower VAS at 12, 24, and 48 h. Patient's satisfaction about catheter placement was poor in three patients the posterior group vs 9 in the lateral group, which was statistically significant (Table 4).

5. Discussion

Despite being a relatively new technique to the operator, posterior approach showed a faster catheter, and procedure block times compared to the conventional lateral approach. Catheter placement time in this study was close to that encountered with Sandefo et al. [19] who use the same approach.

Catheter insertion and maintenance in the brachial plexus sheath represent a technical challenge in many studies [4–6,20]. In this study the difficulties in threatening the catheter including failed insertion were significantly lower in the posterior approach. Easy catheter insertion attempts were close to that encountered with Sandefo et al. [19] who use the same approach. This can be explained by the easily identified surface landmarks in the posterior approach and the excellent ana-

Table 4 Postoperative efficacy of analgesia and patient satisfaction.

	Lateral group (n = 15)	Posterior group (n = 19)
VAS (0–10)		
At 12 h	6.7 + 1.2	3.5 + 1.7*
At 24 h	7.4 + 1.0	3.8 + 1.7*
At 48 h	8.3 + 0.9	3.85 + 1.2*
Patient satisfaction		
Excellent	0 (0%)	4 (21%)
Satisfactory	6 (40%)	12 (63%)
Poor	9 (60%)	3 (15%)*

Data expressed as mean ± SD, and number (%).
VAS = visual analog scale.
* P less than 0.05.

tomic pathway for needle passage and subsequent catheter insertion.

This study showed an excellent maintenance in catheters of the posterior approach patients in the postoperative 48 h study period with no recorded complications, the relatively long pathway of the catheter in the extensor muscles of the neck may have improved the catheter fixation and prevented catheter related complications as dislodgement, occlusion, or anesthetic leakage, while the right angle of the catheters in the lateral group facilitate their advancement or withdrawal during head or shoulder movements. There were no recorded cases of catheter related infection in both groups, this mostly because of the strict aseptic precaution taken during the procedure, and the early catheter removal (48 h in all cases).

Patient's satisfaction about catheter placement was better in the posterior approach patients. This can be explained by the more catheter related irritation and patient discomfort during movement in the anterior neck compared to the posterior one.

The present study reported no systemic adverse effects in posterior approach patients as the puncture site was far away from the cervical vertebra and more cranial to the lung avoiding the risk of cervical and thoracic epidural blockade, total spinal anesthesia, inadvertent injection into the vertebral artery, and pneumothorax. Pippa et al. [8] reported no intrathecal injections in 50 brachial plexus blocks with the posterior approach, but with the classic interscalene approach they found a frequency of 2 in 50 [21].

The efficacy of postoperative analgesia was higher in the posterior approach patients as was evident by the lower VAS could be explained by the improper fixation of catheters in the lateral group.

There were many limitations in the current study; the first one is that subcutaneous tunneling was not implemented. Tunneling might be able to avoid the recorded catheter related complications that affect the analgesic efficacy in the lateral group. The second limitation is that there was no long-term follow up and documentation of the neurological sequale for both approaches. The third limitation was the relatively small sample size in the study. A larger study is recommended to confirm the efficacy of this relatively new approach.

We conclude that, continuous posterior interscalene approach is a proper option for postoperative pain management after major shoulder surgery that provides a higher success rate, lower systemic and technical adverse effects, and better catheter compliance.

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