Original Article

Comparison of ultrasound-guided intermediate vs subcutaneous cervical plexus block for postoperative analgesia in patients undergoing total thyroidectomy: A randomised double-blind trial

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ABSTRACT

Background and Aims: Intermediate cervical plexus block (CPB) is a new procedure whose analgesic efficacy compared to superficial cervical plexus block is yet to be established. We compared the analgesic efficacy of superficial vs intermediate CPB for post-operative analgesia after thyroid surgery. **Methods:** Forty-five patients with American Society of Anaesthesiologists' physical status 1 or 2 undergoing total thyroidectomy were recruited. Forty-four patients in superficial/subcutaneous CPB group (n = 22) and intermediate CPB (n = 22) received 20 mL 0.25% bupivacaine with adrenaline 100 μg bilaterally in ultrasound-guided superficial and intermediate cervical plexus block before induction of general anaesthesia., respectively. The primary outcome measure was the postoperative visual analogue scale (VAS) scores at 0, 2, 4, 6, 12 and 24. Secondary outcome measures included the total dose of rescue analgesic required, duration of postoperative analgesia and patient's satisfaction score. Statistical analysis was with the Mann-Whitney U test and independent t-test. **Results:** The post-operative VAS scores were lower in intermediate CPB group compared to superficial CPB group at 2, 4, 6, 12, 18 and 24 h [$P < 0.05$]. Time to first rescue analgesic demand was prolonged 10.06 ± 3.62 h in intermediate group compared to 7.94 ± 3.62 h in superficial group [$P = 0.017$] and total analgesic consumption were lower in intermediate group (71.25 ± 16.70 μg) than the superficial group (101.25 ± 50.31 μg) [$P = 0.011$]. **Conclusion:** Ultrasound-guided intermediate CPB reduces post-operative pain scores, prolongs duration of analgesia and decreases demands for rescue analgesia compared to superficial CPB.

Key words: Anaesthesia, analgesia, pain, postoperative, thyroidectomy

INTRODUCTION

The advances in anaesthesia have made pain management an integral component of perioperative care with greater emphasis on the use of loco-regional techniques for providing anaesthesia as well as analgesia after surgeries. The cervical plexus block (CPB) is one such block used to provide effective anaesthesia and analgesia for surgery in the head and neck region.[1-3]

The cervical fascia was first described by Burns[4] as a very strong and resisting structure, consisting of two layers, superficial and deep. But more recently Guidera *et al*.[5] classified the cervical fascia as superficial/subcutaneous and deep. The deep cervical fascia is further divided into three layers: (a) the superficial layer, which was also called the investing fascia but is now referred to as the masticator fascia, submandibular fascia or sternocleidomastoid

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(SCM)-trapezius fascia, (b) the middle layer, which is suggested as to be named as strap muscle fascia or visceral fascia; and (c) the deep layer or the 'prevertebral fascia'.[6] Blocks given above this superficial layer of deep cervical fascia are named as superficial/subcutaneous cervical plexus block and below this layer but above prevertebral fascia are named as intermediate plexus block as suggested by Telford and Stoneham.[7] Blocks below the prevertebral fascia are termed as deep cervical plexus block. A literary review offers us many studies comparing superficial and deep blocks with respect to effect and complications but intermediate cervical plexus block is a newer entry for deliberations and research.

The superficial layer of deep cervical fascia has always remained a matter of debate, with conflicting literary results. Pandit and colleagues,[8] have shown that the investing fascia is complete and acts as a barrier to subcutaneous spread and therefore, a subcutaneous injection should be clinically less effective than an intermediate (putative subfascial) injection. But more recently, Nash and colleagues[9] demonstrated that the investing layer of fascia is either lacking or incomplete on histological examination of neck tissues, and thus a subcutaneous cervical plexus block should be clinically as effective as an intermediate block.

Therefore, we conducted this pilot research project to find out the effects of intermediate CPB and its comparison with superficial CPB with respect to analgesic efficacy and side effects.

While superficial cervical plexus block is safe and easy to master, intermediate cervical plexus block is thought to provide more profound analgesia particularly for deep structures that may have an autonomic sympathetic or 'visceral' distribution of pain. Moreover, the risk of complications such as phrenic nerve palsy, Horner's syndrome, subarachnoid or epidural injection is also very less with intermediate blocks compared to deep blocks.[10] Thus, the data provides substantial evidence to compare the efficacy of these two blocks and for their clinical use in the future.

We intended to compare the analgesic efficacy of ultrasound-guided subcutaneous cervical plexus block vs ultrasound-guided intermediate cervical plexus block after thyroid surgery. The study hypothesis was that the intermediate cervical plexus block provides better and longer-lasting analgesia compared to the superficial cervical plexus block.

METHODS

After approval by Institutional Ethics Committee, and written informed consent from the subjects, this study was carried out in 45 patients belonging to the American Society of Anaesthesiologists (ASA) physical status 1 or 2, undergoing elective total thyroidectomy (with normal thyroid function tests) over a period of 1 year. As one patient refused to participate, 44 patients were randomised by means of computer-generated random numbers into two groups: subcutaneous [BS] and intermediate injection [BI] groups of 22 patients each [Figure 1]. Exclusion criteria were patients with known bleeding diathesis, history of allergy to local anaesthetics or known diaphragmatic motion abnormalities. Random groups assigned were enclosed in a sealed opaque envelope. The sealed envelope was opened by an anaesthesiologist not involved in the study. The observer who collected the perioperative data, as well as the patient, was masked to the technique of analgesia performed.

All patients were explained about the procedure, advantages and risks of the procedure during the preoperative assessment done 1 day prior to surgery and then written informed consent was obtained from the patients. Patients were educated about the visual analogue scale [VAS] during the preoperative assessment. All the patients were kept nil orally for 8 h before surgery, and premedication with oral alprazolam 0.5 mg and oral ranitidine 150 mg was given the night before surgery.

In the operation theatre after securing peripheral venous access, standard monitoring, i.e. non-invasive blood pressure, five-lead electrocardiography and pulse oximetry were attached. The cervical plexus blocks were performed by one of the two anaesthesiologists experienced in the technique. During the blocks, anxiolysis was achieved with midazolam 1 mg IV. For both the blocks, patients were positioned supine with the head turned to the opposite side and the skin was cleaned with chlorhexidine.

The patients in group BS received ultrasound (Sonosite™ Micromax machine, Bothell, WA USA, linear high-frequency probe, 6–13 MHz) guided subcutaneous superficial cervical plexus block. The linear probe was placed transversely over the lateral side of the neck at the midpoint of the posterior border of the sternocleidomastoid muscle (SCM) such that the tapering end (posterior border on the ultrasound image)

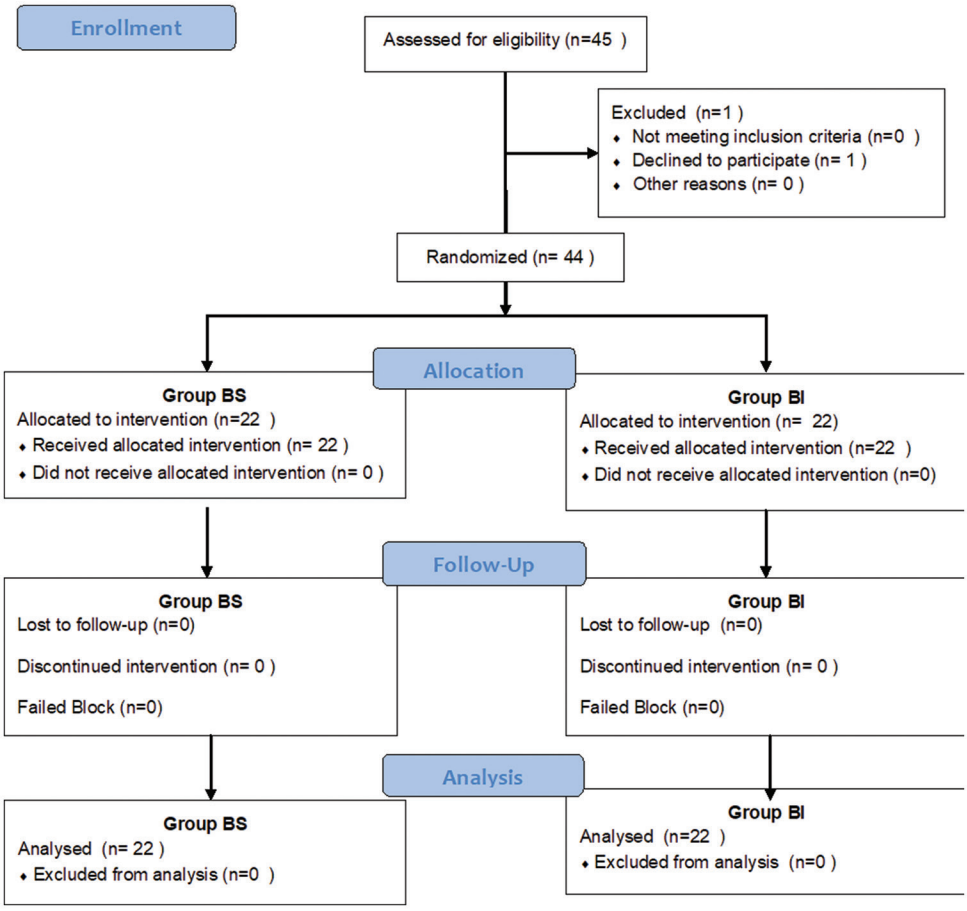

Figure 1: Flowchart of patients recruited and analyzed in the study

of the SCM comes to the centre of the screen. After infiltrating the skin with 1 mL of 2% lignocaine, the needle was introduced from the posterior aspect through the skin and platysma where 10 mL of 0.25% bupivacaine with 5 μg/mL of epinephrine (50 μg) was deposited just behind this landmark to give a single point subcutaneous superficial cervical plexus block [Figure 2]. Block was repeated on the other side as well.

In group BI, patients received ultrasound-guided (Sonosite™ Micromax machine, Bothell, WA USA, linear high-frequency probe, 6–13 MHz) intermediate cervical plexus block. The transducer probe was placed transversely over the midpoint of the sternocleidomastoid muscle such that the tapering posterior edge was positioned in the middle of the screen (at the level of the cricoid cartilage, where the external jugular vein crosses sternocleidomastoid). With the in-plane technique, after infiltrating the skin with 1 mL of 2% lignocaine, the block needle was advanced adjacent to the superficial cervical plexus in the plane deep to sternocleidomastoid, underneath

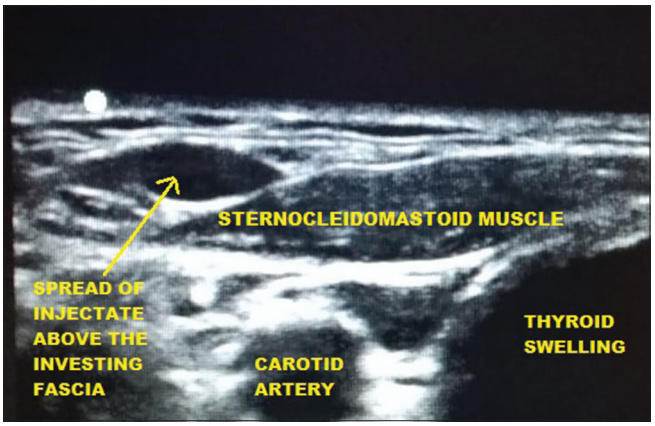

Figure 2: Ultrasound guided superficial cervical plexus block showing spread of injectate above the investing fascia

the investing fascia (sternocleidomastoid-trapezius fascia) and immediately above the interscalene groove [Figure 3]. After negative aspiration, 10 mL of 0.25% bupivacaine with 5 μg/mL of epinephrine (50 μg) was deposited under the fascia after feeling the click or 'pop' on piercing this fascia. The same formulation was given on the other side as well. The patients in two groups received same formulation that is a total

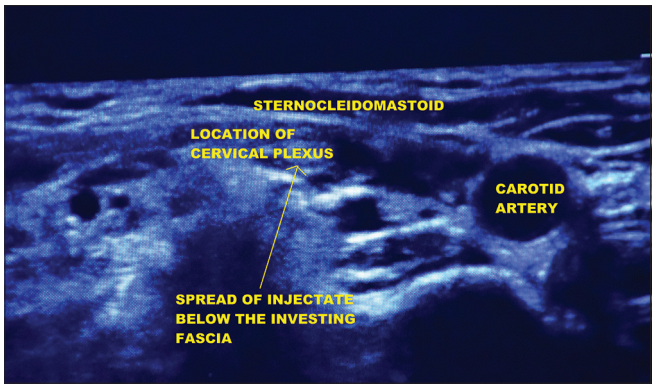

Figure 3: Ultrasound guided intermediate cervical plexus block showing spread of injectate below the investing fascia

of 20 mL of 0.25% bupivacaine (50 mg) and 100 μg of epinephrine.

After block implementation, the sensory block at the surgical incision site (20 min after injection) was tested by the pinprick method using a 25 g hollow needle. The block was defined as successful if there were blunted or loss of sensation compared with the unblocked anatomic area (normal sensation).

General anaesthesia was then induced after preoxygenation for 3 min with a close-fitting mask with 6 L/min of oxygen via the circle circuit with intravenous (IV) Inj. fentanyl (2 $\mu g.kg^{-1}$), inj. propofol (2 $mg.kg^{-1}$), inj. atracurium (0.5 $mg.kg^{-1}$) to facilitate endotracheal intubation. Maintenance was done with O_2, N_2O and isoflurane (33%:66%:0–1%). Muscle relaxation was maintained with IV inj. atracurium 0.1 $mg.kg^{-1}$ as and when required. The monitoring of vitals was continued.

After completion of the surgery, residual paralysis was reversed with IV neostigmine (0.05 $mg.kg^{-1}$) and glycopyrrolate (0.01 $mg.kg^{-1}$). After extubation, all patients were transferred to the postoperative ward. As per institutional protocol, injection diclofenac sodium 75 mg slow IV, 8 hourly, was administered till 24 h.

For rescue analgesia, inj. fentanyl in a dose of 50 μ g (for the patients weighing <50 kg) and 75 μg (for the patients weighing 50 kg or >50 kg) was given whenever visual analogue scale (VAS) was ≥4. IV fentanyl was not repeated before 1 h. At the end of 24 h study period, total rescue analgesic required was recorded.

Patients were asked to rate average pain they experience over 24 h postoperatively on a 10 cm VAS: no pain – 0, very severe pain – 10.

About 24 h after surgery, the patients were asked to rate on a 3-point scale their satisfaction with pain management: Highly satisfied-1, Satisfied-2, Dissatisfied-3.

The primary outcome measure in this study was the postoperative VAS scores at 0 (just after extubation), 2, 4, 6, 12, 18 and 24 h. The secondary outcome measures included the total dose of rescue analgesic required, duration of postoperative analgesia that is time to first analgesic request from the time of giving block, and patient's satisfaction. All the patients were monitored in the perioperative period for haemodynamic stability and any side effects. Any complications related to block were noted.

Data were collected and entered in MS Excel 2010. Statistical analysis was performed using SPSS software version 20. A value of $P < 0.05$ was considered significant. VAS scores were analysed using the Mann Whitney U test. Other quantitative variables were analysed using *t*-test.

The studies comparing superficial and intermediate cervical plexus block are very limited and that too in different settings and populations. Hence, to estimate sample size, we conducted a pilot study in 20 patients, 10 in each group, and the primary outcome of VAS scores was noted. Mean VAS in superficial block were 4.5 ± 1.6 and in intermediate block were 3.1 ± 1.5. Taking these figures as reference, sample size was calculated to be 21 in each group assuming alpha error of 0.05 and power of study 80%.

RESULTS

The total number of patients enrolled during the study period was 45 with 22 patients in each group as one patient refused to participate [Figure 1], being comparable to each other with respect to age, weight and body mass index [Table 1]. VAS was found to be lower in the BI group than BS group at 4, 6, 12, 18 and 24 h [Table 2]. The mean duration of analgesia, that is, duration to first analgesic requirement was found to be 10.06 ± 3.62 h in Group [BI] compared to 7.94 ± 3.62 h in Group [BS] ($P = 0.017$). Total dose of rescue analgesic was significantly more in Group [BS] (101.25 ± 50.31 μg) compared to Group [BI] (71.25 ± 16.70 μg) ($P = 0.011$).

Median value of satisfaction score was better in group BI (1; interquartile range [IQR], 1–2) compared to

Table 1: Demographic data

	Group BS (*n*=22)	Group BI (*n*=22)	*P*
Age (years)	47.96±7.52	49.68±8.73	0.490
Weight (kg)	57.50±5.84	54.17±5.36	0.055
Height (cm)	171.70±5.62	174.66±3.65	0.045
BMI (kg/m^2)	24.043±2.92	23.42±2.7	0.466

Value expressed as mean±SD. Independent *t*-test

Table 2: Comparison of postoperative VAS scores

	Group BS (*n*=22)	Group BI (*n*=22)	*P*
VAS 0 h	0.05±0.22	0.15±0.48	0.779
VAS 2 h	1.5±0.88	0.40±0.68	0.001*
VAS 4 h	2.2±1.36	0.600±0.94	0.001*
VAS 6 h	3.8±1.15	2.80±1.00	0.008*
VAS 12 h	3.8±1.15	3.05±0.68	0.033*
VAS 18 h	3.2±1.19	2.30±0.47	0.013*
VAS 24 h	2.4±0.82	1.85±0.81	0.046*

Mann-Whitney Test. Value expressed as mean±SD. *Indicates *P*<0.05

group BS (2; IQR, 1-2, [$P = 0.034$]). No complications such as vascular puncture, respiratory distress, local anaesthetic toxicity, or Horner's syndrome were seen in any of the groups.

DISCUSSION

The main finding in our study is that the ultrasound-guided intermediate CPB is more effective than the superficial or subcutaneous block given outside the investing fascia. The postoperative pain scores and the total dose of rescue analgesia were significantly lower in intermediate CPB than the superficial one. Our results support the theory proposed by Pandit and colleagues[8] that the injections placed below the investing fascia of the neck penetrate to the deep cervical space and therefore block nerves at their roots, which presumably results in denser, more reliable analgesia. While injections placed subcutaneously cannot permeate through the investing layer and, thereby subcutaneous infiltration would need to block each nerve branch of the superficial cervical plexus to achieve the same effect and this seems less likely.

However, this is in contrast to the theory proposed by Nash and colleagues[9] that the investing fascial layer is incomplete, so subcutaneous cervical plexus block should be clinically as effective as an intermediate block. Ramachandran and colleagues[11] in 2011 compared the efficacy of superficial cervical vs intermediate block in carotid endarterectomy patients and found both these blocks to be equally effective in terms of pain scores and surgeons as well as patient's satisfaction score. A possible explanation for these conflicting results can be attributed to the fact that Zhang[12] and Nash[9] have given anatomical evidence while Pandit and colleagues have given functional evidence. The structure, arrangement and density of the skin ligaments vary greatly through the body and can mimic the behaviour of fascia as well. So it may be possible to achieve the functional result predicted by Pandit *et al*. despite the anatomical absence of the proper fascia.

Even if we go by the description of Nash *et al*.[9] and consider the investing layer to be incomplete or porous then also a subcutaneous injection would require a much larger volume of LA to penetrate to the deeper layer to produce the clinically same effect. Secondly, in the study by Ramachandran and colleagues,[11] they have given blind subcutaneous as well as intermediate blocks, wherein the depth of needle insertion cannot be certainly established. It might be possible that some of the subcutaneous injections may have penetrated to the intermediate level. Apart from this, the surgery in their study does not involve significant tissue trauma and thus, has low pain scores, which may have led to confounding results.

Based on the above description, we can thereby justify our results that injections placed below the investing layer result in better analgesic efficacy compared to subcutaneous ones. We thus recommend ultrasound-guided intermediate block over subcutaneous injections as the reported complications are very rare[10] and comparable to subcutaneous/superficial block yet analgesic efficacy appears better than the subcutaneous/superficial block. In our study we did not encounter any complication with respect to intermediate CPB which might be because of slow diffusion of local anaesthetic into the deep space. Superficial cervical plexus block is safe and easy to master, yet intermediate cervical plexus block may provide another safe alternative to superficial blocks with better analgesic efficacy.

The limitations in our study include small population size, moreover, thyroid surgery itself is a less painful study and the pain scores in both groups were less, thereby, comparing the clinical effectiveness can be confounding as well.

CONCLUSION

We, thus conclude that ultrasound-guided intermediate cervical plexus block is better than superficial cervical plexus block for providing analgesia in thyroid

surgeries, with reduced post-operative pain scores, lesser rescue analgesic requirement, with negligible side effects.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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