Clinical Investigation

# Negative pressure versus loss of resistance technique for interpleural block

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## ABSTRACT

**Background:** Loss of resistance is a commonly practiced technique among the trainees. But, for performing interpleural block (IPB), negative-pressure identification techniques have been popularized. This study was designed to evaluate the two techniques in trainee anaesthetists. **Methods:** Sixty American society of anaesthesiologist (ASA) grade 1 and 2 women scheduled for elective breast surgeries under general anaesthesia were recruited for the study. The patients were randomly assigned to receive IPB (25 mL of 0.5% bupivacaine with adrenaline 5 mg/mL) with either loss of resistance technique (group LR, $n$=45) or the negative-pressure technique (group NP, $n$=45). The success rate and ease of performance was evaluated by the number of attempts and time taken. **Results:** Higher first attempt success rate was observed in group LR (90%) when compared with group NP (80%), with a significantly shorter mean time to successful identification of interpleural space in the group LR (5 min) than in the group NP (5.8 min), $P$<0.01log rank test. All patients had satisfactory IPB and the median numbers of segments blocked were 7 (5–9) and 6 (5–7) in groups LR and NP, respectively. No significant complications were observed in any of the patients. **Conclusion:** Both techniques are safe and effective, but the loss of resistance technique is associated with a higher first attempt success rate performed in a shorter time by trainee anaesthetists.

**Key words:** Anaesthesia, regional, interpleural block

## INTRODUCTION

Breast surgeries are commonly performed under general anaesthesia. Concomitant use of interpleural block can help to minimize pain and narcotic requirement during the perioperative period.[1-3] Interpleural block is the technique of injecting a local anaesthetic into the space between the parietal and the visceral pleura to produce ipsilateral somatic block of multiple thoracic dermatomes. The negative pressure in the interpleural space (IPS) has been used for its identification by several authors using different techniques; for instance, passive suction of air-filled syringe,[4] deflation of a balloon at the hub,[5] falling column of fluid,[6] saline infusion,[7] continuous saline flow[8] and electronic devices.[9] However, these techniques have been reported to have complications like pneumothorax (2%), parenchymal injury, systemic local anaesthetic toxicity, catheter misplacement and ipsilateral bronchospasm.[3,10] The loss of resistance technique is routinely used to identify the epidural space, but its efficacy to identify the IPS has not been tried. The trainee anaesthetists are more skilled and familiar with its use. In addition, the loss of resistance is better perceived as the needle traverses across the parietal pleura to the IPS and might provide a safer option. This study was designed to determine the ease of identification of IPS and complications if any associated with the loss of resistance versus the saline infusion technique (negative-pressure identification) in the hands of trainee anaesthetists.

Hypothesis: Loss of resistance technique makes it easy to locate IPS and is safer in the hands of trainee anaesthetists.

## METHODS

Sixty ASA 1 and 2 women scheduled for elective breast

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surgeries under general anaesthesia were recruited for the study after obtaining a written informed consent for the study, anaesthesia and surgery. Patients with history of respiratory diseases (tuberculosis, asthma, chronic obstructive airway disease, lung and pleural infections), previous lung surgeries, cardiovascular disease, allergy to local anaesthetics, skin infections and bleeding diathesis were excluded from the study.

The patients were randomly assigned to receive interpleural block with either loss of resistance technique (group LR, $n=45$) or negative-pressure technique (group NP, $n=45$) by the sealed envelope technique by a person other than the anaesthesiologist involved in the study. The allocation sequence was generated by a computer in blocks of 10. The anaesthetist performing the block had sufficient training in performing the block and had performed 10 blocks with both the techniques.

All patients were premedicated with oral diazepam 10 mg on the night before and 2 h before surgery. In the operating room, baseline electrocardiogram (ECG), heart rate (HR), mean arterial pressure (MAP) and oxygen saturation (SpO2) and visual analogue score (VAS) were recorded. After securing an intravenous access, the patients were placed in a lateral position with the affected side facing up. Interpleural block was performed after local infiltration of the skin (2 mL of 1% lignocaine) under complete aseptic conditions with an 18 gauge Tuohy needle in the 7$^{th}$ intercostal space, 10 cm lateral to the posterior midline, at the superior border of the rib. The IPS was identified by the negative-pressure technique in group NP and by the loss of resistance technique in group LR. The Tuohy needle was inserted by retracting the skin until the rib was encountered, the stylet was removed and a 3-way stop cock was attached to the hub of the Tuohy needle. In group NP, a saline infusion bag was positioned 60 cm above the patient with an infusion set attached to the side port of the 3-way stop cock, which was primed with saline, and the other port was kept closed. The roller tap of infusion set was fully opened and the needle was advanced (during expiration) after the release of the retracted skin to enter the IPS in the upper border of the rib. Angulation of needle was avoided to prevent injury to the neurovascular bundle. Advancing the needle through the intercostal space produced a brisk flow of saline drops, which was followed by a sudden free flow of saline as the parietal pleura was punctured. This was identified due to the negative pressure in the IPS. In group LR, a saline-filled 10 mL syringe was attached to the Touhy needle through a 3-way stop cock. A constant pressure was applied to the plunger of the syringe, and this force was utilized to advance the needle forward. Once the bevel was inside the potential space, the pressure on the plunger injected saline into the space. Care was taken not to use any other force except that on the plunger to advance the needle while identifying the space. Once the IPS was identified, the 3-way connector was removed and a 20 gauge epidural catheter was threaded through the needle. The epidural catheter was placed 5 cm deep to the space and secured posteriorly. Following a 3 mL test dose (2% lidocaine with 15 mg of epinephrine), 22 mL of 0.5% bupivacaine with 100 mg of epinephrine was injected through the catheter after performing negative aspiration. Epinephrine was added to identify accidental intravascular injection. Patients were turned supine and the number of dermatomes blocked was assessed at 5-min intervals till 20 min and then every minute till 30 min by the attending anaesthetist blinded to the technique used. The ease of IPS identification was evaluated by the number of attempts and time taken (from insertion of needle to injection of test dose). The anaesthetist who performed the interpleural block (IPB) was asked to evaluate the technique on a 3 rank score (1=technique difficult to perform and unable to identify IPS, 2=can perform the technique but with doubtful identification of the IPS and 3=easy to perform technique and offered sure identification of IPS).

Anaesthesia was induced with 2.5% thiopentone in a dose sufficient to abolish eye lash reflex. Vecuronium bromide 0.1 mg/kg was given to facilitate endotracheal intubation. Anaesthesia was maintained with end tidal concentration of isoflurane 0.6% and nitrous oxide 66% in oxygen. Controlled ventilation of lungs was performed using a circle system with a Datex Ohmeda 7000 ventilator set to deliver a tidal volume of 10 mL/kg and minute volume of 100 mL/kg with respiratory rate of 12 breaths/min. Analgesia was supplemented with intravenous fentanyl (1 mg/kg) if there was a haemodynamic response (more than 20% increase in HR and MAP from the baseline) to surgical incision. At the end of the surgery, tracheal extubation was accomplished after antagonizing residual neuromuscular blockade with a mixture of neostigmine (2.5 mg) and atropine (1.2 mg). The patient was transferred to the post-operative recovery room after recording MAP, HR and $SpO_2$. VAS score and level of analgesia (pin prick) were determined at 0.5, 2, 4, 8, 12 and 24 h post-operatively. Ten milliliters of bupivacaine (0.25%) with 50 mg of epinephrine was administered through the catheter when the VAS pain scores were greater than 5 or when the patient complained of pain. Intramuscular morphine (0.1 mg/kg) was administered if the VAS remained above 5 despite the supplementary dose of bupivacaine. Catheter was removed 24 h after surgery.

The data were collected and analyzed using. Statistical Package for Social Sciences (SPSS) statistical software, version 13. Parametric and non-parametric data of the two groups were compared and analyzed using the two tailed Student's *t*-test and Mann–Whitney U-test, respectively. Time taken to perform the IPB and the success rate were analyzed by Kaplan–Meier estimates and log rank test. Continuous data were analyzed by a two-way repeated measure analysis of variance using group as the independent samples factor and time as the repeated measurement factor. A significant group-by-time interaction was followed by tests of significance using Tukey's method to compare the two groups at various points in time. The Fisher's exact test was used for analysis of nominal data. Sample size of 90 subjects was calculated by taking the first attempt success rate with negative-pressure identification as 80% and to detect a difference of 20% between the groups with an $\alpha$-error of 0.05 at a power of 0.8.

## RESULTS

Of 90 patients enrolled for this randomized study as a continuous sample, no patient was excluded. The physical characteristics of the patients and the duration of surgery in both the groups were comparable [Table 1]. The time to successful identification of IPS in the first attempt was significantly shorter in group LR (5 min) than in group NP (5.8 min), $P<0.01$ log rank [Figure 1]. The IPS space was successfully identified in the first attempt in 90% of the patients in group LR when compared with 80% of the patients in group NP [Figure 1]. One patient in group NP required three attempts to identify IPS. However, IPS identification score assessed by the anaesthesiologist performing the IPB was similar in both the groups, with a median IPS score of 3 (2–3). All patients recruited for the study demonstrated a satisfactory IPB. The median numbers of segments blocked were six in group NP and seven in group LR [Table 2]. The block extended from dermatomes T2 to T6 and beyond in 93.4% patients belonging to group LR and in 91.2% in group NP. Only three patients in group LR and four patients in group NP were one segment short of the desirable block (T3–T7). However, the mean time taken for the onset of analgesia was 29±3 and 29±2 min in groups LR and NP, respectively, $P>0.05$ [Table 2].

No significant change was noticed in mean MAP, HR and VAS score at all time intervals between the two groups, $P>0.05$ [Figure 2]. Consequently, none of the

**Table 1: Physical characteristics**

| | Group NP | Group LR |
|---|---|---|
| Age (years) | 47.5±11.8 | 47.8±11.2 |
| Height (cm) | 153.4±3.8 | 152.3±3.7 |
| Weight (kg) | 57.4±7.2 | 59.1±7.8 |
| Duration of surgery (min) | 121.3±29.8 | 137.5±25.2 |

Values expressed as Mean±SD; *n*=45

**Table 2: Characteristics of interpleural block in both the groups**

| | Group NP | Group LR |
|---|---|---|
| Onset of analgesia (min) | 29±3 | 29±2 |
| Dermatomes blocked | 6 (5–7) | 7 (5–9) |
| Duration of analgesia (min) | 455.5±99 | 435±78 |
| Supplementary doses | 3 (1–3) | 3 (1–3) |
| Total dose of morphine (mg) | 33 | 36 |

Median (range), Mean±SD; *n*=45

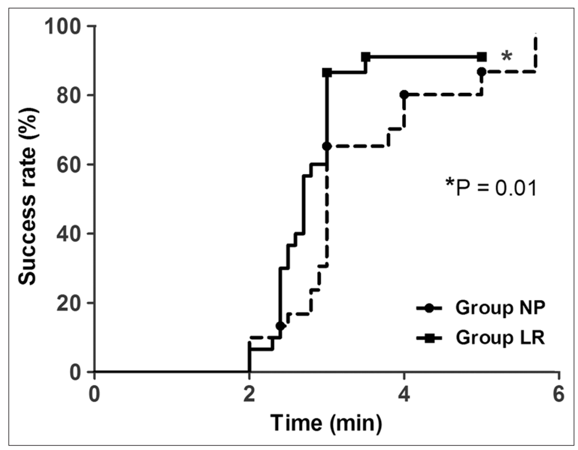


**Figure 1:** The graph represents the Kaplan–Meier estimates of time to successful identification of interpleural space in the first attempt. The time to successful identification was significantly shorter in group LR than in group NP (*P*<0.01, log rank test)

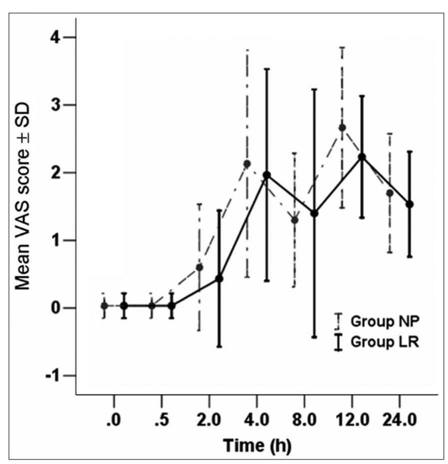


**Figure 2:** Mean VAS score over time in both the groups. VAS: Visual analogue scale

patients required any opioid supplementation during the entire surgical procedure. The mean duration of analgesia and the median supplementary doses of bupivacaine administered through the catheter were also similar in both the groups. Two patients from each group required an almost similar dose of rescue analgesics in the form of morphine [Table 2]. There were no complications encountered in any of the patients during the procedure or in the subsequent follow-up period.

## DISCUSSION

We have demonstrated that the loss of resistance technique is associated with a significantly higher first attempt success rate in a shorter time than the saline infusion technique ($P<0.01$, log rank test). The time to successful identification of IPS in the first attempt was 5 min in group LR and 5.8 min in group NP. Although this is statistically significant, clinically, the difference of 0.8 min is not significant. The shorter time and better success rate can be attributed to the acquired skill and familiarity of the technique among the trainee anaesthetists. In addition, all the trainees reported a better perception of the loss of resistance upon entering the IPS than the epidural space. On the other hand, despite a similar IPS identification score in both the groups, more time was consumed to visually distinguish between the change in initial brisk flow and sudden free flow of saline[8] in the negative-pressure group. Moreover, perception of loss of resistance was better appreciated by the operator to confirm the end point, as 20% of the trainee anaesthetists tried to reposition the needle tip if the pop was perceived but the change in saline flow was not convincing enough to ascertain the needle entry into the IPS. Finally, the loss of resistance is perceived as soon as a small portion of the needle tip enters IPS, while it requires the whole needle tip to be inside the IPS to visualize a significant change in the rate of flow of saline. Considering the length of needle tip required to identify the IPS, a higher incidence of lung injury-associated complications (pneumothorax and parenchymal injury) are likely to occur with negative-pressure techniques. On the contrary, with the loss of resistance method, a constant pressure is applied to the plunger of the syringe and "this force" is used to advance the needle forward. Once the bevel enters IPS, the pressure on the plunger injects saline into the space and deters the needle from moving forward.[11] A potential disadvantage is that a false loss of resistance can occur anywhere in the intercostal space, with puncture of the parietal pleura or when the needle is advanced too far into the lung parenchyma itself.[1] An isolated case report of tension pneumothorax has been reported with the loss of resistance technique.[12] However, none of the patients in the present study showed any evidence of lung injury. Care must be taken not to use any other force except that on the plunger to advance the needle while identifying the space. To avoid accidental lung injury, positive-pressure mechanical ventilation should be interrupted or synchronized to avoid lung inflation during needle advancement while the IPS is being identified when IPB is given in an anaesthetized patient.

Nerve supply of the breast is derived from the anterior and lateral cutaneous branches of the 4$^{th}$, 5$^{th}$ and 6$^{th}$ thoracic nerves[13] and that of the axilla from the 2$^{nd}$ intercostal nerve that supplies the skin of the armpit and the upper medial side of the arm.[14] The extent of sensory block (T2–T6) required for breast surgeries was achieved in 88.4% patients enrolled for the study. In the remaining seven patients, a single dermatome (T2) was missed and the maximum height of sensory block did not extend beyond T3. None of the patients recruited for the present study required any opioid supplementation as there was no demonstrable haemodynamic response during the entire course of surgery. However, in the post-operative period, four patients out of 60 required rescue analgesics for better pain relief. The incidence of the missed T2 segment was similar in both the groups. IPB has been satisfactorily used as sole technique for simple mastectomy in a high-risk patient.[15] Further control trials will be required to prove its efficacy as a sole technique in major breast surgeries. Among the other regional techniques, intercostal nerve block, thoracic epidural and thoracic paravertebral block are commonly being used to provide intra- and post-operative analgesia in patients undergoing modified radical mastectomy.[16]

## CONCLUSION

We therefore conclude that IPB can be performed by trainee anaesthetists with the loss of resistance technique in a shorter time and with a better first attempt success rate.

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