REGIONAL ANAESTHESIA

A comparison of two techniques for ultrasound guided infraclavicular block

P. Bigeleisen¹* and M. Wilson²

¹Department of Anesthesiology, Strong Memorial Hospital, Rochester, NY, USA. ²Department of Anesthesiology, Lindsay House Surgery Center at Linden Oaks, Penfield, NY, USA

*Corresponding author: Box 604, Strong Memorial Hospitals, 601 Elmwood Avenue, Rochester, NY 14642, USA. E-mail: paul_bigeleisen@urmc.rochester.edu

Background. There is some debate about the proper site and arm position and the direction of the needle for the performance of ultrasound guided infraclavicular block.

Methods. Using ultrasound, we compared the ease and success rate of a medial or a lateral approach to the brachial plexus for performing infraclavicular block in two groups of patients (n=202). The proximity of the needle to the lung in each group was also measured with and without the arm abducted from the side.

Results. The medial approach was quicker to perform compared with the lateral approach (9 min vs 13 min). The medial approach also had a faster onset. On average, the three cords were more readily imaged with the medial technique (92%) compared with the lateral technique (82%) and the medial technique prevented tourniquet pain more reliably (97%) vs the lateral technique (83%). In the medial technique, the plexus was also closer to the skin (3.7 cm) compared with the lateral technique (4.5 cm). The lateral approach more frequently avoided the chest wall (49%) compared with the medial technique (35%) but resulted in more frequent vascular puncture. Both approaches provided good anesthesia at the surgical site. Abducting the arm 110° and externally rotating the shoulder moves the plexus away from the thorax and closer to the surface of the skin.

Conclusion. For infraclavicular block using ultrasound guidance the medial approach is faster and easier to perform, has lower incidence of tourniquet pain and vascular puncture, and brings the plexus closer to the skin. We recommend abducting the arm 110° and externally rotating the shoulder to minimize the risk of pneumothorax. Externally rotating the shoulder also brings the plexus closer to the skin.


Keywords: anaesthetic techniques, regional, brachial plexus; anatomy, brachial plexus; ultrasound

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An infraclavicular approach to the brachial plexus block can be used for surgical procedures below midhumerus. It has gained popularity because of its ease of performance and the ability to simultaneously anaesthetize the axillary, musculocutaneous, median, radial and ulnar nerves. The block can be done with minimal risk of pneumothorax and other complications such as block of the phrenic nerve or stellate ganglion. Sandhu and Capan¹ have shown that ultrasound can be a significant aid to infraclavicular block, increasing the success rate and lowering the incidence of arterial puncture.

There is some debate over how the block should be performed using traditional techniques. Most authors have described a technique in which the arm is adducted to the side and the puncture is made inferior to the coracoid process²–⁴ (Fig. 1). We shall refer to that approach as the lateral infraclavicular technique (LIT). Other authors, have abducted the arm 90°, but have angled the needle along the axis of the artery. With this technique, the needle is more likely to contact the plexus distal to the coracoid process⁵ ⁶ and is more likely to miss or partially anaesthetize the axillary and musculocutaneous nerves. We use a technique in
which the arm is abducted $110^\circ$, externally rotated and the elbow is flexed $90^\circ$. The puncture is made at the apex of the delto-pectoral groove in the sagittal plane (Fig. 1). We call this the medial infraclavicular technique (MIT).

We use this proximal approach because the cords are grouped close together, superior to the axillary artery, at this location in the plexus (Fig. 2) and they may lie closer to the skin. As one moves distally along the plexus, the medial cord comes to lie between the axillary artery and vein where it may be more difficult to block (Figs 3 and 4). In addition, abducting and externally rotating the arm may bring the plexus closer to the surface of the skin and further away from the ribs and pleura.

The primary aim of this study was to determine the incidence of tourniquet pain, vascular puncture and to learn more about the position of the plexus in relation to the skin, artery, ribs, lung and pleura with both the techniques. In addition, we wished to learn more about the quality of surgical anaesthesia with both the techniques.

**Methods**

Two hundred and two patients, ASA I or II, aged between 21 and 52 yr, undergoing surgery of the elbow, forearm or hand were enrolled. The study was approved by the Institutional Review Board, and informed consent was obtained from all the patients. We imaged the brachial plexus at the lateral infraclavicular and medial infraclavicular sites in all patients. An 8 MHz transducer with a curved array was placed at the apex of the delto-pectoral groove with the arm abducted $110^\circ$ and the elbow flexed $90^\circ$ (Site 1, Fig. 5A). The axillary artery and vein were imaged and the medial, lateral and posterior cords were identified. The distance from the skin to the artery in the anterior–posterior direction was measured and the locations of the cords relative to the artery and vein. An attempt was also made to image the second or third rib, pleura or lung. With the upper extremity in the same position, the probe was moved to a position inferior to the coracoid process and the same measurements were made (Site 2, Fig. 5A). The arm was then adducted to the side in neutral position with the probe inferior to the coracoid process (Site 3, Fig. 5B) and the same set of measurements were repeated. Finally, with the arm still adducted to the side, the probe was returned to the apex of the delto-pectoral groove (Site 4, Fig. 5B) and all of the measurements were repeated. The distance between the probe positions at Sites 1 and 3 was also measured.

Patients were then allocated into two groups using the last digit of their medical record number. Patients with an odd digit in their medical record number were allocated to the Group LIT. In Group LIT, 100 patients received an ultrasound guided infraclavicular block using the following technique. The arm was adducted to the side and the coracoid

![Fig 1](image1.png) **Fig 1** Positioning of the ultrasound probe and the needle using (A) MIT or (B) LIT.

![Fig 2](image2.png) **Fig 2** Positions of the medial, lateral and posterior cords when the arm is positioned for MIT.
The process was palpated. The axillary artery, vein and cords were again identified. The skin and pectoral muscles were infiltrated, under ultrasound guidance, with 10 ml of a mixture of bupivacaine 2.5 mg ml\(^{-1}\), mepivacaine 7.5 mg ml\(^{-1}\) and epinephrine 3 \(\mu\)g ml\(^{-1}\) using a 4 cm, 22 gauge needle. This needle was introduced 2–4 cm superior to the probe at an angle of 45° to the skin in caudal direction. The infiltration needle was removed and an 18 gauge, 9 cm, Tuohy needle was inserted along the same path (Fig. 1B). Ten millilitres of the same solution was then infiltrated around each cord until each cord was surrounded by a ring of fluid. The final identification of each cord was made, when possible, after it had been surrounded by a ring of fluid.

In Group MIT, 98 patients received an ultrasound guided infraclavicular block using the following technique. The arm was abducted 110°, externally rotated and the elbow was flexed 90°. The axillary artery, vein and cords were identified at the apex of the deltopectoral groove. The skin and pectoral muscles were infiltrated under ultrasound guidance with 10 ml of the same mixture and needle type used in Group LIT. The puncture was made 2–4 cm superior to the probe at an angle of 45° to the skin in caudal direction. The infiltration needle was removed and an 18 gauge, 9 cm, Tuohy was inserted along the same path (Fig. 1A). Ten millilitres of the same solution was then infiltrated around each cord until each cord was surrounded by a ring of fluid. The final identification of each cord was made, when possible, after it had been surrounded by a ring of fluid.

The following measurements were made:

(i) The time required to perform each block including identifying the vessels and cords.
(ii) The incidence of vascular puncture.
(iii) When the rib, pleura or lung could be identified, the distance from the posterior wall of the artery to the posterior surface of the rib or the surface of the lung or pleura along the trajectory of the needle.

(iv) Evaluation of the quality of sensory and motor block of the axillary, musculocutaneous, median, radial and ulnar nerves.

(v) Evaluation of the quality of the sensory block of the intercostal brachial nerve.

Evaluation of the quality of the sensory and motor block was done using the following scale. A value of 3 was given for the patient’s baseline function and a value of 2 represented a diminished response from baseline. For the sensory test, a value of 1 represented a response which would allow surgical incision without pain. This was accomplished by pinching the patient hard between the authors’ index and thumb in the following distributions: axillary nerve (skin over distal deltoid muscle), musculocutaneous nerve (lateral forearm), median nerve (nail bed of third finger), radial nerve (nail bed of first finger), ulnar nerve (nail bed of fifth finger), intercostal brachial nerve (skin distal to the axillary hair patch). For the motor test, a value of 1 represented the inability to flex or extend the following joints: axillary nerve (abduct arm more than 10°), musculocutaneous nerve (flex elbow), median nerve (flex distal interphalangeal joint of second finger) radial nerve (extend wrist), ulnar nerve (abduct third and fourth fingers). Measurements of these parameters were made before the block and at 5 and 20 min after the block. Any complaints of pain in the surgical field during or after the surgery were also noted. All patients were contacted by telephone at home within 48 h after the completion of the surgery to determine if they had residual numbness or paraesthesia in the operative limb. Patients were also asked the time at which they first took pain medicine for the relief of surgical pain.

Analysis of the time to perform the block and use of first analgesics was done using a two tailed Student’s t-test. Analysis of the quality of sensory and motor block, and the incidence of tourniquet pain were done using a \( \chi^2 \)-test. Analysis of the incidence of vascular puncture was done using Fisher’s exact test. Analysis of the distance from the skin to the artery and from the artery to the rib, lung or pleura was done using ANOVA with a Bonferroni correction. A \( P \)-value of 0.05 or less was taken to determine statistical significance.

**Results**

Four patients were excluded from the study because they could not abduct their arms. They received nerve blocks using the LIT. In Group LIT, the mean (sd) age of the patients was 49 (11) yr and the weight was 83 (13) kg. In Group MIT, the age was 53 (8) yr and the weight was 78 (10) kg. These values were not significantly different.

<table>
<thead>
<tr>
<th>Site</th>
<th>Distance mean (sd) Skin to artery (cm)</th>
<th>Range (cm)</th>
<th>Difference from Site 1 (cm–95% CI)</th>
<th>( P )-value Site 1 relative to Sites 2–4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.7 (0.4)</td>
<td>2.9–5.5</td>
<td>0.6–1.0</td>
<td>0.04</td>
</tr>
<tr>
<td>2</td>
<td>4.5 (0.4)</td>
<td>3.8–6.0</td>
<td>0.6–1.0</td>
<td>0.04</td>
</tr>
<tr>
<td>3</td>
<td>4.5 (0.6)</td>
<td>3.2–5.9</td>
<td>0.4–1.2</td>
<td>0.05</td>
</tr>
<tr>
<td>4</td>
<td>4.3 (0.3)</td>
<td>3.0–5.9</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Lung, pleura or both</th>
<th>Rib</th>
<th>Total</th>
</tr>
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<tr>
<td>Site 1</td>
<td>45</td>
<td>19</td>
</tr>
<tr>
<td>Site 2</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>Site 3</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>Site 4</td>
<td>52</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Antero-superior</th>
<th>Postero-superior</th>
<th>Posterior</th>
<th>Between the artery and the vein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral cord</td>
<td>94</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Posterior cord</td>
<td>98</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Medial cord</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Superior</th>
<th>Not viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral cord</td>
<td>95</td>
</tr>
<tr>
<td>Posterior cord</td>
<td>95</td>
</tr>
<tr>
<td>Medial cord</td>
<td>81</td>
</tr>
</tbody>
</table>

The difference in the distance from the skin to the artery as a function of site is shown in Table 1. Comparing the distance from the skin to the artery at Site 1 relative to other sites showed that the artery was significantly closer to the skin at Site 1 (Table 1). The mean (sd) distance between probe positions in all patients at Site 1 (MIT) and Site 3 (LIT) was 3.1 (0.8) cm.

The percent of patients in Groups LIT (Site 3) and MIT (Site 1) in whom the lung/pleura or rib could be identified is shown in Table 2. The mean (sd) distance from the posterior wall of the artery to the posterior surface of the rib or the surface of the lung or pleura was 1.9 (0.7) (range 1.3–3.0) cm at Site 3 and 1.1 (0.4) (0.8–1.5) cm at Site 1. The 95% confidence interval for this difference was 0.6–1.0 cm. This difference was significant (\( P<0.05 \)).

In Group LIT, the lateral cord could be clearly identified in 94 patients anterior and superior to the artery after local anaesthetic had been injected. In six patients it could not
be identified. The posterior cord could be identified in 98 patients posterior and superior to the artery after local anesthetic had been injected. The medial cord could be seen in 18 patients posterior to the artery and in 35 patients between the artery and vein after local anesthetic had been injected. In 47 patients it could not be clearly identified (Table 3).

In Group MIT the lateral and posterior cords could be clearly identified in 95 patients superior to the artery after local anaesthetic had been injected. The medial cord could be seen in 81 patients superior to the artery after local anaesthetic had been injected. In 17 patients, the medial cord could not be identified (Table 4).

In Group LIT, at 20 min, there was no block in 11 patients, a partial block in 35 patients in the sensory distribution of the axillary nerve and in 25 patients a partial block in the motor distribution. Four patients had a partial block in the sensory distribution of the median nerve. Six patients had a partial motor block in the distribution of the ulnar and radial nerves. Thirteen patients had no block in the distribution of the intercostal brachial nerve. In Group MIT, at 20 min, nine patients had no sensory block and 10 patients had incomplete sensory block in the axillary nerve. Sixteen patients had no block and seven patients had a partial block in the distribution of intercostal brachial nerve at 20 min. All patients in Group MIT had a complete motor block in all nerves (Table 5). No patients complained of pain in the surgical field in either group. Seventeen patients in Group LIT complained of diffuse pain when the tourniquet was inflated. In Group MIT, three patients complained of diffuse pain when the tourniquet was inflated. This difference in incidence of tourniquet pain between the two groups was statistically significant ($P<0.01$). No patients in Group LIT complained of pain in the distribution of the intercostal brachial nerve when the tourniquet was inflated. This difference was not significant.

The mean (SD) time to perform the block in Group LIT was 13 (5) (range 5–16) min, and in Group MIT it was 9 (4) (7–12) min. The 95% confidence interval for this difference was 2–6 min. This was significantly different ($P<0.05$). The mean time to the first use of analgesics for surgical pain was 13.1 (3.2) h in Group LIT and 14.2 (5.7) h in Group MIT. The 95% confidence interval for this difference was 0.0–2.3 h. This result was not significantly different.

Eleven patients in Group LIT had tingling or numbness in the distribution of the ulnar or median nerve at 48 h; 10 of these patients had had the same symptoms before nerve block. The single patient who had new onset tingling in his ulnar nerve had resolution of symptoms at 2 months. Nine patients in Group MIT had tingling or numbness in the distribution of the ulnar or median nerve at 48 h; seven of these patients had had the same symptoms before nerve block. Two patients who had new onset tingling in the distribution of the ulnar nerve had resolution at 2 and 3 weeks respectively.

The axillary artery was punctured in two patients in Group LIT and the axillary vein was punctured in two patients in this same group. None of the patients in Group MIT had vascular puncture. This difference was not significant. One of the patients who had an axillary artery puncture, developed a small haematoma in the pectoralis minor muscle. This resolved over 2 weeks without treatment.

### Discussion

The distance from the skin to the artery was the smallest with the arm abducted, the elbow flexed and the probe placed at the apex of the deltopectoral groove (Site 1), when compared with the other sites. At Site 1, or in Group MIT, the ultrasound path to the plexus was shortest so that the ultrasound beam would be attenuated and refracted least as it travelled through tissue. This path should have provided the highest resolution images of the plexus and may have been the reason that the cords were more easily recognizable.
in Group MIT. The lung, pleura or rib were most commonly visualized with the arm adducted and the probe placed at the apex of the delto-pectoral groove. The lung, pleura or rib was least commonly identified with the arm abducted and probe placed inferior to the coracoid process. The distance from the posterior wall of the artery to the posterior wall of the rib or the surface of the lung or pleura was significantly greater in Group LIT than in Group MIT. These results suggest that abducting the arm moves the plexus closer to the surface and that performing the block more laterally may decrease the risk of pneumothorax.

The medial cord was the most difficult to identify in both groups. In 35 patients in Group LIT, the medial cord was sandwiched between the axillary artery and vein.

In these patients, the Tuohy needle needed to be redirected and the artery pushed out of the way with the Tuohy needle in order to anaesthetize the medial cord. It took slightly longer to perform the blocks in Group LIT and this was largely the result of the difficulty of imaging the medial cord in this group and the need to reposition the Tuohy needle to anaesthetize the medial cord for 35 patients in this group. With an experienced practitioner, repositioning the needle between the artery and vein without puncturing either vessel is relatively easy. In the hands of a novice, this part of the procedure is more likely to result in puncture of the artery or vein. In fact, the authors punctured the artery or vein four times during their first 40 LIT procedures. Thereafter, there were no further punctures.

There was little difference in onset, quality or duration of the block in the surgical field between the groups. Sensory and motor block of the axillary nerve was the least consistent in both groups and this may be because it has its origin from the posterior cord proximal to the site of puncture in both techniques. Seventeen patients who had no sensory anaesthesia or a partially anaesthetized axillary nerve complained of tourniquet pain in Group LIT. Three patients who had a partially anaesthetized axillary nerve complained of tourniquet pain in Group MIT. The anatomical reason for this may be that the axillary nerve supplies the long head of the triceps in some patients so that some of these patients may have been feeling pain in their triceps muscle. These patients were sedated with propofol until comfortable. Three patients in Group MIT, complained of pain in the distribution of the intercostal brachial nerve when the tourniquet was inflated.

These patients were treated with a s.c. infiltration in the axilla with lidocaine 1% (5 ml) proximal to the tourniquet. Sensory and motor block of the ulnar nerve set up slowly in Group LIT. This is likely because the nerve has its entire origin from the medial cord which was relatively difficult to identify in this group. Both techniques anaesthetized the intercostal brachial nerve in most patients.

Both techniques provided excellent anaesthesia in the surgical field for the patients. In the MIT approach, the plexus lies closer to the surface, is easier to visualize and the block is faster to perform. It also gives a better proximal block with a lower incidence of tourniquet pain. The LIT approach may be less likely to cause a pneumothorax, but it may be more likely to result in a puncture of the artery or vein while manipulating the needle into the space between the artery and vein. Abducting the arm pulls the plexus away from the thoracic wall. This should decrease the probability of a pleural puncture regardless of whether the block is performed medially or laterally and is recommended regardless of which approach is used as long as moving the arm is not painful to the patient.

Acknowledgement
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References