Supraclavicular Nerve Block: Anatomic Analysis of a Method to Prevent Pneumothorax

David L. Brown, MD*, Donald R. Cahill, PhD‡, and L. Donald Bridenbaugh, MD§

Departments of *Anesthesiology and ‡Anatomy, Mayo Clinic and Foundation, Rochester, Minnesota and §Department of Anesthesiology, Virginia Mason Medical Center, Seattle, Washington

Supraclavicular nerve blocks are technically easy to perform, but may be associated with pneumothorax. The objective of this study is to define the parasagittal anatomy important to our modified technique of supraclavicular nerve block designed to decrease the incidence of pneumothorax and to determine whether this technique is anatomically sound. Two cadaver specimens were studied. One embalmed specimen was dissected to establish the relationship of the brachial plexus to our modified needle entry site. The neck and upper thorax of an unembalmed cadaver were frozen, and parasagittal serial sections were made to establish the relationship of the brachial plexus to surface features and the chest cavity. Additionally, 12 volunteers underwent magnetic resonance (MR) imaging and anatomic measurements of their supraclavicular anatomy important to our modified block. MR imaging showed that in no instance using our modified technique was the lung contacted by the simulated needle before entering either the subclavian artery or contacting the brachial plexus. Our technique has been used in more than 110 patients without pneumothorax. The combination of our cadaver and magnetic resonance data suggests that our plumb-bob technique of supraclavicular nerve block is anatomically sound and may minimize the development of pneumothorax during supraclavicular block.

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The brachial plexus may be anesthetized at multiple sites. Lanz et al. showed that blockade of the brachial plexus with a technique directed near the first rib (at the level of the trunks and divisions of the brachial plexus) provides the most reliable, uniform, and predictable anesthesia for the upper extremity (1). In spite of these advantages and a rapid onset of block, fear of pneumothorax limits the use of the supraclavicular technique (2–4). The original and classic description of supraclavicular block technique directs the needle toward the first rib. The needle is directed along an oblique axis nearly parallel to the long axis of the patient's neck and, thus, often unavoidably toward the cupola of the pleural cavity and apex of the lung (5,6). The incidence of pneumothorax with the classic supraclavicular technique ranges from 0.5% to 6.0% (2). We believe the avoidance of supraclavicular block is detrimental to our patients, because this technique provides an unrivaled rapid onset of predictable upper extremity anesthesia, which is an advantage in a busy surgical practice (1).

In an effort to lessen the incidence of pneumothorax associated with supraclavicular block, clinical modifications of a supraclavicular technique were established, resulting in the plumb-bob technique of supraclavicular block (7). (A plumb bob is a pointed, tapered weight a few inches long that is suspended from a cord. It is used to determine true verticality or "trueness" when hung by a cord.) This block utilizes easily identifiable surface anatomy and directs the needle at approximately a right angle to the classic description of supraclavicular block. Although there have been other attempts to improve on the classical approach, they require more complex measurements or equipment unnecessary with this technique (8–10). The objective of this study is to define the parasagittal anatomy important to our technique of supraclavicular nerve block designed to decrease the incidence of pneumothorax and determine whether this technique is anatomically sound.

Methods

Our modified supraclavicular block evolved over many years. The technique is performed with the patient in the supine position with the head turned away from the side to be blocked. A skin mark is made immediately adjacent and superior to the clavicle at the point of the lateral-most insertion of the sternocleidomastoid muscle onto the clavicle. A blunt 22-gauge needle (5–6 cm in length) is inserted through this point in a parasagittal plane. This technique places the syringe-needle assembly perpendicular to the operating table. If a paresthesia (at or distal to the elbow) is not obtained

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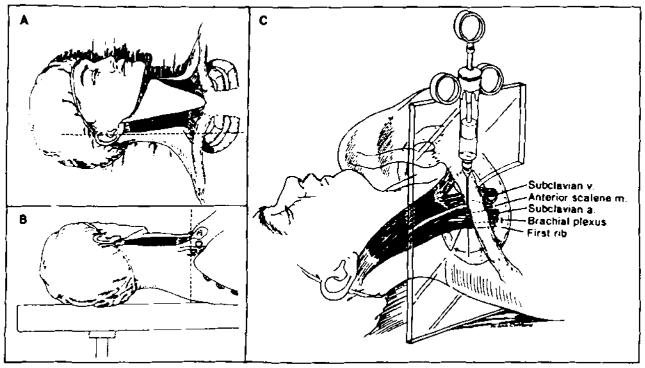

Figure 1. Modified supraclavicular block technique, the "plumb-bob approach." A, needle entry site (black dot on dotted line) shown immediately lateral to insertion of clavicular head of sternocleidomastoid muscle onto clavicle. B, parasagittal plane showing vertical orientation of needle path (black dot on dotted line) from a position immediately superior to clavicle. C, right oblique view of the modified supraclavicular nerve block, with a "pane of glass" outlining the parasagittal plane in which the simulated needle-syringe assembly is moved through 30° arcs to seek paresthesia.

during the initial needle insertion, or if the first rib is not contacted, the needle-syringe assembly is redirected cephalad in small steps until a paresthesia is obtained or until it is angled approximately 30° cephalad. If the brachial plexus has not been contacted, the needle is redirected in small steps until a paresthesia is obtained, or until an angle of 30° caudad is reached (Figure 1). In smaller asthenic individuals, the needle tip usually is directed slightly cephalad to elicit a paresthesia, whereas in larger or more muscular individuals the needle tip usually is directed caudad when a paresthesia is obtained.

Two cadaver specimens were studied. One embalmed specimen (male, age 67 yr, 68 kg, 175 cm) was dissected to establish the relationship of the brachial plexus to the skin entry site previously described in our modified supraclavicular technique. Skin, subcutaneous tissue, platysma, and omohyoid muscle were removed to demonstrate the sternocleidomastoid muscle insertion onto the clavicle. Photographs were made of this dissection (Figure 2). The neck and upper thorax of an unembalmed cadaver (female, age 86 yr, 54 kg, 163 cm) were frozen, and 1-cm parasagittal serial sections were made to show the relationship of the brachial plexus to surface features and the chest cavity as described by Cahill (11) (Figure 3). Photographs of the medial and lateral surfaces of these sections were made (Figures 4 through 7) before placing the specimens into a 10% formaldehyde solution. After preservation, additional dissection was performed to identify anatomy pertinent to our modification of supraclavicular nerve block.

On approval of the institutional review committee, 12 volunteers (six men and six women) gave informed consent for magnetic resonance (MR) imaging of their

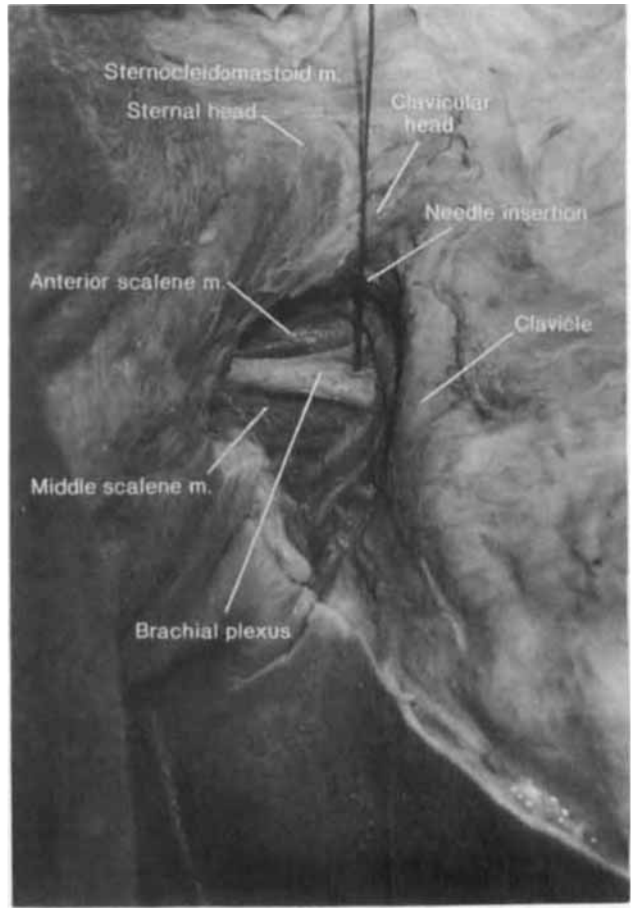

Figure 2. Right oblique view of a supraclavicular fossa dissection (similar in orientation to Figure 1C) demonstrating relationship of brachial plexus and needle inserted in modified supraclavicular technique, i.e., immediately lateral and superior to sternocleidomastoid insertion onto clavicle.

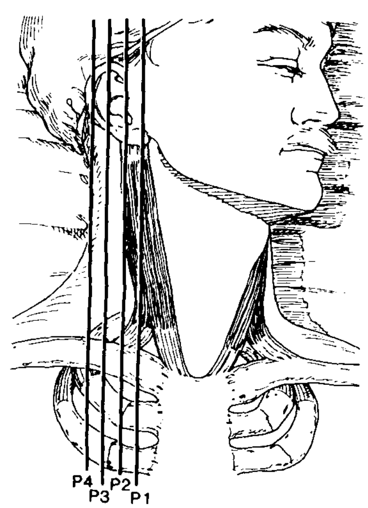

Figure 3. Anterior orientation view demonstrating position of four parasagittal sections (P1, P2, P3, and P4) depicted in detail in Figures 4 through 7.

ANESTH ANALG
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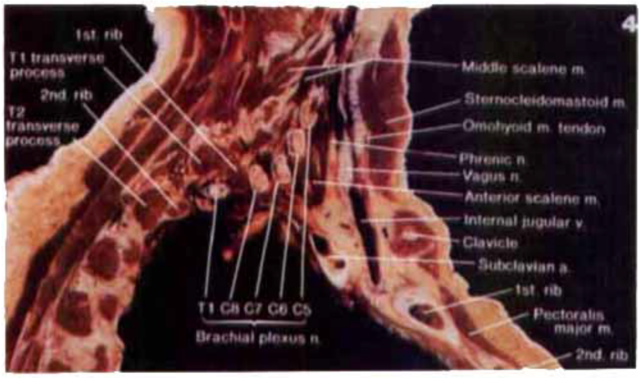
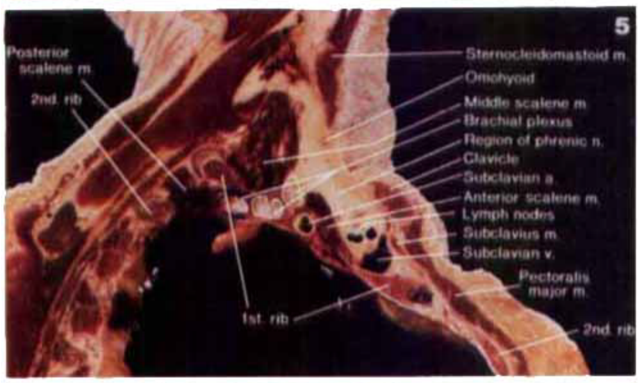
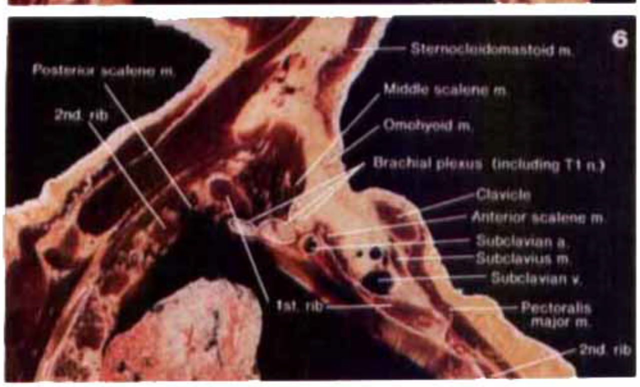
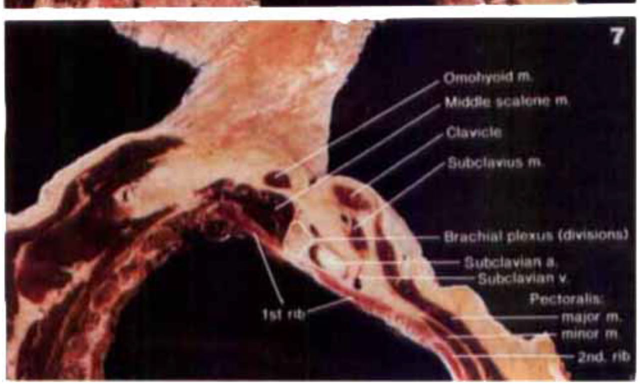
supraclavicular anatomy, in the right parasagittal plane and made through the lateral most insertion of the sternocleidomastoid muscle onto the clavicle. The volunteers were positioned on the MR imaging gantry as if they were undergoing a supraclavicular nerve block (i.e., ipsilateral arm at their side and head turned opposite the side to be blocked). An MR contrast marker was then applied to the needle entry site immediately superior to the clavicle at the lateral border of the sternocleidomastoid muscle. Measurements were then made of the following variables from each volunteer's scan: distance in centimeters from skin marker to the anterior edge of the brachial plexus, the angle in degrees (cephalad or caudad) from a vertical line through the skin entry marker necessary to contact the center of the brachial plexus, and the depth in centimeters at which the subclavian artery or lung would be contacted if the needle was inserted in the vertical plane in the supine volunteer. Each MR image was analyzed to determine whether the lung could be contacted before contacting either the subclavian artery or brachial plexus when the following simulated supraclavicular technique was employed: the needle was inserted vertically until either the brachial plexus or subclavian artery was contacted, if neither was contacted the needle was redirected cephalad in small steps until it was angled 30° cephalad; if the brachial plexus still had not been contacted, the needle was redirected in small steps until an angle of 30° caudad was reached.









Results

The dissection of the cadaver showing the gross relationship of the plumb-bob technique to the brachial plexus is shown in Figure 2. Figure 3 provides orientation to the parasagittal sections. The parasagittal cadaver dissections are shown as original photos in Figures 4 through 7.

The images of 12 volunteers, six men and six women listed in Table 1, have been analyzed; in no instance using our modified technique was the lung contacted before entering either the subclavian artery or contacting the brachial plexus. The distance from skin to brachial plexus was 1.8–3.0 cm and 3.0–4.5 cm, in the female and male volunteers, respectively. The angle from the vertical necessary to reach the center of the brachial plexus was from 11° caudad to 7° cephalad, and from 29° caudad to 11° cephalad, in women and men,

Figure 4. Parasagittal section P1 demonstrating bones, muscles, nerves, and vessels medial to plane of our modified supraclavicular block.

Figure 5. Parasagittal section P2 demonstrating bones, muscles, nerves, and vessels approximating plane of our modified supraclavicular block.

Figure 6. Parasagittal section P3 demonstrating bones, muscles, nerves, and vessels immediately lateral to our modified supraclavicular block.

Figure 7. Parasagittal section P4 demonstrating bones, muscles, nerves, and vessels 2 cm lateral to plane of our modified supraclavicular block (the site of classic approach to supraclavicular block at the level of the first rib).

Table 1. Measurement Data from Modified Supraclavicular Block Technique in Volunteers' Magnetic Resonance Images

	Female patients					
	1	2	3	4	5	6
Height (cm)	173	167	160	179	167	165
Weight (cm)	64	57	59	60	73	68
Dist to bp (cm)	1.8	2.7	3.0	2.8	2.4	3.0
Dist to art (cm)	nc	nc	nc	1.9	nc	nc
Dist to lung (cm)	nc	3.9	nc	3.0	nc	nc
Angle to bp (off vert)	7° ceph	3° ceph	2° caud	15° ceph	11° caud	11° caud
	Male patients					
	1	2	3	4	5	6
Height (cm)	188	185	173	183	178	183
Weight (cm)	89	78	83	80	100	68
Dist to bp (cm)	3.0	3.3	4.2	3.9	4.5	3.3
Dist to art (cm)	nc	2.7	nc	2.7	nc	2.2
Dist to lung (cm)	nc	nc	nc	4.5	nc	nc
Angle to bp (off vert)	4° caud	4° ceph	0° –	11° ceph	29° caud	4° ceph

Dist = distance; bp = brachial plexus; art = subclavian artery; nc = structure could not be contacted when technique carried out as outlined; off vert = direction need angled to reach brachial plexus; ceph = cephalad; caud = caudad; vert = vertical.

respectively. Figure 8 outlines a representative MR image detailing pertinent anatomy for male volunteer number 3.

Our technique has been used by one of the authors (D. L. B.) in 110 patients undergoing upper extremity operations. This technique has been performed clinically in resident teaching. In this series, no patients with clinical symptoms suggestive of pneumothorax were encountered during patient follow-up 24 h after the surgical procedure.

Discussion

The combination of our cadaver and magnetic resonance data suggests that our plumb-bob technique of supraclavicular nerve block is anatomically sound and may minimize the development of pneumothorax. It is clear from our methods of anatomic analysis that the brachial plexus courses in a primarily cephaloposterior relationship to the subclavian artery as these structures pass over the first rib, most clearly highlighted in Figures 5 and 6. This anatomic relationship means that the first rib does not need to be contacted to elicit a paresthesia, which is often not the case for the classic technique or its modifications (12). This minimizes the need to angle the needle used during supraclavicular block as directly at the pleura and lung.

Another potential advantage of our approach is that the lateral border of the insertion of the sternocleidomastoid muscle onto the clavicle is an easily identified skin entry site. Unlike other techniques of supraclavicular block, it does not demand interpretation of an-

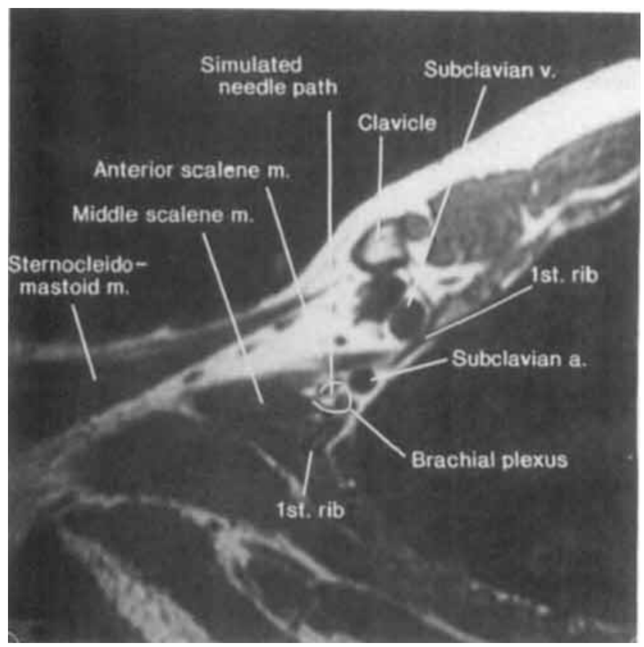


Figure 8. Parasagittal section of magnetic resonance scan in male volunteer 3 demonstrating simulated needle path and bones, muscles, nerves, and vessels pertinent to modified supraclavicular block.

atomical relationships or more complicated measurements (4,5). Although there are similarities between the parascalene method of Vongvises and Panijayanond (8) and this approach, their technique is performed more medially in the neck and describes needle insertion a variable distance cephalad to the clavicle. Similarly the pediatric parascalene technique of Dalens et al. demands a number of measurements be made to identify the skin entry site (10).

An advantage of our technique, perhaps not evident, is the ease of teaching the supraclavicular technique. It seems easier for most residents to understand and perform this vertically oriented approach than the classic technique. Perhaps this is related to the easily identified anatomic planes and an understandable and systematic method of eliciting a paresthesia with our method. Additionally, by designing a technique that demands needle insertion at approximately 90° to the path of the brachial plexus, systematic needle redirection as outlined under methods and in Figure 1 almost guarantees contact with the brachial plexus. We believe the simplicity of needle insertion in a parasagittal plane with our technique should allow anesthesiologists fewer blocks to achieve supraclavicular block proficiency.

We have shown, via anatomic analysis, that a decreased incidence of pneumothorax is likely with our modified supraclavicular block, and that the technique is anatomically sound. Our findings suggest that more anesthesiologists may be willing to utilize the technique, thereby providing more comprehensive anesthetic care.

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