

Appropriate site for intramuscular injection in the deltoid muscle evaluated in 35 cadaverous arms

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ABSTRACT

Since the deltoid muscle is often used as the site of intramuscular injection, how the injection site should be determined to avoid damages to the axillary nerve was evaluated using cadavers. A perpendicular line is drawn from the mid-point of the superolateral margin of the acromion to the line between the upper end of the anterior axillary line and the upper end of the posterior axillary line (anteroposterior axillary line). Since the axillary nerve passes the lower third of this segment, the upper half or third of this segment or the intersection of this line with the anteroposterior axillary line is considered to be the appropriate site for intramuscular injection.

KEY WORDS

deltoid muscle, intramuscular injection, axillary nerve, acromion, axillary line

Introduction

The deltoid muscle is often used for intramuscular injection. In injection in the deltoid muscle, an appropriate site must be selected so as not to damage the axillary nerve with the accompanying posterior circumflex humeral artery and the radial nerve with the accompanying profunda brachii artery. As appropriate sites for injection, 3 finger breadth below the acromial anterior edge,¹⁾ central part of the deltoid muscle,²⁾ anteriorly to the central part of the deltoid muscle,^{3, 4)} and central part of the deltoid muscle 2.5-5 cm below the acromion⁵⁾ have been suggested. However, according to textbooks of anatomy, the axillary nerve is located about 5 cm below the acromion,^{6, 7)} so that an injection 5 cm below the acromion is dangerous. Also, an appropriate site for injection is difficult to determine by definitions such as 3 finger breadth below or a given centimeters below the acromion because of the variation of the thickness of the fingers of the person who gives the injection and the body build of the person who re-

ceives the injection. Similarly, the expression "the central part of the muscle" is unclear. Therefore, we previously determined the site for intramuscular injection in relative terms according to the distance between the acromion and the axilla using one each of anatomized male and female cadavers in which the deltoid muscle was exposed.⁸⁾ In this study, whether this site is appropriate or not for intramuscular injection was examined using a larger number of cadaverous

Materials and Methods

Thirty-five arms of 21 cadavers used for anatomy classes at Kanazawa University were studied. All bodies were skinned, and the deltoid muscle was exposed. The 35 arms studied consisted of 19 arms of 12 males aged 55-88 years and 16 arms of 9 females aged 67-93 years.

The landmarks used in our previous study⁸⁾ were applied to the skinned deltoid muscle. Each body was laid in the supine position with the arms extended in contact with the trunk. The superolateral margin

Table 1. Distances measured on 19 male arms (mm)

measured sites	aa'	bb'	cc'	2/3aa'	2/3bb'	2/3cc'	1/2aa'	1/2bb'	1/2cc'
maximum	114	111	95	76	74	63.3	57	55.5	47.5
minimum	90	87	72	60	58	48	45	43.5	36
mean	100.1	96.7	85	66.7	64.4	56.7	50	48.3	42.5
standard deviation	5.5	6.4	7.3	3.7	4.3	4.9	2.7	3.2	3.7

Table 2. Distances measured on 16 female arms (mm)

measured sites	aa'	bb'	cc'	2/3aa'	2/3bb'	2/3cc'	1/2aa'	1/2bb'	1/2cc'
maximum	106	101	91	70.7	67.3	60.1	53	50.5	45.5
minimum	73	65	47	48.7	43.3	31.3	36.5	32.5	23.5
mean	89	85	75.5	59.3	56.7	50.3	44.5	42.5	37.8
standard deviation	7.9	9.1	9.7	5.3	6.1	6.5	3.9	4.6	4.9

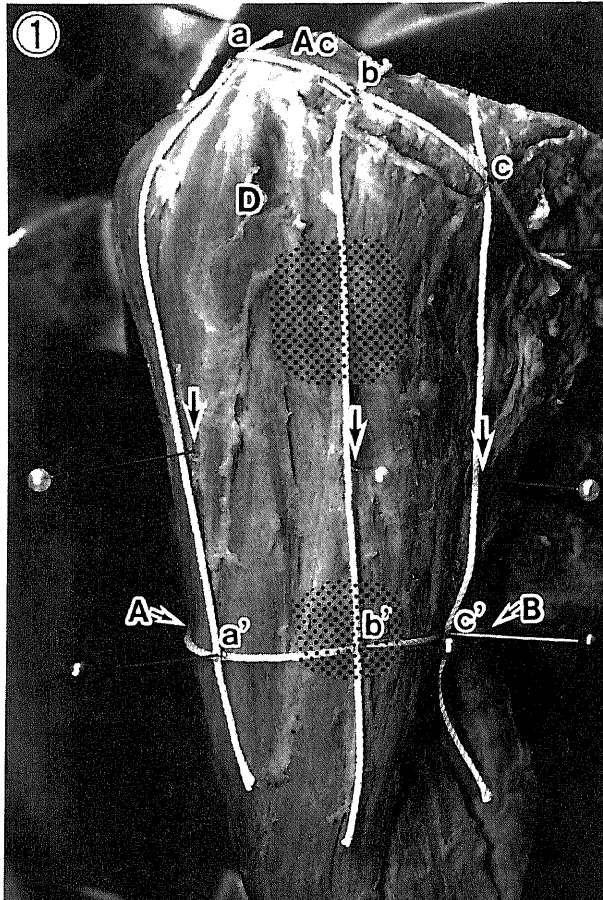


Fig. 1. Lateral aspect of the shoulder. Three perpendicular lines are drawn from anterior edge (a), mid-point (b), and posterior edge (c) of the acromion (Ac) to the anteroposterior axillary line (AB). Arrows indicate the needles inserted perpendicularly into the deltoid muscle (D) at lower 1/3aa', lower 1/3bb', and lower 1/3cc'. Note the shadow indicates the appropriate sites for intramuscular injection.

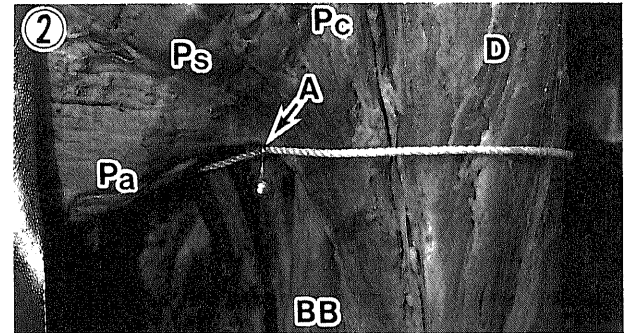


Fig. 2. Anterior aspect of the axilla. The upper end of the anterior axillary line is indicated by a capital letter A.

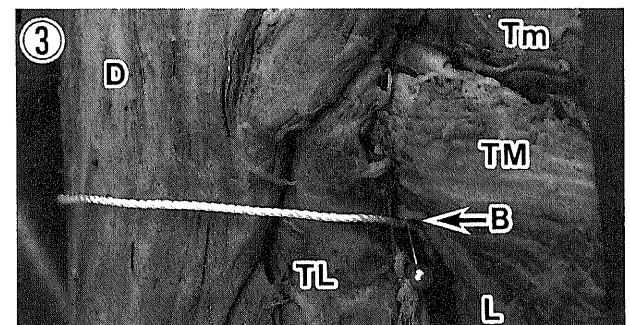


Fig. 3. Posterior aspect of the axilla. The upper end of the posterior axillary line is indicated by a capital letter B. Line AB (figs. 2 and 3) is the anteroposterior axillary line.

the acromion was divided into two equal segments, and the anterior edge (a), mid-point (b), and posterior edge (c) were determined (Fig. 1). The upper end of the anterior axillary line (point of intersection of the

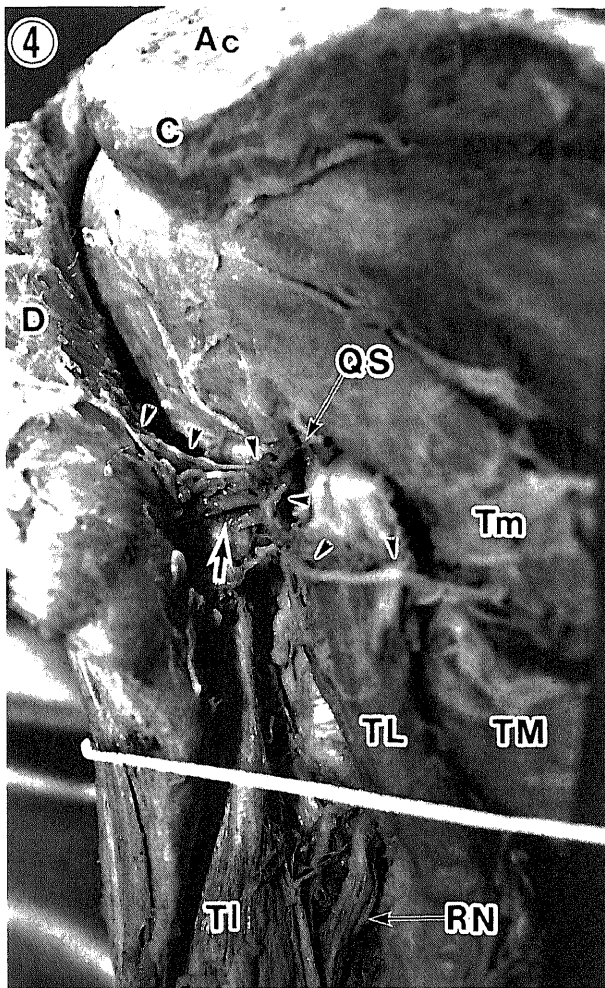


Fig. 4. Posterior aspect of the shoulder. The deltoid muscle (D) is cut at the origin and turned toward the insertion. Arrow indicates the needle inserted at the lower 1/3cc', and its tip reaches the quadrangular space (QS). The axillary nerve appears from the QS and divides into anterior and posterior branches (arrow heads). Note the radial nerve (RA) is situated near the intersection of the anteroposterior axillary line and the perpendicular line from the posterior edge (c) of acromion (Ac).

abdominal, thoracic, and clavicular parts of the pectoralis major muscle ; Fig. 2) was named A, and the upper end of the posterior axillary line (point of intersection of the teres major muscle and latissimus dorsi muscle with the triceps brachii muscle ; Fig. 3) was named B. Line AB (designated the anteroposterior axillary line) is nearly parallel to the ground. Perpendicular lines were drawn from points a, b, and c on the acromion, and the points of their intersection with line AB were defined as a', b', and c',

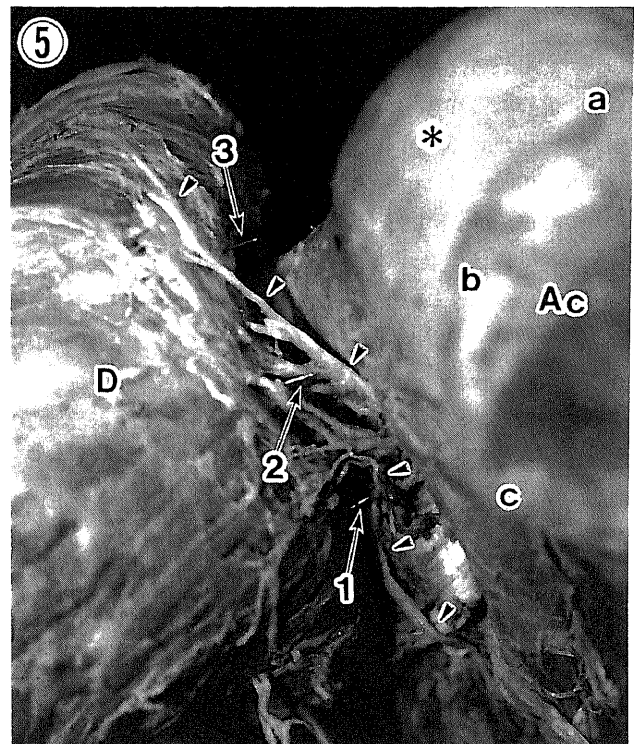


Fig. 5. Superior aspect of the shoulder. Arrow 1, arrow 2, and arrow 3 indicate the tips of needles inserted at lower 1/3cc', lower 1/3bb', and lower 1/3aa', respectively. Note the tips (arrows 1 and 2) contacting with the axillary nerve (arrow heads), and the tip (arrow 3) being situated below the nerve. Asterisk : head of the humerus.

respectively. The distances aa', bb', and cc' were measured using calipers, and their halves and thirds were calculated (Tables 1 and 2). Needles were inserted perpendicularly into the muscle at lower 1/3aa', lower 1/3bb', and lower 1/3cc' (Fig. 1). Next, the deltoid muscle was reversed from the origin to the insertion, and the spatial relationships of the needles with the axillary nerve and radial nerve were examined.

Results

The axillary nerve appeared in the deep layer of the deltoid muscle through the quadrangular space, i.e. the area surrounded by the humerus, teres minor muscle, teres major muscle, and long head of the triceps brachii muscle, ran anteriorly along the surgical neck of humerus in close contact with the deep surface of the deltoid muscle, and divided into a few number of branches in the clavicular part of the deltoid muscle (Figs. 4 and 5).

In all the 35 male and female arms examined, the tip of the needle inserted at lower 1/3cc' nearly reached the quadrangular space and pierced the axillary nerve or posterior circumflex humeral artery, which appeared through this space (Figs. 4 and 5). Also, the tip of the needle inserted at lower 1/3bb' pierced the axillary nerve and posterior circumflex humeral artery, which ran along the surgical neck of humerus (Fig. 5). Also, the tip of the needle inserted at lower 1/3aa' nearly touched the axillary nerve on the anterolateral side of the humerus in two-thirds of the examined arms and was located slightly below the axillary nerve in the remaining one-third of the arms. In the latter group, the axillary nerve ran at the level of 1/2aa' or slightly below (Fig. 5).

Thus, the axillary nerve ran in the lower third of the space between the acromion and the anteroposterior axillary line from the back to the front in close contact with the deep surface of the deltoid muscle. However, in some bodies, the nerve was located between the lower third and half of the distance between the acromion and the anteroposterior axillary line at the anterior acromial edge. The mean distances from the posterior edge, mid-point, and anterior edge of the acromion to the axillary nerve were 56.7, 64.4, and 66.7 mm, respectively, in the males and 50.3, 56.7, and 59.3 mm in the females (Tables 1 and 2). These results indicate that the axillary nerve is located more distally than 5 cm from the acromion, which is mentioned in textbooks of anatomy.^{6, 7)}

The radial nerve passed the gap surrounded by the teres major muscle and long head and lateral head of the triceps brachii muscle (Fig. 4). This position corresponded either to the intersection between line AB and the posterior margin of the deltoid muscle or point c', and none of the needles inserted at lower 1/3aa', lower 1/3bb', and lower 1/3cc' reached the radial nerve.

Discussion

The results obtained in this study supplemented those obtained in a previous study.⁸⁾ The site indicated by the shadow in Fig. 1 is considered to be appropriate for intramuscular injection in the deltoid muscle. The person who receives the injection hangs the arm close to the trunk in the standing position. It

is considered best for the person who gives the injection to feel for the mid-point of the acromion of the person who receives the injection, imagine the line between the upper end of the anterior axillary line and the upper end of the posterior axillary line (anteroposterior axillary line), draw a perpendicular line from the mid-point of the acromion to the anteroposterior axillary line, and perform the injection nearly perpendicularly at a site near 1/2 to upper 1/3 of this perpendicular line or at the intersection of this perpendicular line and the anteroposterior axillary line to avoid damaging the axillary nerve or radial nerve.

The distance between the acromion and axillary nerve is described as about 5 cm in textbooks of anatomy.^{6, 7)} However, according to Kido et al.,⁹⁾ the axillary nerve is located 4.3-6.3 cm from the anterolateral edge of the acromion and 4.1-6.3 cm from the posterolateral edge of the acromion. Also, Burkhead et al.¹⁰⁾ measured the distance from the acromion to the axillary nerve and reported that it was 3.1 cm to 7.7 cm and was less than 5 cm in 20% of the subjects. The results of their study suggest that the distance between the acromion and axillary nerve is frequently less than 5 cm. Moreover, Kulkarni et al.¹¹⁾ reported that the axillary nerve was located 2.2-2.6 cm above the center of the deltoid muscle. These results suggest that the axillary nerve may be located about 5 cm below the acromion but that it is located above or below this position in a considerable percentage of the population.

In our present study, the distance from the mid-point of the acromion to the axillary nerve was 5.8-7.4 cm (mean 6.4 cm) in the males and 4.9-7.1 cm (mean 5.7 cm) in the females, and the axillary nerve often ran 5 cm or more below the acromion unlike the above reports^{6, 7, 10, 11)}. According to our results, intramuscular injections 2.5-5 cm below the acromion⁵⁾ are considered not to damage the nerves, but according to the above reports^{6, 7, 10, 11)}, they are not necessarily considered to be safe.

This discrepancy of the results indicate the danger of expressing the location of the axillary nerve in terms of the distance (cm) from the acromion by disregarding the body build variation and sexual difference. The same danger occurs also when the site of an intramuscular injection is expressed as 3 finger

breadth below the acromion²⁾ or anteriorly to the central part of the deltoid muscle.^{3,4)}

In contrast, estimation of the site of the axillary nerve in relative terms as was done in this study, by which the variation associated with the body build and sex can be ignored, is considered to improve the safety of intramuscular injection in the deltoid muscle. However, as this study was carried out using skinned bodies with the deltoid muscles exposed, confirmation in the presence of the skin is still necessary.

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解剖体35上肢を検討した三角筋筋肉内注射の適切な部位

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要 旨

三角筋は筋肉内注射の部位として良く用いられているので、どのようにして注射部位を決めれば、腋窩神経や橈骨神経を損傷しないかを検討するために、剥皮した55-93歳の解剖体、35上肢(男性19上肢、女性16上肢)、を使用して研究した。前腋窩線の上端と後腋窩線の上端を結ぶ線(前後腋窩線)上に肩峰上外側端の前端、中央点、後端から垂線を引き、それぞれの線分をaa', bb', cc' とすると、腋窩神経がこの3本の線分の下1/3を結ぶ線を通ること、一方、橈骨神経はc'を通り下行することが判明した。これらのことから、線分bb'の1/2から上1/3の部位、または、線分bb'の前後腋窩線上の部位b'付近が、腋窩神経や橈骨神経を損傷しない筋肉内注射の適性な位置であると見なされた。このように相対的に注射部位を決定する方法であれば、体格や男女差に影響を受けずに、安全な注射部位を決定できると考えられる。