

# Appropriate site for intramuscular injection in the deltoid comparing cadaverous with living arms

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## ABSTRACT

Since it is important to administer intramuscular injections to the deltoid muscle without injuring the axillary nerve, the course of the axillary nerve was determined using cadavers with intact skin, without cutting the origin of the deltoid. The course of the nerve was a transverse line situated at lower 1/3, between the superolateral margin of the acromion and the anteroposterior axillary line, which was the same as in our previous studies. This confirms the importance of determining the course of the nerve in relative terms in order to safely administer the intramuscular injection.

## KEY WORDS

intramuscular injection, deltoid muscle, 3 fingers' breadth, axillary nerve, skin

## Introduction

We have located the appropriate site for intramuscular injection in the deltoid muscle<sup>1, 2, 3)</sup>, which is commonly used for intramuscular injection<sup>4, 5, 6)</sup>. We first indicated the appropriate site for intramuscular injection in the skinned deltoid muscle<sup>1, 2)</sup>. However, since the studies were carried out using skinned bodies, we then examined whether the methods used on skinned cadavers were applicable to cadavers with the skin intact. Before skinning the cadaver, we injected Indian ink through the skin into the deltoid at the points identified in the previous study<sup>2)</sup>, and we again confirmed the appropriate site for intramuscular injection<sup>3)</sup>. But since in these previous studies<sup>1, 2, 3)</sup> the origin of the deltoid was cut, pulled down to the insertion of the muscle and the position of the

axillary nerve examined, it is possible that the muscle with the nerve shifted out of place. Therefore, in the present study, before skinning the cadaver and cutting the origin of the deltoid, we cut the muscle transversely with the skin intact, along the landmarks identified in the previous studies, and then examined whether the axillary nerve was situated under the cutting line.

Moreover, since the medical textbook<sup>5)</sup> somewhat archaically describes the appropriate site for intramuscular injection in the deltoid muscle as the area below 3 fingers' breadth from the acromion, we measured 3 fingers' breadth of female nursing students and compared the data with the distance between the acromion and the landmark identified in our studies.

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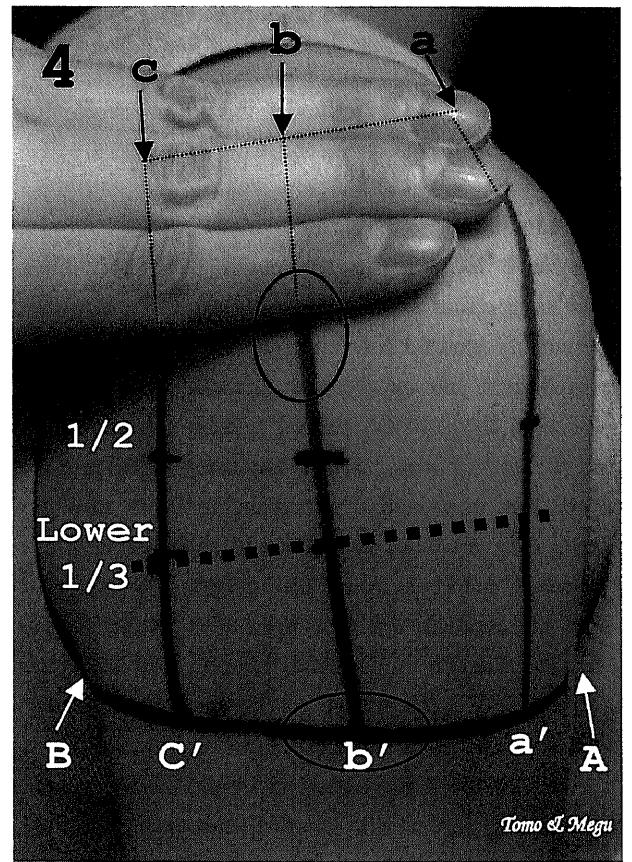
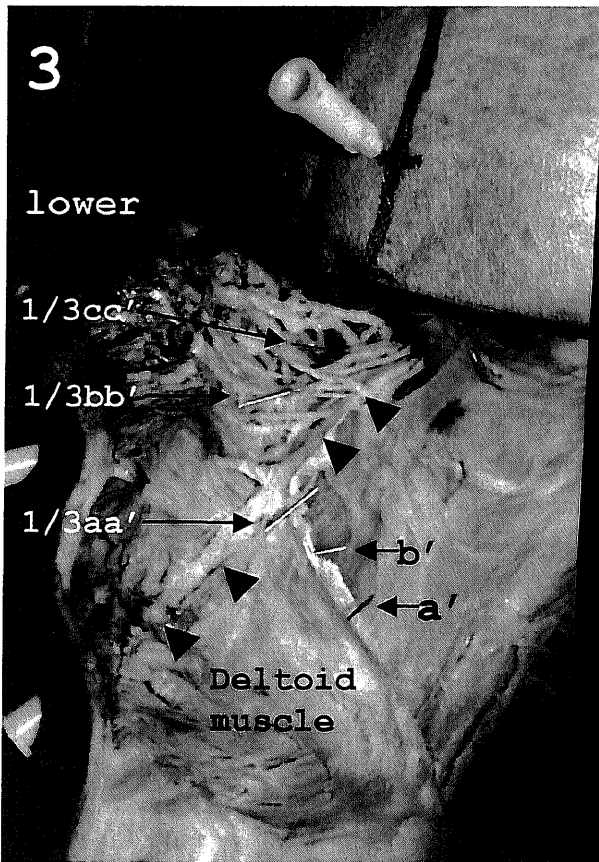
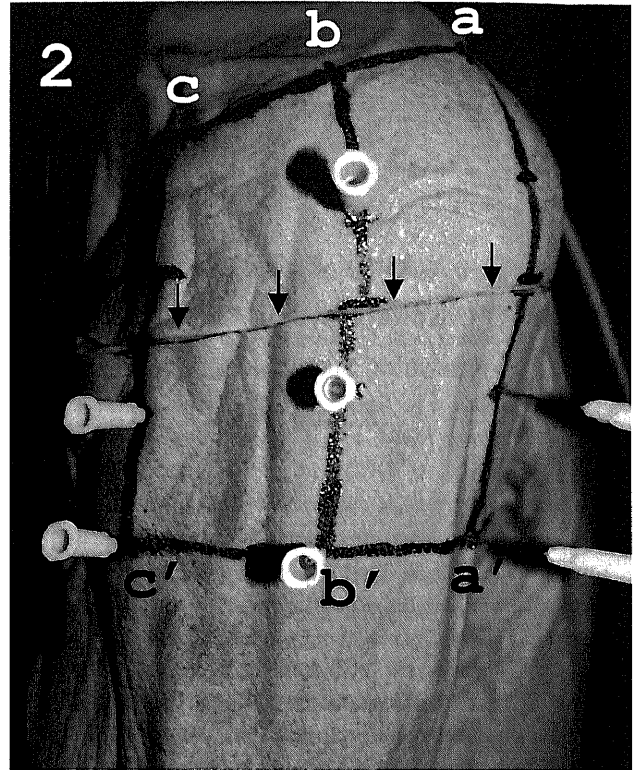
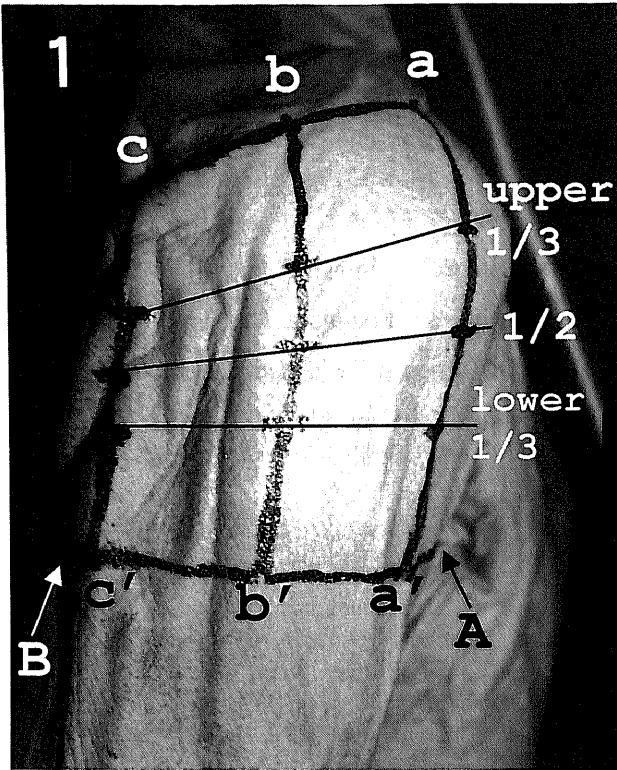


Table 1. Distances measured on arms of 12 male cadavers (cm)

Measured sites	aa'	bb'	cc'	1/2aa'	1/2bb'	1/2cc'	2/3aa'	2/3bb'	2/3cc'
Maximum	12.2	13	12.3	6.1	6.5	6.2	8.1	8.7	8.2
Minimum	8.5	8.8	8	4.3	4.4	4	5.7	5.9	5.3
Mean	10.6	10.7	9.9	5.3	5.3	4.93	7.1	7.1	6.6
SD	0.98	1.21	1.24	0.49	0.60	0.62	0.66	0.81	0.83

2/3aa', 2/3bb', and 2/3cc' are equivalent to distances from a, b, and c on the acromion to points of lower 1/3aa', 1/3bb', and 1/3cc'.

SD: Standard deviation

Table 2. Distances measured on arms of 12 female cadavers (cm)

Measured sites	aa'	bb'	cc'	1/2aa'	1/2bb'	1/2cc'	2/3aa'	2/3bb'	2/3cc'
Maximum	11.9	11.8	11.1	5.9	5.9	5.6	7.9	7.9	7.4
Minimum	6.2	7.5	7.1	3.1	3.75	3.6	4.1	5	4.7
Mean	9.3	9.6	9.0	4.6	4.8	4.5	6.2	6.4	6.0
SD	1.60	1.12	1.04	0.80	0.56	0.52	1.07	0.74	0.69

2/3aa', 2/3bb', and 2/3cc' are equivalent to distances from a, b, and c on the acromion to points of lower 1/3aa', 1/3bb', and 1/3cc'.

SD: Standard deviation

Table 3. Measurements of 78 female nursing students (cm)

Measured sites	Height	3 fingers' breadth	bb'	1/2bb'	2/3bb'
Maximum	170	5.1	11.6	5.8	7.7
Minimum	145.5	4.0	6.1	3.1	4.1
Mean	159.2	4.7	8.9	4.4	5.9
SD	5.77	0.22	1.10	0.55	0.74

2/3bb' is equivalent to distances from b on the acromion to points of lower 1/3bb'. SD: Standard deviation

Abbreviations of Figures 1-4(a, b, c, a', b', c', A, B, aa', bb', cc') are explained in the Materials and Methods.

Figure 1. Lateral aspect of the right shoulder. The acromion is situated at a-b-c.

Figure 2. Lateral aspect of the same right shoulder as in Figure 1. Arrows indicate the transverse cutting line at points 1/2aa', 1/2bb', and 1/2cc'.

Figure 3. Lateral aspect of the same right shoulder as in Figure 2. The cut edge of the deltoid muscle with intact skin is pulled down so that the main trunk of the axillary nerve (arrowheads) rises slightly from the deep surface of the deltoid muscle and is thus separate from the needle tips inserted at lower 1/3cc' and 1/3bb'. The tip of the needle at lower 1/3aa' is in contact with the nerve. Tips of the needles at a' and b' are apparently away from the nerve. The star indicates the quadrilateral space where the axillary nerve with the posterior circumflex humeral artery appears.

Figure 4. Lateral aspect of right shoulder of a living body. The superolateral margin of the acromion is indicated by a, b, and c. The left ring finger is on the superior surface of the acromion. The dotted line at lower 1/3 corresponds to the course of the axillary nerve. The two ellipses are appropriate sites for intramuscular injection in the deltoid.

## Materials and Methods

### *Examination of cadaverous arms*

Twenty-four cadavers used for anatomy classes at Kanazawa University were studied. They consisted of 12 males aged  $79.5 \pm 10.2$  years and 12 females aged  $81 \pm 9.12$  years. We used the right arm of each cadaver before it was skinned.

The landmarks used in our previous studies<sup>1, 2, 3)</sup> were applied to the skin covering the deltoid muscle (Fig. 1). Each body lay in the supine position with the arms extended in contact with the trunk. The superolateral margin of the acromion was divided into two equal segments, and the anterior edge (a), midpoint (b), and posterior edge (acromial angle) (c) were determined. The upper end of the anterior axillary line and the upper end of the posterior axillary line were named A and B, respectively. Line AB (designated the anteroposterior axillary line) was nearly parallel to the ground in anatomical position. 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', respectively. The distances aa', bb', and cc' were measured with calipers, and their halves and thirds were calculated (Tables 1 and 2).

Then needles were put into the skin and muscle perpendicular to the skin at points a', b', c', lower 1/3aa', lower 1/3bb', lower 1/3cc', and upper 1/3bb'. Then the skin and muscle were cut perpendicular to the skin along line 1/2aa'-1/2bb'-1/2cc' with a sharp scalpel (Fig. 2). As the cut edges were pulled gradually and carefully down or up, the axillary nerve was located and the relationship between the nerve and the tips of the needles was observed (Fig. 3).

### *Examination of living bodies*

We measured height, the breadth of index, middle, and ring fingers at the proximal interphalangeal joint of the middle finger, and the length of bb' of the left arms of 78 female nursing students aged  $19.7 \pm 0.80$  years using calipers (Table 3). We examined only females because nurses in Japan are almost always female and the results of the measurements of females can be adapted to males by considering the standard ratio between female and male.

## Results

### *Examination of cadavers*

The main trunk of the axillary nerve with the posterior circumflex humeral artery was observed along cut line 1/2aa'-1/2bb'-1/2cc' in none of the cadavers, but a few thin branches of the nerve and the vessel supplying to the deltoid muscle were observed. As the lower cut edge was pulled down, the axillary nerve with the posterior circumflex humeral artery and the tips of the needles were revealed (Fig. 3). The main trunk of the axillary nerve was observed in 8 out of 12 male arms and 11 out of 12 female arms at the site of the transverse line linking lower 1/3aa', 1/3bb', and 1/3cc'. In 4 out of 12 male arms and 1 out of 12 female arms the nerve was situated between line 1/2aa'-1/2cc' and line lower 1/3aa'-1/3cc'. The nerve did not run along the anteroposterior axillary line (line a'-b'-c'). The tip of the needle inserted at lower 1/3cc' reached the quadrilateral space (star in Fig. 3) bounded by the humerus, the teres major, teres minor, and the long head of the triceps, where the axillary nerve with the posterior circumflex humeral artery appeared. The tips of the needles at lower 1/3bb' and 1/3aa' reached the axillary nerve, which wound around the surgical neck of the humerus. Crossing line aa', the axillary nerve ran gently up to the cut edge near the anterior border of the deltoid muscle. The nerve continued on the deep surface of the deltoid muscle, and then branched into the muscle.

The tip of the needle at c' always reached near to the radial nerve, which ran down in the area bounded by the humerus, the long head of the triceps brachii muscle, and the teres major muscle.

The range of distances from the acromion to the anteroposterior axillary line and from the acromion to the point lower 1/3 were, respectively, 8 to 13cm and 5.3 to 8.7cm in the male and 6.2 to 11.9cm and 4.1 to 7.9cm in the female. Thus, the range of the distances was quite wide.

### *Examination of living bodies* (Table 3)

Although there were somewhat wide differences in height, finger breadth, and length of bb' among the nursing students, there were mild or low correlations between height and finger breadth ( $r=0.52$ ) and between height and length of bb' ( $r=0.26$ ). This

indicates that the wide range of these measurements is probably due to not only height, but also weight.

### Discussion

The present study reconfirmed that the course of the axillary nerve mapped on the skin covering the deltoid muscle could be determined by the same manner used in our previous studies<sup>1, 2, 3)</sup>. The axillary nerve situated on the deep surface of the deltoid was projected on the skin covering the muscle along the line connecting lower 1/3aa', 1/3bb', and 1/3cc' from the quadrilateral space to the anterior edge of the muscle in 19 out of the 24 arms examined, although the nerve was situated between the line 1/2aa'-1/2bb'-1/2cc' and the line lower 1/3aa'-1/3bb'-1/3cc' in the remaining 5 arms. Moreover, the course of the axillary nerve indicated in the present study seemed to more closely reflect that in the living body than that indicated in the previous studies<sup>1, 2, 3)</sup> because, like the living body, the cadaver in this study was not skinned, and because the deltoid was cut not at the origin, but at the transverse line connecting 1/2aa', 1/2bb', and 1/2cc' to prevent the shift of the muscle from its normal position.

Although anatomical textbooks<sup>7, 8)</sup> describe the distance from the acromion to the axillary nerve as about 5cm or no more than about 2 inches, the range of the distance is wide, probably due to gender, age, and body build : 4.1 to 4.6cm according to Kido et al.<sup>9)</sup>, 3.1 to 7.7cm according to Burkhead et al.<sup>10)</sup>, 4.8 to 7.6cm in male and 3.13 to 7.07cm in female skinned cadavers according to Nakatani et al.<sup>2)</sup>, and 5.3 to 8.7cm in male, and 4.1 to 7.9cm in female cadavers covered with skin according to our last study<sup>3)</sup>. Moreover, in the present study the distance from the acromion to the axillary nerve, which runs along the line linking lower 1/3aa', 1/3bb', and 1/3cc' on the skin covering the muscle, is 8 to 13cm in male and 3.1 to 11.9cm in female cadavers with intact skin (Tables 1 and 2), and 6.1 to 11.6cm in young living females (Table 3). On the other hand, 3 fingers' breadth had a mean measurement of 4.7cm in the female in a study by Hasegawa et al.<sup>11)</sup>, and a mean of 4.7cm and arrange of 4.0 to 5.1cm in this study (Table 3). Thus, the range of 3 fingers' breadth is also wide, like the distance from the acromion to the axillary

nerve. If the area of 3 fingers' breadth from the acromion is adopted as the appropriate site for intramuscular injection in the deltoid as described<sup>4)</sup>, it would be possible to injure the axillary nerve because the maximum length of 3 fingers' breadth, 5.1cm, is sometimes longer than the minimum length from the acromion to the nerve, 3.1 to 5.3cm.

Therefore, according to our present and previous studies<sup>1, 2, 3)</sup> showing that the course of the axillary nerve is approximately mapped by a line connecting points lower 1/3aa', 1/3bb', and 1/3cc' on the skin covering the deltoid muscle, and the radial nerve appears beneath the deltoid muscle at point c' on the anteroposterior axillary line, intramuscular injection should be performed in any area of the deltoid muscle except those areas. So when an intramuscular injection is administered to the deltoid muscle, the superolateral edge (a-b-c in Fig. 4) of the acromion and the anteroposterior axillary line (A-a'-b'-c'-B in Fig.4) should first of all be determined with the upper arm extended in contact with the trunk and the deltoid relaxed. Then, the point of lower 1/3bb' should be determined as a dangerous area, and the injection should be made in the area from point upper 1/3bb' to 1/2bb' or b' (ellipses in Fig. 4). If the 3 fingers' breadth measure is used for determining the injection site, the first finger should be on the acromion and not the lateral edge of the acromion (see Fig. 4), and thus the lower edge of the third finger may become the site of injection, which is roughly the area between upper 1/3bb' and 1/2bb'. In any case, it is most important to recognize the course of the axillary and radial nerves when intramuscular injection in the deltoid muscle is performed.

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## 三角筋で行う筋肉内注射の適切な位置，遺体と生体の腕を比較して

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### 要 旨

三角筋に筋肉内注射を行う際に，腋窩神経を損傷させないことが重要である。そのために生体で腋窩神経の位置が解剖学的に確定できれば良いが，困難なので，なるべく生体の筋肉内注射を行うのに近い状態として，剥皮前の遺体を用いて，かつ三角筋の起始を切断し筋を翻す前に，我々の先の研究を参考にして決定した腋窩神経の走行位置より上方で，皮膚と三角筋を同時に切断して，腋窩神経がどの位置にあるかを決定した。さらに，女子看護学生の3横指の幅を測定し，肩峰から3横指の位置と腋窩神経の位置を比較した。腋窩神経は，先の研究と同じく，肩峰と前後腋窩線を結ぶ線を3等分した下方1/3の位置を後ろから前に走行していた。肩峰より3横指下方がその位置になるかならないかは，個人によりかなり異なるので，腋窩神経の走行を個人ごとに相対的に求めて，筋肉内注射を行うことが，神経を損傷しないために重要なことであることが判明した。