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The course of the axillary nerve projected on the skin covering the deltoid muscle of a cadaver for safely administering intramuscular injection in the deltoid muscle

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ABSTRACT

The course of the axillary nerve must be determined from the skin covering the deltoid muscle in order to safely administer intramuscular injection into the muscle without injuring the nerve. In this study, whether the landmarks identified in our previous study of skinned muscle applied to the muscle before it was skinned was examined using cadavers. The course of the axillary nerve projected on the skin covering the deltoid muscle was the transverse line situated at the lower 1/3 between the superolateral margin of the acromion and the anteroposterior axillary line determined by the landmarks used in our previous study. Thus, intramuscular injection in the deltoid muscle can be safely performed using these landmarks without risking injury to the axillary nerve.

KEY WORDS

intramuscular injection, skin, deltoid muscle, axillary nerve, cadaver

Introduction

The deltoid muscle is a common muscle for intramuscular injection^{1,2,3)}. Since it is important to inject the medicine without damaging the axillary nerve and the posterior circumflex humeral vessels or the radial nerve, we previously examined cadavers after the deltoid muscles were exposed, and determined the course of the axillary and radial nerves on the surface of the skinned muscle in relative terms according to the distance between the acromion and anteroposterior axillary line^{4,5)}. Consequently, the appropriate site for intramuscular injection in the skinned deltoid muscle could be indicated. However,

as the previous study was carried out using skinned bodies with the deltoid muscles exposed, confirmation in the presence of the skin is still necessary. Therefore, this study determined whether the methods used on the skinned cadaver were applicable to the cadaver with the skin intact.

Material and Methods

Twenty-two arms of 11 male cadavers aged 60-99 years old and twenty-eight arms of 14 female cadavers aged 60-94 years old used for anatomy classes at Kanazawa University were studied.

Before being skinned by medical students, we

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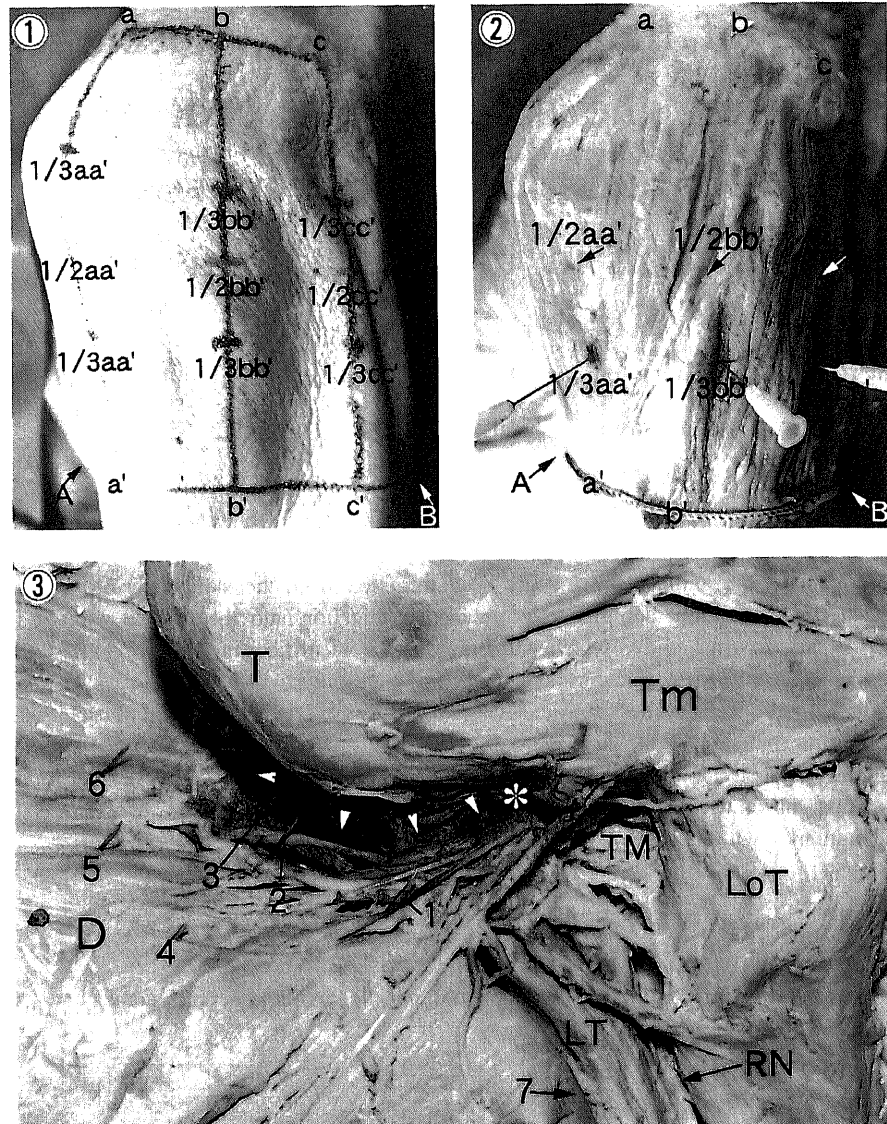


Fig. 1. Lateral aspect of the left shoulder. Three perpendicular lines on the skin were drawn from the anterior edge(a), mid-point(b), and posterior edge(c) of the superolateral margin of the acromion to the anteroposterior axillary line(AB). Lines aa', bb', and cc' were divided into two equal parts and three equal parts. Note that the axillary nerve is situated at line lower 1/3aa'-1/3bb'-1/3cc' and the radial nerve at point c'. Thus, the appropriate sites for intramuscular injection are points higher 1/3 bb' and b'(see discussion).

Fig. 2. Lateral aspect of the left shoulder after the skin was removed. Pins were inserted on the deltoid muscle at points lower 1/3aa', 1/3bb', and 1/3cc' which were stained with injected black ink. Injected red ink spots were observed on points 1/2aa', 1/2bb', and 1/2cc'. Letters a, b, c, A, and B are the same as in the fig. 1

Fig. 3. Superoposterior aspect of the left shoulder. The deltoid muscle(D) was cut near the origin and the origin was reflected off of the spine of the scapula, acromion, and the clavicle downward and forward. Note that the injected black ink had spread over the quadrangular space(*) and along the axillary nerve(arrow heads). Numbers 1, 2, and 3 indicate pins inserted at points lower 1/3cc', 1/3bb', and 1/3aa', respectively, which are situated at the quadrangular space and along the axillary nerve. Numbers 4, 5, and 6 indicate pins inserted at points 1/2cc', 1/2bb', and 1/2aa', respectively, which are some distance from the axillary nerve. A short part of pin inserted at c' was observed at number 7 which reached the radial nerve(RN) when the deltoid muscle was returned to the normal position. LoT : long head of triceps brachii muscle, LT : lateral head of triceps brachii muscle, T : greater tubercle, Tm : teres minor muscle, TM : teres major muscle.

Table 1. Distances measured on 22 male arms(cm)

| measured sites | aa' | bb' | cc' | 1 / 2 aa' | 1 / 2 bb' | 1 / 2 cc' | 2 / 3 aa' | 2 / 3 bb' | 2 / 3 cc' |
|--------------------|------|------|------|-----------|-----------|-----------|-----------|-----------|-----------|
| maximum | 11.8 | 11.8 | 11.3 | 5.9 | 5.9 | 5.7 | 7.7 | 7.9 | 7.5 |
| minimum | 7.2 | 6.9 | 5.6 | 3.6 | 3.45 | 2.8 | 4.8 | 4.6 | 3.7 |
| mean | 9.4 | 9.2 | 8.5 | 4.7 | 4.6 | 4.3 | 6.2 | 6.1 | 5.7 |
| standard deviation | 1.16 | 1.47 | 1.44 | 0.58 | 0.74 | 0.72 | 0.78 | 0.98 | 0.96 |

Table 2. Distances measured on 28 female arms(cm)

| measured sites | aa' | bb' | cc' | 1 / 2 aa' | 1 / 2 bb' | 1 / 2 cc' | 2 / 3 aa' | 2 / 3 bb' | 2 / 3 cc' |
|--------------------|------|------|------|-----------|-----------|-----------|-----------|-----------|-----------|
| maximum | 12 | 11.5 | 9.7 | 6 | 5.8 | 4.9 | 8.0 | 7.7 | 6.5 |
| minimum | 6.6 | 6.4 | 6.2 | 3.3 | 3.2 | 3.1 | 4.4 | 4.3 | 4.1 |
| mean | 8.6 | 8.6 | 8.1 | 4.3 | 4.3 | 4.0 | 5.7 | 5.7 | 5.4 |
| standard deviation | 1.43 | 1.32 | 1.03 | 0.71 | 0.66 | 0.52 | 0.96 | 0.89 | 0.69 |

applied the landmarks identified in the previous studies^{4, 5)} to the skin covering the deltoid muscle (Fig. 1). Each body was laid on an anatomical table in a 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), mid-point(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 an 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 (Fig. 1). The distances aa', bb', and cc' were measured with calipers, and their halves and thirds were calculated (Tables 1 and 2). The height of the cadaver was not calculated.

Needles (23G x 1 1/4, 0.63 x 32mm) were perpendicularly inserted into the skin covering the deltoid muscle at points 1/2aa', 1/2bb', and 1/2cc' and the tip of the needle reached the humerus through the muscle. Then, small doses of red ink were injected about the surface of the muscle and on the humerus. Needles were perpendicularly inserted into the skin over the muscle at points lower 1/3aa', 1/3bb', and 1/3cc' and the tip of the needle at points lower 1/3

aa' and 1/3bb' reached the humerus through the muscle but the tip of the needle at point lower 1/3cc' did not hit the humerus but likely reached the soft connective tissue under the muscle because muscle resistance suddenly disappeared. Then, small doses of black ink were injected about the surface of the muscle, on the humerus, and the connective tissue. Moreover, small doses of black ink were injected into the muscle at points a', b', and c'.

When medical students skinned the cadaver, we examined the deltoid muscle. Since the injected ink diffused on the surface of the muscle of some cadavers, dissecting pins were inserted carefully into the muscle at red colored points 1/2aa', 1/2bb', and 1/2cc' and black colored points lower 1/3aa', 1/3bb', and 1/3cc', and a', b', and c' (Fig. 2). Then the muscle was cut along the acromion, the spine of the scapula and the clavicle, and pulled down to the insertion of the muscle. We observed the distribution of red and black ink and the positions of the tips of inserted pins in comparison with the positions of the axillary nerve and the radial nerve.

Results

Injected black ink at point lower 1/3cc' spread in the quadrilateral space bounded by the humerus, the teres minor, the teres major, and the long head of the triceps brachii where the axillary nerve with the

posterior circumflex humeral artery appeared and reached to the deep surface of the deltoid muscle (Fig. 3). Inserted pins at the point also reached the space and touched the nerve. The nerve ran anteriorly along the surgical neck of the humerus in close contact with the deep surface of the muscle to the anterior edge of the muscle, dividing into a few branches supplying the muscle. The injected black ink at points lower 1/3bb' and 1/3aa' adhered to the surgical neck of the humerus where part of the axillary nerve coursed. The pins inserted at these points were in contact with the nerve. The axillary nerve in 7 of 22 cadavers passed between point 1/2aa' and lower 1/3aa'.

Injected red ink at points 1/2aa' and 1/2bb' was observed on the greater tubercle, and ink at point 1/2cc' attached on the insertion of the teres minor muscle. The pins inserted at points 1/2aa', 1/2bb', and 1/2cc' were not in contact with the axillary nerve.

The pins inserted at points a', and b' reached the humerus. However, the pin at point c' touched or was close to the radial nerve which coursed through the area bounded by the inferior border of the teres major, the lateral head and long head of the triceps brachii (fig. 3).

Distances between the superolateral margin of the acromion and the anteroposterior axillary line were between 11.8cm (max) and 5.6cm (min) in the male and between 12cm (max) and 6.2cm (min) in the female, and being very different from each other (Tables 1 and 2).

Discussion

The axillary nerve passes through the quadrangular space, then winds anteriorly along the surgical neck of the humerus in close contact with the deep surface of the deltoid muscle. This course of the axillary nerve corresponds to the transverse line on the skin covering the deltoid muscle drawn at the lower 1/3 distance between the acromion and the anteroposterior axillary line as demonstrated in the previous study using skinned cadavers^{4,5)}. Moreover, the radial nerve appears through the inferior border of the teres major covering the deltoid muscle and running down the arm. The course of the radial nerve crosses the

intersection of the anteroposterior axillary line and the perpendicular line from the posterior edge of the acromion as shown the previous study^{4,5)}. Therefore, the present study confirms that the method of determining the position of the axillary nerve and the radial nerve on the skinned cadaver in the previous studies^{4,5)} is applicable to the cadaver with intact skin and moreover, to the living body.

The direct distance from the acromion to the axillary nerve is 4.9-7.8cm in the male and 3.1-7.4cm in the female in a study by Burkhead et al.⁶⁾, and 4.1-6.3cm in the male and 4.3-5.6cm in the female in a study by Kido et al.⁷⁾ However, the indirect distance from the acromion to the axillary nerve (points at lower 1/3aa', 1/3bb', and 1/3cc' on the superficial surface of the deltoid muscle or on the skin covering the muscle) is 4.8-7.6cm in the male and 3.1-7.1cm in the female using skinned cadavers in our previous study⁵⁾ and 3.7-7.9cm in the male and 4.1-8.0cm in the female using cadavers with intact skin in the present study (Tables 1 and 2). The range of these distances is very wide probably due to gender and body build. If intramuscular injection on the deltoid muscle is performed at 3 finger breadth¹⁾ (mean of 5.6cm in the male and 4.7cm in the female⁸⁾), the central part of the deltoid muscle^{2,9,10)}, and 2.5-5cm below the acromion³⁾ which are described as appropriate sites for injection, it would be possible to injure the axillary nerve.

Therefore, according to the present study showing that the course of the axillary nerve is almost mapped by a line connecting points lower 1/3aa', 1/3bb', and 1/3cc', and the radial nerve appears beneath the deltoid muscle at point c' on the anteroposterior axillary line, the intramuscular injection should be administered in any area of the deltoid muscle except these areas : the point upper 1/3bb' and b' (Fig. 1) are most recommended. In particular, it is very dangerous to administer an injection at point lower 1/3c c' which corresponds to the quadrangular space where the axillary nerve and the posterior circumflex humeral vessels appear, because it is possible that the injected needle will directly injure the nerve and vessels or that the injection will spread in the space, as the black ink did, (Fig. 3) affecting the nerve and vessels.

Acknowledgements

We pray for the repose of the souls of the cadavers and thank their families for granting permission for their use.

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腋窩神経は皮膚上ではどのような位置を走行するか — 筋肉内注射で腋窩神経の損傷を防ぐために —

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要 旨

背景：我々は先の研究（文献4，5参照）で，剥皮した御遺体を利用して，三角筋の表面からどのようにすれば，腋窩神経の走行を決定できるかを検討し，その方法で腋窩神経を損傷しないような筋肉内注射の位置を明らかにした。しかしながら，生体に適用するには，剥皮していない御遺体を用いて，皮膚上からも，剥皮したのと同じ方法で腋窩神経の走行が決定できるかを検討する必要があるので，このことを検討する研究を行った。方法：剥皮前の御遺体の上肢（男；22上肢，女；28上肢）を利用した。肩峰の外側上縁を二等分し，前点(a)，中間点(b)，後点(c)，とした。前腋窩線と後腋窩線の頂点を結ぶ線を前後腋窩線とした。a，b，cより前後腋窩線に垂線を引き，その交点をa'，b'，c'とした。下1/3aa'，下1/3bb'，下1/3cc'に墨を注入し，印とした。剥皮後にその印に針を刺し，墨，針先と腋窩神経の位置を検討した。結果と結語：墨と針先は腋窩神経の走行部位に一致して見られた。このことは，皮膚上からも腋窩神経の走行を同定するのに，剥皮した筋で行った方法が適用でき，神経を損傷しない筋肉内注射の位置が決定できることを示している。