

Original article

The problem of using deltoid muscle for intramuscular injection

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Abstract

Although the deltoid muscle has often been used as a site of intramuscular injection (ImI), the risk of axillary nerve injury caused by the needle is overlooked. The present study examined the potential risk of needle insertion in the deltoid muscle during the dissection of 14 shoulders from cadavers. A needle was pierced into the deltoid muscle from the overlying skin at the middle of the horizontal line, as described in the standard nursing textbooks. The axillary nerve is located beneath the deltoid muscle, with its branches extending through the quadrangular space as far as the anterior part of the deltoid muscle. It was found that the needle passed very close to the axillary nerve trunk in all cases. This finding suggests that the deltoid muscle is not appropriate for ImI, even if the anterior part is selected as the injection site. This study warns nurse practitioners know of the potential nerve injury as the result of ImI in the deltoid muscle.

Key words: deltoid muscle, intramuscular injection, axillary nerve, human cadaver, acromion

Introduction

Intramuscular injection (ImI) is a general procedure used for the administration of agents including vaccines (National Immunization Committee 2002). However, various risks are associated with ImI. The commonly used sites for ImI in adults are the gluteal and deltoid muscles. Since there is a sciatic nerve beneath the gluteal muscle, the use of the gluteal muscle as a site of ImI should be conducted with caution, and various procedures have, therefore, been proposed for using the gluteal muscle (Lammon et al., 1995, Gaylene, 2004, Smith et al., 2007). On the other hand, the deltoid muscle has increasingly been used as a site of ImI. The deltoid muscle is readily accessible by clinicians, and provides no difficulty regarding patient's exposure for ImI. However, there are problems concerning the use of the deltoid muscle for ImI: the presence of the axillary nerve innervating the muscle (Burkhead et al., 1992; Kulkarni et al., 1992; Choi et al., 2001), subdeltoid bursa beneath the muscle (Beals et al., 1998), and the circumflex humeral arteries lying deep in the

muscle. These are structures at risk of injury during ImI. Several cases have been reported concerning iatrogenic injury of the axillary nerve following deltoid muscle ImI (Choi et al., 2001; Davidson et al., 2007).

The main patterns of distribution of the axillary nerve in the deltoid muscle should be accurately assessed before deciding on the site of ImI. There have been few detailed anatomical studies on the appropriate site of ImI in the deltoid muscle. Standard textbooks of nursing practice give only a simple explanation for selecting the site of ImI in the deltoid muscle, that is, the densest portion of the deltoid muscle situated along an imaginary horizontal line two- or three-finger breadth below the lower edge of the acromion process (Craven & Hirnle, 1996; Gaylene, 2004). Some authors (Davidson et al., 2007) further recommend the anterior portion of the above horizontal line as the site of ImI.

In this study, the distribution pattern of the axillary nerve in the deltoid muscle was examined during the dissection of human cadavers, and the appropriate site for ImI was selected with risk of injuring the axillary

nerve on ImI. At the same time, the feasibility of the proposed ImI site in the deltoid muscle described in textbooks and other sources of literature was examined. This study warns medical practitioners of the potential nerve injury as the result of ImI in the deltoid muscle.

Materials and Methods

Fourteen shoulders from seven embalmed adult cadavers were used during dissection practice for professional beginners of anatomy at the Dissection Training Seminar, Nagoya University, Faculty of Medicine. The ages of cadavers were between 65–96 years old.

As the first step, the shoulder region was approached with the cadaver in the supine position. The skin was cut, and the deltopectoral fascia was divided. The pectoralis major muscle was sectioned at the humeral insertion. A needle (25 mm in length; 23 gage) was pierced into the deltoid muscle from the overlying

skin at the middle of a horizontal line drawn at a level of three-finger breadth (approximately 5cm) below the lower edge of the acromion process. Thereafter, the skin overlying the deltoid muscle portion was removed carefully, keeping the needle in the muscle. The axillary artery and major peripheral nerves were retracted, and the axillary neurovascular bundle was identified. The proximal portion of the axillary nerves was exposed at the front of the quadrangular space.

As the second step, a long incision was made in the horizontal line along the insertion of the deltoid muscle to the acromion in prone-positioned cadavers. Then, the deltoid muscle was turned down from the incision site (Fig. 1a). By this method, the entire length of the axillary nerve was clearly exposed.

As the third step, branches of the axillary nerve were traced into the deltoid muscle as deeply as possible. Attention was paid to the course of the axillary nerve and position of the needle. By this dissection, the relationship be-

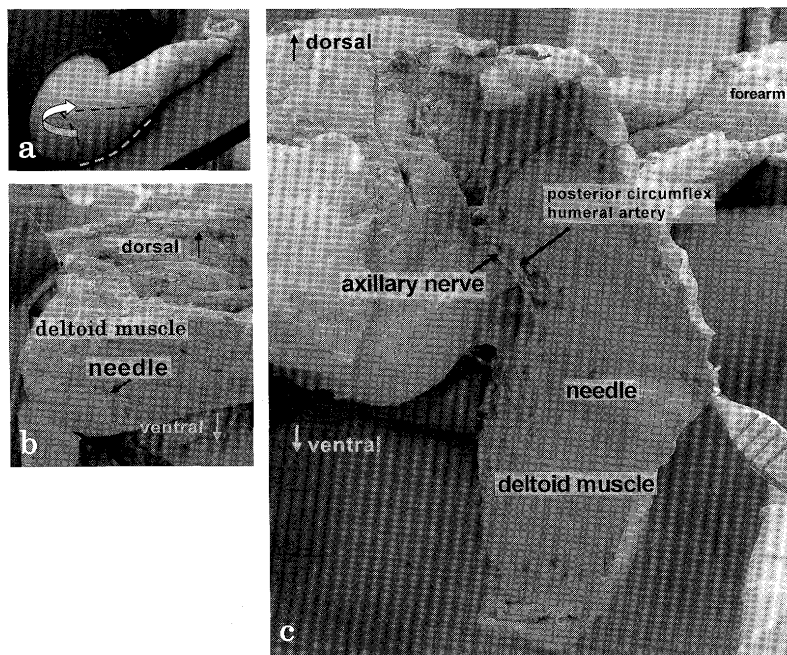


Fig. 1 Deltoid muscle (view in the prone position).
 a: Photo indicating the dissection protocol. The broken line shows the incision site. The deltoid muscle was turned down from the incision site.
 b: A needle was pierced into the deltoid muscle at the middle of a horizontal line drawn at the level of a three-finger breadth below the lower edge of the acromion process.
 c: Posterior view of the deltoid muscle turned down from the incision site. The tip of the needle (large arrow) is located close to the axillary nerve as well as the posterior circumflex humeral artery.

tween the position of axillary nerves, vessels, and needle was examined.

Results

The neurovascular bundle containing the axillary nerve and posterior circumflex humeral artery passes through the quadrangular space. Thereafter, the axillary nerve gives off its branches to the deltoid muscle and the teres minor muscle, and partly joins the superior lateral brachial cutaneous nerve. It also innervates the skin of the shoulder. The axillary nerve contains two fasciculi: one medial and one lateral. At the exit of the quadrangular space, the lateral fasciculus runs anterior (anterior trunk) and the medial fasciculus runs posterior (posterior trunk). The posterior trunk supplies the teres minor muscle and superior lateral brachial cutaneous nerve, whereas the anterior trunk together with some direct branches from the axillary nerve trunk innervate the middle and anterior parts of the deltoid muscle.

In associate with ImI in the deltoid muscle, the most important observation was that the anterior trunk of the axillary nerve runs at almost the same level as the horizontal line at a three-finger breadth below the edges of the acromion (Fig. 1b, c). Fig. 1c shows the position of the needle very close to the axillary nerve. This nerve branch reached as far as the anterior border of the deltoid muscle. This innervating pattern of the axillary nerve was observed in all cadavers.

In the present study, it was also shown that the radial nerve was located far from the

needle (Fig. 2), indicating that there is almost no need to take into consideration the risk of injuring the radial nerve in ImI in the deltoid muscle.

The position of the posterior circumflex humeral artery is also an important point for ImI in the deltoid muscle. This artery runs accompanying the axillary nerve (Fig. 1c) to at least the middle of deltoid muscle from the quadrangular space.

Discussion

ImI has been commonly employed for drug administration in hospitals for over half a century. Knowledge concerning ImI is important for both clinicians and nursing practitioners. Occasional complications have been reported in association with ImI, such as sciatic nerve palsies (Streib & Sun, 1981; Sobel et al., 1997), and contracture of the deltoid and quadriceps muscles (Groves & Goldner, 1974; Konkel, & Lucas 1974, Jackson & Hutton 1985). Well-recognized protocols for ImI have been established in the gluteal muscle that has a sciatic nerve trunk running in close contact with it. On the other hand, in association with deltoid ImI, the precise relationship between the axillary nerve innervation pattern and the ImI site in the deltoid muscle has been overlooked.

The present study showed that the standard protocol for ImI in the deltoid muscle run the risk of injuring the the axillay nerve. This is an important finding, stressing the need for caution when performing the commonly used technique of ImI in the deltoid muscle. Some

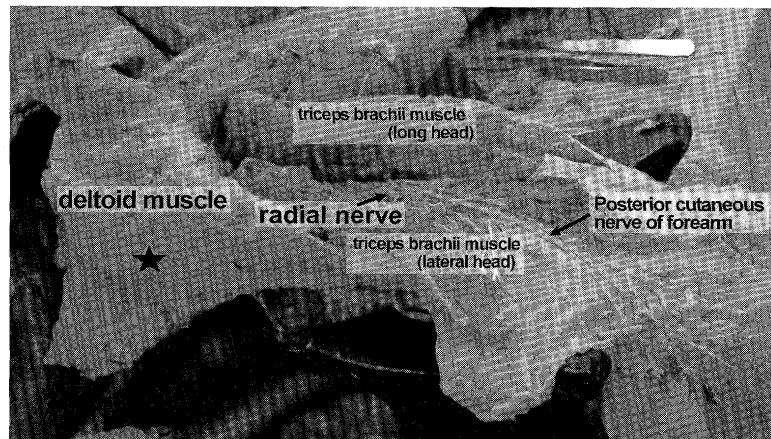


Fig. 2 Posterior view of the upper arm.
The radial nerve is located far from the needle position (★).

reports have described that the potential for injuring the axillary nerve and its branches may be minimized when the middle as well as the anterior part of the deltoid muscle is used for ImI (Davidson et al., 2007). As shown in the present study, even the anterior part is not safe, because the axillary nerve extended through the quadrangular space as far as the anterior part of the deltoid in all cases.

Many nursing textbooks illustrate no axillary nerve, but the radial nerve, and state "you must inject the medication into the densest part of the deltoid muscle to avoid the radial nerve and artery" (Lammon et al., 1995). In fact, the radial nerve is not so close to the deltoid muscle, and there is less risk of injuring the radial nerve by ImI in this muscle. If ImI is mistakenly performed into the triceps, rather than into the deltoid muscle, the radial nerve may be injured. As described above, the axillary nerve should be taken into further consideration on ImI in the deltoid muscle. However, many nursing practitioners seem to pay no attention to the axillary nerve on ImI into the deltoid muscle, with some even being unable to name the anatomical structure lying under the deltoid muscle (Hopper, 2005). On the other hand, some textbooks describe that the radial nerve is at risk on ImI into the deltoid muscle. Therefore, many nurses consider that they should be careful not to injure the radial nerve. However, the present study showed that the radial nerve is not close to the needle, indicating that there is a low-level risk of injuring the radial nerve in ImI in the deltoid muscle.

Then, where is the safest site for ImI into the deltoid muscle? There have been several studies on how ImI should be undertaken safely in the deltoid muscle (Nakatani et al., 1999, 2001). According to these studies, the most appropriate site for ImI is as follows: divide the superolateral margin of the acromion into three points: posterior (a), mid-portion (b) and anterior ends (c). Next, draw a line between the upper corners of the anterior and posterior axillary fold (line AB). Finally, draw a perpendicular line from both points (a) and (b) of the acromion to the AB line. The zone between the half-way point of the a-AB line and the lower one-third of the b-AB line might be safe for ImI.

The deltoid muscle has frequently been selected as the site for ImI since it is convenient for both practitioners and patients.

However, it should be recognized that this muscle is not necessarily safe or appropriate for ImI.

Because of the possibility of axillary nerve injury by ImI in the deltoid muscle, clinicians and nurses should keep in mind the relation of the nerve to the site of injection when they perform ImI into the deltoid muscle.

At present, though it is less convenient, the ventrogluteal site is the first choice for ImI. This site contains the gluteus medius which is thick enough for ImI, and the protocol for ImI has been well-described for this site.

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