

Revisiting the Safe Zone for Axillary Nerve Concerning the Deltoid Intramuscular Injection Site: a Review

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ABSTRACT

Introduction: Deltoid is the favoured site for intramuscular injection. The goals of this review are to revisit and classify the rules of the deltoid intramuscular injection (DIMI) technique and to assess these guidelines regarding studies reporting the location of the axillary nerve.

Methods: An extensive search for articles on deltoid intramuscular injection (DIMI) and physical area of the axillary nerve comparable to the shoulder challenging joint milestones either in the title or keywords was finished utilizing PubMed, ScienceDirect, Google Scholar, SciELO, EMBASE, and Web of Science (WoS) data sets. The pursuit terms were deltoid intramuscular injection, antibody organization, foremost shoulder approach, acromion process, the front constraint of the acromion, axillary nerve, acromion-axillary nerve distance, and acromioclavicular joint.

Results: There were nine rules for DIMI and 12 examinations detailing the axillary nerve area comparable to the shoulder's hard prominences. There are three strategies for distinguishing proof of the site of DIMI. As estimated from the acromion interaction, the injection site is 2.5 cm. One more suggestion depends on denoting the centre third of the deltoid. Three recommendations advocate indicating a triangle in the deltoid. Parting of the deltoid multiple cm from the acromion interaction isn't suggested during shoulder joint medical procedures.

Conclusions: The axillary nerve is found 4 to 7 cm from the front edge of the acromion cycle. The DIMI proposals highlight a comparable area of 4 to 7 cm from the acromion cycle for the intramuscular injection. Subsequently, a thorough re-assessment of the DIMI injection site is required.

Keywords: Intramuscular, Injection; Vaccine administration; Nerve injuries; Guidelines; Acromion process.

Introduction

The deltoid muscle which covers the shoulder gets its name from the Greek delta letter (Δ). The deltoid is the popular intramuscular site for the organization of immunizations¹. as it is effectively uncovered and unadorned for clinicians to manage the injection. Since deltoid muscle is more modest than the other intramuscular injection destinations, this site is chosen for small-volume injections. Even though deltoid intramuscular injections (DIMI) are moderately protected, it has not revealed site-explicit incidental effects. Injecting excessively low and horizontally can harm the outspread nerve², and too high can harm the axillary nerve^{3,4}. DIMI near the shoulder joint can bring about shoulder injury connected with antibody organization (SIRVA), which incorporates bursitis, cement capsulitis, fasciitis, and other shoulder-related wounds⁵. Safe organization of DIMI needs the physical

direction of the nerves connected with the deltoid and a legitimate injection strategy⁶.

The axillary nerve is connected with the deeper surface of the deltoid, and it partitions into the anterior and posterior branches before entering the muscle⁷. The axillary nerve branches (anterior and posterior) provide the deltoid. These parts of the nerve can emerge inside the muscle or outside the muscle. The course of the axillary nerve isn't entirely level and changes for the anterior and posterior parts of the muscle⁸. The radial nerve is found on the back and sidelong part of the muscle, profound inside the arm. In the upper part of the muscle, just underneath the acromion, a huge subdeltoid bursa, subacromial bursa, and the addition of rotator sleeve muscles are found. Profound to the deltoid muscle, the glenohumeral joint case characterizes the shoulder joint. Thought of these physical relations ought to frame the premise of

the rules for the DIMI.

The first rules for DIMI were given by Pitel and Wemett back in 1964⁹. For the most part, it is suggested that the needle should enter 5 mm or more inside the muscular deltoid mass to give compelling retention¹⁰. Medical literature has numerous suggestions and illustrative portrayals of protected and variable needle entrances and injection points.

Different physical examinations outline the axillary nerve area. The specific physical location of the axillary nerve is significant during the front way of dealing with the shoulder joint. While parting the deltoid, care should be taken to avoid injury to the axillary nerve, and this has prompted higher interest among specialists and anatomists to outline the axillary nerve, particularly compared to the shoulder hard prominences. On a shallow note, the DIMI site covers the specific area of the axillary nerve, as shown by numerous cadaveric investigations. This captivating cross-over of the injection site and axillary nerve area reevaluates the DIMI procedure, especially in the majority's current situation of crown immunization. The goals of this survey were to return to and characterize the rules of the DIMI method and to assess these rules concerning concentration on revealing the area of the axillary nerve.

Methodology

Study source and duration: During May 2021, a broad quest for articles depicting the rules for DIMI in title or keywords was finished utilizing PubMed, ScienceDirect, Google Scholar, SciELO, EMBASE, and Web of Science data sets. Additionally, every article depicting the axillary nerve's physical area according to the shoulder joint challenging milestones, either in title or Keywords, was looked at with similar data sets.

Search Criteria: A complete quest for all articles connected with DIMI rules and axillary nerve area was completed to incorporate every significant review. The specific pursuit words are as follows:

- DIMI rules: deltoid intramuscular injection, antibody organization, acromion, acromion process, injection site in the upper arm, intramuscular injection rules, intramuscular injection site, deltoid injection
- Axillary nerve area: front shoulder approach, acromion process, the only restriction of the acromion, axillary nerve, acromion-axillary nerve distance, and acromioclavicular joint.

Study selection: all articles, regardless of the publication date, were considered for the review study. Original research and case reports were remembered for this survey. Moreover, DIMI rules from social orders, devoted teams, and boards, regardless of whether or not they were distributed as examination articles, were incorporated. The axillary nerve area was included mainly concerning shoulder surgeries

and medical procedures (anterior approach).

Data collection, data items, and the blend of results: DIMI guidelines were classified into three subcategories given the technique for finding the injection site. Axillary nerve location, as indicated by different studies chosen, was organized. The relation between the injection site and the axillary nerve area was assessed.

Results

A total of 235 records were found, with keywords used for searching. Of these, 214 records are not directly related to DIMI and the anterior approach of the shoulder joint and were excluded from the review. There were 9 guidelines for DIMI and 11 studies (with one textbook reference) reporting the location of axillary nerve concerning bony prominences of the shoulder.

DIMI guidelines

There are considerable variations in the recommendations of DIMI. Broadly, there are four sites of DIMI recommended. Table 1 summarizes these deltoid intramuscular injections. Overall, there are three methods of identification of the DIMI site. None of these recommendations considers the horizontal position of the DIMI relative to the anterior and posterior limits of the deltoid muscle. Injecting near the anterior edge of the deltoid falls too close to the shoulder joint as the muscle is thinner at the edges. Injecting too posteriorly puts the radial nerve at risk (Table 1).

Location of axillary nerve

Traditionally, splitting the deltoid up to 5 cm is advocated during the anterior approach to the shoulder joint. However, many reports of finding the nerve within this safe splitting distance from the acromion^{16,19}. Therefore, splitting the deltoid more than 4 cm from the acromion process during shoulder joint surgeries is not recommended²⁰. These recommendations differ from bony landmarks for locating the axillary nerve deep into the deltoid muscle tabulates various studies' mean distances from the bony landmarks and axillary nerves (Table-2).

Of particular importance during DIMI is to note the most easily palpable bony landmark in the lateral edge of the shoulder. If one palpates the shoulder resting, the anterior margin of the acromion process will be prominent. Considering this landmark and all the related studies (table 2), we conclude that the axillary nerve is usually located 4 to 7 cm from the anterior margin of the acromion process. Surprisingly, the DIMI recommendations (table 1) also point to a location of 4 to 7 cm from the acromion process for the intramuscular injection (Figure 1).

Table 1. Deltoid intramuscular injections (DIMI) recommendations.

Author	Guidelines
Landmarking based on distance from the acromion	
Ashley Bancsi ⁵	Upper border: two or three fingers below the acromion Lower border: at the level of the armpit. Draw a V-shaped outline using a thumb and forefingers, and inject it into the middle of this outline.
Beyea and Nicoll ¹¹	3-5 cm from the acromion process
Kirk A <i>et al.</i> ¹²	Locate the 'nobbly' acromial process. Inject at 2.5 cm down onto the deltoid muscle.
Ogston-Tuck S <i>et al.</i> ¹³	Identify the acromial process. Place two fingers or measure 2.5cm from this location along the lateral aspect of the humerus. Alternatively, inject just above this and draw an imaginary line from the axilla to the humerus.
Landmarking is based on the middle third or middle of the deltoid muscle.	
Cocoman A <i>et al.</i> ¹⁴	A base is formed in the centre of a triangle between the index and middle finger with the acromion process. Insert a needle in the middle of the triangle.
Kroger AT <i>et al.</i> ¹⁵	Locate the middle of the muscle by asking the patient to abduct the arm, relax the arm and inject at a 90-degree angle to the middle muscle point.
Cook <i>et al.</i> ¹⁶	The mid-point of the muscle (midway between the acromion and the deltoid tuberosity) with the arm abducted to 60° is a safe site for injection.
Landmarking based on triangular injection site	
Wynaden D <i>et al.</i> ¹⁷	Draw an inverted triangle three-fingers in width below the lower edge of the acromion process. Inject at the midpoint of the triangle.
Hunter J <i>et al.</i> ¹⁸	Visualize a triangle with a base at 2 to 2.5 cm below the acromial process with an apex at the mid-point of the arm in line with the axilla. Inject at 2-2.5 cm below the acromion process.

Table 2. Position of axillary nerve concerning acromion as reported by various authors.

Author	Sample size	Findings
Hoppenfeld <i>et al.</i> ¹⁹		The mean distance between the axillary nerve and the anterior limit of the acromion is 7cm.
Ozgun Celik <i>et al.</i> ²⁰	100	The distance from the anterior edge of the acromion process to the axillary nerve is 6.08 cm. From the posterior edge of the acromion process to the axillary nerve is 4.87 cm.
Duparc <i>et al.</i> ²¹	64	The mean distance between the axillary nerve and acromion attachment is 3.40 cm.
Uz <i>et al.</i> ²²	30	The mean distance between the posterior aspect of the acromion and the axillary nerve is 7.8 cm.
Prakash KG <i>et al.</i> ²³	50	Axillary nerve entry into the muscle is 7.46cm from the posterolateral aspect of the tip of the acromion process.
Kontakis <i>et al.</i> ²⁴	134	The distance from the upper border of the deltoid to the axillary nerve is less than 4.6 cm.
Ikemoto <i>et al.</i> ²⁵	48	The mean distance between the anterior aspect of the acromion and the axillary nerve is 5.32 cm.
Burkhead <i>et al.</i> ²⁶	102	In 20% of the specimens, the axillary nerve was located less than 5cm from the palpable edge of the acromion.
Abhinav <i>et al.</i> ²⁷	60	The mean acromion-axillary nerve distance was 6.0 cm. The recommended safe space for deltoid split is 4.2 cm.
Kulkarni <i>et al.</i> ²⁸	122	The axillary nerve is 2.20–2.60 cm above the midpoint of the vertical plane of the muscle.
Nassar <i>et al.</i> ²⁹	42	The distance between the acromioclavicular joint to the axillary nerve is 7.90 cm (range, 7.2 to 9.1 cm) in males and 6.37 cm (range, 5.2 to 8.1 cm) in females.

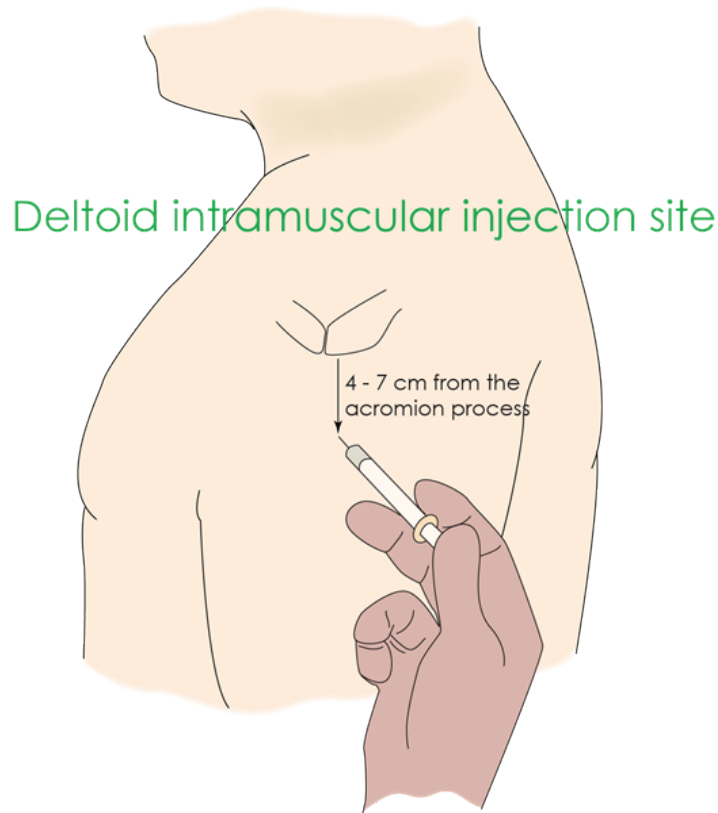


Figure 1. Schematic representation of deltoid intramuscular injection site location from the acromion process.

Discussion

Intraoperative identification and delineation of nerves are crucial for any intervention, whether simple intramuscular injection or shoulder surgery³⁰⁻³².

During DIMI, injecting the needle perpendicular to the surface and deep within the deltoid is generally recommended. The axillary nerve is undoubtedly situated at this equivalent site of suggestion. It is to be noticed that even though the physical axillary nerve is found exceptionally close to the suggested site of DIMI, the nerve injury detailed after the injection is extraordinary. Even though with these physical relations, the harm to the axillary nerve was expected to be more normal during DIMI, in one of the detailed series of nerve wounds post-DIMI, radial nerve wounds were more normal³³. DIMI in an inadequately uncovered shoulder district, without discovering how much arm kidnapping, may misuse the flat place of the needle. With more posterior injections, radial nerve injury is conceivable.

The axillary nerve separates into various (basically front and back) branches before or after the passage to the deltoid²³, and the volume of medication infused is low²², which represents somewhat hardly announced iatrogenic nerve injury. The axillary nerve moves

proximal to the acromion cycle in the abducted arm position, and the protected distance for DIMI lessens²⁷.

There are endeavours to rethink the DIMI site considering the above-expressed constraints of the ongoing practices. As the back branch passes alongside back circumflex humeral vessels, ultrasonographic planning of these vessels is utilized for finding the axillary nerve³⁴. Nakatani *et al.* suggested an injection site at the crossing point between the anteroposterior axillary line and the opposite line from the mid-acromion line³⁵. Even though scientists have considered the level demeanour of the deltoid muscle, there are no reasonable rules for distinguishing the front and back axillary lines. Consequently, an intensive re-assessment of the DIMI injection site is required.

Conclusion

Considering the landmark and all the related studies, we conclude that the axillary nerve is usually located 4 to 7 cm from the anterior margin of the acromion process. Surprisingly, the DIMI recommendations also point to a location of 4 to 7 cm from the acromion process for the intramuscular injection. Therefore, a thorough re-evaluation of the DIMI injection site is required.

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