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Morphometric analysis of safe distance for axillary nerve in deltoid splitting surgeries in South Indian population: A cadaveric study

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Abstract

Background: The axillary nerve is one of the important nerve around shoulder which branches off from posterior cord of brachial plexus (C5, C6). Risk of injuring it during shoulder joint surgery or proximal humerus surgeries involving deltoid splitting concern the orthopaedic an the most. To prevent such iatrogenic nerve damage and to improve treatment outcomes, proper anatomical knowledge is of the utmost significance. Axillary nerve exit axilla through the quadrangular space and muscles gets its innervations are deltoid muscle, teres minor, skin over the lateral aspect of shoulder.

Materials and Methods: 50 shoulders of 25 adult fresh cadavers were taken for dissection as per standard dissection methods. Position of axillary nerve beneath deltoid muscle from anterolateral edge of acromion process was measured along with the arm length which were tabulated and analysed.

Results: The average acromio-axillary nerve distance (AA) was 6.84 ± 0.89 cm and mean arm length 32.19 ± 1.37 cm. AA distance and arm length shows a positive correlation. The minimum acromio-axillary nerve distance was 4.78 cm, which is safe length for deltoid splitting.

Conclusion: The safe distance to avoid axillary nerve injury is identified by with a distance of 4.78 cm from tip of acromion process, and depends on arm length. Which will be useful during surgical procedures to avoid injury to the same.

Keywords: Acromion process, axillary nerve, deltoid splitting, acromio-axillary nerve distance, safe distance

Introduction

The axillary nerve branches off from posterior cord comes out posteriorly through quadrangular space goes around the surgical neck of humerus. It is at great risk during surgical exposure of shoulder joint or proximal humerus. Axillary nerve with a nerve root C5, C6 supplies motor innervation to muscles; teres minor, deltoid. It also gives branches to shoulder joint and skin over lateral aspect of shoulder [1].

Weak forward flexion and abduction of shoulder joint could be the possible the effect of axillary nerve injury due to deltoid palsy or its atrophy [2]. Among all brachial plexus injury, axillary nerve injury constitutes 6-10% [3]. Surgical approach involving splitting of anterior and middle fibres of the deltoid carries more risk to axillary nerve [4, 5]. Proximal humerus fractures fixation, intramedullary fixation, open rotator cuff repair, arthroscopy, axillary nerve is often injured [6].

As a result of unclear information regarding the location of the axillary nerve in the proximal arm, procedures like intramuscular injections in the deltoid and intra-articular and intrabursal steroid injections are also risky for the nerve [7, 8]. In literature many have tried to identify exact location of the axillary nerve in arm. Abbot [9] was first to note 1.5 inch or 3.8 cm seen between the acromion process and axillary nerve in 1949. Subsequently many anatomical studies came to identify the location of axillary nerve with different reference points like coracoid process, different parts of acromion process, head of humerus, deltoid muscle etc.

To avoid iatrogenic injury and its complications for better clinical outcome, knowledge about safe distance for deltoid splitting carries paramount importance.

Materials and Methods

25 fresh cadavers were taken for the study. Paediatric shoulders, shoulder with scar of previous surgery, deformity was excluded. All 50 shoulders of 20 males and 5 females were dissected after obtaining approval from the institutional ethical committee.

Arms were kept side of the body as abduction can cause a decrease in acromio-axillary nerve distance [10]. Arm length was measured prior to the dissection which was measured between tip of acromion process and lateral epicondyle of humerus (Fig-1).



Fig 1: Arm length measurement

Through an incision along delto-pectoral groove, deltoid muscle was exposed [6]. Deltoid attachment over proximal humerus, acromion, clavicle, and scapula was released and flap was reflected laterally with inner surface of deltoid facing outside. Axillary nerve is identified in the quadrangular space and its entry into muscle after dissecting the fascia over inner surface of deltoid muscle. Antero-lateral edge of acromion process and its entry into deltoid was pinned. AA distance was measured between the pins using a digital vernier calliper with 0.01 mm calibre (Fig 2a, b). Reflected deltoid flap was sutured back [11].

Arm length and a length was tabulated and correlation analysis was done to identify the relationship the same.

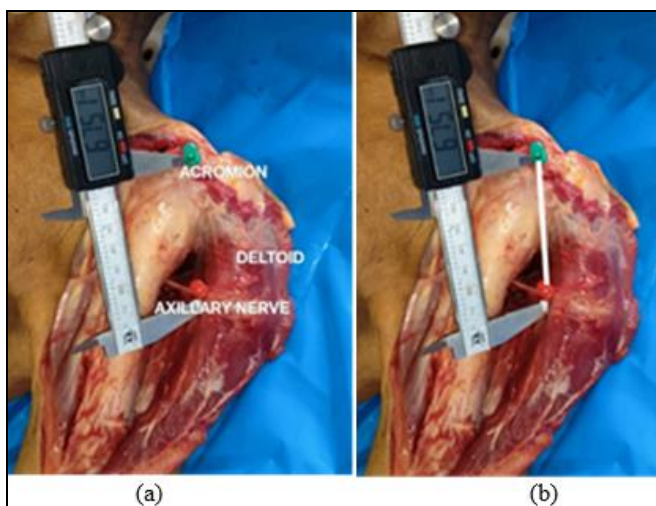


Fig 2: (a) Land marks (b) Acromioaxillary distance

Statistical analysis

- The mean AA distance in males were, right side 7.12 cm with a standard deviation of 0.66 cm (7.12 ± 0.66 cm), left side 7.21 cm with standard deviation of 0.61 cm (7.21 ± 0.61 cm).
- In females right side mean AA distance is 5.55 cm with standard deviation of 0.49 cm (5.55 ± 0.49 cm), left side 5.42 cm with standard deviation of 0.42 cm (5.42 ± 0.42 cm).
- Among 25 right side, mean AA distance is 6.81 cm with standard deviation 0.89 cm (6.81 ± 0.89 cm). Among 25 left shoulders, mean AA distance is 6.86 cm with standard deviation 0.93 cm (6.86 ± 0.93 cm). The lowest AA distance we got is 4.78 cm and maximum is 8.28 cm (Table-1).
- Among 50 shoulders mean AA distance is 6.84 ± 0.89 cm
- In right arm, mean a distance for males is 7.12 cm and females is 5.55 cm. AA distance is higher for males compared to females.
- The right arm t-test reveals a significant difference between a distances of males and females were obtained. ($T=4.979$).
- T test left arm shows similar findings in left side also ($T=6.121$).
- Mean male right arm length is 32.55 ± 1.06 cm, female right arm length is 30.40 ± 0.96 cm, total of 32.12 ± 1.35 cm.
- Mean male left arm length is 32.73 ± 1.12 cm, female left arm length is 30.40 ± 1.08 cm, total of 32.26 ± 1.44 cm (Table-2).
- Mean arm length for 50 cadavers is 32.19 ± 1.37 cm.

Correlations for right arm

- We obtained a positive correlation between right arm length and a distance with an r value of 0.835. It showed 0.1% level significance ($p < 0.001$). Higher arm length is significantly related with higher a distance or vice versa (Table-3, Fig-3).

Correlations for left arm

- We obtained a positive correlation between left arm length and AA distance with an r value of 0.828. It showed 0.1% level significance ($p < 0.001$). That is higher arm length is significantly related with higher AA distance or vice versa. (Table-4, Fig-4).

Combined correlation

- Combined correlation between the variables with $r=0.831$ and 0.1% level significance obtained ($p < 0.001$). (Fig-4).

Results

- In our study, right side, mean a distance is 6.81 ± 0.89 cm, left shoulders, mean a distance is 6.86 ± 0.93 cm.
- The combined average acromio-axillary nerve distance is 6.84 ± 0.89 cm.
- Minimal measurement was 4.78 cm, and maximum length is 8.28 cm.
- Right arm length shows a mean of 32.12 ± 1.35 cm.
- Left arm length shows a mean of is 32.26 ± 1.44 cm.
- Combined mean arm length is 32.19 ± 1.37 cm.
- With an r value of 0.831 arm length and a distance showed significant correlation.

Discussion

The axillary nerve branches off into anterior and posterior

branch after emerging from quadrangular space. Anterior branch supplies anterior and middle fibres of deltoid muscle, posterior fibres supplied by posterior branch and continues as upper lateral cutaneous nerve of arm [13-16]. Deltoid splitting incision are commonly used for intramedullary nailing of humerus fractures, proximal humerus fracture, shoulder arthroscopy surgeries and open rotator cuff repair [13, 17, 18].

Many authors have traced the course of the axillary nerve within deltoid muscle. In literature nerve to acromion distance has generally said as approximately 5-7 cm [10, 19]. In 1992 Burkhead *et al.* [10] reported that 5 cm is not a fixed safe zone for splitting from the acromion. In 20% of his cadavers, he documented axillary nerve location less than 5 cm. He also added location of axillary nerve changes according to position of arm that is abduction of arm reduces a length.

In American population Cheung *et al.* [20] determined a safe zone up to 5 cm and found a danger area from 5-9 cm. Duparc *et al.* [21] found a vertical safe distance of average 34 mm. While Hoppenfeld and Debour's [22] study found to be 70 mm. In 30 shoulders Uz *et al.* [19] reported mean distance of 7.80 cm from the postero-lateral aspect of the acromion process to axillary nerve. On 15 cadavers Abhinav *et al.* [23] recorded a split of 4.2 mm would be safe and he concluded that position of upper limb (abduction) also a risk to axillary nerve. Yildirim *et al.* [24] in Middle East population on 37 cadavers, using antero-lateral deltoid splitting approach, a safe distance

of 5.5 cm from antero-lateral edge of acromion process and it depends on arm length. Similar reference point was used in this study and estimated a 4.78 cm safe split.

We lack a great deal of clarity after reviewing prior material because different authors have varied ideas about what constitutes a safe distance. Variations in the demographic or ethnic group under investigation, measuring techniques, error made by observer, and confounding variables may all contribute to this.

Instead of a safe zone or distance Cetik *et al.* [25] in 24 cadavers demonstrated a quadrangular safe area and its side depends on arm length. Similar results were recorded by Apurba Patra *et al.* [26] in Indian population on 30 cadavers. They demonstrated a safe area and its relationship with arm length. In Indian scenario, Lakshmi Kartha *et al.* [27] recorded AA length of 3.95 cm in right side, 4.13 cm in left from the antero-lateral edge of acromion process. Gurushantappa and Kuppasad [28] in 40 shoulders recorded AA length of 7.46 ± 0.99 cm.

In this study we recorded a similar finding with reference point as antero-lateral edge of acromion process. A minimum of 4.78 cm was obtained, maximum of 8.28 cm. AA length depends on arm length. We emphasis mainly as safe distance as this study demonstrate the safety of axillary nerve between the anterior and middle fibres of deltoid muscle.

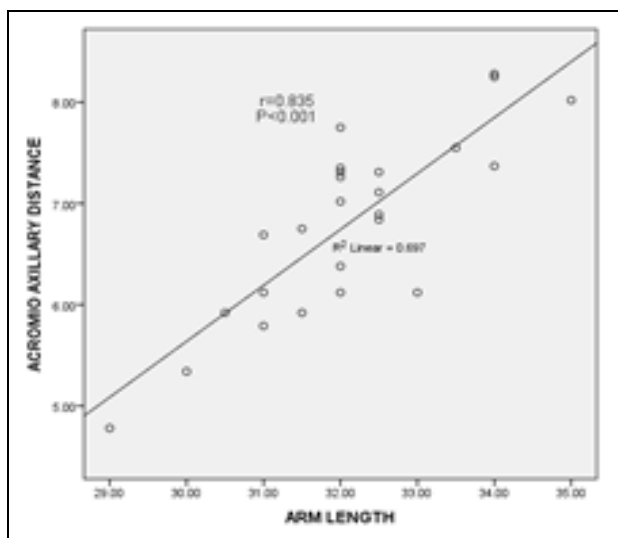


Fig 3: Correlation between right arm length and acromioaxillary length

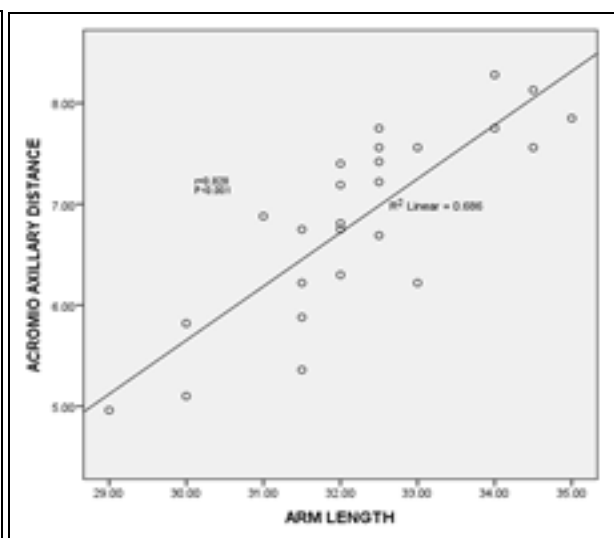


Fig 4: Correlation between left arm length and acromioaxillary length

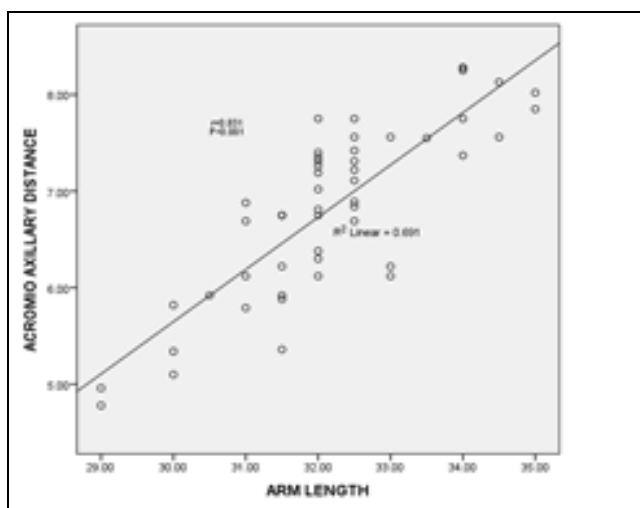


Fig 5: Combined correlation between arm length and acromioaxillary length

Table 1: Acromio axillary distance in right and left side

		Acromio axillary distance									
		Right/left arm									
		Right					Left				
		Mean	S.D	Minimum	Maximum	No.	Mean	S.D	Minimum	Maximum	No.
Gender	Male	7.12	.66	6.12	8.28	20	7.21	.61	6.22	8.28	20
	Female	5.55	.49	4.78	5.92	5	5.42	.42	4.96	5.88	5
Total		6.81	.89	4.78	8.28	25	6.86	.93	4.96	8.28	25

Table 2: Arm length in right and left side

		Arm length									
		Right/left arm									
		Right					Left				
		Mean	S.D	Minimum	Maximum	No.	Mean	S.D	Minimum	Maximum	No.
Gender	Male	32.55	1.06	31.00	35.00	20	32.73	1.12	31.00	35.00	20
	Female	30.40	.96	29.00	31.50	5	30.40	1.08	29.00	31.50	5
Total		32.12	1.35	29.00	35.00	25	32.26	1.44	29.00	35.00	25

Table 3: Correlation between right arm and acromio axillary distance

Correlations		
Acromio axillary distance		
Arm length	Pearson correlation	.835**
	Prob.	.000
	N	25

** Correlation is significant at the 0.001 level ($p < 0.001$).

Table 4: Correlation between left arm and acromio axillary distance

Correlations		
Acromio axillary distance		
Arm length	Pearson correlation	.828**
	Prob.	.000
	N	25

** Correlation is significant at the 0.001 level ($p < 0.001$).

Conclusion

From this study of 50 dissected specimens, we conclude that location of axillary nerve in deltoid muscle with respect to acromion process varies significantly. It is advised to take the shortest deltoid split possible to avoid iatrogenic injury to axillary nerve for a good post-operative outcome. Injury to nerve can cause anterior deltoid atrophy and palsy. To avoid axillary nerve injury deltoid splitting within a distance of 4.78 cm from antero-lateral edge of acromion process, and depends on arm length.

Hence this study redefines safe distance of axillary nerve in anterolateral deltoid splitting surgeries in south Indian population and safe distance of deltoid split depends on individual arm length.

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Conflict of interest: Nil.

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