Original Article

Ulnar Nerve Innervation to Triceps: A Cadaveric Study and a Technical Note on Partial Triceps to Biceps Transfer

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Abstract

Background: The loss of elbow flexion is a routinely encountered problem in clinical practice. There is no literature on ulnar nerve innervation to triceps in addition to the radial nerve which is dual nerve innervation to triceps in the Indian population. We intend to study the incidence of ulnar nerve innervation to the medial head of triceps in Indian population and also the clinical feasibility of transfer of long and medial head of triceps tendon to biceps around the medial aspect of humerus. **Materials and Methods:** A cross-sectional study was conducted using 32 fresh-frozen skeletally mature cadavers of Indian origin. The possible contribution of the ulnar nerve to medial head of triceps in addition to the radial nerve was recorded. The arm length, the distance where the ulnar nerve pierces the medial intermuscular septum from medial epicondyle; the distance of the ulnar nerve fascicle from the medial epicondyle was also measured. **Results:** The incidence of ulnar nerve innervation to the medial head of triceps was 43.8%. Mean arm length was 29.13 cm. Mean distance where the ulnar nerve pierced the medial intermuscular septum from medial epicondyle was 9.93 cm. Mean distance of the ulnar nerve branch to the triceps from medial epicondyle was 8.01 cm. **Conclusion:** This study reveals the presence of dual nerve innervation to triceps in 43.8% of the Indian population. The clinical implication would be to look for the possible contribution of the ulnar nerve fascicle to the medial head of triceps, which will help us to include the medial head along with the long head of triceps while performing partial triceps-to-biceps tendon transfer, and the other use would be as a donor fascicle when performing a nerve transfer.

Keywords: *Brachial plexus injury, elbow flexion, medial head of triceps, medial route, ulnar nerve*

Introduction

The loss of elbow flexion is a routinely encountered a problem in clinical practice and this could be due to the posttraumatic loss of elbow flexors, peripheral nerve injury, arthrogryposis, and poliomyelitis.[1] Delayed presentation of brachial plexus injury involving C5 and C6 roots accounts for 23% of brachial plexus injuries in the Indian population.[2] Restoring elbow flexion is critical to improve the functional capabilities in these patients. In delayed presentation, nerve transfers are not possible, but elbow flexion can be restored using microsurgical methods such as free-functioning muscle transfer or by tendon transfer using latissimus dorsi,[3,4] pectoralis major,[5-7] triceps,[8,9] or common flexor origin.[10-12]

Triceps-to-biceps transfer was first described by Beisalski (1916). In 1948 and 1951, Bunnell[13] described entire triceps transfer; Carroll[14] (1952) later modified that technique. Haninec and Szeder[15] suggested that the partial triceps muscle can be transferred to restore elbow flexion. The fear of loss of elbow flexion was allayed by Naidu *et al*.[16] who revealed the independent function of long head of triceps and lateral head of triceps using electromyography and used the long head of triceps to restore the elbow flexion.

Although the radial nerve predominantly innervates the triceps, cadaveric studies by Bekler *et al*.,[17] Miguel-Perez *et al*.,[18] and Loukas *et al*.[19] have shown that the ulnar nerve may innervate the medial head of triceps in some individuals, leading to dual nerve innervation. Studies by Bekler *et al*.[17] and Pascual-Font[20] *et al*. have reported an ulnar collateral nerve supplying the triceps, which is a radial nerve fascicle communicating with the ulnar nerve in the axilla.

In this study, we intend to study the incidence of ulnar nerve innervation to the medial head of triceps and also the clinical

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use of transfer of long and medial head of triceps tendon to biceps around the medial aspect of humerus.

Materials and Methods

32 (16 pairs) skeletally mature cadavers of Indian origin were included in the study. Age, sex, and side of the cadaver were noted. Cadavers with old surgical scars over arm or elbow were excluded from the study.

The arm length was measured from the acromion to the lateral epicondyle using a nonstretchable measuring tape. A posterior skin incision from the olecranon curving to the posterior axillary fold was made. The subcutaneous tissues were exposed from the axilla to the elbow to explore a possible contribution of the ulnar nerve innervation to the medial head of the triceps brachii under loupe magnification. Further, the ulnar nerve was traced proximally higher up to the axilla to look for an ulnar collateral nerve which was described by Pascual-Font *et al*.[20]

The following other parameters were also measured. The distance where the ulnar nerve pierces the medial intermuscular septum from medial epicondyle, the distance of the ulnar nerve fascicle from medial epicondyle was measured when the ulnar nerve supplies triceps [Figure 1].

We assessed and confirmed the feasibility of the tendon transfer of the long head of the triceps along with the medial head of triceps-to-biceps tendon. A cadaver with ulnar nerve innervation to the triceps was randomly selected. Posterior incision was taken along the olecranon and was extended further distally. The interval for the long head of triceps was identified in the proximal part of arm. The long head of the triceps along with the medial head of triceps was detached along with 5-cm periosteal sleeve beyond the olecranon [Figure 2]. The medial head was partly elevated from humerus for adequate mobilization. To reduce the tension on the ulnar nerve fascicle supplying the medial head of triceps, the ulnar nerve was anteriorly transposed, and the long and medial head of triceps were transferred to biceps through the medial route instead of the lateral route which was originally described by Bunnell.[13]

The ethical committee approval from institutional ethics committee has been obtained for this study.

Statistical analysis

The statistical analysis was performed using SPSS version 20.0 software (IBM Corp, Armonk, New York, USA). The incidence of ulnar nerve innervation to medial head of triceps was estimated regarding percentage. The differences in the ulnar innervation between the genders and between the right and left side were studied for statistical significance using Chi-square test of significance. A value of $P < 0.05$ was considered as statistically significant. Descriptive statistics such as mean and standard deviation was used to describe the arm length and length of ulnar nerve branch.

Results

Thirty-two (16 pairs) limbs of skeletally mature fresh-frozen cadavers of seven males and nine females were dissected. The right and left sides were dissected for all cadavers. We found 14 ulnar nerve branches in 32 limbs.

The mean arm length was 29.13 cm (range 27.5-34 cm); 29.07 cm in males (range 27.5-34 cm) and 29.17 cm in females (range 27.5-32 cm). The mean distance where the ulnar nerve pierced the medial intermuscular septum from medial epicondyle was 9.93 cm (range 5.5-11.5 cm); (10.07 cm in males (range 6.1- 11.5 cm) and 9.81 cm in females) (range 5.5 -10.5 cm). The incidence of ulnar nerve innervation to the medial head of triceps in our study was 43.8% (28.6% in males and 71.4% in females) [Table 1]. There was no statistical significance in the incidence of ulnar innervation between the males and females ($P = 0.127$).

Left side showed 57.1% of ulnar nerve innervation, and the right side showed 42.9% of ulnar nerve innervation to triceps [Table 2]. There was no statistical significance in the incidence of ulnar innervation between the right and left sides ($P = 0.476$).

The mean distance of the ulnar nerve branch to the triceps from medial epicondyle was 8.01 cm; 9.6 cm in males and

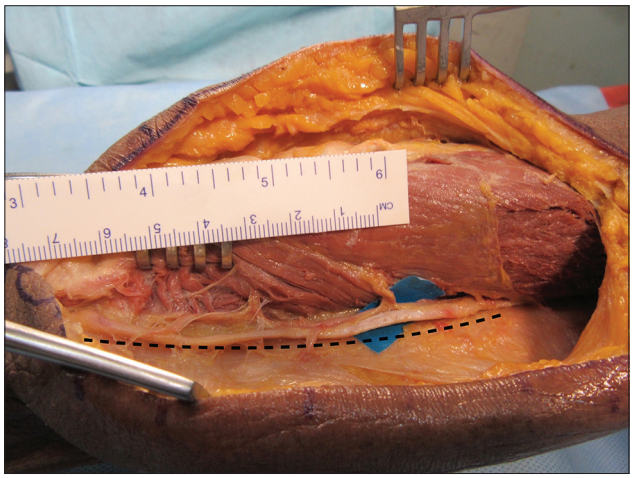

Figure 1: Ulnar nerve fascicle to the medial head of triceps and dotted line depicts the course of the ulnar nerve

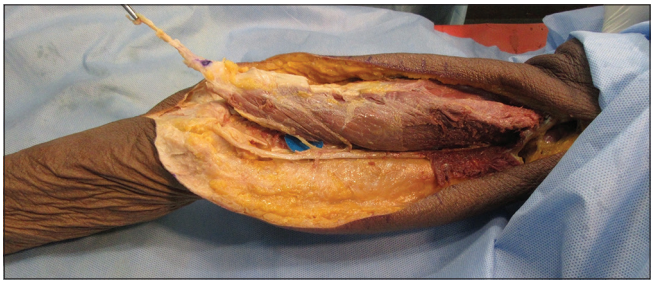

Figure 2: Triceps detached with 5-cm periosteal sleeve

7.38 cm in females. None of the cadavers in our study had an ulnar collateral nerve.

Discussion

The average distance of the ulnar nerve piercing the intermuscular septum in our study was 9.93 cm and Contreras[21] reported as 10 cm. Bekler *et al.*[17] had found that 61% of the ulnar nerve fascicle supplying the medial head of triceps had originated from the main nerve and 33% had an accessory ulnar collateral branch of the radial nerve. Miguel-Perez *et al.*[18] described the ulnar innervation in triceps in a single cadaveric dissection. Loukas *et al.*[19] observed the ulnar innervation of the triceps brachii muscle in 28% of specimens. In this study, we have found 43.8% innervation of ulnar nerve to triceps. Table 3 shows the ulnar nerve innervation comparison with other studies.

As it is difficult to assess the ulnar nerve innervation to the medial head of triceps preoperatively, we would recommend to look for the ulnar nerve branch to triceps intraoperatively, as it would be beneficial as a donor nerve for nerve transfer and also for a tendon transfer, where medial head of triceps can be included along with the long head of triceps-to-biceps tendon for elbow flexion in brachial plexus injury patients.

In this study, the mean distance of the ulnar nerve branch to triceps from the medial epicondyle was 8.01 cm. Loukas *et al.*[19] found that the mean distance of the ulnar nerve branch, midpoint of the intersection point along the surgical neck, and the inter-epicondylar line of the distal humerus was 26% or 7.28 cm (from distal to proximal), with a range of 11% (3.1 cm) to 39% (10.9 cm). They have used a different method to measure the distance of the ulnar nerve branch.

We would suggest to perform anterior transposition of ulnar nerve and use the medial route for partial triceps tendon transfer to biceps on finding a ulnar nerve fascicle to medial head of triceps and then including the medial head along with long head of triceps, otherwise using the long head alone of triceps by a lateral head may be preferable.

However, a larger clinical series will be useful to validate the benefits of the technique and histomorphometry of the ulnar nerve fascicle supplying the medial head of triceps will enlighten us to use it as a donor fascicle.

Table 1: Incidence of ulnar nerve innervation to medial of triceps in males and females

Sex	Ulnar nerve innervation		Total
	Absent	Present	
Male, *n* (%)	10 (55.6)	4 (28.6)	14 (43.8)
Female, *n* (%)	8 (44.4)	10 (71.4)	18 (56.2)
Total, *n* (%)	18 (56.2)	14 (43.8)	32

Table 2: Incidence of ulnar nerve innervation in the right and left sides

Side	Branches		Total
	Absent	Present	
Left, *n* (%)	8 (44.4)	8 (57.1)	16 (50.0)
Right, *n* (%)	10 (55.6)	6 (42.9)	16 (50.0)
Total, *n* (%)	18 (56.2)	14 (43.8)	32

Table 3: Percentage of ulnar nerve innervation to the medial head of triceps in various studies

Study	Ulnar nerve innervation (%)
Bekler[18]	61
Loukas[20]	28
Our study	43.8

Conclusion

This study reveals the presence of dual nerve innervation to triceps in 43.8% of study sample of the Indian. The clinical implication would be to look for the possible contribution of the ulnar nerve fascicle to medial head of triceps, which will help us to include the medial head along with the long head of triceps while performing partial triceps-to-biceps tendon transfer. The other use would be as a donor fascicle when performing a nerve transfer. We would also prefer to use a medial route instead of the conventional lateral route around the humerus while performing the partial triceps-to-biceps tendon transfer when including the medial head innervated by a fascicle of the ulnar nerve.

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Conflicts of interest

There are no conflicts of interest.

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