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Original article

The pectoralis major footprint: An anatomical study^{☆,☆☆}

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ABSTRACT

Objective: To study the insertion of the pectoralis major tendon to the humerus, through knowledge of its dimensions in the coronal and sagittal planes.

Methods: Twenty shoulders from 10 cadavers were dissected and the pectoralis major tendon insertion on the humerus was identified and isolated. The dimensions of its “footprint” (proximal to distal and medial to lateral borders) and the distance from the top edge of the pectoralis major tendon to apex of the humeral head structures were measured.

Results: The average proximal to distal border length was 80.8 mm (range: 70–90) and the medial-to-lateral border length was 6.1 mm (5–7). The average distance (and range) from the apex of the pectoralis major tendon to the humeral head was 59.3 mm.

Conclusions: We demonstrate that the insertion of the pectoralis major tendon is laminar, and the pectoralis major tendon has an average footprint height and width of 80.8 mm and 6.1 mm, respectively.

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Footprint do tendão do peitoral maior: Estudo anatômico

RESUMO

Objetivo: Estudar a inserção do tendão do peitoral maior no úmero, por meio do conhecimento de suas dimensões nos planos coronal e sagital.

Métodos: Foram dissecados 20 ombros de dez cadáveres frescos (cinco homens e cinco mulheres). Todos os cadáveres encontravam-se em bom estado, sem cicatrizes ou sinais de trauma prévios. Fez-se o estudo por meio da via deltopeitoral estendida e foi identificada e isolada a inserção do tendão do peitoral maior no úmero. Mensuraram-se as dimensões do footprint por meio das aferições com um paquímetro milimetrado, de seus limites de proximal para distal e medial para lateral. Foi aferida a distância da borda superior do tendão do peitoral maior ao ápice da cabeça umeral.

Palavras-chave:

Músculos peitorais/cirurgia

Músculos peitorais/anatomia e histologia

Cadáver

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Resultados: Em todos os cadáveres o peitoral maior apresentou uma inserção única. O comprimento médio de proximal para distal foi de 80,8 mm (70-90) e de lateral para medial de 6,1 mm (5-7). Já a distância média do ápice do tendão do peitoral maior ao ápice da cabeça umeral foi de 59,3 mm (55-64).

Conclusões: O tendão do músculo peitoral maior apresenta inserção laminar. O footprint tem a altura e a largura média de 80,8 mm e 6,1 mm, respectivamente.

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Introduction

Injuries to the pectoralis major muscle are infrequent,¹ with approximately 200 cases reported in the literature since the first description by Patissier in 1822.²

They most frequently affect young and active patients, especially weightlifters while practicing supine movements.^{3,4} Tearing of the tendon of the pectoralis major muscle is a situation for which surgery is indicated among athletes, and primary repair of these injuries has typically been done by means of anchors or bone tunnels.⁵ However, placement of a torn tendon in its anatomical position may be difficult, because this requires accurate identification of its insertion in the humerus. If there are no residual fibers in its insertion, knowledge of the anatomical relationships at the proximal extremity of the humerus is required for the surgical treatment.⁶

The present study had the objectives of describing the insertion of the tendon of the pectoralis muscle and measuring its limits, in order to obtain a correct parameter for its treatment.

Methodology

This anatomical study was conducted at the Death Investigation Service of Hospital das Clínicas de São Paulo after obtaining approval from its review board. Twenty shoulders from 10 fresh cadavers (five men and five women) of mean age 65.4 years (range: 51-75 years) were dissected. All of the cadavers were in good condition, without scarring or signs of previous trauma.

The study was conducted by means of the extended deltopectoral route, and the tendon insertion of the pectoralis major in the humerus was identified and isolated. After highlighting the insertion, the footprint of the tendon of the pectoralis major on the humerus was identified. Its dimensions were measured using a pachymeter calibrated in millimeters (proximal to distal and medial to lateral limits) (Figs. 1-6).

Following this, with the arm in neutral rotation and extended at 45°, the distance from the top edge of the pectoralis major tendon on the humerus to the apex of the humeral head above the tendon of the supraspinatus muscle was identified and measured (Fig. 7).

Statistical analysis was performed using Pearson correlation tests, and the significance level was set at $p < 0.01$. The SPSS 17.0 software was used for the analysis.



Fig. 1 – Instrument used to position the cadaver.

Results

The mean proximal to distal border length was 80.8 mm (range: 70-90) and the medial-to-lateral border length was 6.1 mm (5-7). The mean distance from the upper border of the pectoralis major tendon to the apex of the humeral head was 59.3 mm (range: 55-64) (Table 1).

In all the cadavers dissected, the footprint of the tendon of the pectoralis major muscle occurred just laterally to the long head of the biceps, and its laminar insertion was composed of a single layer. As an anatomical relationship of importance as a parameter in surgical procedures, it could be seen that the height of the footprint of the tendon of the pectoralis major muscle was around 1.36 times greater than the distance from



Fig. 2 – Cadaver in deckchair position for dissection.

Table 1 – Summary measurements (mean, standard deviation, median, minimum and maximum).

Variable	Mean	SD	Median	Minimum	Maximum	N
Height of footprint	80.80	7.14	83.5	70	90	20
Width of footprint	6.10	0.72	6	5	7	20
Humeral head	59.30	2.70	59	55	64	20

Table 2 – Simple linear regression for estimating the relationship between the height of the footprint and the distance from the upper edge of the insertion of the pectoralis major to the apex of the humeral head.

Factor	Coefficient	Standard error	t value	p	R ²
Humeral head	1.363	0.02	66.648	<0.001	0.996



Fig. 3 – Deltopectoral route in progress, with insertion of the tendon of the pectoralis major identified and isolated.

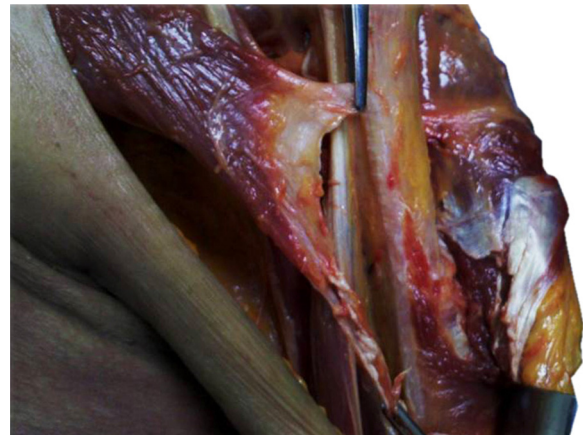


Fig. 5 – Deltopectoral route in progress, with insertion of the tendon of the pectoralis major identified and isolated.



Fig. 4 – Deltopectoral route in progress, with insertion of the tendon of the pectoralis major identified and isolated.

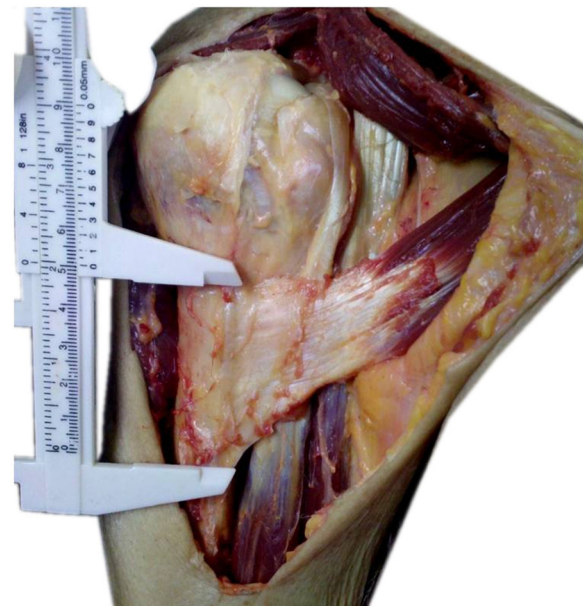


Fig. 6 – Footprint of the tendon of the pectoralis being measured by means of a pachymeter calibrated in millimeters.

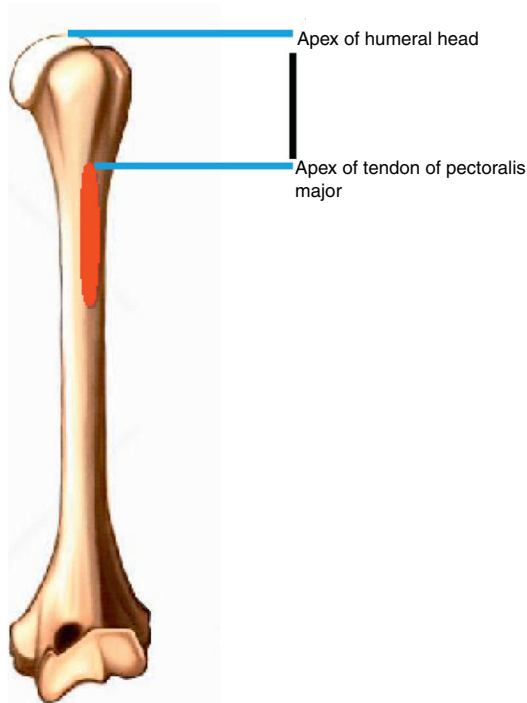


Fig. 7 – Drawing illustrating how the data were measured.

the upper edge of the footprint to the apex of the humeral head (Table 2 and Fig. 8).

Discussion

The pectoralis major muscle occupies a large area on the anterior chest wall and its function consists basically of providing adduction and medial rotation of the shoulder.^{4,6,7}

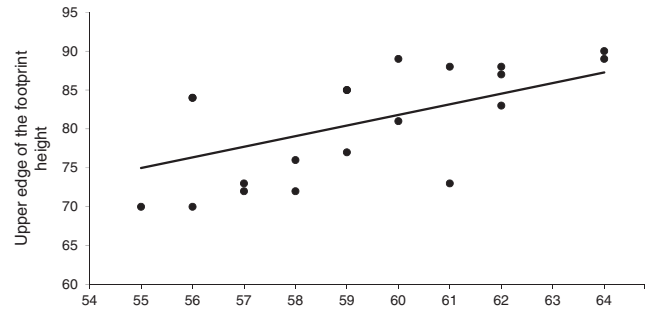


Fig. 8 – Linear regression on the height of the footprint of the pectoralis major and its distance from the apex of the humeral head.

It is traditionally divided into two portions: clavicular and sternal. However, there are few descriptions in the literature regarding its surgical anatomy.⁶

Lately, injury to this muscle and its surgical treatment have become more frequent. In a prospective study published in 2009, such injuries were described in 20 patients.⁸ However, a subsequent study reported that there was no significant difference in strength, assessed through isokinetic tests, between surgical and nonsurgical treatments.⁹

The difficulties encountered in surgical treatment for these patients, especially in situations of retraction of the medial stump and absence of fibers at the insertion, provided motivation for conducting this anatomical study.

Fung et al.⁷, in 2009, described two separate layers (anterior and posterior), which were inserted in the humerus, with proximal-to-distal lengths of 66 mm and 77 mm. However, we agree with Carey and Owens⁶ who in 2010 reported that it was not possible to differentiate between these layers in the

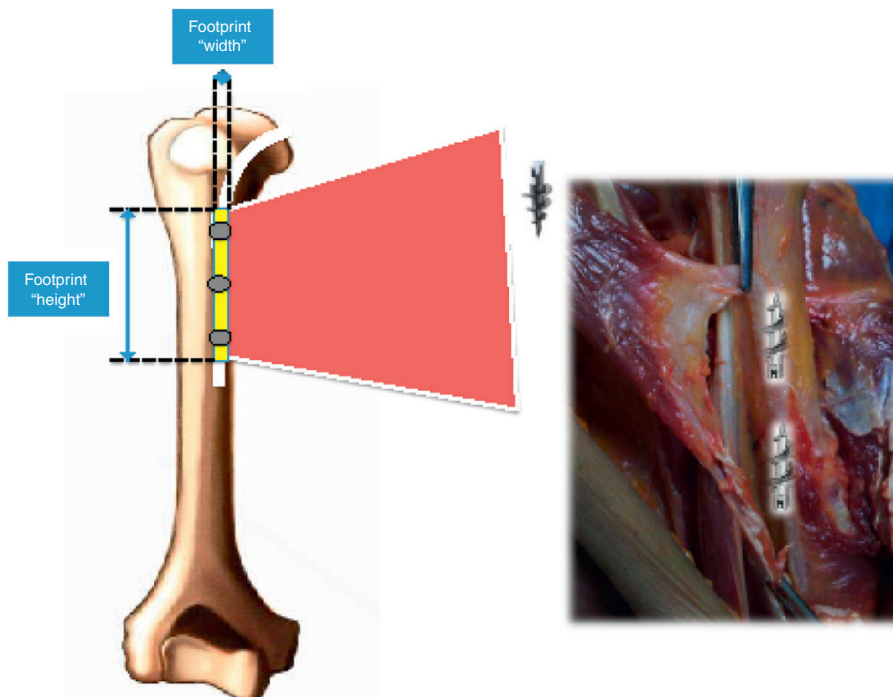


Fig. 9 – Drawing demonstrating the restoration of the footprint, which was possible by means of a single row of anchors.

region of the insertion in the humerus. These authors found, in dissecting 12 shoulders of fresh cadavers, that the mean proximal-to-distal length was 72 mm. In addition to this measurement, they found that the mean distance from the apex of the upper edge to the superomedial edge of the greater tubercle was 42 mm.

From the results described above, we can conclude that the insertion of the tendon of the pectoralis major in the humerus is done by means of a narrow layer (approximately 6 mm on average) that cannot be distinguished into anterior and posterior portions, which is located just lateral to the long head of the biceps. Thus, we disagree with Fung et al.⁷ and Wolfe et al.¹⁰ who described two and three layers, respectively.

Based on the width of the insertion footprint of the pectoralis major, the mean measurement of 6 mm may suggest that its anatomical repair can be done by using a single row of anchors of 5–5.5 mm (Fig. 9). The schematic drawing of the insertion of the pectoralis major shows the reestablishment of its insertion by using a row of anchors.

One weak point of this study is that we believe that it was conducted on a population of higher age group than those who generally have such injuries.

On the contrary, the strong point that we can highlight is the parameters for surgical treatment and the anatomical correlation with a high significance level ($p < 0.01$) between the height of the footprint and the distance from the upper edge of the tendon insertion of the pectoralis major to the apex of the humeral head. The relationship described above is an important parameter to be followed while repairing such injuries, particularly in chronic cases in which no fibers are present at the insertion. We also believe that this study provides important data not only for repairing injuries to the pectoralis major but also for carrying out several other surgical procedures on the shoulder, such as arthroplasty, fracture fixation and muscle transfer.

Conclusions

The tendon of the pectoralis major muscle presented a single laminar insertion in the humerus, in the cranial-caudal direction, with a mean of 80.8 mm (range: 70–90 mm) and narrow width with a mean of 6.1 mm (range: 5–7 mm).

The reference that the height of the footprint of the pectoralis major is 1.36 times (36%) greater than the distance from the upper edge to the apex of the humeral head can be used during surgical treatment.

Conflict of interest

The authors declare no conflicts of interest.

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