ORIGINAL ARTICLE

Pectoralis Major Tendon as Landmark for Proximal Humerus Surgery: A Cadaveric Study on the Adult Filipino Population

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ABSTRACT

Objective. It is common to get lost during a comminuted proximal humerus surgery, and the pectoralis major insertion is always a constant. Therefore, this study aimed to do a cadaveric study on the Filipino population to assess the distance from the pectoralis major tendon to the top of the humeral head (PMT) as a reference during proximal humerus surgery.

Methods. This study dissected the shoulders of cadavers. The distance from the pectoralis major tendon insertion to the top of the humeral head (PMT) was measured using a caliper. This PMT distance was also correlated to the cadaver's height and sex.

Results. This study dissected 110 shoulders (55 cadavers | 24 females, 31 males). The median PMT was 5.40 cm for males and 4.90 cm for females, with a combined value of 5.40 cm overall. There was a direct and moderate correlation between the PMT with overall height. Height and PMT of both the left and right shoulder were significantly longer among males compared to females. The study showed that for every centimeter increase in the height of males, there was a corresponding 0.02 cm increase in the PMT, adding the constant factor of 1.83. A corresponding 0.04 cm increase in the PMT for females added the constant factor of -0.81.

Conclusion. The pectoralis major tendon insertion is a consistent landmark that can accurately restore humeral length when reconstructing complex proximal humerus fractures where landmarks are otherwise lost because of comminution.

Key Words: pectoralis major tendon, proximal humerus fracture, humeral length

INTRODUCTION

Humerus fractures are the seventh most frequent fracture among adults, and it is the third most common fracture in patients over 65 years old following femoral neck and distal radius fractures. In proximal humerus fractures, stabilizing the humeral head is vital due to its limited vascularization, making it a high risk for head necrosis.[1]

The restoration of humeral head position in the reconstruction of a complex proximal humeral fracture during hemiarthroplasty is a challenging procedure wherein incorrect implant placement could result in poor surgical cosmetic and functional outcomes. Even in the setting of preoperative planning, the recreation of proper proximal humeral length remains problematic.[2]

There are numerous proposed techniques to restore proximal humeral length, and one method is to use the pectoral major tendon reference, which is measured by the

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distance between the pectoral major tendon insertion and the top of the humeral head (PMT) as landmarks to restore the humeral length for shoulder surgeries.[3]

A study made by Murachovsky et al. had observed that among Russians, the PMT could be a valuable landmark to recreate the humeral length. The average distance was 5.6 ± 0.5 cm in 40 dissected shoulders.[2]

In another study made by Torrens et al. amongst Europeans, they analyzed twenty shoulders and showed data proving that the PMT constituted a reproducible and reliable reference point for restoring proper humeral height and retroversion in proximal humerus surgeries. The average PMT in their research was 5.64 cm.[4]

This was also in line with the study made by Ponce et al. that showed a consistent association between the patient's height and PMT, with a mean PMT of 5.89 cm for men and 5.52 cm for women. They also correlated that for every 1 cm increase in height over 1.7 meters, there was an increase of 1.7 mm in the PMT.[5]

To our knowledge, there is currently no local study on PMT reference amongst the Filipino population. Therefore, this study aimed to do a cadaveric study on the Filipino population to assess the PMT reference and correlate it with the demographic profile.

Figure 1. Dissected cadaver with PMT measurement.

METHODS AND MATERIALS

This study included the dissection of adult cadaver shoulders of both genders. None of the cadavers had prior surgery or alteration of the shoulder that could hinder the evaluation.

The dissection of the shoulders employed a 15 cm deltopectoral approach. The cephalic vein was identified, and dissection in the deltopectoral interval was performed to preserve the pectoralis tendon insertion. A standard caliper was used to measure the pectoralis major distance from the top of the humeral head to the pectoralis major insertion. To measure the height, a measuring tape was used to measure from the vertex of the head to the heel. All data were tabulated and collected.

Statistical Procedure

A two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to compare the median age, height, and distance between male and female cadavers. The linear relationship between height and PMT and top of humeral head distance was quantified using Pearson's product-moment correlation coefficient and was presented in tables and graphs. Furthermore, a simple linear regression of PMT and top of humeral head distance with height as a predictor was done, and the results were reported in terms of beta coefficients, constants, and p-values.

RESULTS

A total of 110 shoulders were dissected from 55 cadavers of Filipino descent. Of the cadavers examined, 24 were females, and 31 were males. There was a significant difference in height comparing males to females. The median age was 50 years (male = 50 years, female = 48 years). The median cadaver height was 1.60 meters (male = 1.6 meters, female = 1.54 meters)

Table 1 shows that the distance measured from the pectoralis major tendon and the top of the humeral head was significantly different for males and females. For males, the distance has a median of 5.40 cm compared to females with a median of 4.90 cm. However, there was no significant difference in comparing the right and left shoulder distance between males and females.

Table 1. Distance of pectoralis major tendon and the top of the humeral head, n=55

	Total (n=55) Median (IQR)	Female (n=24) Median (IQR)	Male (n=31) Median (IQR)	p-value
Right shoulder	5.30 (0.80)	4.85 (0.80)	5.40 (0.50)	0.0015
Left shoulder	5.40 (0.80)	4.95 (0.90)	5.50 (0.50)	0.0003
Overall shoulder	5.40 (0.85)	4.90 (0.82)	5.40 (0.50)	0.0006

Table 2. Median pectoralis major tendon and top of humeral head distance by height categories and sex

Height, m	Female (n=24)	Distance (overall) Median (IQR)	Male (n=31)	Distance (overall) Median (IQR)
1.40-1.44	3	4.15 (0.75)	2	4.95 (0.30)
1.45-1.49	2	4.88 (0.85)	1	5.00 (–)
1.50-1.54	7	4.60 (0.90)	1	5.40 (–)
1.55-1.59	2	4.95 (0.10)	5	5.40 (0.20)
1.60-1.64	6	5.40 (0.75)	11	5.40 (0.55)
1.65-1.69	4	5.50 (0.55)	8	5.52 (0.32)
1.70-1.74	0	–	3	6.0 (1.45)

Simple linear regression analysis was done and showed that for every centimeter increase in the height of males, there was a corresponding 0.02 cm increase in the PMT distance, adding the constant factor of 1.83 for every 1 cm increase. On the other hand, in the height of females, there was a corresponding 0.04 cm increase in the PMT distance, adding the constant factor of -0.81.

The correlation between the distance of the pectoralis major and the patient's height was analyzed as shown in Table 2. It showed an increasing trend that as height increases, so does the distance of the PMT measured.

DISCUSSION

It is common to get lost during surgery of comminuted proximal humerus. Therefore, restoration of proper anatomy is paramount to get good results. Unfortunately, consistent landmarks in the proximal humerus are hard to use because of the amount of comminution. This can lead to improper proximal humeral height and malposition.

The pectoralis major insertion on the humerus is usually not affected even in severe proximal humerus comminutions. This can serve as a consistent landmark in aiding the surgeon to correct proximal humeral height during reconstruction.[2]

Current studies on using the pectoralis major as a landmark have placed the average distance at 5.6 cm.[2,4] These measurements were done on European cadavers. A study on Asian cadavers has not been done.

In line with our study, we were able to dissect 110 shoulders and gathered measurements for the Filipino population. The median distance computed was 5.40 cm (male= 5.40 cm, female= 4.90 cm). Comparing it to other races such as the Russians, which have an average of 5.6 cm, and Europeans, with an average of 5.64 cm, our measurement was significantly shorter. This was mainly due to the height stature difference of Filipinos. This is due to a direct correlation between height and the PMT. Our study results showed a significant difference between the measured PMT of males and females. In general, the PMT of the male is greater than that of the female. This was directly correlated also to the height difference between male and female subjects.

There was no significant difference noted in comparing the right and left shoulder in our study. This conclusion is important because, in the pre-operative preparation, the surgeon can use the contralateral proximal humerus measurement to guide for the proper length.

The height of the patient also has a direct correlation to the distance of the pectoralis major. The data collected will be of great value during surgery of the proximal humerus. A hemiarthroplasty prosthesis placed too high at >10 mm can cause excessive tension of the supraspinatus muscle and puts the tuberosities at risk of detachment.[6]

Long-term follow-up studies also showed that unsatisfactory results, stiffness or weakness, and persistent pain correlated with patients who had malpositioning of the tuberosity. Common factors included poor initial positioning of the implant, specifically excessive height, retroversion, or both.[7]

Although various techniques have been described to improve significantly surgical outcomes, such as radiographs from the opposite humerus, intraoperative measurements, and the use of soft tissue tensioning and holding devices, such techniques are either unpredictable or cumbersome. When used in conjunction with other techniques, proper straightforward use of the PMT distance measurement may provide more accurate assistance to surgeons in treating complex fracture injuries of the proximal shoulder.

CONCLUSION

The pectoralis major tendon insertion was a consistent landmark that may accurately restore the humeral length when reconstructing complex proximal humerus fractures. In our study, the average distance of the pectoralis major insertion in males was 5.4 cm in males and 4.9 cm in females. In addition, there was a direct correlation between the PMT distance and the patient's height.

Statement of Authorship

All authors contributed to the conception or design of the study; or the acquisition, analysis, or interpretation of data for the work; drafting the study or revising it critically for important intellectual content; approved the final version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the study have been appropriately investigated and resolved.

Author Disclosure

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