

# Anatomic Relationship of the Pectoralis Major and Minor Muscles: A Cadaveric Study

Erick R. Sanchez, MD; Ruston Sanchez, BS; and  
Clayton Moliver, MD, FACS

Aesthetic Surgery Journal  
2014, Vol. 34(2) 258–263  
© 2014 The American Society for  
Aesthetic Plastic Surgery, Inc.  
Reprints and permission:  
[http://www.sagepub.com/  
journalsPermissions.nav](http://www.sagepub.com/journalsPermissions.nav)  
DOI:10.1177/1090820X13519643  
[www.aestheticsurgeryjournal.com](http://www.aestheticsurgeryjournal.com)  
 SAGE

## Abstract

**Background:** Although the anatomy of the individual pectoralis major and minor muscles has been described previously, never before has the anatomic relationship between these muscles been investigated.

**Objective:** The authors identify the anatomic relationship of the costal origins of the pectoralis major and minor muscles.

**Methods:** Bilateral thoracic wall dissection was completed in 102 cadavers. In each dissection, the chest wall soft tissue was removed, and the distance between costal origins of the pectoralis major and the pectoralis minor muscles was measured.

**Results:** In 49 female and 53 male cadavers, 202 pectoralis major muscles were lifted to expose the costal origins of the pectoralis major and minor muscles. Distances between pectoralis major and pectoralis minor muscles were separated into 3 categories: less than 1 cm, between 1 and 3 cm, and greater than 3 cm. Forty-nine (24%) pectoralis muscle dissections displayed a distance of less than 1 cm between costal muscle origins. Eighty-three dissections (41%) showed an intermediate distance of between 1 and 3 cm, while the remaining 70 (35%) were over 3 cm. No significant difference was observed in these percentages with regard to sex. Ten cadavers displayed asymmetry in pectoralis muscle origin distance. Eight specimens displayed shared fibers between pectoralis major and minor muscles.

**Conclusions:** The anatomic relationship between the costal origin of the pectoralis major and minor muscles is highly variable. Understanding this spatial relationship has important implications for cosmetic and reconstructive breast surgery.

## Keywords

pectoralis major, pectoralis minor, subpectoral, subpectoral augmentation, breast surgery

Accepted for publication July 17, 2013.

Variations in pectoral muscle anatomy have significant implications for surgeons operating on the breast. The anatomy of the individual pectoralis major and minor muscles has been described extensively.<sup>1–6</sup> Previous investigations have detailed the individual anatomic variations of the pectoralis major and minor muscles but lacked description of the inconsistent spatial relationship created by these individual muscle variations. Specifically, neither the variable arrangement of pectoralis major and minor muscles' costal origins nor the incidence of conjoined origins has been investigated. An extensive review of cadaveric and embryological studies has provided the following morphological description of the pectoral musculature.

Pectoral muscle development begins during the fourth week of embryological development when arm buds form

from somite mesenchymal proliferations. The pectoralis major and minor muscles develop from a common mesodermal origin located in the lower cervical region on the medial side of the arm bud. The pectoral premuscle mass becomes clearly present in a 6-week embryo.<sup>3</sup> At this stage, the

---

Dr E. Sanchez is a Resident and Dr Moliver is a Clinical Professor of Plastic Surgery in the Department of Surgery, Division of Plastic Surgery, University of Texas Medical Branch, Galveston, Texas. Mr R. Sanchez is a medical student at the Louisiana State Health Sciences Center, New Orleans, Louisiana.

## Corresponding Author:

Dr Clayton L. Moliver, 575 East Medical Center Blvd, Webster, TX 77598, USA.  
E-mail: [claymoliver@gmail.com](mailto:claymoliver@gmail.com)

pectoralis premuscle mass has reached the level of the third rib, but the 2 individual muscles continue to form a single columnar mass attached at the humerus, clavicular rudiment, and coracoid process.<sup>3</sup> The mass flattens as it extends caudoventrally to the region of the distal upper ribs. At week 7, the muscle has taken position down to the fifth rib and assumes a more adult form with fibers from the upper 5 ribs, sternal angle, and clavicle.<sup>3</sup> The muscle mass then begins to split in a caudal to rostral direction with 1 tendon attached to the humerus and the other to the coracoid, with fusion still remaining at the costal attachments. At week 8, the costal head of the pectoral mass splits into the pectoralis minor and the sternocostal head of the pectoralis major, creating 2 distinctive pectoral bodies.<sup>7</sup>

In adults, the origin of the pectoralis major typically includes a clavicular head arising from the medial half of the clavicle, a sternocostal head arising from the anterior surface of the sternum and superior 6 costal cartilages, and an abdominal head arising from the aponeurosis of the external oblique and the rectus sheath. In a large-scale cadaveric study of the pectoralis muscles, Anson et al<sup>1</sup> reported that costal origin fibers of the pectoralis major originate from the fifth rib 70% of the time, the fourth rib 38% of the time, and the third rib 7% of the time. Fibers of the pectoralis major converge and insert into the lateral lip of the humerus' bicipital groove. The pectoralis minor typically originates from tendinous slips arising from the superior borders of the second through fifth ribs and is blended with the anterior intercostal aponeurosis medially and the external intercostal muscles laterally.<sup>1</sup> The original study by Anson et al<sup>2</sup> of 200 cadaveric specimens found costal origins from ribs 2 through 5, 3 through 5, 2 through 4, and the second intercostal space through rib 4 (42%, 28.5%, 15%, and 5% of the time, respectively). Subsequent study of 400 cadaveric specimens found the origin of the pectoralis minor to include the fourth rib 100% of the time, the fifth rib 78% of the time, and the sixth rib 3% of the time.<sup>1</sup> Fibers of the pectoralis minor pass upward and outward and insert onto the scapula's coracoid process.

Given that the pectoralis major and minor develop from a single embryologic premuscle mass and that in adults, these 2 muscles frequently arise from costal origins along the same rib, it is not impractical to question the occurrence of crossover or sharing of muscle fibers. The only evidence we found regarding the occurrence of these anatomical variations were brief descriptions of muscular slips from the costal origins of the pectoralis minor as it was observed crossing over to fuse with the pectoralis major.<sup>6</sup> The purpose of this study was to identify the proximities of the pectoralis major and minor muscle costal origins and the incidence of conjoined origins.

## METHODS

Cadaveric studies were undertaken of the bilateral thoracic wall in 102 embalmed cadavers. The cadavers spanned a

full range of body habitus. Forty-nine female cadavers and 53 male cadavers were included; all were clearly adults, although cadaver ages were unknown. This study was approved by the Institutional Review Board of the University of Texas Medical Branch.

Dissection began with removal of the skin and subcutaneous tissue from the bilateral anterior thoracic wall, extending from the sternum to the midaxillary line transversely and from the clavicle to the hypochondriac region vertically. This allowed exposure of the clavicular, sternal, and costal origins of the pectoralis major. The clavicular and sternal origins of each pectoralis major muscle were released, allowing subpectoral dissection of the pectoralis from a medial to lateral direction. Subpectoral dissection was done bluntly for the medial half of the muscle and then with more attention laterally to carefully lift the pectoralis major from the underlying minor muscle. Care was taken to preserve the costal origins of the pectoralis major muscle.

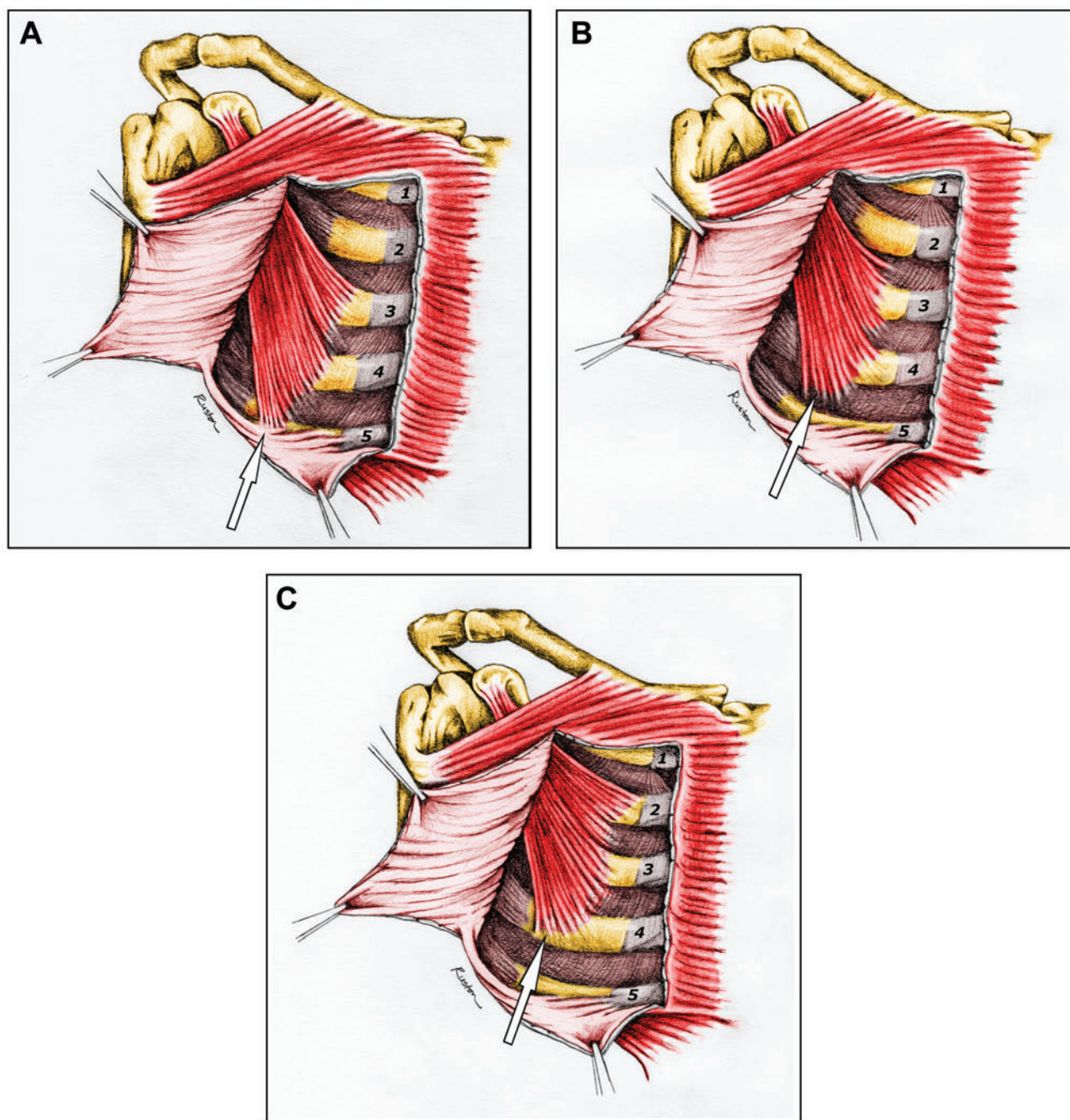
Muscle fibers shared by the pectoralis major and minor muscles were recorded. The distance from the costal origins of the pectoralis major and minor was then measured. Each distance measured was categorized into 1 of 3 groups: those with less than 1 cm between origins, 1 to 3 cm between origins, and greater than 3 cm between origins.

## RESULTS

In 102 cadavers (female, 49; male, 53), 202 pectoralis major muscles were elevated to expose the costal origins of the pectoralis major and minor muscles. Large variability was found in the relationship of costal origins. Figure 1 displays 3 defined relationships of pectoral costal origins. Table 1 shows that 49 (24%) pectoralis muscle dissections had a distance of less than 1 cm between costal muscle origins, 83 (41%) had an intermediate distance of between 1 and 3 cm, and the remaining 70 (35%) had over 3 cm of separation. Ten cadavers displayed asymmetry in pectoralis muscle origin distance, with 5 having smaller distances between origins on the left side and 5 having smaller distances between origins on the right side. One female cadaver lacked a pectoralis minor muscle on the left. One sternalis muscle and 1 chondroepitrochlearis muscle, both in male cadavers, were also observed. No significant difference concerning costal origin was observed with regard to sex (Tables 2 and 3). Eight pectoral specimens displayed shared fibers between the pectoralis major and minor muscles at their costal origins.

## DISCUSSION

An inconstant relationship exists between the pectoralis major and minor muscles at their costal origins. We have shown that in 102 cadaver dissections, 49 (24%) displayed a distance of less than 1 cm between pectoralis major and minor costal muscle origins, 83 (41%) had an intermediate



**Figure 1.** Anatomic relationship of the pectoralis major and minor muscle costal origins. Arrows indicate areas of variable distance between pectoralis major and minor muscles. (A) Less than 1 cm between costal muscle origin; (B) 1 to 3 cm between costal muscle origin; (C) 3 cm or greater between costal muscle origin.

distance between 1 and 3 cm, and the remaining 70 (35%) had more than 3 cm of separation (Table 1). No significant differences in these percentages were found between males and females (Tables 2 and 3). The tables included display total numbers of pectoralis relationship variants: less than 1 cm, 1 to 3 cm, and greater than 3 cm. Ten cadavers

displayed asymmetry with respect to their pectoralis muscle relationships. Each of the cadavers with 2 different pectoralis relationship variants was included twice, once in each respective variation column. Eight pectoral specimens also displayed shared fibers between pectoralis major and minor muscles at their costal origins.

Table 1. Distances Between Costal Origins of Pectoralis Major and Minor in 102 Cadavers

Characteristic	Distances Between Origins, cm		
	<1	1-3	>3
Number of cadavers <sup>a</sup>	29	46	37
Number of pectoralis flaps	49	83	70
Bilateral occurrence	20	37	33
Unilateral occurrence	9	9	4
Bilateral percentage	69	80	89
Unilateral percentage	31	20	11
Total percentage of cadavers	24	41	35

<sup>a</sup>Some cadavers exhibited asymmetry between the left and right pectoralis groups.

Table 2. Distances Between Costal Origins of Pectoralis Major and Minor in 49 Female Cadavers

Characteristic	Distance Between Origins, cm		
	<1	1-3	>3
Number of cadavers	14	23	17
Number of pectoral flaps	23	41	32
Bilateral occurrence	9	18	15
Unilateral occurrence	5	5	2
Bilateral percentage	64	78	88
Unilateral percentage	36	22	12
Total percentage	23	43	34

We believe that this variable anatomic relationship can present problems for even the most experienced surgeon. Cosmetic and reconstructive surgeons commonly rely on the pectoralis major muscle as a structural tool integral for implant coverage and position. The pectoral muscle relationships defined in this study have the most clinical relevance in the creation of implant pockets during subpectoral or dual-plane breast augmentation with an inframammary incision approach. An uninformed reliance on presumably reliable anatomy of the costal region’s pectoral muscles can lead to inconsistent surgical results. In patients with shared pectoral muscle fibers or origin distances less than 1 cm (Figure 2), pectoralis major and minor muscle fibers could conceivably be confused. Unintentional dissection under the pectoralis minor—splitting the muscle mass—can cause bleeding, pain, and possible implant malposition from abnormal muscular forces.

Our study shows that the subpectoral plane is most consistently and reliably dissected under the pectoralis major’s medial aspect. The inconstant pectoralis major and minor relationship found beneath the pectoralis major muscle’s lateral aspect makes lateral subpectoralis major dissection more

difficult and prone to error. These anatomic findings imply that in subpectoral implant pocket creation from an inframammary incisional approach, the surgeon should begin pocket dissection medially, then continue laterally under direct vision, defining and dissecting above the pectoralis minor muscle. All shared muscle fibers between pectoralis major and minor muscle muscles were also found laterally. The shared muscle fibers’ lateral location further suggests the value of medial to lateral subpectoral direction under direct visualization. Blind dissection of these shared fibers could cause bleeding and/or variation in the subsequent forces the implant will experience.

Presumably, other abnormalities in the origins and insertions of the pectoralis major and minor muscles can cause imbalance in subpectoral implant pocket design, resulting in implant malposition. An attenuated or shortened medial pectoralis major muscle origin could promote overrelease and medial implant malposition in repose. Overrelease of the medial pectoralis major can also cause pectoralis major “window shading” and abnormal inferolateral implant movement on animation.<sup>8,9</sup> Conversely, pectoralis major muscles with abnormally abundant costal origins conceivably can result in



**Table 3.** Distances Between Costal Origins of Pectoralis Major and Minor in 53 Male Cadavers

Characteristic	Distances Between Origins, cm		
	<1	1-3	>3
Number of cadavers	15	23	20
Number of pectoral flaps	26	42	38
Bilateral occurrence	11	19	18
Unilateral occurrence	4	4	2
Bilateral percentage	73	83	90
Unilateral percentage	27	17	10
Total percentage	24	40	36

**Figure 2.** Cadaveric dissection displaying less than 1 cm between costal muscle origins.

incomplete release of the inferior pectoralis border, leading to superior implant malposition. In this study, we investigated only the relationship of the costal origins of the pectoralis major and minor muscles. Research into the anatomic variations of the medial and inferior aspect of the pectoralis major muscle is currently ongoing.

## CONCLUSIONS

An inconstant relationship exists between the pectoralis major and minor muscles at their costal origins. This

unpredictable relationship results from inconsistency in both the pectoralis major and minor muscles' costal origins. Care must be taken in elevation of the pectoralis major to not include a portion of the pectoralis minor, which would result in an inaccurate pocket dissection. This is especially true when approaching the subpectoral space from an inframammary approach.

## Acknowledgments

The authors thank the Department of Neuroscience and Cell Biology, University of Texas Medical Branch, Galveston, Texas, and the Department of Anatomy and Cell Biology, Louisiana State University Health Sciences Center, New Orleans, Louisiana, for their collaboration on this study.

## Disclosures

The authors declare no potential conflicts of interest with respect to the research, authorship, and publication of this article.

## Funding

The authors received no financial support for the research, authorship, and publication of this article.

## REFERENCES

1. Anson BJ, Jamieson RW, O'Connor VJ, Beaton LE. The pectoral muscles; an anatomical study of 400 body-halves. *Q Bull Northwest Univ Med Sch.* 1953;27:211-218.
2. Anson BJ, Beaton LE, McDonald JJ. The origin of the M. pectoralis minor. *J Anat.* 1938;72:629-630.
3. Lewis WH. Observations on the pectoralis major muscle in man. *Johns Hopkins Hosp Bull.* 1901;12:172-177.
4. Macalister A. Observations on muscular anomalies in the human anatomy: third series with a catalogue of the principal muscular variations hitherto published. *Trans Roy Irish Acad Sci.* 1875;25:1-130.
5. Jackson CM. *Morris's Human Anatomy: A Complete Systematic Treatise by English and American Authors.* B.

- Pectoral Muscles and Axillary Fascia*. Philadelphia, PA: P. Blakiston's Son & Co; 1921.
6. Perrin JB. Notes on some variations of the pectoralis major, with its associate muscles seen during sessions 1868-69, 69-70, at King's College, London. *J Anat Physiol*. 1871;5:233-240.
  7. Al-Qattan MM, Yang Y, Kozin SH. Embryology of the upper limb. *J Hand Surg Am*. 2009;34:1340-1350.
  8. Lesavoy MA, Trussler AP, Dickinson BP. Difficulties with sub-pectoral augmentation mammoplasty and its correction: the role of subglandular site change in revision aesthetic breast surgery. *Plast Reconstr Surg*. 2010;125:363-371.
  9. Codner MA, Cohen AT, Hester TR. Complications in breast augmentation: prevention and correction. *Clin Plast Surg*. 2001;28:587-596.