

Surgical Configurations of the Pectoralis Major flap for Reconstruction of Sternoclavicular Defects: A Systematic Review and New Classification of Described Techniques

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Abstract

Objectives The pectoralis major flap has been considered the workhorse flap for chest and sternoclavicular defect reconstruction. There have been many configurations of the pectoralis major flap reported in the literature for use in reconstruction sternoclavicular defects either involving bone, soft tissue elements, or both. This study reviews the different configurations of the pectoralis major flap for sternoclavicular defect reconstruction and provides the first ever classification for these techniques.

Methods EMBASE, Cochrane library, Ovid medicine and PubMed databases were searched from its inception to November of 2018. We included all studies describing surgical management of sternoclavicular defects. The studies were reviewed, and the different configurations of the pectoralis major flap used for sternoclavicular defect reconstruction were cataloged. We then proposed a new classification system for these procedures.

Results The study included 5 articles published in the English language that provided a descriptive procedure for the use of pectoralis major flap in the reconstruction of sternoclavicular defects. The procedures were classified into three broad categories. In Type 1, the whole pectoris muscle is used. In Type 2, the pectoralis muscle is split and either advanced medially (type 2a) or rotated (type 2b) to fill the defect. In type 3, the clavicular portion of the pectoralis is islandized on a pedicle, either the TAA (type 3a) or the deltoid branch of the TAA (type 3b).

Conclusion There are multiple configurations of the pectoralis flap reported in the English language literature for the reconstruction of sternoclavicular defects. Our classification system will help facilitate communication when describing the different configurations of the pectoralis major flap for reconstruction of sternoclavicular joint defects.

Background

The very reliable and versatile pedicled pectoralis major muscle (PM) flap is currently considered the work horse flap for soft tissue reconstruction of chest and sternoclavicular defects [1-3]. The flap's blood supply is based on the thoracoacromial artery (TAA) and the sternal perforators from the internal mammary artery. The TAA has four described branches, the deltoid, pectoral, clavicular and acromial. Sternoclavicular defects can result from many etiologies including debridement after osteomyelitis and tumor resection. The pectoralis major flap has been used to reconstruct these defects. Resection of the manubrium and medial aspect of the clavicle results in substantial defects, as well as potentially exposed bone and/or blood vessels, making soft tissue coverage essential in wound healing [4-6]. Over the years, there have been reports of different configurations of the pectoralis flap for sternoclavicular reconstruction. We reviewed the current literature to document the various configurations of the pectoralis major flap that have been described for sternoclavicular defect reconstruction. We propose a classification system for the flap configuration to facilitate better communication when describing these procedures.

Methods

We performed our systematic review in accordance to the guidelines set out in the Preferred Reporting Items for Systematic Reviews and Meta-analyses statement. We identified current published literature through a literature review. We did serial searches for articles published in English language. We searched Embase (up to 2018), PubMed (up to 2018), Cochrane library up to (2018) and Ovid medicine up to (2018). The search strategy included the following medical subject heading (MeSH terms): *Sternoclavicular defects; pectoralis flaps; sternoclavicular infections; sternoclavicular osteomyelitis; chest wound infection*. Related non-MeSH free-text search string was also included. Figure 1 illustrate our literature search strategy.

We included all full-text articles and abstracts with information on sternoclavicular defects, management of sternoclavicular joint defects and surgical management of sternoclavicular joint infection and tumors. All studies pertaining to the surgical management of sternoclavicular defects were included. The resulting articles were reviewed to select for papers that provide a description of the technique used for the reconstruction using the pectoralis major muscle flap. The first published paper describing the unique technique was included and duplicates excluded.

The articles were reviewed by and the techniques were catalogued. The images were reproduced by one of the authors. The techniques were then classified using our new classification system.

Results

We identified 88 studies from our initial search. Only 10 of the articles provided a description of the technique involving the use of the pectoralis major muscle flap in the reconstruction of the sternoclavicular defects. 5 of the articles essentially detailed procedures that have already been described.

Case 1.

The pectoralis major muscle advancement flap (Fig. 2A): The use of this flap for sternoclavicular defect reconstruction was first described by **Munoz et al in 1996 [7]**. In this flap, the medial aspect of the PM is released from its attachments, and the flap is raised laterally. The PM flap is advanced medially to cover ipsilateral sternoclavicular defects. This flap is based on the thoracoacromial vascular trunk.

Case 2.

Split pectoralis major muscle flap (Fig.2B): First described by **Zehr et al. in 1996 [8]** in the reconstruction of a sternoclavicular defect. The upper half of the pectoralis muscle is split and detached from its humeral attachment and rotated to cover the defect. The flap is supplied by the internal mammary perforators.

Case 3.

Partial pectoralis major muscle advancement flap (Fig.2C): First described by **Song et al in 2002 [9]**. In this configuration, the upper one third of the pectoralis major muscle is split and mobilized laterally as far as the deltopectoral groove. The muscle flap is advanced medially to cover the sternoclavicular defect. The flap is based off the TAA.

Case 4

The islandized hemipectoralis major muscle flap (Fig. 2D): First described by **Schulman et al in 2007 [10]**. They described the use of this flap for reconstruction of sternoclavicular defect. The clavicular portion of the pectoralis is islandized based on the TAA. The pectoral branch of the TAA is sacrificed. The flap is rotated to cover the defect

Case 5. Faisal:

Deltoid branch-based clavicular head of pectoralis major muscle flap (Fig.2E) : First described by **Al-Mufarrej et al in 2013 [11]**. It is basically a partial islandized pectoralis flap based on just the deltoid branch of the TAA. The branches of the TAA are not sacrificed.

Discussion

Sternoclavicular defects are rare in clinical practice. These defects are usually a result of surgical resection of the medial head of the clavicle and the manubrium for sternoclavicular joint infection or resection of tumors. These resulting defects are usually reconstructed with soft tissue. The pectoralis major muscle flap has been the workhorse flap for this type of reconstruction [1-3]. The first use of the pectoralis major muscle flap for reconstruction of chest defects was reported by Heuston in 1977 [12] and its first use in sternoclavicular defect reconstruction was described by Munoz [7]. Munoz essentially used the whole pectoralis major muscle as an advancement flap for the reconstruction of a sternoclavicular defect. The use of the whole muscle has been associated with loss of function of the pectoralis major muscle, aesthetic concerns related to the bulky appearance of reconstruction, and large access incisions. Since the use of the PM flap by Munoz in 1996, there have been multiple configurations of the PM flap to address these concerns. The various configurations have been termed differently in the reported literature for e.g., “compound pectoralis flap,” “split pectoralis flap,” “pectoralis advancement flap,” “islandized pectoralis flap,” etc. The names can be very confusing. For example, the islandized flap described by Schulmam and the deltoid branch flap described by Faisal et al. are both islandized flaps but differ based on the blood supply to the flap. There currently exists no classification system for the different configuration of the pectoralis flap for these reconstructions. We have classified the different configurations of the PM flap for sternoclavicular defects based on the reported cases in our literature review. The most obvious limitation of our study is that there may be studies that were missed in our search published in other language other than the English language.

Type 1: Whole muscle advancement

Type 1 configuration of the PM flap for sternoclavicular defect reconstruction includes procedures that use the whole pectoralis major muscle for reconstruction. It includes the pectoralis advancement flap in which the whole muscle is detached from its sternal clavicular attachments, mobilizing it laterally and advancing it medially to cover the defect [Fig. 2A]. This flap is based on the TAA. Included in this category is the flap when released from its humeral attachment to allow for more advancement

Type 2: Hemipectoralis muscle flap

Type 2 configuration includes splitting the pectoralis muscle and using the upper part of the muscle, usually the clavicular part for reconstruction. This configuration is subcategorized:

Type 2A is a hemipectoralis rotated flap. In this configuration, the pectoralis muscle is split and the upper (sternoclavicular) portion is released from its insertion laterally. The flap is then rotated to fill the defect [Fig. 2B]. The flap is supplied by the internal mammary sternal perforators.

Type 2B is a hemipectoralis advancement flap in which the upper part of the pectoralis major is split, and its sternoclavicular attachment is released. The muscle is then advanced to cover the defect. [Fig. 2C]. This flap is supplied by the TAA.

Type 3: Islandized pectoralis flap

Type 3 configuration includes procedures in which a portion of the clavicular head of the pectoralis major muscle is split and then islandized by releasing all of its attachments.

Type 3A is an islandized flap where the flap is supplied by the TAA. In this flap configuration, the distal part of the TAA is sacrificed [Fig. 2D]

Type 3B is an islandized flap where the flap is supplied by the deltoid branch of the TAA. The TAA remains wholly intact without sacrificing distal blood flow [Fig. 2E].

Conclusions

Sternoclavicular defects are rare in clinical practice. Different configurations of the pectoralis major flap have been described for this purpose mainly to circumvent the use of the entire muscle and limit the functional defects associated with the use the whole muscle. Our classification system, the Opoku Classification will help facilitate communication when describing the different configurations of the pectoralis major muscle flap for reconstruction of sternoclavicular joint defects.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

Not applicable

Competing interests

The authors declare that they have no competing interests

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Authors' contribution

JO wrote the initial draft, participated in the literature search and completed the final draft. DM participated in the literature search and proofread the initial draft. JS participated in the literature search and proofread the initial draft. All authors read and approved the final manuscript

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Not applicable

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Tables

Table 1. Opoku Classification for pectoralis flap configuration for SCJ defect reconstruction

Classification		Blood supply to flap	Example of flap
Type 1	Whole muscle advancement		
	With or without release of humeral attachment	TAA	Munoz et al.
Type 2	Split muscle flap		
A	Advancement	TAA	Zehr et al.
B	rotated	pectoralis	Song et al.
Type 3	Islandized clavicular head flap		
A	Based on TAA	Whole TAA, distal TAA sacrificed	Schulman et al.
B	Based on deltoid branch of TAA	Deltoid branch of TAA	Mufarrej et al.

Figures

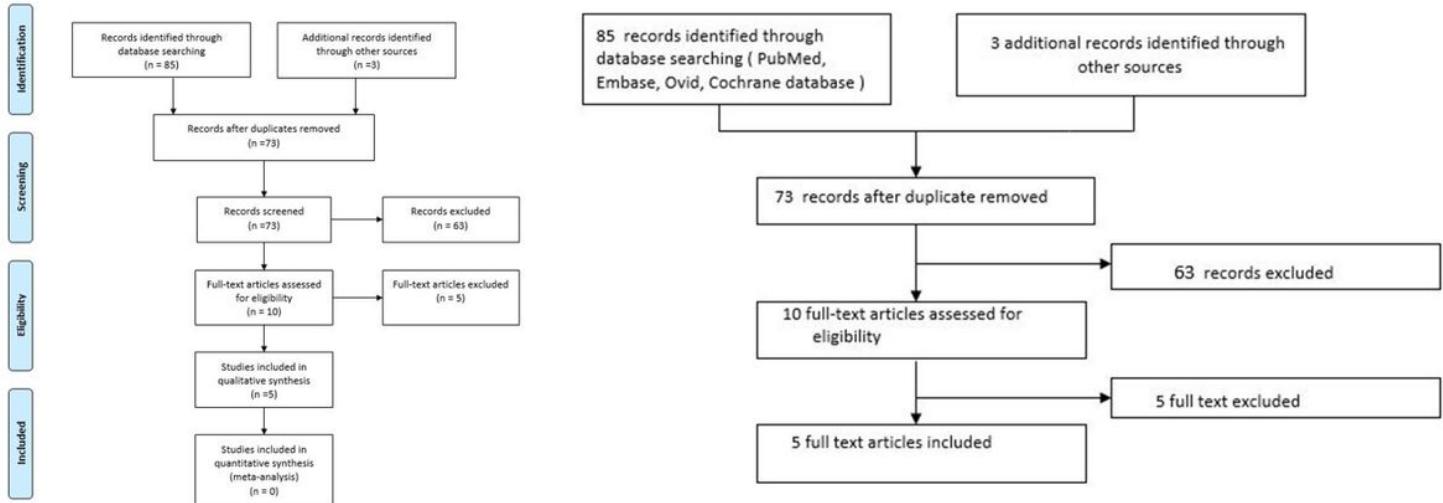


Figure 1

Flow chart of the literature search

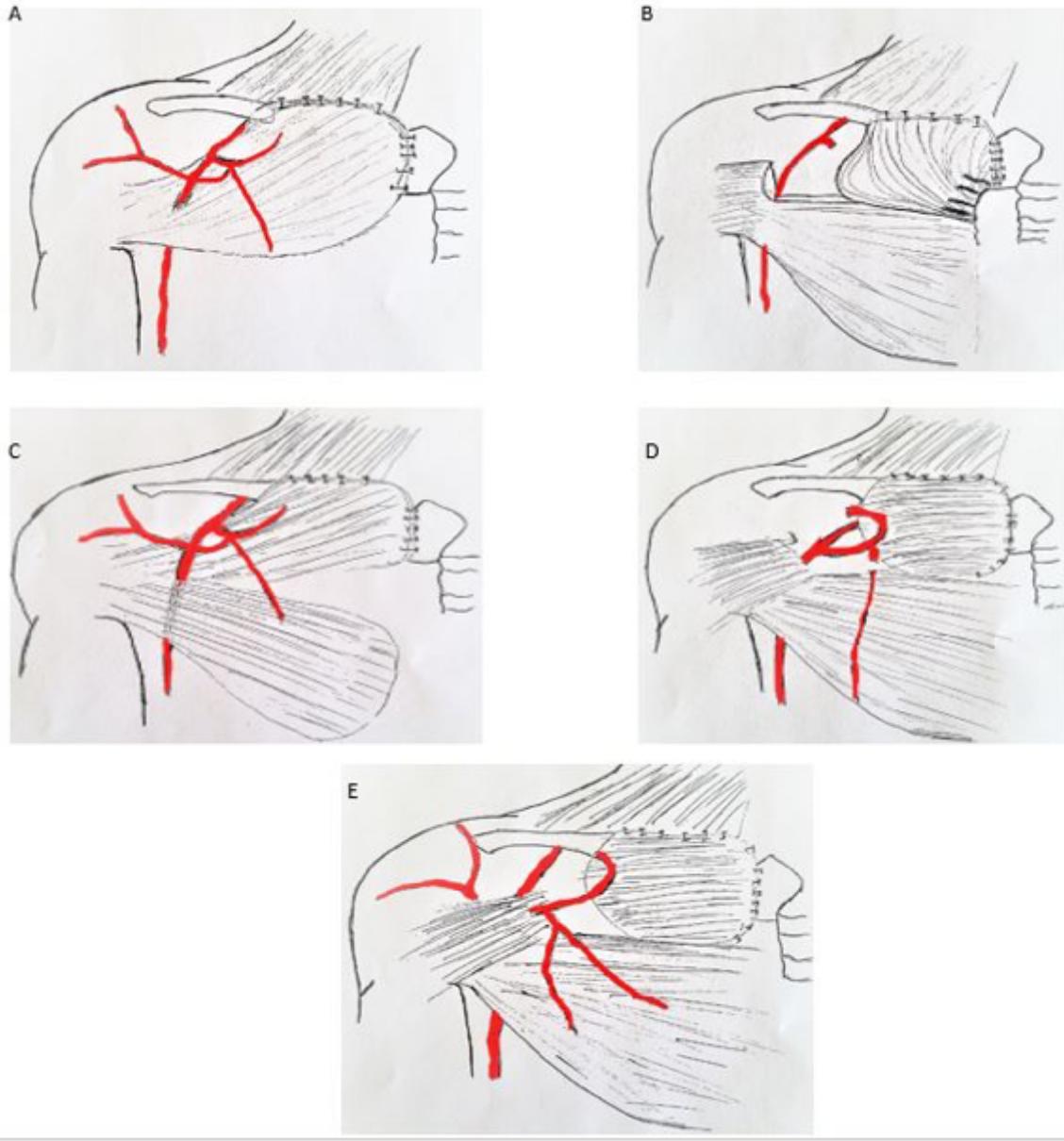


Figure 2

Different configurations of pectoralis major flap

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