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*Full Length Research Article*

# The use of pectoralis major tendon transfer in the treatment of irreparable subscapularis tears in the adult: a meta-analysis of the last 5 years

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The musculotendinous forces must be balanced in all planes around the glenohumeral joint in order to guarantee the stability and functionality of the shoulder. The transfer of the pectoralis major tendon is described as a salvage procedure in this situation, proving to be a reasonable but little explored alternative in case of failure to heal the rotator cuff with improvement of pain and functionality of the shoulder, partially restoring the subscapular function, ensuring balance in the coupling process and allowing the deltoid to effectively contribute to shoulder elevation. This meta-analysis study objectives to evaluate the efficacy of transferring the pectoralis major tendon as a treatment of irreparable subscapularis tears. Concerning the parametric data analyzed in all of the studies included, we can observe the distribution of the Constant score recovery average prior to the pectoralis major transfer and after the procedure. The reduced samples, absence of the control group in all included studies prevented the determination of the actual efficacy and/or superiority of the pectoralis major transfer over the other methods used in the treatment of this unique pattern of injury. Therefore, greater efforts are needed in the research and application of randomized controlled clinical trials that can define the most effective therapeutic measures in the treatment of this pathology.

**Keywords:** Pectoralis Major, Rotator Cuff, Subscapularis, Anterosuperior Rotator

## INTRODUCTION

The musculotendinous forces must be balanced in all planes around the glenohumeral joint in order to guarantee the stability and functionality of the shoulder (Galatz et al., 2003; Gerber and Hersche, 1997; McMahon et al., 1995). The most important musculotendinous unit that integrates the rotator cuff is

the subscapular (Galatz et al., 2003; Rokito et al., 1999; Gerber et al., 1996). The subscapular tendon contributes biomechanically to maintaining the anterior shoulder stability, providing strength in the internal rotation process and balancing the glenohumeral joint in the transverse plane (Galatz et al., 2003; Rokito et al., 1999; Gerber et al., 1996; Warner, 200; Nelson et al., 2014). However, the findings of tendon retraction and muscle infiltration, which are commonly found in long-standing injuries, make it difficult to repair directly (Galatz et al., 2003).

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Failure to heal the rotator cuff occurs mostly in the tendon-bone interface and has been reported in 11 to 94% of patients who underwent a previous surgical repair approach (Elhassan et al, 2017). The transfer of the pectoralis major tendon was described for the first time in 1997 by Wirth and Rockwood (2017) as a salvage procedure in this situation, proving to be a reasonable but little explored alternative in these cases with improvement of pain and functionality of the shoulder, (Galatz et al., 2003; Nelson et al., 2014; Elhassan et al, 2017; Moroder et al., 2017) partially restoring the subscapular function, ensuring balance in the coupling process and allowing the deltoid to effectively contribute to shoulder elevation (Nelson et al., 2014).

In addition, the procedure allows the optimization of the post-surgical rehabilitation process since the functionality of the subscapularis and pectoralis tendon is similar (Nelson 2014; Shin et al., 2014).

**METHODOLOGY**

This meta-analysis study objectives to evaluate the efficacy of transferring the Pectoralis major tendon as a treatment of irreparable subscapularis tears.

A systematic review of the literature was fulfilled, with meta-analysis, of the clinical trials published in the Pubmed and Medline databases in the last 5 years, using the keywords ‘pectoralis major’, ‘subscapularis’, ‘anterosuperior rotator’ and ‘rotator cuff’.

**RESULTS**

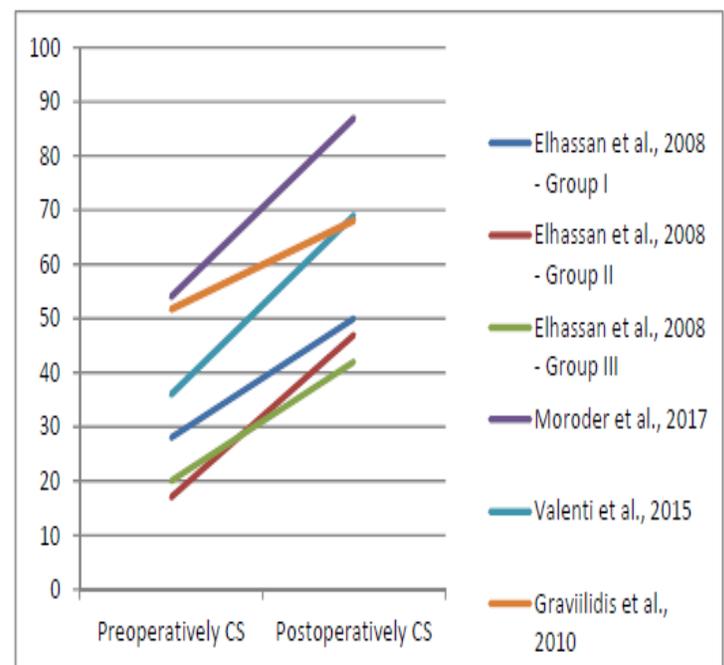
The literature research using the described terms showed 16 relevant articles: 12 in Pubmed, and 4 in Medline, of which 4 were excluded as they were duplicates. All the enduring articles were submitted to a cautious manual analysis by 2 authors through the reading of the abstract and the prospective studies, the research target of which involved patients with subscapular irreparable lesions submitted to pectoralis major tendon transfer, having been analyzed.

Two reviewers independently evaluated the methodological quality of the trials included, using a 12-item scale (Moher et al., 1999). The weighted kappa of agreement in the analysis of the quality of the clinical trial among the reviewers was 0.91 (95% with a confidence interval of 0.78-0.99).

Literature reviews, retrospective studies, editorials and studies the research target of which was not mentioned above and/or the methodology of which was unclear with respect to the design applied were excluded. Lastly, 82 patients were included in 4 follow up studies (Moroder et al., 2017; Elhassan et al., 2008; Valenti et al., 2015; Gavriilidis et al., 2010) (Table 2).

Concerning the analysis of the results presented, the main measures used were the Constant Score (CS) and the Simple Shoulder Test (VAS). The pectoralis major approach techniques described were sternal head (Elhassan et al., 2008), subcoracoid partial (Moroder et al., 2017), sternal and clavicular head (Valenti et al., 2015) and deltopectoral (Gavriilidis et al., 2010). The follow-up ranged from 24 months to 10 years. (Figure 1)

Our results were organized and dichotomized individually and the quantifiable data was analyzed statistically using Graphpad Prism 6.0. The discrepancy of the statistical data was investigated using the chi-square test to determine the heterogeneity. The I<sup>2</sup> values of 75%, 50% and 25% were considered as high, average and low heterogeneity.



**Figure 1.** Comparative analysis of clinical outcomes in relation to Constant Score (CS) pre and postoperatively.

Table 2. Characteristics of included studies

Authors	Year of publication	Group/technique	Measures of clinical outcome	Time of follow up
Elhassan et al	2008	<p>11 patients with a failed procedure for instability of the shoulder submitted to transfer passing the sternal head of pectoralis major beneath its clavicular head to create a fulcrum for the sternal head when both contract.</p> <p>8 patients with a failed shoulder replacement submitted to transfer passing the sternal head of pectoralis major beneath its clavicular head to create a fulcrum for the sternal head when both contract.</p> <p>11 patients with massive tear of the rotator cuff submitted to transfer passing the sternal head of pectoralis major beneath its clavicular head to create a fulcrum for the sternal head when both contract.</p>	The mean Constant score improved from 40.9 points (28 to 50) in group I, 32.9 (17 to 47) in group II and 28.7 (20 to 42) in group III pre-operatively to 60.8 (28 to 89), 41.9 (24 to 73) and 52.3 (24 to 78), respectively.	49 months.
Moroder et al	2017	22 patients with irreparable anterosuperior rotator cuff submitted to a partial subcoracoid pectoralis major tendon transfer.	The adjusted Constant score increased from 54% to 87%. The increase in strength returned to the preoperative level ( $p = 0.178$ ), and the improvement in range of motion diminished again over time despite remaining significantly improved ( $p = 0.029$ ), especially with regard to internal rotation ( $p < 0.001$ ). The mean absolute Constant 24 months.	10 years.
Valenti et al	2015	<p>8 patients with irreparable anterosuperior rotator cuff submitted to clavicular head of the pectoralis major tendon transfers.</p> <p>7 patients with irreparable anterosuperior rotator cuff submitted to sternal head of the pectoralis major tendon transfers.</p>	The mean absolute Constant score of the entire series increased significantly from 36 preoperatively to 69 at the latest follow up ( $p < 0.01$ ); it improved significantly and similarly in both types of tendon harvested.	24 months.
Gavriilidis et al	2010	15 patients with irreparable anterosuperior rotator cuff submitted to deltopectoral approach and transfer of the clavicular part of the pectoralis major to the lesser tuberosity and to the anterior part of the greater tuberosity.	The mean subcategories of the Constant score for pain ( $p=0.005$ ), activities of daily living ( $p=0.008$ ) but not for range of motion ( $p=0.9$ ), significantly improved.	37 months.

## DISCUSSION

Elhassan et al. (2008) described their experience with transfer of the sternal head of the pectoralis major for the treatment of irretrievable ruptures of the tendon of subscapularis in three different groups: those with an irreparable tear of the subscapularis after failed instability procedures, those with failed repair after shoulder replacement, and those with an concomitant massive tear of the rotator cuff. They demonstrated that in patients with isolated subscapularis insufficiency after a unsuccessful stabilization procedure, improvement in pain and function can be predictable in those who have a concentric glenohumeral joint preoperatively. However, if the shoulder joint is subluxed or not concentric the transfer of pectoralis tendon is more likely to fail and substitute treatment such as transfer of the coracoid, bone block or capsular reconstruction using tendon allograft or autograft, should be considered as a salvage procedure.

Moroder et al. (2017) performed a 10 years follow-up in order to evaluate the long term outcome of the pectoralis major transfer, concluding that the procedure resulted in a significant clinical improvement, expressly with regard to pain and internal rotation, which was preserved 10 years after surgery. In spite of long-term radiographic progression of cuff arthropathy, the authors demonstrated that the patient satisfaction remained high over time, with only a minimal requirement for revision with reverse shoulder arthroplasty.

In their study with 15 patients, Valenti et al. (2015) compared the clinical benefits of transporting the clavicular or the sternal head of the pectoralis major tendon underneath the conjoint tendon, concluding that the technique promotes reduction of pain and improves the strength and function of the shoulder with no significant difference between the groups.

Finally, Graviilids et al. (2010) assessed 15 patients which underwent deltopectoral approach and transfer of the clavicular portion of the pectoralis major to the lesser tuberosity and to the anterior part of the greater tuberosity, finding results confirming that the procedure appears to be a reliable option for irreparable combined tears of the subscapularis and supraspinatus tendon with regard to function, pain relief and stability of the glenohumeral joint.

## CONCLUSION

Because of the limited number of validated clinical trials and the varying techniques approaches of transfer, it was impossible to analyses the influence of other clinically relevant factors, such as the severity rotator cuff prior to the procedure, age, evolution time of the lesion as well as the presence of other clinical comorbids to define the existence of superiority of the procedure in relation to the other existing treatment methods.

Concerning the parametric data analyzed in all of the studies included, we can observe the distribution of the Constant score recovery average prior to the pectoralis major transfer and after the procedure. Only Moroder et al. (2017) presented a prolonged follow-up analysis, in contrast to the other studies assessed that had a follow-up time of up to 49 months after the procedure. Although all four studies included different surgical approaches, such as: sternal head (Elhassan et al., 2008), subcoracoid partial (Moroder et al., 2017), sternal and clavicular head (Valenti et al., 2015) and deltopectoral (Gavriliidis et al., 2010), the absolute values before and after the procedure are similar and, universally, showed a statistically significance improve at pain relief, strength and function of the shoulder.

The reduced samples, absence of the control group in all included studies prevented the determination of the actual efficacy and/or superiority of the pectoralis major transfer over the other methods used in the treatment of this unique pattern of injury. Therefore, greater efforts are needed in the research and application of randomized controlled clinical trials that can define the most effective therapeutic measures in the treatment of this pathology.

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