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DELTOID FLAP for MANAGEMENT of MASSIVE IRREPARABLE ROTATOR CUFF TEARS Case Series

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Roukoz S, Nabhane L, Aidibi AAR, Sebaaly A. Deltoid flap for management of massive irreparable rotator cuff tears: case series. J Med Liban 2016 ; 64 (1) : 8-12.

ABSTRACT • Background : Muscle transfer has been reported as a good surgical option to reconstruct the deficient rotator cuff. The purpose of this study is to report the outcome of deltoid muscle flap transfer to restore shoulder function in patients with massive irreparable rotator cuff tear. **Material and methods :** This is a retrospective descriptive case series. Included patients had a lesion of two or more tendons of the rotator cuff or lesion of one tendon of more than 5 cm in width and no lesion to the subscapularis. Evaluation was done using the Constant score, visual analog scale for satisfaction and quality of life. **Results** : Twenty patients met the inclusion criteria. Three patients were lost to follow-up. The remaining (9 males and 8 females) had a mean follow-up period of 40.5 months. The mean age at surgery was 61.3 years. Thirty-five percent of patients were involved in heavy labor while the lesions affected the dominant side in 70% of the cases. Mean preoperative Constant score was 40.8 and increased to 78.8 ($p < 0.05$) with a difference of +38 points on the raw Constant score and an improvement rate of 64%. The greatest improvement involved essentially pain and quality of life (improvement rate of 82%) ($p < 0.05$). Eighty-nine percent of patients have good and excellent self-reported results. **Conclusion :** More than just a salvage procedure, deltoid muscle flap seems to be an adequate option in terms of appropriate pain relief, function recovery as well as patient satisfaction.

Keywords : massive rotator cuff tears, deltoid muscle flap

Roukoz S, Nabhane L, Aidibi AAR, Sebaaly A. Lambeau deltoïde dans le traitement des ruptures massives de la coiffe: étude rétrospective. J Med Liban 2016 ; 64 (1) : 8-12.

RÉSUMÉ • Introduction : Les lambeaux musculaires présentent une bonne option pour la reconstruction d'une coiffe déficiente des rotateurs. Le but de cette étude est d'évaluer les résultats du lambeau deltoïdien dans la restauration de la fonction chez des patients avec une rupture massive irréparable de la coiffe des rotateurs. **Matériel et méthodes :** Cette étude rétrospective évalue les patients ayant une rupture irréparable de 2 ou 3 tendons de la coiffe des rotateurs ou une lésion de plus de 5 cm d'un tendon sans lésion du sous-scapulaire. L'évaluation a été faite en utilisant le score de Constant, l'échelle visuelle analogue pour la satisfaction et la qualité de vie. **Résultats :** Vingt patients ont rempli les critères d'inclusion. Trois patients ont été perdus de vue. Les patients restants (9 hommes et 8 femmes) ont eu un suivi moyen de 40,5 mois; l'âge moyen au moment de la chirurgie était de 61,3 ans. Trente-cinq pourcent des patients étaient des travailleurs de force tandis que l'atteinte du membre dominant était de 70%. Le score de Constant augmente de 40,8 en préopératoire à 78,8 ($p < 0,05$) avec une différence de +38 points et une amélioration de 64%. La douleur et la qualité de vie sont les deux paramètres les plus améliorés (de l'ordre de 82%) ($p < 0,05$); 89% des patients rapportent de bons ou excellents résultats. **Conclusion :** Le lambeau deltoïdien est plus qu'une solution sauvetage. Il permet une amélioration de la douleur, de la fonction ainsi qu'une grande satisfaction du patient.

INTRODUCTION

Rotator cuff tear is the most common degenerative lesion in the older population, found in 20% of cases during autopsy [1]. With aging, tears and especially massive tears present major therapeutic challenges [2-3]. Massive tear, which accounts to less than 10% of all rotator cuff tears [3], was defined by Cofield as a tear of more than 5 cm in diameter [4] while Zumstein defined it as a complete tear of two or more muscles of the cuff [5]. Radiologic diagnosis is made with ultrasonography in neutral position and dynamic test, and a shoulder MRI which is non-operator dependent [2].

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Treatment options are multiple and enclose nonsurgical treatment, arthroscopic debridement, open repair using auto- or allograft, latissimus dorsi flap, deltoid flap or prosthetic replacement. Nonsurgical solutions as well as arthroscopic treatment and prosthetic replacement are traditionally used in elderly, while muscle transfer is reserved for younger and active patients [6]. There is no consensus or randomized controlled trials regarding the ultimate management of massive cuff tears [2-3].

First described by Takagishi in Japan in 1978, deltoid muscle flap was adapted by Apoil in 1984 by limiting the harvest to the anterior bundle of the middle deltoid [2,7]. During the latest decade, many improvements have been done to the initial technique of deltoid flap [6,8-9].

The purpose of this study is to report the midterm outcome of deltoid muscle flap transfer to restore shoulder function in patients with massive irreparable rotator cuff tear.

MATERIAL AND METHODS

This study is a retrospective descriptive case series of patients operated for irreparable cuff tear by deltoid flap at our institution by one senior surgeon (SR). Repair of the cuff lesion was attempted; if it was unsuccessful, deltoid flap was then done. Inclusion criteria are a lesion of two or more tendons of the rotator cuff or lesion of one tendon of more than 5 cm in width and no lesion to the subscapularis, and complain of weakness [10]. Exclusion criteria were small lesion treatable by direct arthroscopic repair, cuff tears associated with a proximal humeral fracture or instability, glenohumeral arthritis, preexisting important deltoid damage and axillary nerve palsy [6].

Surgical technique

The anterior fascicle of the middle deltoid is harvested with a periostal sleeve from the site of insertion via a direct lateral approach as described by Apoil [7]. Distal sutures prevented flap excursion and axillary nerve damage. Resection of the long head of the biceps as well as tenodesis is performed followed by acromioplasty. Debridement of tear edges is executed and tension free sutures were applied between the flap and the tear. The free margins of the deltoid are joined next by single sutures.

Postoperatively, the patient arm is immobilized in an abduction splint for six weeks. Passive mobilization with external rotation and abduction movements are initiated on the first week after surgery followed by active exercises at six weeks postoperatively. Weight bearing and strengthening exercises were started at 12 weeks.

We used Constant score to evaluate our patients preoperatively. Cuff tear was confirmed with magnetic resonance imaging or ultrasonography. Patients were reevaluated at the latest follow-up visit using the Constant Score and a specific shoulder examination. Patients gave subjective feedback about functional improvement (visual analog scale), satisfaction and life quality changes. Imaging studies were performed in patients with bad functional or pain results during any point time of the follow-up.

RESULTS

Twenty patients were operated on with a deltoid flap for massive rotator cuff tear and met our inclusion criteria. They all complained of severe pain and loss of function (decrease in range of motion) for at least six months which did not respond to conservative treatment. Three patients were lost to follow-up due to relocation. Mean age at surgery was 61.3 (48-78) with 47% females and 53% males. Thirty-five percent of patients were involved in heavy labor; furthermore, lesions affected the dominant side in 70% of the patients. Mean follow-up time was 40.5 months (31-54).

Mean preoperative Constant score was 40.8 and increased postoperatively to 78.8 with a difference of +38 points on the raw Constant score and an improvement rate of 64% ($p < 0.05$). Constant score subcategories showed major improvement in pain and quality of life (improvement rate of 82%) while muscular force improvement rate was evaluated at merely 24% (Table I).

TABLE I
CONSTANT SCORE AND SUB-CATEGORIES

	Pain	QOL	ROM	Force	Constant
Preoperatively	5.56	10.38	17.63	7.25	40.81
Postoperatively	13.06	18.29	34.82	12.76	78.82
Amelioration rate	82.5%	81.7%	78.7%	23.7%	63.5%

QOL: quality of life **ROM**: range of motion

Patients showed generally satisfaction concerning the surgery. Eighty-nine percent of patients had good and excellent self-reported results with only two patients having fair and poor results. One of the patients reporting poor results is a 65-year-old woman who had previous mastectomy for a breast adenocarcinoma with adjuvant radiotherapy and had Behçet disease treated with steroids for the last twenty years. The poor self-assessment in this patient can be on account of her comorbidities. There seem to be no explication for the other bad result. Eighty-two percent of the patients would undergo the same procedure again if needed on the contralateral shoulder.

There were no correlation found between age and the clinical outcome ($p > 0.05$). Moreover, there were no difference found on the postoperative Constant score between young patients (< 60 years old) and elderlies (> 60 years old).

DISCUSSION

Massive tears prevalence varies from 10 to 40% [2,6]. The most common association is the concomitant tear of the supraspinatus and the infraspinatus tendons while the massive anterosuperior tear (supraspinatus and subscapularis) seems to be the least common (5-20%) [2]. Nonsurgical management yields early pain control but results fade with time. This phenomenon is related to muscular tear size, fatty degeneration and associated osteoarthritis [11].

Direct operative repair of the rotator cuff massive tear may be technically challenging and is associated with high rates of re-rupture and recurrence especially in the case of a U-shaped tear [2,10]. Arthroscopic debridement yields moderate outcome and the effect decreases with time [3,9,12]. Thus, muscular flaps (deltoid, latissimus dorsi) are a better option of reconstruction of massive cuff tears in young adults.

Deltoid muscle can be a good solution for massive tears repair. Levy has demonstrated that anterior deltoid can compensate for deficient rotator cuff since anterior deltoid muscle prevents superior humeral migration and increases the coaptation of the glenohumeral joint [13, 14]. Nonetheless, some authors found that deltoid muscle flap did not prevent cephalic migration of the humeral

head [3]. However, it was not associated with increased risk of osteoarthritic changes [9]. Deltoid muscle flap is relatively an easy operative technique with rare surgical complications while offering the window to perform a wide surgical acromioplasty [6,8-9,12]. Acromioplasty is critical in this technique as the muscle flap is sensitive to repetitive microtrauma [12]. Contraindications for deltoid muscle flap are glenohumeral arthritis, preexisting deltoid damage, axillary nerve palsy and rupture of the subscapularis muscle [6]. According to Gerber, subscapularis integrity is critical for the function of the repaired rotator cuff [15-16].

Pain relief is one of the most satisfactory outcomes of this procedure. Our study showed a pain relief up to 82%, while Schneeberger's 2012 study showed a 91% relief [6]. Other studies presented with similar results [8-10,12,17]. *Functional improvement* was quoted around 82% and is similar to previous series (Table II) [6,8-10, 17-18] while others reported less improvement rates [3]. Functional improvement may result solely of the surgery by itself or could be linked to pain relief. Furthermore, pain relief could explain the high subjective satisfaction score [3]. Moreover, deltoid muscle flap give better results when compared to arthroscopic debridement alone or with biceps tenodesis [10]. *Strength restoration* was the least improved variable after this procedure scoring around 24% and matching other results found in the literature [8,12,17,19]. *Strength improvement* is nonetheless present especially in assuring coaptation of the humeral head while maintaining a functional shoulder

TABLE II COMPARISON BETWEEN THE DIFFERENT LITERATURE RESULTS IN TERM OF PATIENT'S CHARACTERISTICS, PAIN IMPROVEMENT, FUNCTIONAL IMPROVEMENT AND SATISFACTION

Author	Patients	Follow-up period	Results	*Conclusion*
Gédouin (2002) [17]	26 males & 15 females 41 shoulders 86% dominant hand	7 years	Increase of Constant score: + 25 points 92% of patient satisfaction Maintenance of results over time	*Good surgical technique and option for massive rotator cuff tears*
Vandenbussche (2004) [8]	18 males & 11 females Mean age: 56 years	10.5 years	Increase of Constant score: + 29 points 80% improvement in Constant score 89% of patient satisfaction	*Deltoid flap reconstruction is a valid* option *for young patients with massive tears*
Spahn (2006) [9]	20 patients 14 males & 6 females) Right shoulder: 13 cases Mean age: 60.9 years	3.97 years (47.6 months)	Increase of Constant score: + 48.2 points 80% patients satisfaction	*The repair of massive rotator cuff tears by a deltoid transfer produces acceptable clinical and radiological results*
Lu (2008) [12]	18 patients 15 males & 3 females 20 shoulders Mean age: 52.3 years Dominant side : 65% 11 were heavy manual	13.9 years	Increase of Constant score: + 23 points Most improvement in pain score (80%) 50% of deltoid flaps rupture Muscular strength deterioration	*Significant analgesic effect of deltoid transfers* *Do not recommend further use of this procedure in the treatment of massive, irreparable rotator cuff tears*
Gille (2009) [10]	20 patients 15 males & 5 females Mean age: 62 years	3.5 years (42 months)	Increase of Constant score: + 46.6 points Most improvement in pain score (80%) All patients had glenohumeral congruity	*Deltoid muscle flap is a reliable option for irreparable massive rotator cuff tears with regard to pain relief, function and stability of the glenohumeral joint in the short- or medium term*
Glanzman (2010) [3]	33 patients 20 males & 11 females Mean age: 65 years	4.4 years then 14.6 years	Increase of Constant score: + 25 points 64% satisfaction at midterm follow-up Maintenance of results over time 85% rupture at last follow-up Cranial migration of the humeral head progressed in all cases	*No longer use nor recommend this technique*
Schneeberger (2012) [6]	57 patients Mean age: 60 years	6 years	88% improvement of Constant score 91% improvement in Constant pain score 84% of patient satisfaction	*Deltoid muscle flap should be considered a viable alternative for the treatment of irreparable rotator cuff tears especially in younger patients*
This Study	17 patients 9 males & 8 females Mean age: 61.3 years Dominant side: 70%	3.375 years (40.5 months)	Increase of Constant score: + 38 points 80% improvement in Constant pain score 89% of patient satisfaction	*Deltoid muscle flap seems to be a good option in terms of appropriate pain relief and function improvement. Above all, deltoid muscle flap seems to be more than just a salvage procedure*

[9]. Fatty degeneration could well be incriminated in those mediocre results [11], as fatty infiltration of the rotator cuff muscles is associated with less abduction, a lower Constant score and lower satisfaction rate [6]. Some authors even found a reverse correlation between the duration of symptoms (thus the degree of fatty degeneration) with the overall end result [18,20].

Self-satisfaction scores were high in our series; 89% reported good to excellent results, while Spahn reported an 80% satisfaction rate [9]; Gédouin reported patient satisfaction of 92% [17] and Vandenbussche a satisfaction rate of 89% on long-term follow-up (10 years) [8]. Nonetheless, surgery and the postoperative rehabilitation period are extensive and patients should be aware of the procedure magnitude and the long postoperative period as well as the importance of the rehabilitation program since it has the most direct effect on satisfaction [2].

The most feared long-term complication of deltoid muscle flap is retear. Flap integrity was shown to be correlated with maintenance of clinical results [3,8]. Some authors reported retear rate of 14% at 5.5 years [6] and 17% at 10.5 years [8]. Two recent reports by Glanzmann and Lu reported retear rate to be 85% at 14.5 years and 50% at 13.9 years respectively [3,12].

Concerns about the effect of the scarred deltoid on future salvage procedures (reverse shoulder arthroplasty) were raised in these studies [3] and contributed to this technique not being recommended by these authors. However, in both series, positive clinical results were present at latest follow-up and were maintained over time. Major criticism of Glanzmann *et al*.'s study is the presence of glenohumeral osteoarthritis in most of patients whilst deltoid muscle flap is not recommended when in the presence of osteoarthritis [6], besides the presence of a subscapularis rupture in 40% of the cases. No study or report have shown that deltoid flap jeopardizes a reverse shoulder prosthesis where a deltoid flap tear could be recovered with a reverse shoulder arthroplasty as demonstrated in two reports [6,21]. Shown in these reports was an interesting case of a 64-year-old female patient with a torn 14-year-old deltoid flap. The distorted deltoid muscle seemed to not have a direct effect on neither the surgical technique nor on the outcome of the reverse shoulder prosthesis [21].

As an alternative to deltoid flap, Gerber proposed the latissimus dorsi flap for massive rotator cuff tears [22], which seems to have functional outcome [8,22-24]. But this technique has a steep learning curve and some authors report unacceptable high rate of complications (around 50%) [25]. Moreover, humeral head migration seems to be greater with latissimus dorsi transfer and glenohumeral osteoarthritis seems to develop at a faster rate [8].

As a result of this study, we believe that deltoid muscle flap remains a good option for massive rotator cuff tear repair in patients without glenohumeral osteoarthritis, with involvement of maximally two muscles with intact subscapularis. For the other patients, debridement with biceps tenolysis or reverse shoulder arthroplasty seem to be a better surgical options.

CONCLUSION

Along with population aging and the higher incidence of massive rotator cuff tears, surgical strategy and management algorithm are yet to be defined. Deltoid muscle flap seems to be a valuable option in terms of appropriate pain relief and functional improvement as well as patient satisfaction. Mainly, it proves to be more than merely a salvage procedure and does not jeopardize a secondary reverse shoulder replacement.

CONFLICT OF INTEREST: None to be declared.

The study was authorized by the ethical committee of Saint-Joseph University and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki as revised in 2000.

The patients gave the informed consent prior being included into the study.

REFERENCES

1. Löhr JF, Uhthoff HK. [Epidemiology and pathophysiology of rotator cuff tears]. Orthopade 2007; 36: 788-95.
2. Bedi A, Dines J, Warren RF, Dines DM. Massive tears of the rotator cuff. J Bone Joint Surg Am 2010; 92: 1894-908.
3. Glanzmann MC, Goldhahn J, Flury M et al. Deltoid flap reconstruction for massive rotator cuff tears: mid- and long-term functional and structural results. J Shoulder Elbow Surg 2010; 19: 439-45.
4. Cofield RH, Parvizi J, Hoffmeyer PJ et al. Surgical repair of chronic rotator cuff tears. A prospective long-term study. J Bone Joint Surg Am 2001; 83-A: 71-7.
5. Zumstein MA, Jost B, Hempel J et al. The clinical and structural long-term results of open repair of massive tears of the rotator cuff. J Bone Joint Surg Am 2008; 90: 2423-31.
6. Schneeberger AG, Schuler L, Rikli D, Thür C. Rotator cuff tears treated with a modified deltoid flap repair technique. J Shoulder Elbow Surg 2012; 21: 310-18.
7. Augereau B, Apoil A [Repair using a deltoid flap of an extensive loss of substance of the rotary cuff of the shoulder]. Rev Chir Orthop Reparatrice Appar Mot 1988; 74: 298-301.
8. Vandenbussche E, Bensaïda M, Mutschler C et al. Massive tears of the rotator cuff treated with a deltoid flap. Int Orthop 2004; 28: 226-30.
9. Spahn G, Kirschbaum S, Klinger HM. A study for evaluating the effect of the deltoid-flap repair in massive rotator cuff defects. Knee Surg Sports Traumatol Arthrosc 2006; 14: 365-72.
10. Gille J, Suehwold J, Schulz AP et al. Deltoid muscular flap transfer for the treatment of irreparable rotator cuff tears. Orthop Rev (Pavia) 2009; 1: e15.
11. Zingg PO, Jost B, Sukthankar A et al. Clinical and structural outcomes of nonoperative management of massive rotator cuff tears. J Bone Joint Surg Am 2007; 89: 1928-34.
12. Lu XW, Verborgt O, Gazielly DF. Long-term outcomes

after deltoid muscular flap transfer for irreparable rotator cuff tears. J Shoulder Elbow Surg 2008; 17: 732-7.
13. Levy O, Mullett H, Roberts S, Copeland S. The role of anterior deltoid reeducation in patients with massive irreparable degenerative rotator cuff tears. J Shoulder Elbow Surg 2008; 17: 863-70.
14. Gagey O, Hue E. Mechanics of the deltoid muscle. A new approach. Clin Orthop Relat Res 2000: 250-7.
15. Gerber C, Krushell RJ. Isolated rupture of the tendon of the subscapularis muscle. Clinical features in 16 cases. J Bone Joint Surg Br 1991; 73: 389-94.
16. Hansen ML, Otis JC, Johnson JS et al. Biomechanics of massive rotator cuff tears: implications for treatment. J Bone Joint Surg Am 2008; 90: 316-25.
17. Gédouin JE, Katz D, Colmar M et al. [Deltoid muscle flap for massive rotator cuff tears: 41 cases with a mean 7-year (minimum 5-year) follow-up]. Rev Chir Orthop Reparatrice Appar Mot 2002; 88: 365-72.
18. Dierickx C, Vanhoof H. Massive rotator cuff tears treated by a deltoid muscular inlay flap. Acta Orthop Belg 1994; 60: 94-100.
19. Le Huec JC, Liquois F, Schaeverbecke T et al. [Results of a series of deltoid flaps for the treatment of massive rotator cuff tears with an average follow-up of 3.5 years]. Rev Chir Orthop Reparatrice Appar Mot 1996; 82: 22-8.
20. Warner JJ, Parsons IM. Latissimus dorsi tendon transfer: a comparative analysis of primary and salvage reconstruction of massive, irreparable rotator cuff tears. J Shoulder Elbow Surg 2001; 10: 514-21.
21. Glanzmann MC, Flury M, Simmen BR. Reverse shoulder arthroplasty as salvage procedure after deltoid muscle flap transfer for irreparable rotator cuff tear: a case report. J Shoulder Elbow Surg 2009; 18: e1-e2.
22. Gerber C. Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. Clin Orthop Relat Res 1992: 152-60.
23. Gerber C, Maquieira G, Espinosa N. Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. J Bone Joint Surg Am 2006; 88: 113-20.
24. Miniaci A, MacLeod M. Transfer of the latissimus dorsi muscle after failed repair of a massive tear of the rotator cuff. A two- to five-year review. J Bone Joint Surg Am 1999; 81: 1120-7.
25. Irlenbusch U, Bensdorf M, Gansen H-K, Lorenz U. [Latissimus dorsi transfer in case of irreparable rotator cuff tear – a comparative analysis of primary and failed rotator cuff surgery, in dependence of deficiency grade and additional lesions]. Z Orthop Ihre Grenzgeb 2003; 141: 650-6.