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ORIGINAL STUDY

Treatment of irreparable rotator cuff tears by latissimus dorsi muscle transfer

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In this retrospective study, a latissimus dorsi transfer as first described by Gerber in 1988 was performed in 12 patients with massive, irreparable rotator cuff tears. Their average age was 59 years and the preliminary results are reported here after an average follow-up of 39 months. In 50% of the patients there was no pain and 41% had mild to moderate pain at follow-up. Functional Constant scoring was excellent in 42%, good in 8%, moderate in 42% and poor in 8%. Active range of motion in the shoulder improved significantly in external rotation and abduction. Abduction force as measured with Atlantech and Cybex systems showed weak results. In two patients these tests could not be performed due to lack of force, in 9 patients abduction force was much weaker than on the contralateral side and in one patient the operated arm was stronger than the other side. We conclude that in most patients good pain relief and functional improvement can be achieved after latissimus dorsi transfer for irreparable rotator cuff tear. A good active range of motion can be expected but a lack of force persists. However, it remains difficult to conclude for which patients this surgery can be predictably successful.

Key words : shoulder ; rotator cuff tear ; latissimus dorsi transfer.

INTRODUCTION

Symptomatic rotator cuff tears are repaired for pain relief, restoration of function and to prevent progressive degeneration of the shoulder. When primary repair is impossible due to a long existence of the tear with retraction of the tendon and fatty degeneration of the muscles, a salvage procedure is necessary. Various procedures have been advocated : debridement of the rotator cuff, acromioplasty, autologous tendon grafts, allograft or synthetic grafting and various tendon transfers (subscapularis, teres major, pectoralis major) are well studied techniques with more or less satisfactory results. When concomitant glenohumeral degeneration is present, prosthetic replacement is advocated (hemiarthroplasty or reverse shoulder arthroplasty). Gerber proposed the latissimus dorsi transfer in 1988 and reported excellent results. We retrospectively reviewed our experience in 12 patients with massive irreparable rotator cuff tears and an intact glenohumeral joint who underwent latissimus dorsi transfer.

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PATIENTS AND METHODS

Between October 1997 and March 2003, 13 patients with irreparable rotator cuff tears were treated with a latissimus dorsi transfer. The indication was a massive tear in the supraspinatus and infraspinatus tendon associated with important retraction and/or significant fatty degeneration (Goutallier stage 3-4) as seen on arthro-computed tomography (CT) or arthro-magnetic resonance images (MRI) with an intact subscapularis *(7)*. Patients with massive tears and significant degeneration of the glenohumeral joint were excluded from this study. The subscapularis tendon was intact in all cases. There were 6 women and 7 men with an average age of 59 years (range : 44 to 75). In 12 patients the operation was done on the right dominant side. Six patients had undergone a previous attempt at rotator cuff repair, two others had had a previous arthroscopic debridement and in the remaining 4 patients a primary decision was made to perform the transfer, based on the preoperative CT/MRI findings (table I).

The operation technique as described by Gerber and Warner was used *(6, 19)*. The tendon was fixed with transosseous stitches and augmented with a Button plate (Mathys, Bettlach, Switzerland) in three cases.

Postoperatively the arm was immobilised in an abduction splint for 6 weeks. After this period, rehabilitation exercises were started, first passively, then actively after 6 weeks.

All patients were invited for a follow-up evaluation. One patient could not be traced and was excluded from the study. The follow-up of the remaining 12 patients was 39 months on average (range : 9 to 74). The patients were asked to fill in a Disabilities of the Arm, Shoulder and Hand (DASH) outcome questionnaire. Clinical evaluation pre-operatively and at follow-up was done with the Constant score and force-measurements using the Nottingham Mecmesin Myometer (NMN, Atlantech) and Cybex (Henley Healthcar, Inc.) systems, comparing the operated side with the non-operated one. NMN

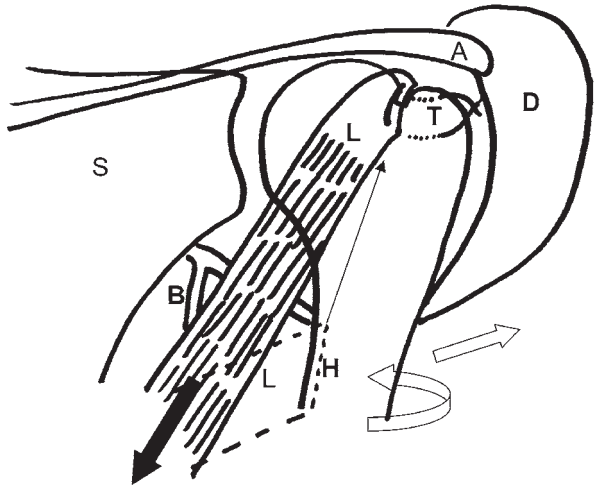

***Fig. 1.* —** Picture of the anatomy, biomechanical principle and fixation method of the latissimus dorsi transfer in a schematic posterior shoulder view : the humeral insertion (H) is released, with submuscular tunnelling of the tendon (L) (mobilising its neurovascular bundle (B)) and transferred (thin arrow) with transosseous fixation on the greater tuberosity (T). This causes a depressing force (black arrow) on the humeral head and makes active abduction and external rotation (white arrows) of the humerus possible. A = acromion, S = scapula.

Table I. — Summary of the results with pre- and postoperative values of the 12 patients with irreparable rotator cuff tears treated with latissimus dorsi transfer. R = right, L = left, M = male, F = female, debride = rotator cuff debridement and acromioplasty without suture, preop = preoperative value, post = postoperative value, FU = follow-up, m = moderate, n = none, s = severe, aff = affected side, nonaff = non-affected side, migr = proximal migration of the humeral head, calc = calcifications, US = ultrasound examination, subscap= subascapularis tendon, Mo = months.

age	side	sex	previous	Constant		pain	flexion		abduction		exorotation		NMN		Cybex		DASH	X-ray			US	FU
			surgery	preop	post	FU	preop	post	preop	post	preop	post	aff	nonaff	aff	nonaff	post	migr	arthritis	calc	subscap	Mo
74	R	F	suture	19	35	m	90	90	60	90	45	90	0	13	19	38	76	s	n	few	normal	53
82	R	M	none	13	62	n	50	90	45	90	0	50	42	8	46	39	27	n	m	none	normal	78
46	R	M	suture	45	79	m	160	160	160	160	0	90	70	145	64	127	54	n	n	few	calc	17
72	R	F	none	19	71	n	90	120	90	150	0	70	17	48	35	62	2	m	n	none	normal	66
55	R	F	suture	23	45	m	60	120	120	90	0	70	12	47	21	50	39	n	n	none	normal	46
65	R	F	none	37	88	n	15	180	90	180	20	90	31	34	51	67	25	n	n	none	calc	56
65	R	M	suture	43	73	m	15	180	150	180	15	90	16	35	21	39	59	n	n	none	calc	43
60	R	M	suture	31	81	n	100	180	110	180	10	70	28	170	57	148	x	n	n	none	normal	13
55	R	F	debride	43	83	n	80	180	80	180	20	90	13	52	39	79	12	s	n	none	calc	16
64	R	M	none	9	21	s	45	60	60	90	0	15	0	0	15	28	60	s	s	none	normal	74
62	L	F	debride	37	37	m	110	90	100	90	50	15	2	27	33	48	58	n	n	none	normal	10
50	R	M	suture	39	69	n	70	150	70	90	30	70	11	108	28	73	32	s	m	none	normal	9

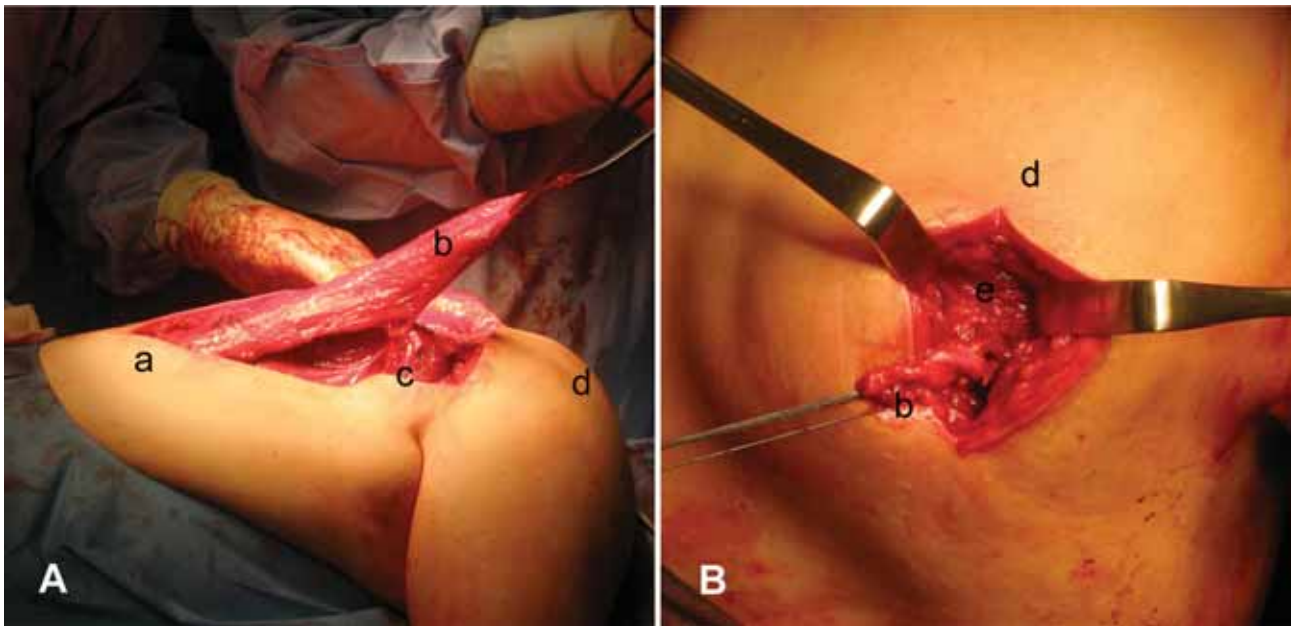

***Fig. 2.* —** Raised flap and incisions on the left side of the patient in lateral decubitus : A : (a) hemithoracic incision with Z-shape under the axilla demonstrating the (b) raised latissimus dorsi flap and its neurovascular pedicle (c). B : Anteriorsuperior approach (d) of the rotator cuff, with tunnelling of the tendon under the deltoid muscle and fixation on the greater tuberosity (e).

abduction force evaluation was done in a standardised position of 90° shoulder abduction, measuring the maximal abduction force of the deltoid and latissimus dorsi transfer in Newton (with a maximal instrumental measurement of 500 N). Three measurements were done, and the average abduction force value was calculated. After this, Cybex evaluation was done at a 0° angle starting point, measuring the latissimus dorsi transfer abduction force without interference of the deltoid muscle abduction force in this position. Abduction force and speed during 5 seconds were measured during three repetitive cycles and an average value was calculated. This value was defined as the peak torque. To make a comparison between individuals possible, the peak torque was calculated in percentage to the body weight (% BW). Ultrasound examination was performed by an independent radiologist and a standard anteroposterior radiograph of the shoulder was made. Glenohumeral joint space, proximal humeral migration and heterotopic ossification were evaluated.

RESULTS

There were no postoperative complications and all wounds healed uneventfully. The Button plate loosened and migrated in two of the three patients. In one patient it asymptomatically resided in the inferior glenohumeral poach. In the other patient it stayed in the subacromial space, causing pain. It was removed four months after the operation. During this operation we noted that the new latissimus dorsi insertion had healed to the bone. The Constant score improved from an average of 29.8 (range : 9 to 45) preoperatively to an average of 62.0 (range : 21 to 88) at follow-up, showing a global improvement of 32.2 points (table I). Pre- and postoperative comparisons were made by Wilcoxon paired statistics. Of the 12 patients, 6 had no pain, 5 had mild to moderate pain and 1 mentioned important pain. Seven patients had resumed their previous professional activities and showed no limits in recreational activities, 5 patients had to adjust their daily activities to a lower level. No disturbance in sleep was noted in 8 patients. Active shoulder flexion improved from 74° preoperatively (range : 15° to 160°) to 133° postoperatively (range : 60° to 180°). Active abduction improved from 95° preoperatively (range : 45° to 160°) to 131° postoperatively (range : 90° to 180°). Active external rotation of the shoulder improved from 16° preoperatively (range : 0° to 50°) to 66° post-

operatively (range : 15° to 90°). A significant improvement was found in Constant score, flexion and external rotation ($p < 0.01$) and in abduction ($p < 0.05$). No significant difference in Constant score improvement was found between the subgroup of patients operated on primarily and those who underwent previous surgery (debridement or rotator cuff suture). This was checked by unpaired Wilcoxon statistics on the paired differences, resulting in $p > 0.1$. DASH scores showed a mean value of 40 points (range : 2 to 76). One patient did not complete the DASH form. NMN could only be done in 11 patients. The other two patients could not actively elevate their arm to 90° abduction. The results showed an average of 25.5 N (range : 0.0 to 69.9) compared to an average of 58.7 N (range : 8.3 to 169.5) on the non-operated side. Cybex examination showed an average peak torque of 35.0% BW (range : 15.4 to 63.8) compared to 65.6% BW (range : 27.7 to 148.2) on the non operated side. Anteroposterior radiographs showed narrowing of the glenohumeral joint in 3 cases and minor heterotopic ossifications at the lateral acromion and greater tubercle in 2 cases. There was marked upward migration of the humerus in 4 cases. Ultrasound examination showed an intact subscapularis tendons in all cases with minor calcifications in the tendon in 4 cases. In all cases the latissimus dorsi transfer tendon was still in continuity with the greater tuberosity of the humerus.

DISCUSSION

Up to 30% of the rotator cuff tears at the shoulder are irreparable *(20)*. There are no perfect solutions for patients with a painful and dysfunctional shoulder due to a massive rotator cuff tear, irresponsive to conservative therapy. The poor vascularity of the rotator cuff in the critical zone of convergence between anterior and posterior circumflex humeral arteries, the suprahumeral artery and the thoracoacromial artery, is one of the causes of a progressive rotator cuff tear and failure of tendon repair *(3)*. When extensive proximal migration of the humeral head, fatty degeneration and/or massive retraction of the supra- and infraspinatus tendons is seen on arthro-MRI or arthro-CT, primary repair of the cuff should not be attempted *(7, 13)*. Several procedures have been proposed in such cases : arthroscopic debridement, acromioplasty, biceps tenotomy and reversed arthroscopic decompression have been performed with good results in selected patients *(2, 4, 9, 15-17)*. When glenohumeral joint degeneration is present, prosthetic replacement (e.g. cuff tear arthropathy hemiarthroplasty, reversed shoulder prosthesis) should be considered *(18)*. Reconstruction of the rotator cuff with allografts or synthetic material has been attempted with very unpredictable results and uncertain prognosis *(1, 11, 12)*. Multiple distant muscular tendinous flaps have been described for the treatment of the non-functioning cuff after massive ruptures, combined with repair of the anterior and posterior components of the cuff : deltoid, trapezius, and trapezio-deltoid flaps, pectoralis major transfer, teres major and rhomboideus major transfer *(20)*. Although a certain degree of pain relief can be expected, no improvement in active range of movement has resulted from these procedures *(14)*. Gerber *et al (6)* first introduced the latissimus dorsi transfer from the humeral shaft to the superolateral humeral head for symptomatic irreparable rotator cuff tears in 1988 *(5, 6)*. This transfer provides a large, vascularised tendon that closes the cuff defect and exerts an external rotational and head-depressing moment, allowing more effective action of the deltoid muscle. The pedicle with the neurovascular supply of the latissimus dorsi muscle by the long thoracic artery and nerve can easily be mobilised over 8 cm without tension on it *(8, 14, 16)*. Although Gerber *et al (6)* mentioned poor results if the subscapularis tendon was torn or could not be adequately repaired, Miniaci and MacLeod *(10)* described a favourable outcome even in these patients.

In this study, we describe the results of 12 patients treated with this technique. This study could not clearly confirm the data of Warner and Parsons *(19)*, who showed that a latissimus dorsi transfer yields more limited gains in patient satisfaction and functional outcome when performed as a salvage procedure after failed rotator cuff repair than when used as a primary reconstruction. We found good to excellent function in half and complete to good pain relief also in half of the patients.

In 10 of the 12 patients, force measurements however demonstrate persistent lack of force after the transfer. These results are comparable with the results published by Aoki *et al (2)*, Gerber *et al (6)* and Miniaci and MacLeod *(10)*.

CONCLUSION

For symptomatic irreparable rotator cuff tears with an intact glenohumeral joint, the latissimus dorsi transfer can result in functional improvement and pain relief. However it remains difficult to determine in which patients this surgery can be predictably successful. Force improvement however remains insufficient. In the long term, salvage procedures such as reversed shoulder arthroplasty remain possible.

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