Acta Orthop. Belg., 2010, **76**, 449-455

ORIGINAL STUDY

Outcome of latissimus dorsi transfer for irreparable rotator cuff tears

Philippe DEBEER, Luc DE SMET

From the University Hospital Pellenberg, Leuven Belgium

The aim of this retrospective study was to assess the mid- and long-term functional and radiological results following latissimus dorsi transfer for symptomatic irreparable tears of the supra- and infraspinatus tendons (postero-superior cuff tears).

Twenty-six shoulders with an irreparable postero-superior rotator cuff tear were assessed preoperatively and after latissimus dorsi transfer, using the Constant score and standard radiographs to determine the degree of osteoarthritis and to measure the acromio-humeral distance.

After a minimal follow-up of one year (range : 13 to 124 months) we observed a significant increase in Constant score from 39 to 60 points at the time of the last follow-up ($p < 0.00001$). Eighty-five percent of the patients were satisfied or very satisfied with the result and would undergo the same surgery again. An increase in the grade of gleno-humeral osteoarthritis was noted in 38.5% of the operated shoulders, and this was associated with a lower Constant score. We noted a decrease in acromio-humeral distance, indicating further proximalisation of the humeral head, but this was not significant ($p = 0.049$).

Keywords : rotator cuff ; latissimus dorsi ; muscle transfer.

INTRODUCTION

Massive rotator cuff tears represent a serious problem in young and active patients. Primary repair is often not possible because of the retraction of the cuff ends and progressive fatty infiltration, known to be associated with a poor outcome after repair (*9,12*). In older, low demand patients, arthroscopic debridement with biceps tenotomy provides good pain relief (*22*). Good results have been reported after reverse shoulder arthroplasty in cases of massive irreparable rotator cuff tears and in patients with cuff tear arthropathy. However, this procedure is usually reserved for patients above 65 years of age because of the relatively high incidence of complications (*23*).

In 1988, Gerber *et al* (*11*) described transfer of the latissimus dorsi tendon as a treatment option in younger patients with a massive irreparable rotator cuff tear. They reported good to excellent results after this procedure. Since then, similar results have been reported by others (*1,3,8,10,13-20,24,26*).

We reviewed our first 12 latissimus dorsi transfers in 2005 and found results comparable to other authors (*7*).

The aim of this retrospective study was to evaluate the mid- to long-term functional outcome of the

■ Philippe Debeer, MD, PhD, Orthopaedic Surgeon, Clinical Research Investigator of the Fundation for Scientific Research, Flanders, Belgium.

■ Luc De Smet, MD, PhD, Orthopaedic Surgeon, Surgeon-in-Chief

Division of Orthopaedics, Department of Musculoskeletal Science, University Hospital Pellenberg, Belgium

Correspondence : Philippe Debeer, Division of Orthopedics, Department of Musculoskeletal Science, University Hospital Pellenberg, Weligerveld 2, B-3212 Pellenberg, Belgium.

E-mail: philippe.debeer@uzleuven.be

© 2010, Acta Orthopædica Belgica.

No benefits or funds were received in support of this study

latissimus dorsi transfers performed in our department. More specifically, functional and radiological results were evaluated.

PATIENTS AND METHODS

Between 1997 and 2007 both authors performed 31 latissimus dorsi transfers in 32 patients. Twenty-five patients (26 shoulders) agreed to participate in this retrospective study. We were able ro review 6 of the patients from our original study in 2005 (*7*). Seven patients of the original study were lost to follow-up and were not included in the analysis. Five of them did not respond to the invitation to participate in the study. One patient had a failure of the transfer and was revised with a Cuff Tear Arthropathy shoulder prosthesis (CTA-prosthesis) (De Puy Orthopaedics, Warsaw, Indiana, USA). The other one stated that he was happy with the final result but did not want to make the long trip to our hospital for re-evaluation. The local institutional ethics board approved the study and all patients signed a consent form. The average age at the time of surgery was 56.5 years (range : 42 to 66 years). Eight patients (30.77%) were male ; 17 patients (69.23%) were female. There were three left shoulders and 23 right shoulders. The indication for latissimus dorsi transfer was in all cases a symptomatic irreparable postero-superior rotator cuff tear with an intact subscapularis. A rotator cuff tear was considered to be irreparable when there was fatty infiltration grade 3-4 (Goutallier) on MRI (6 patients) or arthro-CT scan (9 patients). In 9 patients, irreparability was confirmed during a procedure prior to the transfer. In these cases the rotator cuff could not be brought back to its anatomical footprint after extensive release.

All operations were carried out under general anaesthesia ; the two-incision technique described by Gerber *et al* (*8,11*) was used in all 26 cases. The patient was installed in the lateral decubitus position with the arm on a contralateral arm holder. This position allows for an easy access to the border of the latissimus dorsi muscle and the axilla. A superolateral skin incision was made to expose the lateral deltoid. A small deltoid split was made to visualize the rotator cuff tear. If necessary the anterolateral part of the deltoid was detached from the acromion to get a better view on the rotator cuff. The lateral part of the greater tuberosity was debrided and prepared for later fixation of the latissimus dorsi tendon. When the biceps tendon was intact, it was left untouched. In cases of partial tearing or inflammation of the tendon, a biceps tenotomy was performed. A second 15 cm long skin incision was made along the lateral border of the latissimus dorsi muscle. The latissimus dorsi muscle was identified and both the anterior and posterior part of the muscle belly were bluntly dissected, taking care not to damage the neurovascular bundle. The tendon of the latissimus dorsi was identified and released towards its insertion on the humeral shaft. Abduction and internal rotation of the arm facilitated this maneuver. The tendon was cut at its humeral insertion. Two non-resorbable Ethibond #2 sutures were passed along each side of the tendon, fixing a pre-cut Vicryl mesh (Ethicon, Livingston, UK) onto the dorsal aspect of the tendon. We prefer to us this Vicryl mesh as a reinforcement of the latissimus dorsi tendon, which is often very thin. The mesh covers the end of the tendon towards the musculotendinous junction and provides strong fixation points for later fixation of the tendon onto the greater tuberosity. Next a tunnel was created underneath the posterior deltoid muscle from the first deltoid split incision towards the incision on the back. The latissimus dorsi tendon was passed through this tunnel, over the top of the humeral head and was fixed with two suture anchors onto the previously prepared footprint. After fixation of the tendon, both wounds were irrigated and checked for bleedings. Careful haemostasis was performed to prevent postoperative haematoma formation. The wounds were closed in layers over three suction drains and a compressive bandage was applied. Postoperatively the arm was kept in an abduction brace in 60° of abduction for six weeks. During this period all patients followed the same standard rehabilitation protocol. Only mobilization of hand, fingers and elbow was allowed during the first six postoperative weeks. After six weeks the brace was discontinued, and passive and active shoulder exercises were started. After three months, the patient was allowed to perform strengthening exercises.

The minimum postoperative follow-up was 13 months (mean : 43.3 months, range 13 to 124 months). One patient had a congenital brachial plexus palsy with pre-existing weakness of the entire upper limb. One patient had sclerodermia. Fifteen patients had had a total of 24 interventions (range : 1 to 4 interventions) prior to the latissimus dorsi transfer.

Clinical assessment included pre-and postoperative recording of the Constant and Murley score (*4*). The mean age- and gender-matched Constant score was calculated using the reference tables of normalized values by Constant *et al* (*5*). Postoperatively, the Quick DASH score was used as a self-report outcome measure (*2*). All patients were asked whether they were very satisfied, satisfied or unsatisfied with the result of the operation.

Radiological assessment included measurement of the pre- and postoperative acromiohumeral distance (AHD) on a standard antero-posterior radiograph in neutral rotation. Measurements were performed from the dense cortical bone at the inferior aspect of the acromion to the subchondral lamina of the humeral head. The shortest distance was measured (*21*). The degree of pre- and postoperative osteoarthritis was measured on standard antero-posterior radiographs. Osteoarthritis was graded as mild (grade 1) in the presence of a humeral head or glenoid osteophyte measuring < 3 mm in size. Moderate osteoarthritis (grade 2) was defined as the presence of an osteophyte measuring 3 to 5 mm in size associated with mild joint-line irregularity and subchondral sclerosis. The presence of greater joint degeneration was defined as severe osteoarthritis (grade 3).

Statistical analysis. Wilcoxon signed rank tests were used to evaluate the change between the preoperative situation and the situation at follow-up for a set of continuous and ordinal measurements. Due to the large number of evaluated outcomes, a Bonferroni-type correction was used to keep the overall alpha-level ≤ 5%. More specifically, p-values were considered significant if smaller than 0.005. All p-values were two-sided. The association between different outcome variables was analyzed with Spearman's correlation coefficient. All analyses were performed using the SAS (version 9.1) statistical package.

RESULTS

Patient satisfaction. At the time of the latest follow-up, 14 shoulders (54 %) were rated as very satisfactory, 8 as satisfactory (31%) and 4 (15%) as unsatisfactory. Two of the unsatisfied patients had an increase in glenohumeral arthritis, one had persisting pain after the transfer and one patient had had a postoperative infection with subsequent rupture of the subscapularis tendon and an antero-superior subluxation of the humeral head.

Functional outcome (fig 1)

We noted a significant improvement in all scores after the transfer. The mean absolute Constant and Murley score increased from 39 points preoperatively to 60 points at the time of the last follow-up ($p < 0.0001$). The mean age and gender-matched Constant and Murley score improved from 51% preoperatively to 78.8% postoperatively ($p < 0.0001$). The average pain sore on the VAS improved from 7 (of 15) points preoperatively to 12 points postoperatively ($p < 0.0001$). Scores for

Fig. 1. — Functional result one year after latissimus dorsi transfer.

activities in daily living (ADL) improved from 7.85 (of 20 points) preoperatively to 13.85 points at the last follow-up ($p < 0.0001$). We observed an improvement in overall range of movement from 23.3 (of 40) points to 30.5 points ($p = 0.0006$). Age at time of surgery or gender were not significantly related with the final outcome.

Active abduction and forward flexion increased by 26° (from 114° to 140°) ($p = 0.002$) and 33° respectively (from 110° to 143°) ($p < 0.0001$). Active external rotation improved by 8° from 21° to 29° ($p = 0.058$). Mean internal rotation improved, but not significantly ($p = 0.014$). Strength, measured in 90° of abduction with a dynamometer, improved from 0.6 kg preoperatively to 1.6 kg postoperatively ($p = 0.0011$).

The mean postoperative Quick DASH score was 31.7 (range 0-82). We found a strong correlation between the postoperative Quick DASH score on the one hand and the postoperative Constant score (Spearman $\rho = -0.59$, $p = 0.0015$) or the age and gender matched Constant score on the other hand (Spearman $\rho = 0.55$, $p = 0.003$). All the subcategories of the Constant score, except force, were also significantly correlated with the postoperative Quick DASH score (Spearman ρ for pain, ADL, ROM and force are -0.65 ($p = 0.0030$), 0.63 ($p = 0.0006$), -0.41 ($p = 0.037$) and -0.27 ($p = 0.19$) respectively).

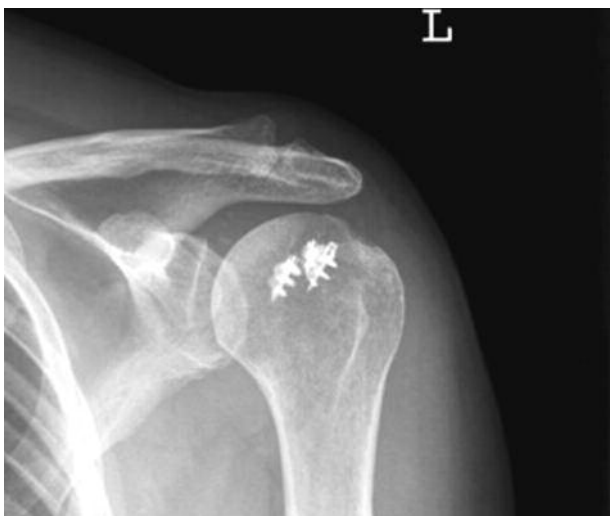

Fig. 2. — Radiological result after latissimus dorsi transfer. The acromiohumeral distance is 9 mm

Fifteen patients had undergone in total 24 operations (range : 1 to 4 interventions) prior to the latissimus dorsi transfer : failed rotator cuff repair (17 shoulders), acromioplasty with debridement of the cuff (6 shoulders), biceps tenodesis (1 shoulder). Within the group of patients who had a previous operation, the mean age and gender matched Constant and Murley score improved from 45.6% to 73.8% ($p = 0.0006$) ; in the group of the primary latissimus dorsi transfers, the mean age and gender matched Constant and Murley score improved from 58.4% to 85.4% ($p = 0.0009$). When comparing both groups, we did not observe a significant difference in mean age and gender matched Constant and Murley score ($p = 0.26$).

Radiological outcome (fig 2)

Radiologically, the mean AHD decreased from 6.6 mm preoperatively to 5.6 mm postoperatively ($p = 0.05$). Overall, the mean degree of osteoarthritis significantly increased from 0.15 preoperatively to 0.65 at the time of the latest follow-up ($p = 0.002$). Fourteen shoulders had no signs of osteoarthritis, 8 shoulders had stage-1 osteoarthritis, three shoulders had stage-2 osteoarthritis and one shoulder had stage-3 osteoarthritis. Progression of the osteoarthritis was observed in ten shoulders (38.5%) : the majority (six shoulders) changed from stage 0 to stage 1, one shoulder changed from stage 1 to stage 2 and two shoulders made a two-stage progression (one from stage 0 to stage 2 and another one from stage 1 to stage 3). The mean Constant and Murley score of patients with no or mild osteoarthritis (stage 0-1) was 62.1 points whereas patients with moderate to severe osteoarthritis (stage 2-3) had a mean Constant and Murley score of 49.4 points. This difference, however was not statistically significant ($p = 0.13$). Patients who had an increase in the degree of osteoarthritis, had a lower mean Constant and Murley score as compared to the group with no change in the degree of osteoarthritis, but this was not statistically significant ($p = 0.28$).

Complications and associated procedures. There were no nerve lesions but we had two postoperative infections, both of them requiring drainage,

irrigation and antibiotic treatment. The occurrence of a postoperative infection was not necessarily associated with a poor outcome : one patient had a postoperative Constant and Murley score of 30 whereas the other one had 66.8 points. One patient had a postoperative haematoma which was drained. In one patient, fixation of a mobile mesacromion was performed together with the muscle transfer. In one patient a secondary acromioclavicular joint resection was performed.

DISCUSSION

Irreparable tears of the rotator cuff may cause serious disability and functional limitations. The outcome of latissimus dorsi transfer for these types of tears has been encouraging. The results of this retrospective analysis of 26 latissimus dorsi transfers for irreparable postero-superior tears of the rotator cuff are comparable to those reported by other authors (*1,3,7,8,10,13-20,24,26*). In this series, 85% of the operated patients were satisfied or very satisfied and would undergo the same procedure again. This excellent subjective rating is also reflected in the objective measurements of the shoulder function after the latissimus dorsi transfer. We were able to review 6 patients from our first study in 2005. Four of these patients were still satisfied or very satisfied with the result, two of them were not satisfied. The non-satisfied patients clearly had a lower Constant and Murley score at final follow-up (43.5 and 26 points). One of them had a grade 3 osteoarthritis and the other had a massive rupture of her subscapularis tendon. The four others had an excellent Constant and Murley score (range 52.6-70.8 points).

Overall, a significant increase in absolute and age- and gender-matched Constant and Murley score was noted at the last follow-up. Pain relief was dramatic and active forward flexion and abduction increased significantly but we did not see a significant gain in active internal or external rotation. In their study, Ianotti *et al* (*14*) noted that patients with a preoperative elevation to at least shoulder level (90°) and external rotation of 20° had a better postoperative result. We also found that a preoperative flexion above 90° was associated with a significantly better functional outcome ($p = 0.006$). This indicates that patients with a poor preoperative range of motion (so-called pseudo-paralytic shoulder) are not good candidates for a latissimus dorsi transfer.

Strength measured in 90° abduction also increased significantly in our study. Nevertheless, the ultimate postoperative strength in this study only corresponds to approximately 34% of the normal strength of women and 17.5% of the normal strength of men. Despite the fact that the transferred latissimus dorsi tendon heals to the footprint (*14*) and shows electromyographic activity (*1*), the gain in strength remains low after the transfer. Other authors also reported a significant increase, but low ultimate strength. In the large (69 transfers) series of Gerber *et al* (*10*) the mean strength increased from 0.9 kg preoperatively to 1.8 kg postoperatively, reflecting approximately 40% of normal strength in women and 25% of normal strength in man. A similar observation was made by Habermeyer *et al* (*13*). In 14 patients the mean strength increased significantly from 5.6 points preoperatively to 7.8 points (out of a maximum of 25 points) postoperatively. In the study performed by Aoki *et al* (*1*) strength was measured as part of the UCLA scaling and was found to recover only moderately from a mean of 3.3 points (out of a maximum of 5 points) preoperatively to 4.2 postoperatively. These authors, however, used manual muscle testing to determine the muscle strength. Ianotti *et al* (*14*) made some interesting remarks regarding the recovery of muscle strength after latissimus dorsi transfers. They concluded that the postoperative strength after a latissimus dorsi transfer is greatly influenced by the preoperative strength of the rotator cuff and the general strength of the patient. Generalized muscle weakness and a poor preoperative shoulder function were associated with a poor functional outcome. We did not have information on the preoperative strength of the contralateral, unaffected shoulder, so it remains unclear whether patients with generalized muscle weakness had a worse outcome in this study. In our study, patients with higher preoperative force had a significantly better postoperative Constant score ($p = 0.038$, Spearmann rho = 0.41). Interestingly, the postoperative age- and sex-

adjusted Constant score, on the other hand, was not significantly better ($p = 0.14$, Spearman rho = 0.30). This finding once more illustrates that the use of Constant's original values can result in overestimation of the shoulder function in women over 40 years of age and men over 60 years of age (*25*).

In this study, a latissimus dorsi transfer resulted in a significantly better postoperative shoulder function. To determine whether this objective improvement also meant that the patient rated his shoulder function as being better after the transfer, we evaluated the results of the Quick DASH questionnaire. Postoperative pain, range of motion and activities of daily living were strongly correlated with an increase in postoperative Constant score. We therefore conclude that this procedure can improve the quality of life in patients with a massive irreparable rotator cuff tear.

Several factors are known to influence the functional outcome after a latissimus muscle transfer. Preoperative function of the deltoid, integrity of the subscapularis muscle and the number of prior surgeries can have a negative effect on the result after a latissimus dorsi transfer. In this study we did not observe a significant difference between the primary latissimus dorsi transfers and those who had prior interventions. We believe that this can be explained by the fact that most of the prior operations were arthroscopic procedures respecting the deltoid integrity. Fatty infiltration of the teres major is also known to influence the outcome of a latissimus dorsi transfer (*6*). We only had information on the preoperative status of the teres major tendon and muscle in 17 cases. This small number did not allow sufficient analysis to show a difference in outcome in relation to the integrity of the teres major muscle.

Overall, we observed a decrease in postoperative AHD on standard radiographs and progression of osteoarthritic changes on the glenoid and/or humeral head was observed in 38.5% of our patients. Interestingly, progression of osteoarthritis after latissimus dorsi transfer does not seem to be associated with worse clinical results. In the study of Aoki *et al* (*1*) 41% of the transfers showed progression of osteoarthritis. Gerber *et al* (*10*) found progressive superior subluxation of the humeral head in 30% of their patients and they also did not observe a worsening of clinical outcome if there was progression of osteoarthritis. Habermeyer *et al* (*13*) used a single-incision technique for the transfer and found a non-significant increase in AHD from 4.8 before to 5.3 mm after latissimus dorsi transfer. In 23.1% of their patients a progression of osteoarthritic changes was noted.

The results from this study confirm that a two-incision latissimus dorsi transfer is an excellent option in the treatment of irreparable postero-superior tears of the rotator cuff in well-selected patients. Pain relief and a good range of motion can be expected after the transfer. Restoration of force, however, remains unpredictable. Mild progression of osteoarthritic changes cannot be halted by the transfer, but thus far this does not seem to be associated with inferior clinical results.

Acknowledgements.

The authors wish to thank Steffen Fieuws for help with the statistical analysis.

Philippe Debeer is a Clinical Research Investigator of the Fundation for Scientific Research, Flanders, Belgium.

REFERENCES

1. **Aoki M, Okamura K, Fukushima S, Takahashi T, Ogino T.** Transfer of latissimus dorsi for irreparable rotator cuff tears. *J Bone Joint Surg* 1996 ; 78-B : 761-766.
2. **Beaton DE, Wright JG, Katz JN. Upper Extremity Collaborative Group**. Development of the QuickDASH : comparison of three item-reduction approaches. *J Bone Joint Surg* 2005 ; 87-A : 1038-1046.
3. **Birmingham PM, Neviaser RJ.** Outcome of latissimus dorsi transfer as a salvage procedure for failed rotator cuff repair with loss of elevation. *J Shoulder Elbow Surg* 2008 ; 17 : 871-874.
4. **Constant CR.** *Age Related Recovery Of Shoulder Function After Injury.* Thesis. University College, Cork, Ireland. 1986.
5. **Constant CR, Murley AH.** A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res* 1987 ; 214 : 160-164.
6. **Costouros JG, Espinosa N, Schmid MR, Gerber C.** Teres minor integrity predicts outcome of latissimus dorsi transfer for irreparable rotator cuff tears. *J Shoulder Elbow Surg* 2007 ; 16 : 727-734.
7. **Degreef I, Debeer P, Van Herck B *et al.*** Treatment of irreparable rotator cuff tears by latissimus dorsi muscle transfer. *Acta Orthop Belg* 2005 ; 71 : 667-671.

8. **Gerber C.** Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. *Clin Orthop Relat Res* 1992 ; 275 : 152-160.
9. **Gerber C, Fuchs B, Hodler J.** The results of repair of massive tears of the rotator cuff. *J Bone Joint Surg* 2000 ; 82-A : 505-515.
10. **Gerber C, Maquieira G, Espinosa N.** Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. *J Bone Joint Surg* 2006 ; 88-A : 113-120.
11. **Gerber C, Vinh TS, Hertel R, Hess CW.** Latissimus dorsi transfer for the treatment of massive tears of the rotator cuff. A preliminary report. *Clin Orthop Relat Res* 1988 ; 232 : 51-61.
12. **Gladstone JN, Bishop JY, Lo IK, Flatow EL.** Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome. *Am J Sports Med* 2007;35:719-728.
13. **Habermeyer P, Magosch P, Rudolph T *et al.*** Transfer of the tendon of latissimus dorsi for the treatment of massive tears of the rotator cuff. A new single-incision technique. *J Bone Joint Surg* 2006 ; 88-B : 208-212.
14. **Iannotti JP, Hennigan S, Herzog R *et al.*** Latissimus dorsi tendon transfer for irreparable posterosuperior rotator cuff tears. Factors affecting outcome. *J Bone Joint Surg* 2006 ; 88-A : 342-348.
15. **Irlenbusch U, Bensdorf M, Gansen HK, 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.] (in German) *Z Orthop Ihre Grenzgeb* 2003 ; 141 : 650-656.
16. **Lehmann LJ, Mauerman E, Strube T *et al.*** Modified minimally invasive latissimus dorsi transfer in the treatment of massive rotator cuff tears: a two-year follow-up of 26 consecutive patients. *Int Orthop* 2009 ; 34 : 377-383.
17. **Miniaci A, Mac Leod 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* 1988 ; 81-A : 1120-1127.
18. **Nové-Josserand L, Costa P, Liotard JP *et al.*** Results of latissimus dorsi tendon transfer for irreparable cuff tears. *Orthop Traumatol Surg Res* 2009 ; 95 : 108-113.
19. **Postacchini F, Guminna S.** Results of surgery after failed attempt at repair of irreparable rotator cuff tear. *Clin Orthop Relat Res* 2002 ; 397 : 332-341.
20. **Pearsall AW 4th, Madanagopal SG, Karas SG.** Transfer of the latissimus dorsi as a salvage procedure for failed debridement and attempted repair of massive rotator cuff tears. *Orthopedics* 2007 ; 30 : 943-949.
21. **Petersson CJ, Redlund-Johnell I.** The subacromial space in normal shoulder radiographs. *Acta Orthop Scand* 1984 ; 55 : 57-58.
22. **Walch G, Edwards TB, Boulahia A *et al.*** Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: clinical and radiographic results of 307 cases. *J Shoulder Elbow Surg.* 2005 ; 14 : 238-246.
23. **Walch G, Wall B, Mottier F.** *Reverse Shoulder Arthroplasty. Clinical Results, Complications, Revision. Complications And Revision Of Reverse Prosthesis: A Multicenter Study.* Sauramps Medical, Montpellier, 2006, pp 335-352.
24. **Warner JJ, Parsons IM 4th.** Latissimus dorsi tendon transfer : a comparative analysis of primary and salvage reconstruction of massive, irreparable rotator cuff tears. *J Shoulder Elbow Surg* 2001 ; 10 : 514-521.
25. **Yian EH, Ramappa AJ, Arneberg O, Gerber C.** The Constant score in normal shoulders. *J Shoulder Elbow Surg* 2005 ; 14 : 128-133.
26. **Zafra M, Carpintero P, Carrasco C.** Latissimus dorsi transfer for the treatment of massive tears of the rotator cuff. *Int Orthop* 2009 ; 33 : 457-462.