The Breast 27 (2016) 78–86

Contents lists available at ScienceDirect

The Breast

journal homepage: www.elsevier.com/brst

Original article

Shoulder function after breast reconstruction with the latissimus dorsi flap: A prospective cohort study – Combining DASH score and objective evaluation

C. Garusi [a], A. Manconi [a], G. Lanni [b], G. Lomeo [a], P. Loschi [a, *], M.C. Simoncini [b], L. Santoro [c], M. Rietjens [a], J.Y. Petit [a]

[a] Department of Plastic and Reconstructive Surgery, European Institute of Oncology, Via Ripamonti 435, 20141 Milan, Italy
[b] Division of Physical Therapist, European Institute of Oncology, Via Ripamonti 435, 20141 Milan, Italy
[c] Division of Epidemiology and Biostatistics, European Institute of Oncology, Via Ripamonti 435, 20141 Milan, Italy

ARTICLE INFO

Article history:
Received 25 December 2015
Received in revised form
11 February 2016
Accepted 29 February 2016

Keywords:
Latissimus dorsi flap
Breast reconstruction
Joint function

ABSTRACT

Objectives: The latissimus dorsi (LD) flap is well-known in breast reconstruction especially in previously-irradiated patients, in order to have a low capsular contraction rate whenever an implant is associated. The aim of this study is to closely evaluate the effect of LD flap harvesting on shoulder function as well as specific movements related to the LD, both objectively and subjectively.

Materials and methods: We retrospectively collected data on 86 patients who underwent pedicled LD muscle flap for breast reconstruction at the European Institute of Oncology between September 1995 until March 2011.

Results: The majority of patients showed a joint recovery superior to 80% in all joint movements examined. Disabilities of the Arm, Shoulder and Hand questionnaire revealed minimal disability similar to normal range and furthermore it appears to decrease in all sports and in particular in those who practice with LD involvement.

Conclusion: Focusing this data, a growing, “disability-free” percentage changes depending on whether or not the patients have practiced sport could be appreciate.

Introduction

The latissimus dorsi (LD) flap is still a well-known flap for breast reconstruction, especially in previously-irradiated patients with breast implant, and shows a very low capsular contraction rate. Our previous study [1] supports the indication of an immediate LD flap with implant reconstruction in the previously-irradiated breast since it shows low capsular contracture rate and implant-related complications. We observed only 3.1% Baker III contracture and no major complications in a 36.5 months follow-up period. The implant-associated complications are generally lower than those of implant reconstruction alone and are comparable to results of two-stage expander/implant reconstructions. However, the LD muscle has an important function in normal shoulder girdle motion and stability [2,3]. Innervated by the thoracodorsal nerve (C6–C8), the LD muscle acts on the humerus in internal rotation, adduction, shoulder extension, depressing of the raised arm and downward rotation of the scapula.

Several previous studies [3–13] have shown that LD muscle transfer can have sequelae at the ipsilateral shoulder, but the exact functional impairment has been a subject of debate.

The aim of this study is to closely evaluate the effect of LD flap harvesting on shoulder function as well as specific movements related to the LD both objectively and subjectively. We evaluate objective joint ability, measuring the Shoulder Range of Motion (ROM) percentage recovery in five movements, and function of the shoulder ipsilateral to breast reconstruction with the LD flap, using Medical Research Council (MRC) scales.

We also evaluate the subjective functional ability of the upper extremity by using a Verbal Numeric rating scale (NRS) including pain, aesthetic satisfaction and subjective functionality; then the patient has to complete the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.

* Corresponding author. Tel.: +39 02 57489733; fax: +39 02 9437.
E-mail addresses: cristina.garusi@ieo.it (C. Garusi), andrea.manconi@ieo.it (A. Manconi), gabriella.lanni@ieo.it (G. Lanni), giuseppe.lomeo@gmail.com (G. Lomeo), pietro.loschi@ieo.it (P. Loschi), maria.simoncini@ieo.it (M.C. Simoncini), luigi.santoro@ieo.it (L. Santoro), mario.rietjens@ieo.it (M. Rietjens), jean.petit@ieo.it (J.Y. Petit).

http://dx.doi.org/10.1016/j.breast.2016.02.017
0960-9776/

Furthermore, we consider the degree of aesthetic satisfaction of the patient and an evaluation of the surgical scars. The peculiar result of our study was the importance of sport practice in relation to better functional recovery of agonist muscle.

Materials and methods

Study design and patient population

We retrospectively collected data on 115 consecutive patients who underwent pedicled LD muscle flap for breast reconstruction at the European Institute of Oncology (I.E.O) between September 1995 until March 2011. 86 patients were included in the study, while 19 were excluded due to major exclusion criteria. Major exclusion criteria were the presence of psychiatric disorders, acute or chronic disease at the upper limbs, neurologic lesions, history of severe heart failure and mastectomy performed with the Halsted approach. All the included patients underwent a follow-up visit after the LD flap breast reconstruction procedures (min–max time since breast reconstruction: 1–14 years); considering contralateral LD as a control, we have decided to perform a study with at least one year of follow up.

Between March 2010 and March 2012 all the patients were reviewed by the physiotherapists for the evaluation of both Shoulder Range of Motion (ROM) as well as specific movements related to the LD muscle.

Data collection

We reviewed the patients who underwent LD flap breast reconstruction, focusing on age, dominant arm, type of breast surgery before and after LD flap reconstruction, type of axillary surgery, LD tendon section, type of LD surgery, type of contralateral breast surgery, timing of breast reconstruction related to mastectomy, Intraoperative Radiotherapy (IORT) or External Radiotherapy (RT) and complications after LD flap reconstruction.

According to the type of axillary surgery (Sentinel lymph node biopsy –SLNB- or Axillary lymph node dissection -ALND-), LD patients received suggestions from I.E.O. physiotherapists regarding improvement of shoulder movement but no suggestions were given to strenght agonist LD muscles.

All patients were assessed in a single examination by a physiotherapist and the plastic surgeon after LD flap reconstruction. During the clinical evaluation by the physiotherapist, a specific question regarding rehabilitation after LD reconstruction was asked and detailed questions were asked to the patient on their weekly number of treatments, regarding the type of rehabilitation, whether dedicated to shoulder function and/or muscle strength of the ipsilateral shoulder after the surgery. The patient was asked, at least one month after surgery, whether they practiced any sports that involved the LD muscle, and the frequency of the sport activity.

Objective evaluation by dedicated physiotherapy

Objective evaluation was performed by a dedicated physiotherapist measuring both Shoulder Range of Motion (ROM; percentage of recovery in 5 movements: flexion, extension, abduction, internal rotation, external rotation) as well as shoulder performance considering the movements related to LD muscle (extension and adduction).

Shoulder ROM

Flexion, extension, abduction, medial and lateral rotation of the shoulder were evaluated by using a universal full-circle manual goniometer. No passive support was given to the arm.

All movements were evaluated in accordance with information published in: [14]

Flexion:

- Starting position: the patient was supine with the shoulder in 0 degrees of abduction, adduction and rotation. The elbow was in extension, the forearm was in 0 degrees of supination and pronation so that the palm of the hand faced the body.
- Testing motion: the patient flexed the shoulder by lifting the humerus off the examining table; bringing the hand up over the subject's head. The extremity was maintained in neutral abduction and adduction during the motion.

Extension:

- Starting position: the patient was prone with the face turned away from the shoulder which was being tested, and with the shoulder in 0 degrees of abduction, adduction, and rotation. The elbow was positioned in slight flexion. The forearm was at 0 degrees of supination and pronation so that the palm of the hand faced the body.
- Testing motion: the patient extended the shoulder by lifting the humerus off the examining table. The extremity was maintained in neutral abduction and adduction during the motion.

Abduction:

- Starting position: the patient was supine, with the shoulder in lateral rotation and 0 degrees of flexion and extension so that the palm of the hand faced anteriorly. The humerus was not laterally rotated. The elbow was extended so that tension in the long head of the triceps did not restrict motion.
- Testing motion: the patient abducted the shoulder by moving the humerus laterally away from her trunk. The upper extremity was maintained in lateral rotation and neutral flexion and extension during the motion.

Medial and lateral rotation:

- Starting position: the patient was supine with 90 degrees of shoulder abduction. The forearm was perpendicular to the supporting surface and in 0 degrees of supination and pronation so that the palm of the hand faced the feet. The humerus was at its full length, on the examining table. The elbow was not supported by the examining table. A pad was placed under the humerus so that the humerus was level with the acromion process.
- Testing motion: patient rotated the shoulder medially or laterally by moving the forearm anteriorly bringing the palm of the hand toward the floor. The shoulder was maintained iat 90 degrees of abduction and the elbow in 90 degrees of flexion during the motion.

Compensatory movements of the shoulder and/or the trunk defined clinical endpoints of each shoulder movement. Pain and/or soft tissue tightness, beyond which the patient was unable to move her shoulder, determined ROM limitation.

Shoulder performance

The shoulder function was evaluated bilaterally using Medical Research Council (MRC) scales, a scale aimed to evaluate muscle strength, and is the most used in rehabilitation [15–17].

The scale has six levels, essentially identical to those originally introduced by Lovett and Martin in 1915 [18] which was employed for the evaluation of children with polio. The subject must perform a movement with maximum effort, scoring depends on whether or not he is able to contract, moving the segment against gravity or against an external resistance.

The scores are:

- Grade 5: Muscle contracts normally against full resistance.
- Grade 4: Muscle strength is reduced but muscle contraction can still move joint against resistance.
- Grade 3: Muscle strength is further reduced such that the joint can be moved only against gravity with the examiner's resistance completely removed. As an example, the elbow can be moved from full extension to full flexion starting with the arm hanging down at the side.
- Grade 2: The muscle can move only if the resistance of gravity is removed. As an example, the elbow can be fully flexed only if the arm is maintained in a horizontal plane.
- Grade 1: Only a trace or flicker of movement is seen or felt in the muscle or fasciculations are observed in the muscle.
- Grade 0: No movement is observed.

This study evaluates the LD muscle by observing shoulder extension and abduction (excluding the medial rotation in which the muscle has little involvement). Firstly against gravity movement was evaluated in the following way:

MRC scale 3

Extension:

Against gravity movement (MRC scale 3): Patients is in prone position with the arm at her side, then raises the arm upward until full range of motion.

Adduction:

Against gravity movement (MRC scale 3): Patient is in leaning position with the examined arm on the lower and more forward lean until the shoulder slightly protrudes from the bed and lets the arm fall to abduct 90 degree. The patient is asked to move the arm from that initial position upward behind the back until full range of motion.

MRC scale 4

Extension:

Patient in prone position with the arm on her side. The hand was placed with minimum weight 0.5 kg and the patient is asked to extend her arm throughout the range of motion with the weight on. If patient can complete extension, weight is increased by further 0.5 kg until the limit is reached.

Adduction:

The patient is in the lateral decubitus position on the side for assessment, the shoulder protrudes from the bed, the arm is abducted to 90 degrees, holding a minimum weight of 0.5 kg the, in hand, the patient is asked to move the arm throughout the range of motion. If patient can complete adduction, weight is increased by further 0.5 kg until the limit is reached.

MRC scale 2

Extension:

Patient is in lateral decubitus position on the side of contralateral limb to assessment, flexed to 0 degrees the assessment arm, extended the arm in position of internal rotation (with the palm down) throughout the range of motion.

And for MRC scale 1–0 (no movement or no contraction): the therapist palpates for the large round fibers at the bottom of axillary margin of the scapula and asks the patient to extend her shoulder.

Adduction:

Patient in supine position with the arm abducted to 90 degrees and was asked to adduct arm.

For MRC scale 1–0 (no movement or no contraction): the therapist palpated for the large round fibers at the bottom of axillary margin of the scapula and asked the patient to adduct their shoulder.

If compensatory movements of shoulder and/or trunk occurred, the clinical endpoint of each shoulder movement was reached.

If the patient could not move her shoulder because of pain or soft tissue stiffness, this was determined on data collection.

Objective evaluation by the plastic surgeon

On the same day as the physiotherapy assessment, patients received an evaluation by one out of 3 plastic surgeon, who judged the type of breast and dorsal scar (keloid, normo-trophic or hypertrophic) and the presence or absence of dorsal edema.

Subjective evaluations

Pain: The presence of breast and/or shoulder pain were evaluated by the patient through the administration of the Verbal Numeric Rating Scale (NRS) [19] or a numerical scale at intervals between 0 (absence of pain) and 10 (the worst pain imaginable), indicating the details of the pain experienced.

If the patient reported pain, she was asked whether she took NSAIDs or analgesics to manage it.

Aesthetic Satisfaction: The degree of satisfaction of the aesthetic result of the donor area and breast reconstruction was assessed again by the Verbal Numeric Rating Scale (0 = unsatisfactory, 10 = Great) [19].

Subjective Functionality: The degree of subjective assessment of limb global function ipsilateral to the breast reconstruction with LD in the daily was evaluated again by the Verbal Numeric Rating Scale (0 = very bad, 10 = best) [19].

Patients were also asked to report to the presence or absence of tension and/or adhesions at the level of the dorsal scar.

Patients were asked to report to the presence or absence of edema at the level of the dorsal and breast surgical scar.

At the end of the evaluation patients were asked if they would be choose this method of breast reconstruction with the LD flap, and whether or not they would recommend it to others.

Subjective evaluation of LD function was recorded by the DASH score using a well-used and validated questionnaire consisting in a simple, reliable and standardised functional outcome tool.

Disability of the arm, shoulder and hand (DASH) questionnaire

The DASH questionnaire scoring system is a validated method for measuring arm shoulder and hand function. This system gives a percentage disability score of upper limb, where 0 indicates no disability and 100 indicates complete disability. This standardized measurement of function gives a percentage of disability and has been demonstrated as valid and reliable for both proximal and distal upper limb disorders [20,21].

The DASH questionnaire consists of 30 questions assessing the impact of upper limb disability (if any) on activities of daily living. There are also optional sections within the questionnaire examining the effect of their limb function at the work place during sports or when playing musical instruments.

The scoring for each question ranges from 1 (no difficulty) to 5 (unable to perform the task). Disability scores are calculated using the following equation:

$$\text{DASH disability score} = \left[\frac{(\text{sum of n responses})}{\text{n}} - 1\right] \times 25$$

These calculations produce a score out of 100; the higher the score, the greater the disability. The Score was then converted to categorical groups of – no disability (0%), minimal disability (1–20%), mild disability (21–40%), moderate disability (41–60%), severe disability (61–80%), very severe disability (81%–100%) [22,23].

After instruction by the dedicated physiotherapist following the user's manual guidelines, patients completed the DASH score on the day the physiotherapist assessed them.

Statistical methods

Descriptive analyses were summarized as frequencies and percentages for categorical variables and as mean and standard deviation, median and range (min–max) for continuous variables and scores.

When the variable of interest was on a categorical scale, differences between subgroups were assessed using Pearson's Chi-square test; when the variable of interest was on a ordinal or continuous scale, differences between subgroups were assessed by the Wilcoxon test, if comparing two subgroups, or the Kruskal–Wallis test if comparing more than two subgroups.

The statistical analyses were performed using the Statistical Analysis Systems statistical software, version 8.02, for Windows (SAS Institute, Cary, NC).

Results

Our sample of patients (86 patients) was relatively young with a median age of 45 years (min–max: 29–68 years) (Table 1). Twenty-four cases (27.9%) were <40 years, 35 cases (40.7%) between 41 and 50 years, 20 cases (23.3%) between 51 and 60 years and only 7 cases (8%) > 60 years. Nearly the same number of left and right side breast reconstructions were conducted (53.5% and 46.5% respectively). The right arm was found dominant in 78 cases (90.7%), while the left side was dominant in 5 cases (5.8%). Focusing on the type of reconstruction, we had several types of pedicled LD muscle flap reconstructions: Extended (autologous) LD in 23 (26.7%), conventional LD + implant in 55 (64.0%), extended LD + implant in 6 (7.0%) and pure LD were performed in 2 (2.3%) patients respectively.

Surgical complications were summarized in Table 2.

Twenty-nine of 86 patients received physiotherapy (33.7%). Indications of physiotherapy for shoulder rehabilitation is a standard protocol in our institute after ALND. Despite the indication of physiotherapy after ALND, only 29/36 followed the suggestions (Table 3). The majority of them (18 of 29 cases) underwent shoulder joint rehabilitation, only one patient underwent the procedure for the muscle strength and one patient did both joint rehabilitation and the muscle program. For 9 patients we had no data.

Thirty-six out of 86 patients (41.9%) (Table 3) do practice sport regularly, not competitive (at least 2 times a week) and sport was divided according to sport that engages the LD muscle (19 patients) and other sport (17 patients).

Evaluation of the shoulder joint

Most patients show a shoulder joint recovery exceeding 80% in all movements (flexion, extension, abduction, internal rotation, external rotation) at least 1 year after surgery, as summarized in Table 4. Shoulder ROM recovery rates was used.

The specific strength of the LD muscle was evaluated measuring extension and adduction of the shoulder bilaterally by the use of Kg weights, as shown in Table 5a. MRC scales were used.

Table 1
Characteristics of the operations.

Characteristic	No. of patients
Number of patients	86
Age (years)	
Mean ± SD	46.5 ± 8.5
Median (min–max)	45 (29–68)
Age (range), years	
<=40	24 (27.9%)
41–50	35 (40.7%)
51–60	20 (23.3%)
>60	7 (8.1%)
Side	
Rt	46 (53.5%)
Lt	40 (46.5%)
Dominant side	
Rt	78 (90.7%)
Lt	5 (5.8%)
Ambidextrous	2 (2.3%)
Missing	1 (1.2%)
Resection of the tendon	
No	33 (38.4%)
Partial	37 (43.0%)
Total	16 (18.6%)
Type of previous breast surgery	
No	5 (6.0%)
Previous mastectomy	23 (26.7%)
Previous quadrantectomy	58 (67.3%)
Axillary surgery	
No	21 (24.4%)
Only SLNB (sentinel lymph node biopsy)	29 (33.7%)
Only ALND (axillary dissection)	35 (40.7%)
SLNB + ALND	1 (1.2%)
Reconstruction	
Delay	31 (36.0%)
Immediate	55 (64.0%)
Type of the Latissimus Dorsi	
Extended LD	23 (26.7%)
Extended LD + prosthesis	6 (7.0%)
Conventional LD + prosthesis	55 (64.0%)
Dorsal myocutaneous/muscle	2 (2.3%)
Electrosurgery	
Yes	86 (100/0%)
Intervention contralateral breast	
No	40 (46.5%)
Mastectomy	10 (11.6%)
Mastopexy	15 (17.4%)
Breast Reduction	7 (8.1%)
Quadrantectomy	2 (2.3%)
Reconstruction with implants	1 (1.2%)
Augmentation	11 (12.8%)
Post-surgery breast reconstruction	
No	30 (34.9%)
At least one operation after surgery	56 (65.1%)
Nipple areola complex reconstruction	16
Capsulotomy	13
Changing/inserting implants	21
Lipofilling	26
Radiation Treatments	
IORT	1 (1.2%)
RTP	5 (5.8%)
Eliot	5 (5.8%)
IORT + RTP + Eliot	1 (1.2%)

Table 2
Complications of surgery.

Characteristic	No. of patients
Number of patients	86
Seroma	
No	36 (41.9%)
Yes	45 (52.3%)
Dorsal	41
Mammary	2
Dorsal + Breast	2
Unavailable	5 (5.8%)
Seroma treated with aspiration	
Yes	6 (7.0%)
Necrosis of the skin	
Yes	9 (10.5%)
Infections	
Yes	4 (4.6%)
Brachial plexus injury	
Yes	0 (–)
Currently pathology to one or both shoulders	
Yes	6 (7.0%)

Table 3
Follow-up with physiotherapy.

Characteristic	No. of patients
Number of patients	86
Months between intervention and follow-up physiotherapy	
Mean ± SD	54.5 ± 43.3
Median (min–max)	35 (9–183)
Physiotherapy	
Yes	29 (33.7%)
Articular recovery	18
Strengthening Muscle	1
Articular recovery and Strengthening Muscle	1
Not known	9
Sport (not-competitive)	
Yes	36 (41.9%)
That engages the dorsal muscle	19
Other sports	17

Table 4
Assessment scapular-humeral articulation of Shoulder R.O.M. (recovery rates).

		Percent recovery		
		<60%	*>=60%–80%*	*>80%–100%*
FLEXION	n (%)	0 (–)	5 (5.8)	81 (94.1)
EXTENSION*	n (%)	0 (–)	3 (3.5)	82 (96.5)
ABDUCTION	n (%)	4 (4.6)	15 (17.4)	67 (77.9)
Internal rotation	n (%)	1 (1.2)	4 (4.6)	81 (94.2)
External rotation	n (%)	0 (–)	4 (4.6)	82 (95.4)

Regarding the two movements, the extension was affected more than adduction. In extension movement: 58 cases had a strength measured in kg (MRC scale) > 3, while 18 cases had a strength (MRC scale) ≤ 3. The movement of adduction, however, was always assessed in Kg, then the MRC scale was >3 (83 cases).

Extension and adduction were not measurable in 10/86 case and in 3/86 cases respectively, due to joint limitations and/or the presence of pain.

Table 5b describes the percentage recovery of extension and adduction strength in cases where MRC scale was >3. In the evaluation of the strength in the extension movement, the majority of patients (34 of 58 pts) have a low recovery (<to 60%), while in the movement of adduction, 62 pts of 83 were found to have a recovery > 80%.

Table 5a
Shoulder strength – description of cases.

	Extension	Adduction
	(N = 86)	(N = 86)
Missing data due to pain and joint limitations	10	3
Data not measured in kg of one of the two limbs	18	0
When expressed in kg on both limbs (recovery rate estimated)	58	83

Recovery rates of strength in relation to the sport

Fig. 1 shows the percentage recovery of the strength of the shoulders in terms of extension and abduction, comparing patients who did not play sports at all, with those who have practiced sport with or without involvement of the LD muscle. While no difference between subgroups was found in terms of extension (Fig. 1a), a significative improvement for patients practicing sport was found in terms of adduction (Fig. 1b). Moreover adduction was significantly improved when patients practiced sports which involved the LD (p-trend = 0.007).

DASH questionnaire

A DASH score may not be calculated if there are greater than 3 missing items (Table 6).

In our series, two patients have more than three items missing, and analysis was performed on 84 patients with 27 or more items.

Low values of DASH indicate a good physical condition, muscle and joint while high values of DASH indicate greater disability. In the group of patients who did not practice sport, the median DASH score resulted as 18.7, compared to 10.8 of patients who practiced sport without involvement of the LD muscle and 7.5 of the patients who play sports with LD muscle involvement. Disability therefore appears to decrease in all sports and in particular in those who practice with LD involvement.

In general, almost 2 out of 3 patients (52/84 = 62%) appear to have a DASH score ≤20 (Fig. 2), which falls within the range of no or minimal disability [22,23].

Fig. 3 shown that this percentage of disability changes substantially depending on whether or not the patients have practiced sport. In fact, minimal disability went from 54.2% in patients who did not engage in sports, to 64.7% in those who have practiced sport without involvement of the LD muscle, to 79.0% in those who have practiced sports with involvement of the latissimus dorsi muscle. This growing trend of disability-free is statistically significant (p = 0.02).

Discussion

The LD flap is still a well-known technique in breast reconstruction especially in previously irradiated patients with breast implants and shows a very low capsular contraction rate. Several studies [5–11,24] have investigated the possible sequelae resulting from the removal of the LD muscle for the purpose of reconstruction. Majority of publication support the belief than muscle is

Table 5b
Evaluation shoulders Strength kg (recovery rates).

			Recovery rate		
			<60%	*>=60%–80%*	*>80%–100%*
Extension	N = 58	n (%)	34 (58.6)	11 (19.0)	13 (22.4)
Adduction	N = 83	n (%)	10 (12.0)	11 (13.2)	62 (74.7)

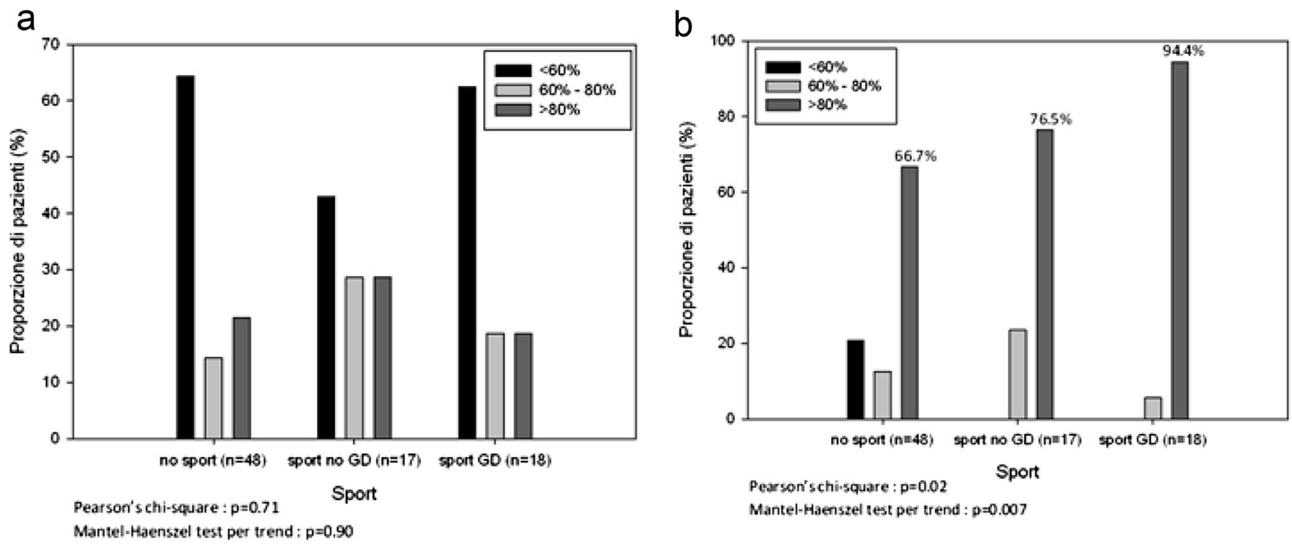

Fig. 1. Strength of shoulder. a Percentage recovery of the strength of the shoulders in terms of extension according to the type of sport. b Percentage recovery in terms of adduction according to the type of sport.

Table 6
Dash questionnaire.

DASH	All	Sport			p-value^
		No	Yes without GD	Yes with GD	
Number of patients	84	48	17	19	
Mean ± SD	19.6 ± 18.5	22.4 ± 19.2	18.6 ± 19.8	13.6 ± 14.2	0.18
Median (min–max)	16.0 (0–85.3)	18.7 (0.8–85.3)	10.8 (0–82.1)	7.5 (0–54.2)	

Kruskall–Wallis test for non-parametric data (on the medians).

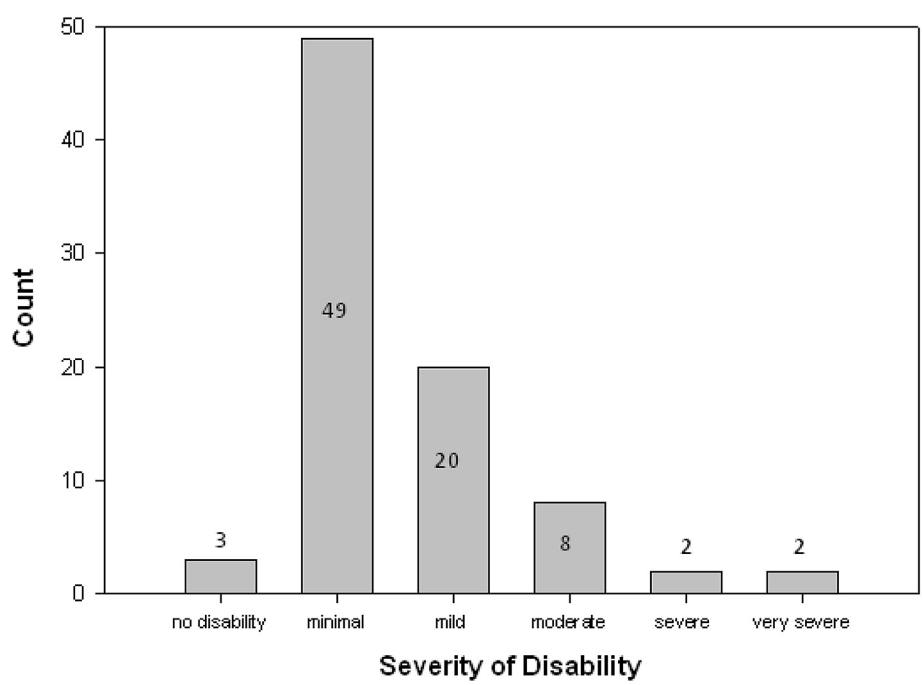

Fig. 2. Disability at the physiotheraphic visit.

expendable and residual muscles of the shoulder joint would compensate for it [25,26].

The topic is debated, but functional impairment and changes in daily lives after flap transfer may not be as tolerable as previously considered. Nevertheless, the patient samples for most of these studies are limited, and assessment modalities used in some of these studies were not standardized. Our study is conducted on a large sample of patients (115 patients, 86 included in the study), the

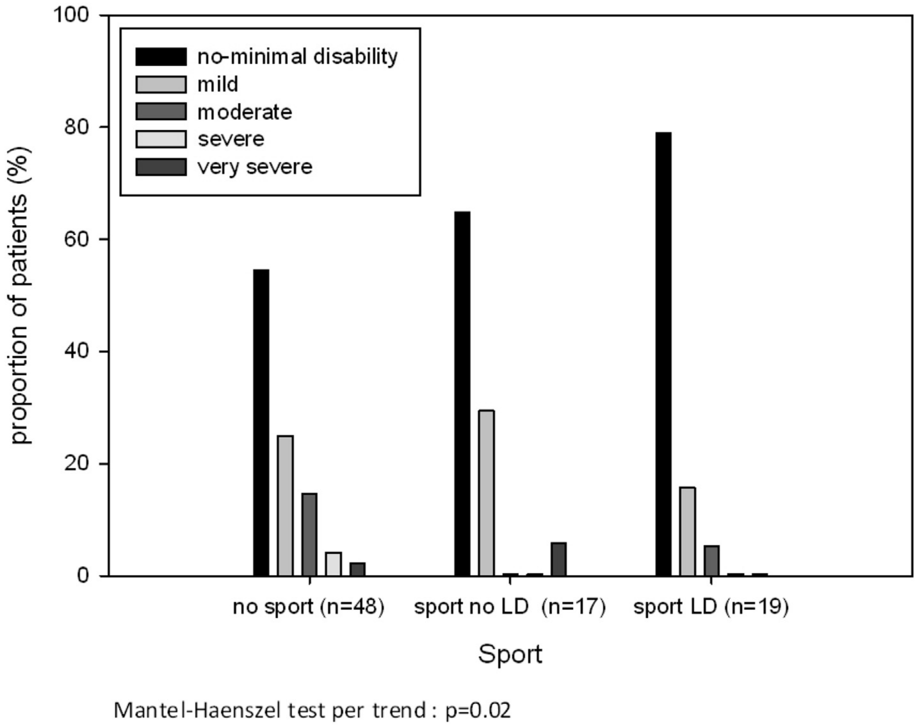

Fig. 3. DASH at the physiotherapic visit according to type of sport.

highest number of all the studies conducted so far, and an objective functional assessment of the shoulder has been done. The majority of patients showed a shoulder joint recovery exceeding 80% in all movements examined at least 1 year after surgery. Data are objectively taken by a dedicated physiotherapist measuring shoulder ROM in flexion, extension, abduction, internal and external rotation by using a manual goniometer. Considering contralateral LD as a control, we have decided to perform a study with at least one year of follow up. Previous studies demonstrated that the recovery is stable after one year.

In the literature [13], nine out of thirteen articles reported some type of limitations in shoulder range of motion after flap transfer. In the majority the degree was not severe, while four articles reported no limitation.

Clough et al. [5] evaluated 43 pts who underwent breast reconstruction with LD flap.

The study states that 46% of patients had limitations in upward mobility of the hand, while 70% of patients do not show objective limitation in muscle function, 37% have a certain functional limitation which did not significantly affect strength and mobility of the shoulder.

The most affected movement in our patient was abduction (recovery 67%), followed by flexion, internal/external rotation and extension with equal percentages (81–82%). Literature reports flexion as the most impaired movement, and abduction after [13].

Probably mastectomy procedures [27], postoperative pain and scar have a significant influence on shoulder ROM, because LD muscle does not participate actively in those two movements, and other factor are included [13].

Spear et al. [8] detected no significant restrictions for the passive and active range of motion of the shoulder in the long term, stating that within 2–3 weeks the full range of motion is recovered and functional loss will be compensated within a 6–12-month period.

Glassey et al. [9] revealed that in the first 6 months after surgery, there is a slight loss of mobility and strength (<1 kg) compared to the preoperative period. This loss improves in the next 6 months, with an average recovery of the joint by 10 degrees on the various planes of motion of the shoulder and a recovery of strength equal to or very close to the value of preoperative strength.

Nevertheless, LD muscle is more involved in extension and adduction movements. Its specific strength, evaluated bilaterally by the use of Kg weights reveals the extension was affected more than adduction in our study (MRC scale was >3 in 58/86 in extension and 83/86 in adduction). Detailed analysis reveals extension movement recovery is very much lower than adduction movement (recovery was <60% in 58.6% for extension and >80% in 74.7% for adduction).

Some weakness in shoulder strength have been tested for any type of motion as described in literature [13] in all studies except four, and impaired shoulder extension was most frequent, in concordance with our data.

Clough et al. [5] reported weakness in 33% of patients while Glassey et al. [9] assessing 22 patients who undergone breast reconstruction with the LD flap, revealed weakness in 0.06% of patients in extension and 0.3% in adduction.

Forthomme et al. [10] used instrumentation (Cyber Norm) for the evaluation of the muscular strength of the shoulders. They showed that 6 out of 20 women who had reconstruction with LD flap have no deficit. Muscle weakness was measured in the remaining 14 patients at 3 and 6 months after surgery in the ipsilateral shoulder, as being 20% less than the presurgical (value especially in the movements of adduction and internal rotation of the shoulder).

Spear et al. [8] examined the functional changes and biomechanics of the shoulder after LD transfer. They measure a moderate strength deficit in extension and adduction and a lower exercise tolerance in performing long-term activities such as climbing stairs, swimming, getting up from a chair with the help of the upper limbs. Most studies detected less than fully recovered shoulder strength. Many authors agree with the theory that the “moderate” loss of strength in extension and adduction of the shoulder is attributable to hypertrophy of the teres major muscle (one of synergistic muscles of the LD) and other muscles in the shoulder girdle that compensates for the loss of function of the LD [13].

We analyze the percentage recovery of extension and adduction comparing patients who did not play sports at all, with those who have practiced sport with or without involvement of the LD muscle. This parameter has never been taken in consideration before. No difference was found in terms of extension but significant improvement for patients practicing sport was found for adduction. Interestingly, adduction was significantly improved when patients practiced sports involving the LD.

Median DASH score in our patients was 18.7% and 62% have a DASH score which falls within the range of no or minimal disability. The percentage correspond to that described in literature.

Button et al. [11] administered the DASH questionnaire after surgery to 58 patients undergoing unilateral breast reconstruction with the LD flap for total of 8 times until 3-years post-op. The DASH score at the first check-up was an average of 49, at 6 weeks was 29 and 19 for 3 months up to 36 months with a plateau value of about 15. The study therefore shows that although a certain functional limitation of the shoulder could be appreciate at 6–12 weeks, most of the patients show a “normal” shoulder function at 6 months. Fraulin et al. [28] reported weakness and pain and functional difficulties in some patients, and two patient had to change their work, but the study is quite old.

In our study DASH test revealed disability appears to decrease in all sports and in particular in those who practice with LD involvement (DASH score of 10.8 and 7.5 respectively). Focusing this data, a growing, “disability-free” percentage changes depending on whether or not the patients have practiced sport could be appreciate. The trend is statistically significant, being 54.2% of no–minimal disabilities in patients who did not engage in sports, reaching 64.7% in those who have practiced sport without LD involvement, 79.0% in those with LD involvement.

Strengths of this study are the high number of subject and the use of validated scales and standardized assessment modalities: DASH; Verbal Numeric Scale (NRS) that allow an assessment of the outcome which is reliable and repeatable. Some previous studies have used questionnaires and rating scales which were not validated [3,5–7].

Also the performance of specific movements related to the LD muscle has been evaluated by the validated MRC scale, while in previous studies, questionnaires and rating scales were not validated [3,5–9].

All the published studies, our included too, are retrospective and preoperative shoulder assessment has not been compared to postoperative one [9]; moreover, it is inappropriate to compare shoulder ROM between two set of subjects, as shoulder motion varies within normal population [25].

Limits of this study is also the single evaluation at least one year.

Conclusions

Regarding specific LD movements, extension was affected more than adduction. We demonstrated a minimum disability in general (DASH: 16.0) and in particular a lower disability in those who practice sports (DASH: 7.5),compared to those who do not practice sport (DASH: 10.8), especially in the sport which involving the agonist muscle and contralateral LD.

Conflict of interest statement

None of the authors has any commercial associations or financial interests to disclose;

None of the authors received any funding for this work from any of the following organizations: National Institutes of Health (NIH); Wellcome Trust; Howard Hughes Medical Institute (HHMI); and other(s).

Statement of Institutional review board approval and/or statement of conforming to the declaration of Helsinky.

This study is in compliance with the principles of the Helsinki Declaration.

The paper has never been presented before.

Acknowledgment

No.

References

[1] Garusi C, Lohsiriwat V, Brenelli F, et al. The value of latissimus dorsi flap with implant reconstruction for total mastectomy after conservative breast cancer surgery recurrence. Breast 2011;20:141–4.
[2] Konrad GG, Jolly JT, Labriola JE, McMahon PJ, Debski RE. Thoracohumeral muscle activity alters glenohumeral joint biomechanics during active abduction. J Orthop Res 2006;24:748–56.
[3] Adams Jr WP, Lipschitz AH, Ansari M, Kenkel JM, Rohrich RJ. Functional donor site morbidity following latissimus dorsi muscle flap transfer. Ann Plast Surg 2004;53:6–11.
[4] Brackley PT, Mishra A, Sigaroudina M, Iqbal A. Modified muscle sparing latissimus dorsi with implant for total breast reconstruction - extending the boundaries. J Plast Reconstr Aesthet Surg 2010;63:1495–502.
[5] Clough KB, Louis-Sylvestre C, Fitoussi A, Couturaud B, Nos C. Donor site sequelae after autologous breast reconstruction with an extended latissimus dorsi flap. Plast Reconstr Surg 2002;109:1904–11.
[6] Losken A, Nicholas CS, Pinell XA, Carlson GW. Outcomes evaluation following bilateral breast reconstruction using latissimus dorsi myocutaneous flaps. Ann Plast Surg 2010;65:17–22.
[7] Dejode M, Bordes V, Jaffré I, Classe JM, Dravet F. Oncologic, functional, and aesthetics results; evaluation of the quality of life after latissimus dorsi flap breast reconstruction. About a retrospective series of 450 patients. Ann Chir Plast Esthet 2011;56:207–15.
[8] Spear SL, Hess CL. A review of the biomechanical and functional changes in the shoulder following transfer of the latissimus dorsi muscles. Plast Reconstr Surg 2005;115:2070–3.
[9] Glassey N, Perks GB, McCulley SJ. A prospective assessment of shoulder morbidity and recovery time scales following latissimus dorsi breast reconstruction. Plast Reconstr Surg 2008;122:1334–40.
[10] Forthomme B, Heymans O, Jacquemin D, et al. Shoulder function after latissimus dorsi transfer in breast reconstruction. Clin Physiol Funct Imaging 2010;30:406–12.
[11] Button J, Scott J, Taghizadeh R, Weiler-Mithoff E, Hart AM. Shoulder function following autologous latissimus dorsi breast reconstruction. A prospective three year observational study comparing quilting and non-quilting donor site techniques. J Plast Reconstr Aesthet Surg 2010;63:1505–12.
[12] de Oliveira RR, Pinto e Silva MP, Gurgel MS, Pastori-Filho L, Sarian LO. Immediate breast reconstruction with transverse latissimus dorsi flap does not affect the short-term recovery of shoulder range of motion after mastectomy. Ann Plast Surg 2010;64:402–8.
[13] Lee KT, Mun GH. A systematic review of functional donor-site morbidity after latissimus dorsi muscle transfer. Plast Reconstr Surg 2014;134:303–14.
[14] Norkin CC, Joice White D. Measurement of Joint Motion: A Guide to goniometry 3rd Edition [Spiral-Bound].
[15] Medical Research Council. Aids to the examination of the peripheral nervous system, Memorandum no. 45. London: Her Majesty's Stationery Office; 1981 [Medline].
[16] www.fisionline.org.
[17] Daniels L, Williams M, Worthingam C. Examination of the muscular system: techniques for clinical exploration. 1984. Roma. Verducci.
[18] Martin EG, Lovett RW. A method of testing muscular strength in infantile paralysis. J Am Med Assoc 1915;65:1512.
[19] Hjermstad MJ, Fayers PM, Haugen DF, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manag 2011;41:1073–93.
[20] Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. J Hand Ther 2001;14:128–46.
[21] Jester A, Harth A, Wind G, Germann G, Sauerbier M. Disabilities of the arm, shoulder and hand (DASH) questionnaire: determining functional activity profiles in patients with upper extremity disorders. J Hand Surg Br 2005;30:23–8.
[22] http://www.bu.edu/sargent/clinical-practice/clinical-education/ebp/outcome_measures/.
[23] Moore CM, Leonardi-Bee J. The prevalence of pain and disability one year post fracture of the distal radius in a UK population: a cross sectional survey. BMC Musculoskelet Disord 2008;29:9–129.
[24] Koh CE, Morrison WA. Functional impairment after latissimus dorsi flap. ANZ J Surg 2009;79:42–7.

[25] Brumback RJ, McBride MS, Ortolani NC. Functional evaluation of the shoulder after transfer of the vascularized latissimus dorsi muscle. J Bone Jt Surg Am 1992;74:377–82.
[26] Laitung JK, Peck F. Shoulder function following the loss of the latissimus dorsi muscle. Br J Plast Surg 1985;38:375–9.
[27] de Oliveira RR, do Nascimento SL, Derchain SF, Sarian LO. Immediate breast reconstruction with a Latissimus dorsi flap has no detrimental effects on shoulder motion or postsurgical complications up to 1 year after surgery. Plast Reconstr Surg 2013;131:673e–80e.
[28] Fraulin FO, Louie G, Zorrilla L, Tilley W. Functional evaluation of the shoulder following latissimus dorsi muscle transfer. Ann Plast Surg 1995;35:349–55.