

The Effect of Mini-Latissimus Dorsi Flap (MLDF) Reconstruction on Shoulder Function in Breast Cancer Patients

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ABSTRACT

Objective: The aim of this study is to investigate the effect of mini latissimus dorsi flap (MLDF) reconstruction on ipsilateral shoulder functions.

Materials and Methods: Those included in the study are the patients aged between 23 and 73, who were operated with the diagnosis of early breast cancer (cT1-3)N0). The first group includes the patients who had sentinel lymph node biopsy (SLNB) with partial mastectomy. The second group consists of the patients who had axillary lymph node dissection (ALND) with partial mastectomy. The third group includes the patients who had SLNB and MLDF with partial mastectomy. The fourth group includes the patients who had ALND and MLDF with partial mastectomy. Patients' Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) score work model point were recorded.

Results: 174 patients were included in this study. According to Q-DASH score, no functional change was detected in 69.5% of the patients, whereas slight functional loss was identified in 23.6%, moderate functional loss in 5.7%, severe functional loss 1.1%. In the comparison of Q-DASH scores in surgery groups, while these four groups were being analyzed, a significant difference was determined ($p=0.007$). When dual analyses were made, it was also established that the difference resulted from the group to which ALND and MLDF were applied together.

Conclusion: We conclude that MLDF application for reconstruction purposes after breast surgery has a negative impact on shoulder functions of the patients who had both of partial mastectomy and ALND.

Keywords: Breast reconstruction, latissimus dorsi flap, shoulder functions

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Introduction

Breast cancer is the most common cancer type among women and can lead to death (1). According to World Health Organization data, the frequency and mortality of breast cancer has increased substantially in developing countries (2, 3). Although the breast cancer incidence has increased, the general survival rate at 5 years for Stage I breast cancer has reached 100% and for Stage II has reached 93% due to early disease recognition and advanced treatment methods (4). Increase in length of life has helped to provide better cosmetic appearance of the breast and to have an increase in breast-conserving surgery. As a result, the number of studies dedicated to reducing the morbidity of surgical treatment is increasing (5-7). Treatment for early stage breast cancer is usually initiated by surgical intervention and it is necessary to fill the cavity occurring after partial mastectomy (8-10). There are two different fundamental approaches available regarding breast reconstruction after breast cancer. The first approach refers to volume replacement procedures, which combine resection with immediate reconstruction of the defect using autologous tissue (local fasciocutaneous flaps and latissimus dorsi mini-flaps) (11) and the second approach is repre-

sented by volume-displacement procedures, which combine resection with a variety of different breast-reduction and reshaping techniques, according to the location of the tumor (12-15). This method is often applied just after mastectomy and its positive psychological effect has been demonstrated (16, 17). In spite of positive effects, complications of latissimus dorsi flap (LDF) reconstructions cannot be ignored. These complications are seroma formation, wound infection, flap necrosis and shoulder dysfunction (18). For decreasing these complications, a part of latissimus dorsi muscle should be used that called mini-latissimus dorsi flap (MLDF), which is less invasive than LDF.

Latissimus dorsi flap effects shoulder mobility and upper extremity daily living activities negatively due the decreasing stability of shoulder joint however adequate information cannot find on effects of MLDF to shoulder functions in our literature search. Because of this reason the aim of this study was to investigate the effect of MLDF in partial mastectomy on upper extremity functionality.

Materials and Methods

174 patients who were treated with breast-conserving surgery (BCS) due to breast cancer at the Istanbul Florence Nightingale Breast Health Center were included in this study. A cross-sectional descriptive study was planned. The necessary sample size was determined by including all patients who fulfilled the inclusion criteria who applied to our clinic between 2014-2017. Approval was obtained from the Istanbul Science University Ethics Committee before the study. Written informed consent was obtained from all patients.

Inclusion criteria for the patient group was set as follows: being over 18 years old, having BCS with a diagnosis of stage I or stage II breast cancer, having received radiotherapy and chemotherapy, having no neurologic, orthopedic or rheumatic diseases affecting upper extremity function, and not having any disability related to the upper extremities before the surgery. Exclusion criteria were rejecting to participate in the study, having mastectomy, having operation on the same breast previously and/or having applied LDF, having treatment with a muscle relaxant or having treatment forming a neuromuscular block, not having radiotherapy or chemotherapy, having disability of the shoulder joint before the operation and having a disease affecting shoulder and upper extremity functions.

Patients were divided into 4 groups according to the surgical procedures applied. These groups were: I. Group: patients having sentinel lymph node biopsy (SLNB) with partial mastectomy (n=50), II. Group: patients having axillary lymph node dissection (ALND) with partial mastectomy (n=37), III. Group: patients having partial mastectomy + SLNB + LDF (n=50), IV. Group: patients having partial mastectomy + ALND + LDF (n=37). After having recorded the demographic information of the patients, joint movements and examinations were performed to complete the quick disabilities of the arm, shoulder and hand (Q-DASH) form for functional assessment.

In the MLDF surgical reconstruction procedure, the tumor is removed from the breast within clean surgical margins and the tumor bed is marked with clips. The patient is placed in the semi-lateral decubitus position, and the incision performed for SLNB or ALND is slightly extended laterally in order to find the lateral edge of the latissimus dorsi muscle. This muscle is drawn and separated from the chest wall, and the point where thoracodorsal vessels enter the muscle is found. Since the blood supply of the flap is from this vascular bundle, care-

ful attention is required not to injure it. The latissimus dorsi muscle is separated from teres major and minor muscles superficially. To fill the space occurring in the breast tissue, the lower part of the tissue excised from axillary apex is measured and 5 cm is added on to it. This 5-cm-excess, which is added in order to have the necessary amount of muscle, is used to give a better shape to the breast. It forms pre-muscular fascia in the anterior, lumbosacral fascia in dorsal and rib arcuate limit in inferior. This area becomes free from muscle structures with the help of bipolar scissor and electrocautery. The muscle is prepared from the inferior according to the amount of muscle needed. The superior part of the muscle is separated from the humerus adherence point. During this process, utmost care is taken not to rotate the muscles in order to prevent vascularity. Muscle tissue is transported through the subcutaneous tunnel opening towards the excision cavity from the axillary region. Muscle tissue is here fixed to the pectoralis muscle and then shaped.

Upper extremity functional assessment was carried out with Q-DASH. Q-DASH is a regional result criterion that was developed for upper extremity musculoskeletal system disease. It evaluates all upper extremity functions, is filled out optionally and includes sport and musician modules. It contains eleven questions. To calculate the score of the criterion that can be used instead of Q-DASH, at least 10 questions out of 11 must be answered. Each question is graded on a 5-point- Likert scale. The total score of the questionnaire is calculated in such a way that the total points of the marked questions is divided by the number of questions marked, and then 1 is subtracted from the result, and the result multiplied by 25. Point total between 0-20 indicates normal, 21-40 indicates slight, 41-60 indicates moderate, and 61-80 indicates severe disability. The business model investigation survey of Q-DASH contains 4 questions intended for the assessment of problems that the patient has with his/her arms while working. Difficulty level is scored between 1 and 5. The total score of the questions is divided by 4, then 1 is subtracted from the result and then this result is multiplied by 25 (19). The validity and reliability of this scale was confirmed by Düger et al. (20).

The reasons why we have selected the Q-DASH survey for our study are that the survey's Turkish cultural adaptation has been done, that measurement features have been tested, that it is a survey especially for upper extremities and that it gives an idea about whole upper extremity functionality.

Statistical Package for the Social Sciences version 22.0 (IBM Corp., Armonk, NY, USA) package has been used for statistical analysis. In descriptive statistics of the data, average, standard deviation, minimum and maximum values, median, rate and frequency values have been used. Distribution analysis of the variables has been controlled and tested by Kolmogorov-Smirnov test. Mann-Whitney U test and Kruskal Wallis test have been used for quantitative data analysis. For qualitative data analysis, Chi-Square test has been used, however, when it did not give results, Fisher test has been used. In correlation analyses, Pearson and Spearman tests have been used. Significance level was accepted as $p < 0.05$.

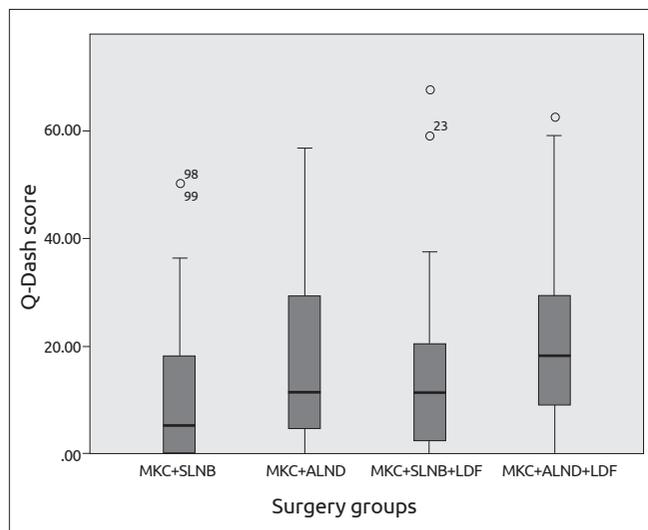
Results

174 patients were involved in this study. The mean age of the patients was 50.32 ± 10.18 , the mean body mass index (BMI) was 26.7 ± 5.8 and the median value of the time passed after the surgery was 24 (3-108) months. 57.4% of the patients had surgery on the dominant side. The distribution of patient demographic data by surgery groups is provided in Table 1.

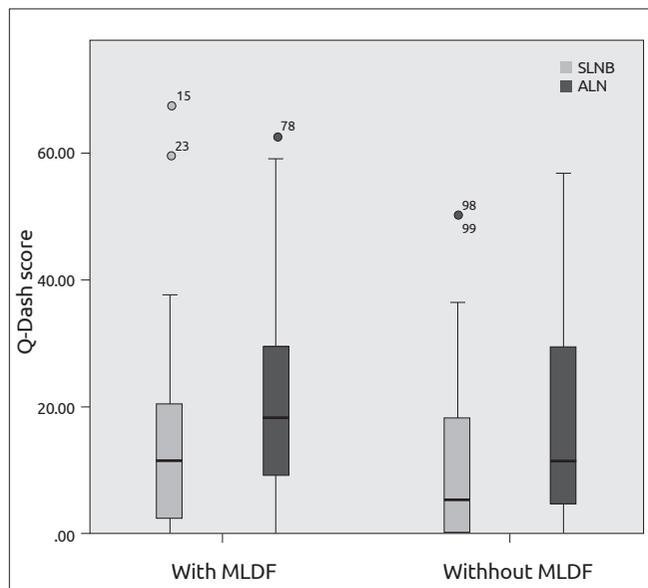
Table 1. Demographic data between groups

	MCS+SLNB (n=50)	MCS+ALND (n=37)	MCS+MLDF+SLNB (n=51)	MCS+MLDF+ALND (n=37)	p
BMI (kg/m ²)	25.5 (18.5-37)	28.4 (18.6-57.7)	24 (19.1-33)	25 (20-38.3)	0.003
Age (year)	51.5 (30-71)	51 (23-73)	48 (33-70)	47 (35-72)	0.80
Elapsed time after operation (month)	24 (3-128)	29 (5-108)	21 (3-108)	34 (4-78)	0.248

Mann-Whitney U Test
 MCS: Mastectomy; SLNB: Sentinel lymph node biopsy; ALND: Axillary lymph node dissection; MLDF: Mini Latissimus dorsi flap; BMI: Body mass index



Graphic 1. Comparison of between surgery groups and Q-Dash scores



Graphic 2. Comparison of between reconstruction performed with/without MLDF and Q-Dash

According to Q-DASH score, no functional change was observed in 69.5% of the patients. On the other hand, slight functional loss, moderate functional loss and severe functional loss were detected in 23.6%, 5.7% and 1.1% of the patients, respectively. It was determined that having surgery on the dominant side did not have any impact on the arm functions (p=0.567).

Having compared Q-DASH scores in the surgery groups, a significant difference was established across the four groups analyzed (p=0.007) (Graphic 1). Dual analyses also revealed a difference resulting from the group in which ALND and MLDF were applied together. This significant difference disappeared once the three groups were reassessed after excluding those that were subjected to concomitant application of ALND and MLDF (p=0.22).

Although the findings suggested that reconstruction performed with MLDF did not have any statistically significant impact (p=0.17, p=0.12) on upper extremity functions when patients were classified as SLNB and ALND by lymph node surgery, Q-DASH scores were found to be relatively higher in patients to whom MLDF was applied than those who did not have MLDF application in both groups (Graphic 2).

In the comparison of Q-DASH business model scores of the patients in whole groups, no significant difference was determined (p=0.11).

In the evaluation of questions one by one in the groups, a significant breakdown (p=0.032, p=0.048) was found only in carrying a bag and opening a new or tight jar cap functions, whereas no significant difference was identified for the other nine questions.

No significant correlation was found in the comparison of functionality questions and the time passed after surgery (p=0.903).

Discussion and Conclusion

Reconstruction with mini-latissimus dorsi after partial mastectomy has begun to be implemented as one or two-stage procedures from the 1990's (21-24). Especially for patients who have a small breast and a large tumor or who are diagnosed with multifocal breast cancer, MLDF after partial mastectomy has been implemented in our clinic since 2010 and this has increased our breast protective surgery rate by 12.5% (3, 10, 25-27).

According to Spears et al. (28) article published in 2005, concerning stabilization and power of the shoulder joint, joint range of motion and functionality decrease after latissimus dorsi muscle transfer within the first 4 weeks after the implementation of LDF, there was a 30% decrease in shoulder function. These restraints affect daily life and free time activities negatively for the first 3 months after surgery. General functionality will return to the patients 6-12 months after surgery (28). Glassey et al. (29) assessed preoperative, postoperative, 6th week, 6th month and 1st year shoulder joint movement, power, pain and functionality levels of 22 patients who had LDF. In the results they obtained, they found that the assessments covering the period up to 6 months were poor, however after the first year, shoulder function recovered to a significant level (29). Button et al. (19) evaluated

preoperative, postoperative, 6th week, 3rd, 6th, 12th, 18th, 24th and 36th month shoulder functions of 58 patients who had LDF. Although they saw that Q-DASH scores decreased in each subsequent period, they reported that functional disability continued even in the long term, and that the patients receiving physiotherapy had better scores. They also reported that patients returned to preoperative values completely after 3 years (19). The relation of shoulder functions with the time given in these studies was not determined in our study. The reason for this is that while the LDF method has been used in the mentioned studies, we have used the MLDF method, which is less invasive.

Koh and Morrison (30) assessed latissimus dorsimuscle-skin reconstruction results in various patient groups (breast, upper extremity, head and neck patients) with the Q-DASH investigation form. 33% of the patients had changed their lifestyles because of dysfunction, and a clear majority of the patients stated that they had difficulty in overhead activities. It has been reported that this decrease in terms of functionality became clear especially between 6-12 months after the surgery (30). In our study, a serious functional loss in the upper extremity was found in 1.1% of the patients. In follow-ups 1 year after the operation for 22 patients diagnosed with breast cancer who had latissimus dorsi muscle-skin reconstruction, Glassey et al. (29) demonstrated that those who were operated on the dominant side recovered functionality over a longer time without having a decrease in muscle force or joint range of motion (29). In a prospective study, Forthomme et al. (31) evaluated 20 patients with whom they applied unilateral mastectomy and LDF reconstruction at the pre-operation, and post-operation 3rd and 6th months, and they reported that there was a restriction in overhead movements, especially among patients who were operated on the dominant side, and that there was no decrease in fine motor skills (31). In our study, we determined that having the operation on the dominant side had no impact on functionality.

Gosselink et al. (32) stated that 27% of 76 women with breast cancer who had ALND had continuous upper extremity functional disorders for 3 months after the surgery. In their studies in which shoulder functions of women to whom ALND was applied and only SLNB or no surgery were compared, Mansel et al. (33) determined that shoulder functions of women to whom ALND was applied were worse at the post-op 6th and 12th months. According to the results of our study, for all patients to whom BCS was applied, surgical interventions performed on axilla (SLNB/ALND) and MLDF affected shoulder functions and functionality in daily life activities adversely for up to one year. This exposure rate changed based on the type of surgical intervention performed. The gradation of surgical interventions affecting the upper extremity functions from minimum to maximum were as follows: Partial mastectomy + SLNB, Partial mastectomy + ALND, Partial mastectomy + SLNB + MLDF and Partial mastectomy + ALND + MLDF.

In conclusion, MLDF was applied to patients having a high tumor/breast ratio and diagnosed with multifocal/multicentric breast cancer as an alternative to reconstruction with subcutaneous mastectomy and prosthesis. Although with this method, which uses less latissimus dorsi muscle than latissimus dorsi muscle skin flap, led to less upper extremity functional disorders, the use of MLDF may cause upper extremity functional disorders in patients who require ALND.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Istanbul Science University (04.11.2014/25-17).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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References

- DeSantis CE, Bray F, Ferlay J, Lortet-Tieulent J, Anderson BO, Jemal A. International Variation in Female Breast Cancer Incidence and Mortality Rates. *Cancer Epidemiol Biomarkers Prev* 2015; 24: 1495-1506. (PMID: 26359465) [[CrossRef](#)]
- Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D, Bray F. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer* 2015; 136: E359-E386. (PMID: 25220842) [[CrossRef](#)]
- Özmen V. Breast Cancer in Turkey: Clinical and Histopathological Characteristics (Analysis of 13,240 Patients). *J Breast Health* 2014; 10: 98-105. (PMID: 28331652) [[CrossRef](#)]
- Cho J, Jung SY, Lee JE, Shim EJ, Kim NH, Kim Z, Sohn G, Youn HJ, Kim KS, Kim H, Lee JW, Lee MH. A review of breast cancer survivorship issues from survivors perspectives. *J Breast Cancer* 2014; 17: 189-199. (PMID: 25320616) [[CrossRef](#)]
- Ditsch N, Bauerfeind I, Vodermaier A, Tripp C, Löhns B, Toth B, Himsel I, Graeser M, Harbeck N, Lenhard M. A retrospective investigation of women's experience with breast reconstruction after mastectomy. *Arch Gynecol Obstet* 2013; 287: 555-561. (PMID: 23090185) [[CrossRef](#)]
- Cubasch H, Dickens C, Joffe M, Duarte R, Murugan N, Tsai Chih M, Moodley K, Sharma V, Ayeni O, Jacobson JS, Neugut AI, McCormack V, Ruff P. Breast cancer survival in Soweto, Johannesburg, South Africa: A receptor-defined cohort of women diagnosed from 2009 to 11. *Cancer Epidemiol* 2018; 52: 120-127. (PMID: 29306221) [[CrossRef](#)]
- Senkus E, Kyriakides S, Penault-Llorca F, Poortmans P, Thompson A, Zackrisson S, Cardoso F. Primary breast cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol* 2013; 24: 7-23. (PMID: 23970019) [[CrossRef](#)]
- Thiruchelvam PTR, McNeill F, Jallali N, Harris P, Hogben K. Post-mastectomy breast reconstruction. *BMJ* 2013; 347: 5903. (PMID: 24128977) [[CrossRef](#)]
- Alço G, Iğdem S, Okkan S, Dincer M, Sarsenov D, İlgun AS, Ağacayak F, Elbüken F, Ercan T, Selamoğlu D, Özmen V. Replacement of the tumor bed following oncoplastic breast conserving surgery with immediate latissimus dorsi mini flap. *Mol Clin Oncol* 2016; 5: 365-371. (PMID: 27699027) [[CrossRef](#)]
- Noguchi M, Saito Y, Mizukami Y, Nonomura A, Ohta N, Koyasaki N, Taniya T, Miyazaki I. Breast deformity, its correction and assessment of breast-conserving surgery. *Breast Cancer Res Treat* 1991; 18: 111-118. (PMID: 1912608) [[CrossRef](#)]
- Nos C, Fitoussi A, Bourgeois D, Fourquet A, Salmon RJ, Klough KB. Conservative treatment of lower pole breast cancers by bilateral mastoplastic and radiotherapy. *Eur J Surg Oncol* 1998; 24: 508-514. (PMID: 9870725) [[CrossRef](#)]
- Spector DJ, Mayer DK, Knafi K, Pusic A. Women's recovery experiences after breast cancer reconstruction surgery. *J Psychosoc Oncol* 2011; 29: 664-676. (PMID: 22035539) [[CrossRef](#)]

13. Winters ZE, Afzal M, Balta V, Freeman J, Llewellyn-Bennett R, Rayter Z, Cook J, Greenwood R, King MT. Prospective Trial Management Group. Patient-reported outcomes and their predictors at 2- and 3-year follow-up after immediate latissimus dorsi breast reconstruction and adjuvant treatment. *Br J Surg* 2016; 103: 524-536. (PMID: 26924354) [\[CrossRef\]](#)
14. Hamdi M, Decorte T, Demuyneck M, Defrene B, Fredrickx A, Van Maele G, De Pypere H, Van Landuyt K, Blondeel P, Vanderstraeten G, Monstrey S. Shoulder function after harvesting a thoracodorsal artery perforator flap. *Plast Reconstr Surg* 2008; 122: 1111-1117. (PMID: 18827644) [\[CrossRef\]](#)
15. Szychta P, Butterworth M, Dixon M, Kulkarni D, Raine C, Stewart K. Breast reconstruction with the denervated latissimus dorsi musculocutaneous flap. *Breast* 2013; 22: 667-672. (PMID: 23374963) [\[CrossRef\]](#)
16. Tomita K, Yano K, Nishibayashi A, Fukai M, Miyasaka M, Hosokawa K. The role of latissimus dorsi myocutaneous flaps in secondary breast reconstruction after breast-conserving surgery. *Eplasty* 2013; 13: 206-214. (PMID: 23837111)
17. Bhatt CR, Prajapati B, Patil DS, Patel VD, Singh BGP, Mehta CD. Variation in the insertion of the latissimus dorsi and its clinical importance. *J Orthop* 2013; 10: 25-28. (PMID: 24403744) [\[CrossRef\]](#)
18. Itani Y, Hagiwara A, Hashimoto T, Isogai N, Kusuhara H. Preliminary Study of PGA Fabric for Seromas at Latissimus Dorsi Flap Donor Sites. *Plast Reconstr Surg Glob Open* 2017; 5: e1499. (PMID: 29184727) [\[CrossRef\]](#)
19. Button J, Scott J, Taghizadeh R, Weiler-Mithoff E, Hart AM. Shoulder function following autologous LD breast reconstruction. A prospective three year observational study comparing quilting and non-quilting donor site techniques. *J Plast Reconstr Aesthet Surg* 2010; 63: 1505-1512. (PMID: 19819774) [\[CrossRef\]](#)
20. Düger T, Yakut E, Öksüz Ç, Yörükan S, Bilgütay BS, Ayhan Ç, Leblebicioğlu G, Kayihan H, Kırdı N, Yakut Y, Güler Ç. Reliability and Validity of the Turkish Version of the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire. *Fizyoter Rehabil* 2006; 17: 99-107.
21. Sajid MS, Betal D, Akhter N, Rapisarda IF, Bonomi R. Prevention of postoperative seroma-related morbidity by quilting of latissimus dorsi flap donor site: A systematic review. *Clin Breast Cancer* 2011; 11: 357-363. (PMID: 21705282) [\[CrossRef\]](#)
22. Hernanz F, González-Noriega M, Sánchez S, Paz L, Muñoz P, Hermana S. Oncoplastic breast conserving surgery with tailored needle-guided excision. *Gland Surg* 2017; 6: 698-705. (PMID: 29302488) [\[CrossRef\]](#)
23. Dixon JM, Venizelos B, Chan P. Latissimus dorsi miniflap: a new technique for extending breast conservation. *Breast* 2002; 11: 58-65. (PMID: 14965647) [\[CrossRef\]](#)
24. Mele S, Wright D, Paramanathan N, Laws S, Peiris L, Rainsbury R. Long-term effect of oncoplastic breast-conserving surgery using latissimus dorsi miniflaps on mammographic surveillance and the detection of local recurrence. *J Plast Reconstr Aesthet Surg* 2017; 70: 1203-1209. (PMID: 28734752) [\[CrossRef\]](#)
25. Jeevan R, Cromwell DA, Browne JP, Caddy CM, Pereira J, Sheppard C, Greenaway K, van der Meulen JH. Findings of a national comparative audit of mastectomy and breast reconstruction survey in England. *J Plast Reconstr Aesthet Surg* 2014; 67: 1333-1344. (PMID: 24908545) [\[CrossRef\]](#)
26. Smith S. Functional Morbidity Following Latissimus Dorsi Flap Breast Reconstruction. *J Adv Pract Oncol* 2014; 5: 181-187. (PMID: 25089217) [\[CrossRef\]](#)
27. Kim Z, Kang SG, Lee MH, Roh JH, Park JH, Lee J, Kim S, Lim CW, Lee MH. Skin-sparing mastectomy and immediate latissimus dorsi flap reconstruction: A retrospective analysis of the surgical and patient-reported outcomes. *World J Surg Oncol* 2012; 10: 259. (PMID: 23192102) [\[CrossRef\]](#)
28. Spear SL, Hess CL. A review of the biomechanical and functional changes in shoulder following transfer of the latissimus dorsi muscles. *Plast Reconstr Surg* 2005; 115: 2070-2073. (PMID: 15923857) [\[CrossRef\]](#)
29. 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: 1334-1340. (PMID: 18971716) [\[CrossRef\]](#)
30. Koh CE, Morrison WA. Functional impairment after latissimus dorsi flap. *ANZ J Surg* 2009; 79: 42-47. (PMID: 19183378) [\[CrossRef\]](#)
31. Forthomme B, Heymans O, Jacquemin D, Klinkenberg S, Hoffmann S, Grandjean FX, Crielaard JM, Croisier JL. Shoulder function after latissimus dorsi transfer in breast reconstruction. *Clin Physiol Funct Imaging* 2010; 30: 406-412. (PMID: 20633032) [\[CrossRef\]](#)
32. Gosselink R, Rouffaer L, Vanhelden P, Piot W, Troosters T, Christiaens M. Recovery of upper limb function after axillary dissection. *J Surg Oncol* 2003; 83: 204-211. (PMID: 12884231) [\[CrossRef\]](#)
33. Mansel RE, Fallowfield L, Kissin M, Goyal A, Newcombe RG, Dixon JM, Yiangou C, Horgan K, Bundred N, Monypenny I, England D, Sibbering M, Abdullah TI, Barr L, Chetty U, Sinnott DH, Fleissig A, Clarke D, Ell PJ. Randomized multicenter trial of sentinel node biopsy versus standard axillary treatment in operable breast cancer: the ALMANAC Trial. *J Natl Cancer Inst* 2006; 98: 599-609. (PMID: 16670385) [\[CrossRef\]](#)