

**Functional recovery after bilateral extended autologous latissimus dorsi breast reconstruction: A prospective observational study**

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## SUMMARY

**Background:** The impact of unilateral extended autologous latissimus dorsi (EALD) flap harvest and axillary surgery on shoulder function has been well described, but the impact of bilateral EALD flap harvest not clearly defined. Nor is it clear whether reconstructions should be synchronous, or staged.

**Methods:** In this prospective observational study, patients undergoing bilateral EALD breast reconstruction (February 2003 - December 2009) completed the disability, arm, shoulder and hand (DASH) questionnaire pre-operatively, and at five post-operative time-points. Intensive shoulder physiotherapy was offered to those whose DASH score was >30 at 6 weeks, or >20 at 12 weeks post-operatively.

**Results:** Sixty patients underwent bilateral EALD flap breast reconstruction (51 synchronous, 9 metachronous). Patients with pre-existing shoulder pathology (n=1) and those who failed to return any post-operative DASH questionnaire (n=10) were excluded from initial DASH analysis. However, these eleven patients were included in a separate analysis as an intention to treat analysis. A statistical analysis was performed using non-parametric, Friedman test and multiple comparison model. Forty-nine patients' DASH scores were analysed. DASH score initially increased after surgery then returned to functionally normal within 3-6 months (median DASH: pre-operative=1 vs. 6 weeks post-operative=26,  $P<0.001$ ; vs. 3 months=19,  $P<0.001$ ; vs 6 months=13,  $P<0.001$ ; thereafter the scores remained less than 12  $P<0.001$ ). Median DASH score after synchronous reconstruction was not higher than after metachronous reconstructions, although the metachronous sample size was small.

**Conclusion:** With appropriate patient selection and intensive physiotherapy bilateral EALD breast reconstruction does not appear to cause significant longterm impairment of shoulder function, and patients can now be counselled about the likely timecourse of shoulder recovery. There seems no reason to stage bilateral reconstruction in order to reduce shoulder morbidity.

## **INTRODUCTION**

The latissimus dorsi flap is a reliable, versatile and frequently used method in reconstructive breast surgery.<sup>1-3</sup> In 1998, Delay demonstrated that the extended latissimus dorsi flap is able to offer adequate volume for breast reconstruction and minimise the need for an additional prosthesis.<sup>2,4</sup> Accordingly, the extended autologous latissimus dorsi (EALD) flap accounted for 49% of all breast reconstructions in the Canniesburn Plastic Surgery Unit (2010-2011). The impact upon upper limb function after unilateral reconstruction was previously studied in detail, using the Disabilities, Arm, Shoulder and Hand (DASH) questionnaire – the timecourse of recovery and longterm functional outcomes were favourable, with no deleterious effect of donor site quilting found.<sup>3</sup>

Approximately 10% of all EALD breast reconstructions in the Canniesburn Plastic Surgery Unit are bilateral, and the frequency is increasing due to a pro-active risk stratification and prophylactic mastectomy.<sup>5,6</sup> Reconstructions are performed either in one procedure (synchronous) for bilateral disease, or at different time-points (metachronous) for metachronous contralateral disease or risk reduction. The impact upon shoulder and upper limb function of these bilateral EALD procedures is not known. This study therefore established the timecourse of functional recovery in such patients, using the DASH questionnaire.

## **PATIENTS AND METHODS**

This was a prospective observational study with blinded data interpretation by an independent statistician. All patients undergoing bilateral EALD flap breast reconstruction within the Canniesburn Plastic Surgery Unit between February 2003 and December 2009 were recruited (n=60, 51 synchronous & 9 metachronous), and their clinical and demographic data analysed (Table 1).

Patients were appropriately counselled and had selected their reconstructive technique prior to recruitment. This study did not impact upon patient care.

### **Operative technique**

Cases comprised a mixture of immediate (mainly skin-sparing mastectomy) and delayed reconstructions. Some cases involved delayed reconstruction of one breast and immediate reconstruction of the other. A previously described surgical technique<sup>3</sup> was used, similar to that described by Delay.<sup>2,4</sup> Fat was not harvested from the lower lumbar area because previous audit had demonstrated excessive fat necrosis (unpublished data).

Bilateral synchronous EALD breast reconstructions undertaken by a single operator were performed one side at a time, with inseting finalized bilaterally after being returned to the supine position. When dual operators were present, both breast pockets were created with the patient supine, before turning prone to raise both flaps and pass them into the breast pockets. The patient was turned supine for final inseting. Metachronous reconstructions were performed as was previously described for unilateral reconstructions.<sup>3</sup>

In all reconstructions donor site closure was obtained over vacuum suction drains (Exudrain™, Astratec, Sweden) using deep (3/0 Vicryl™, Ethicon, U.K.) followed by subcuticular absorbable sutures (Vicryl™/Monocryl™ Ethicon, U.K.). The practice of donor site quilting (2/0 polydioxanone, PDSII™, Ethicon, UK) depended upon surgeon's preference (28/60 of all cases; 22/49 of cases followed with DASH questionnaire).

### **Post-operative Care**

An active shoulder exercise programme was initiated on the first post-operative day.<sup>3</sup> Prior to discharge (after drain removal when <50ml/24 h, or post-operative day 7-10), patients were instructed on a home exercise programme, and given a written handout to follow. They were advised to continue the illustrated exercises until post-operative day 14, then to gradually increase range of movement. Physiotherapy follow-up was not routinely provided. Patients who showed slow recovery at 6 weeks (DASH score >30) and 3 months (DASH score >20) were contacted and offered intensive outpatient physiotherapy. All patients attended nurse led dressing and breast care clinics as appropriate, in addition to surgical reviews.

### **Primary outcome measure – DASH**

Patients were invited to complete the DASH questionnaire pre-operatively (on admission prior to surgery) and at the following five post-operative time-points: 6 weeks, 3, 6, 12 months and at a subsequent final timepoint (12-36 months). Response rates were variable at different time-points (Table 2), and lowest at the 6 month timepoint (22 of 60 patients).

### **Secondary outcome measures**

In keeping with previous work<sup>3</sup>, relevant demographic data (age, chest circumference, cup size), co-morbidities, surgical treatment (timing of mastectomy and axillary dissection relative to reconstruction, adjuvant chemotherapy, radiotherapy, or hormonal management), presence of pre-existing shoulder conditions, intra-operative details (operative time, division of latissimus dorsi tendon or thoracodorsal nerve) and length of hospital stay were prospectively recorded. Post-operative complications including wound dehiscence, formation of persistent donor site seroma (defined as serous collection requiring more than two aspirations), or those indicating re-operation were also recorded.

### **Statistical analysis**

DASH scores were analysed from returned questionnaires, pre-operative and five post-operative time-points; and at each analysis  $p < 0.01$  indicated a statistically significant difference between the timepoints. Clinical data were extracted from prospective records by a blinded assessor. Statistical analysis of the anonymised dataset was undertaken by an external, blinded, senior statistician. The Friedman-test was used for the DASH analysis of global cohort. Mann-Whitney Test was used for analysis of the metachronous cohort, due to small sample size.

## **RESULTS**

### **Description of cohort**

Demographic and oncological data are summarised in Table 1. Patients were aged 25-69 years old (median 47). Forty-two patients had undergone axillary dissection, 34 had adjuvant radiotherapy and 44 received cytotoxic chemotherapy.



Metachronous bilateral reconstructions (BMEBR, N=9) were performed a median of 18 months apart. Synchronous bilateral reconstructions (BSEBR, N=51) were for immediate reconstruction of bilateral mastectomy (N=37), for delayed reconstruction after previous bilateral mastectomy (N=9), or for synchronous reconstruction after previous unilateral mastectomy (delayed side) and subsequent contralateral mastectomy (immediate side) (N=5).

All patients returned the pre-operative DASH questionnaire, returns at later timepoints were: 49/60 at 6 weeks (82%), 45/60 at 3 months (75%), 22/60 at 6 months (36%), 47/60 at 12 months (78%) and 48/60 at the final timepoint (80%).

Eleven patients did not return any postoperative DASH questionnaire, therefore we analysed data on patients who returned questionnaire at various timepoints and separately on all sixty patients on an intention to treat basis.

### **Surgical outcome data**

Median operative duration for bilateral EALD breast reconstruction was 7 hours (range 4 to 11 hours), and inpatient stay was 8 days (range 4 -10 days). Three patients (5%) required early reoperation for breast wound dehiscence (N=2 treated by split-thickness skin grafting, N=1 by direct closure), and two donor site infections were managed conservatively. Seven patients developed persistent donor site seroma (sufficient to indicate aspiration – 6 had no quilting and one quilting primarily), six were managed with aspiration and one required excision of seroma cavity and quilting of skin flaps. Nine received lipofilling to enhance breast contour (N=8) or for fat necrosis (N=1).

No flaps were lost, and no venous congestion was noted. No patient developed thromboembolic disease, fluid overload, significant basal atelectasis or respiratory infection/distress, ileus or delayed gut function, or necrotising infection.

### **Timecourse of change in DASH score after bilateral EALD breast reconstruction**

DASH score after all bilateral EALD breast reconstruction patients at all timepoints is illustrated in Table 2 and Figure 1 & 2.

Statistical analysis was restricted to the datasets obtained from patients who returned post-operative DASH questionnaires (N=49), median DASH scores at 6 weeks and 3 months after surgery were significantly elevated from the pre-operative score (minimal clinically significant change = 12.7 points; median increase from pre-operative DASH after 6 weeks=25, after 3 months=18; both  $P < 0.001$ ). The scores then improved (median DASH score, 6 months= 13,  $p < 0.001$ ; 12 months=12,  $p < 0.001$  and final timepoint=10,  $p < 0.001$ ). Final functional outcome was ‘functionally normal’, since the median DASH score remained  $< 14$ .<sup>26</sup>

Intention to treat analysis (including the eleven patients who returned a pre-operative DASH questionnaire but no post-operative questionnaire) gave a similar pattern of results – scores were statistically significantly elevated at only 6 weeks and 3 months after surgery (median DASH score preoperative=1; 6 weeks=25, 3 months=20, both  $p < 0.0001$ ). The final outcome after 6 months remained ‘functionally normal’  $< 14$  (Table 3).

### **DASH scores at 6 weeks and 3 months after EALD flap breast reconstruction correlate with long-term outcome**

Twenty of forty-nine patients (40%) returning scores at 6 weeks had DASH score >30, and 17 of 45 (37%) returning scores at 3 months had DASH >20. This group was identified as at risk of developing poor outcome and offered additional physiotherapy.

### **Synchronous vs. metachronous bilateral EALD reconstruction**

Comparison of the DASH scores obtained from patients that underwent synchronous bilateral EALD breast reconstruction against those from patients that underwent metachronous bilateral EALD breast reconstruction (Figure 3) revealed that scores were higher in the metachronous group at all time-points studies (Table 4). That difference was not clinically (ie. >12.7 points difference) or statistically significant at the 5% level (most likely due to small sample size in the metachronous group). This observation remained similar within the intention to treat analysis. Recovery from synchronous bilateral EALD breast reconstruction is no worse than that occurring after each episode of metachronous reconstruction, and there is a trend towards better functional recovery after synchronous bilateral breast reconstruction.

## **DISCUSSION**

Breast cancer occurs bilaterally in 2–12% of women.<sup>7,8</sup> The published risk of synchronous contralateral breast cancer varies from 1-3%, and of metachronous contralateral disease is 1-12% of patients. The risk of developing any contralateral breast cancer is 1-5% per annum.<sup>9-13</sup> Furthermore, the increased availability of genetic and other breast cancer risk assessments tools has made risk reducing interventions (including prophylactic mastectomy<sup>14</sup>) more common, also increasing the need for bilateral breast reconstruction.

Options for breast reconstruction after mastectomy include implant-based techniques, and those solely employing autologous tissue. Implant based reconstruction is an attractive, easy and convenient option, but the results may worsen over time, especially after radiotherapy.<sup>15</sup> In contrast, autologous reconstructions place greater demand on the patient in the short term, but give more natural consistency with the native breast<sup>16</sup>, and a reduced need for subsequent revision. Paolini et al<sup>17</sup> presented a lower complication and reoperation rate than that published after bilateral implant with latissimus dorsi flap reconstruction (50%).

The most commonly used techniques for autologous breast reconstruction are pedicled or free abdominal flaps, and latissimus dorsi flaps that may either be extended, or combined with a prosthesis. The free abdominal flap in its various forms has become a routine and highly effective technique for breast reconstruction,<sup>18,19</sup> but it has certain disadvantages that potentially include longer anaesthesia, protracted postoperative convalescence, abdominal pain, respiratory splinting, possible reduction of abdominal wall strength<sup>20</sup>, and partial flap failure<sup>21</sup>. Complete flap loss occurs in a small percentage of every large reported series. Potentially life-threatening complications (e.g. pulmonary embolism<sup>21</sup>, abdominal necrotising fasciitis<sup>22</sup>) are rare, but reported with greater frequency than for other reconstructive techniques.

Additionally, other patient factors such as diabetes mellitus, tobacco smoking, chest wall radiotherapy, abdominal scars, and obesity can affect outcome<sup>23,24</sup>. However, the autologous latissimus dorsi is able to offer satisfactory outcomes even for these high-risk patients and the extended flap can provide sufficient volume for implant-free breast reconstruction.<sup>2,3,23,24</sup>

Published literature suggests that, on balance, there is no significant longterm impact upon shoulder function from latissimus dorsi transfer, when assessed by a range of outcome measures<sup>3,25,26</sup>, although all studies document temporary shoulder dysfunction, and infrequent patients with more noticeable longterm deficits.<sup>2,27</sup> The physical assessment methods used could be challenged<sup>28,29</sup>, but more robust studies have suggested the presence of some loss of power and endurance.<sup>30</sup> Pedicled transfer was also associated with mildly reduced function in certain activities (e.g. ladder climbing, painting above shoulder level and pushing up from a chair), although free flap transfer was not. Spear and Hess<sup>31</sup> concluded that patients may experience deficits in adduction and extension during overhead or prolonged function, but no decrease in the range of shoulder motion. The relative impact of latissimus dorsi transfer, as opposed to mastectomy or axillary treatment in breast reconstruction has not been clearly defined, and the majority of patients do not describe any significant impact upon daily function.<sup>3,27</sup>

The DASH questionnaire for shoulder function assessment has been recognized as a simple, reliable and an acceptable functional assessment tool.<sup>3,32</sup> Based on a 30 item self-administered questionnaire, it measures the patient reported global functional deficit rather than focusing only on isolated movements. The score is calculated using DASH formula, where a score of 0 correlates to no functional deficit and 100 correlates maximum functional impairment. Evidence suggests that a DASH score of 20-30 indicates a level of function enabling to work, whereas that of 50-60 indicates inability to work and impairment of activities of daily living. To differentiate a true change in clinical status from potential measurement error requires a minimum change of 12.7 points (MDC95).<sup>3,32</sup>

After unilateral EALD breast reconstruction Button et al<sup>3</sup> demonstrated a statistically and clinically significant increase in DASH score at the initial post-operative review and up to 3 months after surgery. Shoulder function then returned to normal, and remained so 3 years after surgery. This study demonstrates the same pattern of recovery, and lack of longterm deficit, after bilateral EALD breast reconstruction. Recovery from synchronous bilateral reconstruction was no worse than after unilateral reconstruction, or after each episode of bilateral staged reconstruction.

Koh and Morrison<sup>33</sup> report a retrospective assessment of bilateral non-extended ALD reconstructions, applying the DASH questionnaire at one post-operative timepoint by telephone, in contrast to established DASH methodology. Only four bilateral cases were reported, with no comment as to whether reconstructions were synchronous or metachronous. One case had a DASH score of 31. Although it was concluded that bilateral LD flap harvest can cause significant deficits in sporting ability and warned against use, there are obvious methodological weaknesses to the study including lack of pre-operative screening for shoulder dysfunction. Paolini et al<sup>17</sup> reported one-off DASH score >12 months after delayed metachronous implant with latissimus dorsi flap reconstruction, and showed infrequent functional deficit to relate to revisionary surgery due to complications. The results of this study show that the overwhelming majority of patients do not develop significant shoulder dysfunction, and that the complication profile and recovery time is favourable in comparison to that of bilateral DIEAP flap reconstruction.

Yang et al<sup>34</sup> conducted a prospective study of physical and functional disability and quality of life after immediate latissimus dorsi flap reconstruction, by

using manual muscle test, range of motion and DASH. The DASH analysis was performed pre-operative and three post-operative time-points (3 months, 6 months and 12 months). The authors reported significant increase in the functional disability at 3 months (Mean scores at 3 months, 18.0 +/- 8.89,  $p < 0.001$ ) and reduced but persistently elevated at 12 months (Mean scores at 12 months 13.8 +/- 4.25,  $p < 0.001$ ). The authors concluded shoulder strength and range of motion returned to baseline but functional disability persisted at one year after reconstruction. They also reported confounding factor of high drop out rate of their cohort (91 recruited and 31 analysed), small sample size and suggested a long-term follow-up.

Use of the EALD flap also seems more pertinent than the DIEAP for the unilateral autologous reconstruction case in whom risk stratification indicates an increased possibility of subsequent contralateral mastectomy. In these patients the same reconstruction could then be used for the metachronously for the contralateral breast, if required, optimizing reconstructive symmetry.

We believe women should be appropriately counselled regarding options for breast reconstruction, and that the selection of technique should be individualised. Women should be screened to detect those with high sporting / occupational shoulder function requirements, or pre-existing shoulder pathology, and should complete a DASH questionnaire to further detect those at risk of shoulder dysfunction from EALD breast reconstruction. These groups should carefully consider whether the EALD flap is the right reconstruction for them. However the majority of women can be advised that they will develop mild-moderate shoulder symptoms for around 6-12 weeks, and then return to essentially normal function. There is no objective reason to avoid the use of the EALD flap for bilateral reconstructions, and synchronous reconstruction offer the patient the least downtime. As for unilateral reconstruction, it

seems pertinent to screen for a high DASH score at 6 weeks after surgery, and target those patients with more intensive physiotherapy with the aim of improving long-term function.

Future studies should delineate the impact of EALD flap use in patients with challenging shoulder functional requirements (e.g. high-level gymnasts, golfers, swimmers, etc.).

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Table 1: Demographic & cancer management summary data

BEBR Cohort	
N	60
Age	47 years (range 25-69)
BMI	26 (range 20-37)
Smoker	16 of 60
Chest circumference (median)	36 (range 32-42)
Cup size (median)	C (range A-E)
Pre-operative DASH (median)	1; Interquartile range 7
Immediate vs Delayed reconstruction	45 vs 15*
Axillary dissection	41 of 60
Axillary radiotherapy	34 of 60
	19 prior to reconstruction
	14 subsequent
	1 pre & post reconstruction
Cytotoxic chemotherapy	44 of 60
	20 prior to reconstruction
	20 subsequent
	1 synchronous
	3 pre & post reconstruction

\*\*of 15 metachronous reconstructions, 6 unilateral mastectomy cases underwent delayed ipsilateral reconstruction plus delayed contralateral mastectomy and immediate reconstruction; 9 bilateral mastectomy cases underwent a unilateral delayed reconstruction followed by another unilateral reconstruction. BEBR – Bilateral EALD Breast Reconstruction.

Table 2: Descriptive statistical analysis of DASH scores of BEBR. (BEBR - Bilateral EALD Breast Reconstruction)

Timepoint	N at Timepoint	Median	Range	Interquartile Range
Pre-Op	60	1	0 - 77	0 - 7
6 weeks	49	26	3 - 82	3 - 44
3 months	45	19	1 - 57	1 - 38
6 months	22	13	0 - 49	0 - 21
12 months	47	12	0 - 53	0 - 20
12-36 months*	48	10	0 - 48	6 - 16

\*Final timepoint;

Table 3: Descriptive analysis of DASH score in all BEBR with intention to treat analysis. The last DASH score of all patients were analysed at each timepoint.

Timepoint	N at Timepoint	Median	Range	<u>Interquartile Range</u>
Pre-Op	60	1	0 - 77	0 - 7
6 weeks	60	25	0 - 82	19 - 39
3 months	60	20	0 - 82	9 - 33
6 months	60	13	0 - 82	0 - 21
12 months	60	13	0 - 82	7 - 22
12-36 months*	60	10	0 - 82	6 - 21

\*Final Timepoint, BEBR – Bilateral EALD Breast Reconstruction

Table 4: Descriptive analysis of DASH scores in BSEBR and BMEBR.

Timepoint	Group	N at Timepoint	Median	Range	Interquartile Range
Pre-op	M	9	0	0-22	0-5
	S	51	1	0-77	0-8
6 weeks	M	8	33	16-80	26-54
	S	41	25	3-82	21-42
3 months	M	8	29	9-50	18-44
	S	37	19	1-57	8-32
6 months	M	4	15	12-33	12-29
	S	18	13	0-49	8-21
12 months	M	8	21	1-45	11-38
	S	39	12	0-53	7-16
12-36months*	M	8	17	1-45	10-38
	S	40	9	0-48	6-15

\*Final timepoint; BSEBR - Bilateral Synchronous EALD Breast Reconstruction;  
BMEBR – Bilateral Metachronous EALD Breast Reconstruction



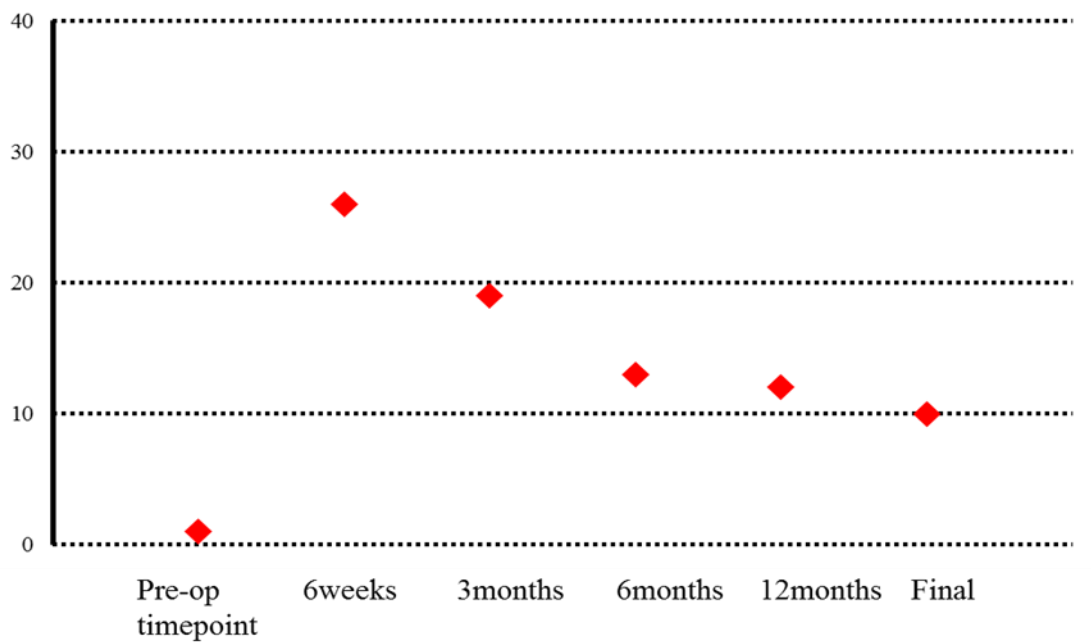


Figure 1: Timecourse of change in median DASH score after whole bilateral EALD breast reconstruction (BEBR) cohort. The median DASH scores (X-axis) and various timepoints (Y-axis). The median DASH scores were significantly elevated at 6 weeks and 3 months post-operatively  $p < 0.01$ , but remained less than to 14 (functionally normal).

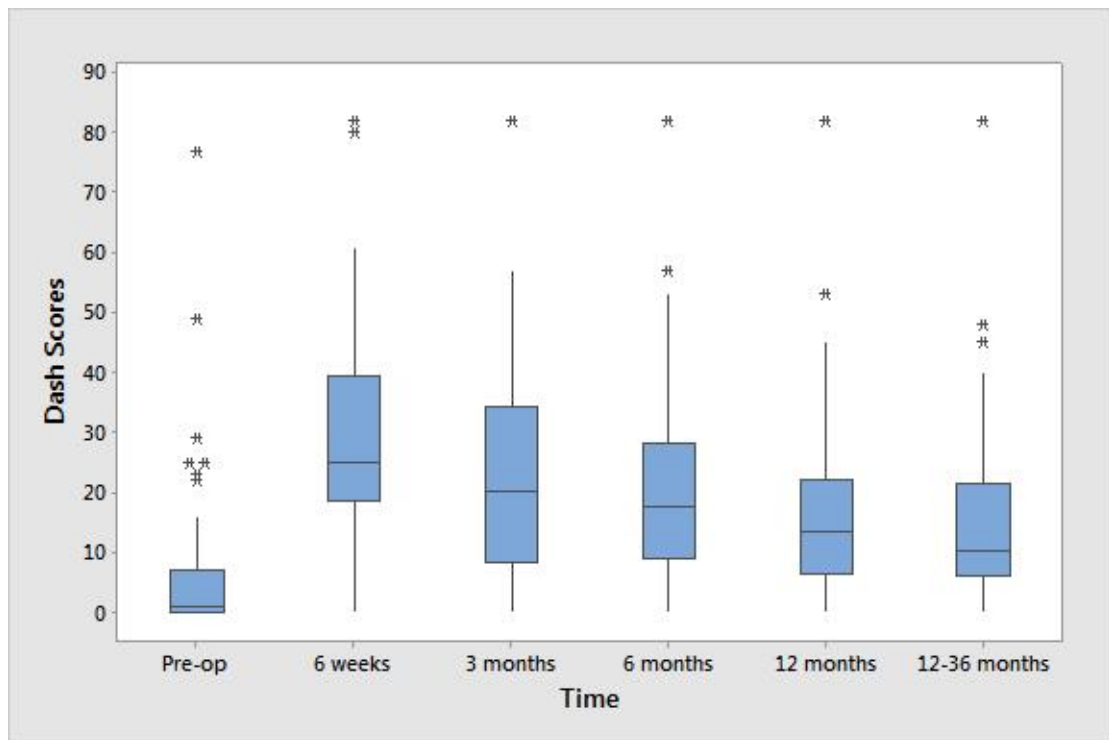


Figure 2: The box and whisker plot shows the distribution of DASH scores over time, i.e. Pre-operative, and 5 postoperative time points. The box denotes median (central bar of the box), interquartile range (upper and lower end of the box) and range (minimum and maximum; vertical lines extending from the box - *whiskers*); \* shows outliers in the data set.

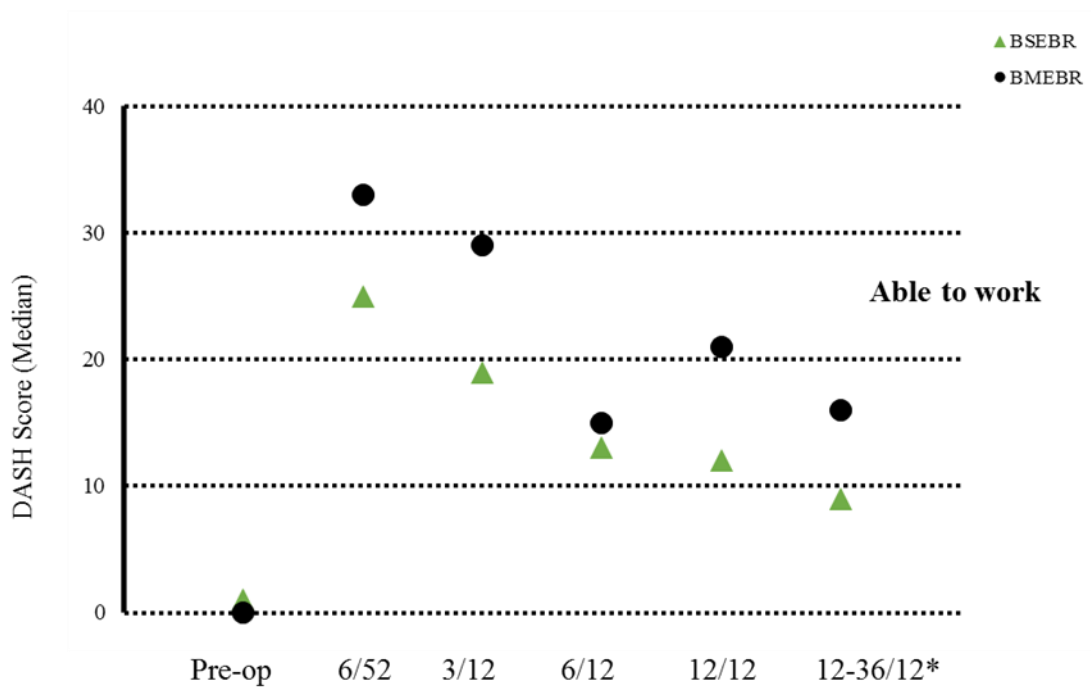


Figure 3: Timecourse of change in DASH score after BSEBR vs BMEBR. (BSEBR - Bilateral Synchronous EALD Breast Reconstruction; BMEBR - Bilateral Metachronous EALD Breast Reconstruction; \* Final timepoint)