



Shoulder function following oncoplastic breast conserving surgery—a narrative review

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Background and Objective: The high prevalence of breast cancer survivors makes it very relevant to investigate late morbidity following the treatment. Oncoplastic breast conserving surgery (OPS) has gained great popularity over the past years, and evidence-based knowledge suggest better prognosis for treatment with breast conserving surgery (BCS) compared to mastectomy. The aim was to investigate if OPS causes late effects on an acceptable level compared to what we know about breast surgery causing late effects.

Methods: Using the Medical Subject Headings (MeSH) terms “Breast Neoplasms”, “shoulder”, “oncoplast*”, and “reconstruct*”, the databases PubMed, Embase, and Scopus were searched on the 6th of June 2023. The literature search was managed in Covidence. We focused on studies describing late effects especially shoulder function including restrictions in mobility, reduced strength, as well as functional impairment.

Key Content and Findings: Nine studies fulfilled the inclusion criteria. Different kinds of oncoplastic procedures were described—most of them described volume replacement procedures. The knowledge of shoulder morbidity following OPS is limited. The heterogeneity in the selected studies was broad. Some of the studies were small and there was a considerable variation in follow-up time. They described shoulder function based on several different evaluation methods [range of motion (ROM), Disabilities of the Arm, Shoulder, and Hand (DASH), Quick-DASH (Q-DASH), Shoulder Pain and Disability Index (SPADI), health-related quality of life (HRQoL), and non-validated subjective questionnaires]. All studies found acceptable levels of shoulder morbidity.

Conclusions: The requisite knowledge of late effects following OPS is still not available for unambiguous recommendations. This narrative review has elucidated the knowledge and has reached a conclusion based on review of the existing literature of this item. We found that the risk of decreased shoulder function caused by OPS—volume displacement as well as volume replacement—does not exceed the risk of shoulder problems seen after BCS and mastectomy with or without immediate reconstruction. Therefore, OPS can be considered if conventional BCS is not possible. But the knowledge of shoulder function after OPS is limited, and studies comparing shoulder function after OPS, BCS and mastectomy with or without immediate reconstruction are warranted.

Keywords: Breast cancer (BC); shoulder morbidity; shoulder function; shoulder mobility; range of motion (ROM)

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Introduction

The high prevalence of breast cancer (BC) survivors makes it highly relevant to investigate late morbidity following the treatment. During the last decades, increased focus has been on late effects following the treatment of BC (1,2). The most important and prevalent late effects following BC surgery are lymphoedema, pain, as well as shoulder and arm morbidity (3-10). Besides, the cosmetic outcome is important to the women (11,12).

The risk of shoulder and arm morbidity following mastectomy with or without reconstruction is described in a recent review by Klein *et al.* (10). They found increased risk of locoregional morbidity following mastectomy compared to breast conserving surgery (BCS), and a risk of pain and functional deficits following mastectomy with reconstruction. Lauridsen *et al.* compared Constant Shoulder Score in patients having a mastectomy to patients having BCS. A higher risk of shoulder disability was seen among the group of mastectomized women, but the difference was non-significant unless the mastectomy was followed by radiation therapy (RT) to the chest wall (13).

Axillary surgery, especially axillary lymph node dissection (ALND), is known to be a risk factor for shoulder morbidity (1,14). Especially if followed by radiotherapy (4,10). Axillary surgery has been de-escalated during the last decades, and RT has been optimized by improved targeting and dose reduction. De-escalation of axillary surgery decrease the risk of late effects (14), but with the very good prognosis and many long-term survivors of BC, we must still focus on planning optimal surgery with as few late effects as possible, not only to the axilla, but also surgery of the breast.

Evidence-based knowledge assess a better overall survival of patients undergoing BCS *vs.* mastectomy, recommending BCS as the best treatment option for early BC. Indications to mastectomy for instance locally advanced BC still remain valid (15,16). The reason for the better prognosis is not fully understood, but it is speculated that the reason might be the RT following BCS leading to the abscopal effect (17). Another explanation might be the less invasive trauma of BCS compared to mastectomy, where the risk of triggering dormant tumour cells thereby facilitating relapse, is believed to be increased (18).

With the broad spectrum of oncoplastic breast conserving surgery (OPS) techniques, the possibilities of performing BCS as an alternative to mastectomy increases (19). If not only the survival benefit but also the risk of

locoregional morbidity is as good or maybe even better for OPS, we should advise the patient to opt for BCS with oncoplastic techniques even if the lesion is large.

BCS means that only the cancer is removed (lumpectomy) with a margin of non-affected breast tissue followed by minor intramammary corrections. OPS covers a broad spectrum of different surgical techniques based on the integration of plastic surgery. A consensus from The American Society of Breast Surgeons was established in 2019, where OPS was divided in two main categories (20):

- ❖ Volume displacement—lumpectomy including redistribution of the resection volume over the preserved breast. Divided into two levels: level I, where less than 20% breast tissue is removed; level II, where 20–50% of breast tissue is removed.
- ❖ Volume replacement—lumpectomy, where volume is added using flaps or implants to correct the defect.

The evidence of the oncological safety and re-resection rate following OPS has been established in several studies (21-28). They report high overall survival rates and disease-free survival after OPS. Re-excision rates in the range 2.7% to 6.0% have been reported in OPS (25,29).

The overall risk of complications following OPS, which seem to be related to larger resection size, displacement of larger volumes, and longer scars, has been estimated to range from 9% to 38% (30-32). A meta-analysis from 2014 showed no significant difference in complication rates whether BCS was performed with or without OPS (21). It has been reported that some complications may delay and negatively affect subsequent adjuvant RT (33). On the other hand, delayed onset of chemotherapy has not been demonstrated (34,35).

A high level of excellent cosmetic outcome for BCS as well as OPS was demonstrated by Santos *et al.* with best results for OPS (36). Cosmetic results favoured OPS compared to mastectomy with immediate reconstruction (MxIR) (11).

The knowledge of late effects following BCS with and without oncoplastic surgery followed by RT is limited. If simple BCS is not possible the alternative has traditionally most often been mastectomy with or without immediate reconstruction.

The key question is if OPS causes late effects to the shoulder and arm on an acceptable level when compared to other surgical techniques of the breast. The main focus in this narrative review is shoulder function including restrictions in mobility, reduced strength, as well as functional impairment.

We present this article in accordance with the Narrative Review reporting checklist (available at <https://gs.amegroups.com/article/view/10.21037/gS-23-530/rc>).

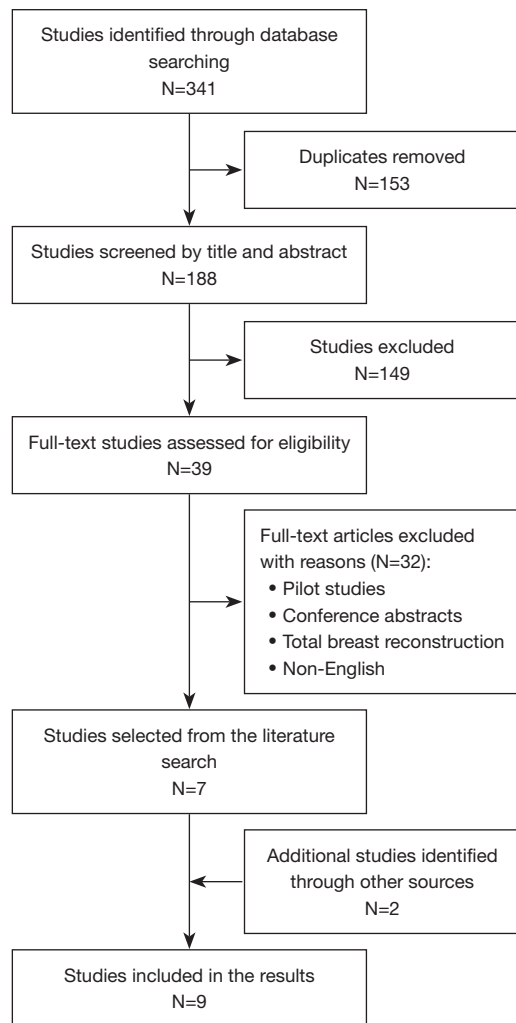


Figure 1 Flow chart regarding selection of included studies.

Methods

This narrative review aimed to examine the evidence on late effects following OPS focusing on shoulder morbidity.

Using the MeSH Terms “Breast Neoplasms”, “shoulder”, “oncoplast*”, and “reconstruct*”, the PubMed database was searched for relevant literature on the 6th of June 2023 and a similar search was done in Embase and Scopus. An update was made on November 28th, with no further results. All study types were eligible and at first there was no language restrictions or definite period of time.

The results from the literature search were managed in Covidence (www.covidence.org). After initial removal of duplicates (N=153), a total of 188 papers were left. Their titles and abstracts were screened for relevance by at least two of the authors, leaving 39 papers for a full text review. Eligibility criteria was: studies examining OPS reporting results concerning shoulder and arm function. Furthermore, only studies with full text available in English were included. We excluded non-human studies, conference abstracts, pilot studies, and papers where OPS was a part of total breast reconstruction. The full text review resulted in inclusion of seven papers. During the process, the reference lists of relevant publications were screened for supplementary studies, and two more articles were added (*Figure 1, Table 1*).

Each step of the screening was done by at least two independent authors, and the findings were compared. Discussion solved disagreements.

Key contents and findings

In general, OPS has limited postoperative complications (11,30,37), low re-resection rates (25,29), and the cosmetic outcome is acceptable with high patients’ satisfaction (11,36-38). Furthermore, OPS is safe with high overall and disease-free survival rates (21,23-25).

Table 1 The search strategy summary

Items	Specification
Date of search	6 th June 2023
Databases and other sources searched	PubMed, Embase, Scopus
Search terms used	“Breast Neoplasms”, “shoulder”, “oncoplast*”, and “reconstruct*”
Timeframe	Up to June 2023
Inclusion criteria	All study types; English texts only
Selection process	At least two authors (M.D.L. & K.R.H.) screened the titles and abstracts

The knowledge of shoulder morbidity following OPS in general is limited, and few studies focus on the issue. In the present literature search, only nine relevant papers were identified (Table 2). Only two of them, Hauerslev *et al.* and Rose *et al.*, included volume displacement. Both of them included volume replacement too, and did not differentiate between the surgical techniques (38,39). The rest of the studies only described volume replacement.

In an observational study, Zhou *et al.* compared shoulder morbidity in two groups: latissimus dorsi (LD) mini-flap *vs.* conventional BCS (depending on the need for replacement of volume) and found the LD mini-flap an excellent additional technique to conventional BCS according to shoulder morbidity (40). With a follow-up of 1 year, the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used, and an objective evaluation of range of motion (ROM) and muscle strength was made. In their conclusion, the patients having a LD mini-flap OPS enabling larger excision had a low risk of postoperative complications, a high level of aesthetics, and minimal functional impairment. All the patients had received ALND and RT, and no description of the extent of RT was given, which makes it difficult to judge the effect of the breast surgery, as the axillary surgery and RT is assumed to affect the shoulder function and thereby blurring the effect of the breast surgery.

In the small cohort study by Hamdi *et al.* 63% of the 22 included patients had ALND—RT was not consequent in all patients. This reduce the strength of the conclusion, saying donor site morbidity following thoracodorsal artery perforator (TDAP) flap was reduced to a minimum (41). They focused on donor site morbidity and compared the operated sides to the non-operated sides by measuring strength, LD thickness and shoulder mobility by ROM. The ROM was equal on both sides in most directions except active and passive forward elevation and passive abduction. The muscle strength and thickness of LD was preserved.

The systematic review from Mangialardi *et al.* was based on studies reporting on the use of the TDAP and included among others the study by Hamdi *et al.* and a randomised controlled trial (RCT) by Abdelrahman *et al.* (37,41,42). Five of the 12 included studies reported on shoulder function following oncoplastic surgery. None of them reported severe shoulder morbidity. A broad spectrum of evaluation methods was used in the studies, but despite that, the review concluded that OPS with TDAP is safe and has low morbidity.

The cross-sectional study by Rose *et al.* compared

96 BC patients treated with OPS to 631 BC patients treated with conventional BCS (39). Of the 96 OPS patients, 32 had level I and 64 had level II OPS surgery. Level I was defined as adaption and minor mobilisation of glandular tissue with or without repositioning of the nipple-areola-complex. Level II OPS comprised reduction mammoplasty, volume displacement, and volume replacement techniques. The patients were identified from the Danish Breast Cancer Cooperative Group (DBCG) registry and evaluated by patient-reported outcome measure (PROM) using the Breast-Q and a study-specific questionnaire. The response rate was 48.3%. They found no clear difference in physical well-being evaluated by the health-related quality of life (HRQoL) even though it was indicated that the OPS group comprised BC patients with a more advanced disease stage.

Another cross-sectional study including 174 patients divided into four groups with difference in axillary surgery [ALND *vs.* sentinel node (SN)] as well as in breast surgery (BCS *vs.* LD mini-flap reconstruction) found a negative impact on shoulder function for the group treated by the combination of ALND and LD mini-flap (43). This may speak to the favour of conventional BCS over LD mini-flap OPS in combination with ALND. The shoulder function was evaluated by Quick-DASH (Q-DASH) and the median follow-up time was 24 months with a very wide range of 3–108 months making the results difficult to compare.

The mean follow-up time in the cross-sectional study by Aristokleous *et al.* was 24 months and, like in the above-mentioned study, with a wide range (2–55 months) (44). They compared OPS and BCS in 215 BC patients and found for both surgery types that they affected physical function evaluated by DASH and Breast-Q, without any difference between surgery types. RT and SN did not adversely affect the outcome but was however not described in detail. The performed OPS was therapeutic mammoplasties, reductions, or volume replacement by chest wall perforator flaps (CWPF). The aim of the study was to compare the difference in PROMs when the patients were submitted to preoperative standardized surgical assessment and shared decision-making and the conclusion supported that these tools may de-escalate OPS.

Kelsall *et al.* compared mastectomy with MxIR (281 patients) including deep inferior epigastric perforator (DIEP) flap with OPS including therapeutic mammoplasty and CWPF (286 patients) in two unmatched and afterwards case-matched cohorts. An institution-specific questionnaire revealed favouring of OPS according to “return to full function and activity” (11). Even if the OPS group that

Table 2 Selected articles

Authors	Study type	OPS type	Included patients	Follow-up (months)	Shoulder function evaluation method	Results	Axillary surgery	Radiation therapy
Kelsall <i>et al.</i> 2017, (11)	Cohort study; case-matched	OPS including therapeutic mammoplasty and CWPF vs. MxIR including DIEP flaps, LD flaps and implant	567 patients (286 OPS and 281 MxIR)	–	Institution-specific patient reported outcome measures (3 questions regarding return to activity)	Return to work and function favoured OPS	Not described in details but 34.2% node-positive in OPS group vs. 21.6% in MxIR group	94.3% in OPS and 23.9% in MxIR
Mangialardi <i>et al.</i> 2020, (37)	Systematic review	TDAP flap	337 patients (in 12 studies)	Mean 17.42	Variable	Shoulder-related donor site morbidity was very low	Variable	Variable
Hauerslev <i>et al.</i> 2021, (38)	Cohort study; prospective follow-up	OPS in general	334 patients (229 BCS and 105 OPS)	Mean 18 (range, 13–28)	Study-specific questionnaire including Likert items and VAS	Risk of shoulder and arm morbidity following OPS is comparable to BCS	17% ALND in BCS group and 27% ALND in OPS group	No difference in breast RT between groups
Rose <i>et al.</i> 2019, (39)	Cross-sectional study	OPS in general (32 level I and 64 level II) vs. BCS	727 patients (96 OPS and 631 BCS)	Mean 60.8 (range, 26–100)	Breast-Q; HRQoL domain “Physical Well-being”	No significant difference	44.8% ALND in OPS group and 33.8% ALND in BCS group	97.9% in OPS group and 95.6% in BCS group
Zhou <i>et al.</i> 2019, (40)	Cohort study	LD mini-flap vs. CCS	60 patients (32 LD mini-flap and 28 CCS)	Mean 12	ROM; muscle strength; DASH	Minimal functional impairment following LD mini-flap	All had ALND	All had RT, but no further description of the extent
Hamdi <i>et al.</i> 2008, (41)	Cohort study	TDAP flap	22 patients	Mean 19.4 (range, 6–45)	Compare operated and non-operated sides	Donor-site morbidity was reduced to a minimum	63.3% ALND	18% axillary RT
Abdelrahman <i>et al.</i> 2019, (42)	RCT	LD flap (group A) vs. TDAP flap (group B)	42 patients (21 in each group)	Mean 12	SPADI	TDAP flap has significantly better functional outcome of the shoulder	No description available; 62% node-negative in group A vs. 52% in group B	No description available
Duymaz <i>et al.</i> 2019, (43)	Cross-sectional study	LD mini-flap vs. BCS (and SN vs. ALND)	174 patients, 4 groups: (I) SN + BCS (n=50); (II) ALND + BCS (n=37); (III) SN + LD mini-flap (n=50); (IV) ALND + LD mini-flap (n=37)	Median 24 (range, 3–108)	Q-DASH	LD mini-flap OPS in combination with ALND has a negative impact on shoulder function	SN =100; ALND =74	No description available
Aristokleous <i>et al.</i> 2023, (44)	Cross-sectional study	OPS: therapeutic mammoplasties/reductions or volume replacement by CWPF	215 patients (95 BCS and 120 OPS)	Mean 24 (range, 2–55)	DASH; Breast-Q	No difference in morbidity of upper extremity following a combination of standardised surgical assessment and shared decision making	Not described in details	Not described in details

OPS, oncoplastic breast conserving surgery; CWPF, chest wall perforator flaps; MxIR, mastectomy with immediate reconstruction; DIEP, deep inferior epigastric perforator; LD, latissimus dorsi; TDAP, thoracodorsal artery perforator; BCS, breast conserving surgery; VAS, Visual Analogue Scale; ALND, axillary lymph node dissection; RT, radiation therapy; HRQoL, health-related quality of life; CCS, conventional BCS; RCT, randomised controlled trial; ROM, range of motion; DASH, Disabilities of the Arm, Shoulder, and Hand; SPADI, Shoulder Pain and Disability Index; SN, sentinel node; Q-DASH, Quick-DASH.

received RT was compared to a MxIR group that required or did not require post-mastectomy RT the “return to full activity” was still faster in the OPS group. One of the forces in this study was the consideration and matching according to RT but also breast size.

In a large prospective study comparing OPS (105 patients) with BCS (229 patients), Hauerslev *et al.* found a comparable risk of shoulder morbidity in a follow-up period of 18 months—even though OPS was offered in patients with larger tumours and with a more advanced disease stage (38). The study mostly, but not exclusively, described volume displacement including reduction OPS. The study did not distinguish between volume displacement and volume replacement in the inclusion of patients nor in the reporting of the results. The shoulder morbidity was evaluated by a non-validated questionnaire including Visual Analogue Scale and Likert items.

Only one suitable RCT was identified in the literature search (42). The study was very small with only 42 included BC patients divided into two groups: partial breast reconstruction using LD flap or using TDAP. Follow-up was after 3, 6 and 12 months. The TDAP group had a significantly better functional outcome of the shoulder evaluated by Shoulder Pain and Disability Index (SPADI).

Agrawal recommends, in a review of how to plan oncoplastic and reconstructive breast surgery, how to select patients for the different procedures. Patient and case characteristics were divided into three categories (high, average, and low complexity) to aid selection in the complexity of a certain BC cases. One of the patient characteristics of importance for choosing the right kind of surgery was the patient’s shoulder limitations before surgery (45).

Following the Delphi consensus conference in 2019, Weber *et al.* reviewed the gaps in the knowledge of OPS. Their conclusion was that quality-of-life and surgical morbidity should be further investigated. They recommend to implement a prospective register based on a defined set of core variables for oncoplastic procedures in centers performing OPS. This register could facilitate further investigation by observational and RCT studies (46).

The heterogeneity in the selected studies was high—one publication was a systematic review, one an RCT, four were cohort studies, and three were cross-sectional studies (11,37-44). Some of the studies were small and there was a considerable variation in follow-up time. They described shoulder function following different kinds of OPS; primarily volume replacement techniques including CWPF. Only two studies included volume displacement too, but not

separating the two techniques neither according to inclusion nor to reporting the results. Separating the two techniques would have been interesting, as one could imagine that volume replacement would affect the shoulder morbidity more than volume displacement. This review cannot answer the question whether the two techniques are comparable according to shoulder morbidity.

The assessment of shoulder function was based on several different evaluation methods. Among them, ROM, DASH, Q-DASH, SPADI, HRQoL and non-validated subjective questionnaires were used. Also, the variation in axillary surgery and RT within and between the studies made the comparison difficult.

With the use of Covidence to manage the literature search, the risk of missing important studies is low. At least two authors have systematically screened titles, abstracts and finally full text studies. The references in the selected full text studies were screened for relevance and the review was supplied with further studies. During the whole process the authors solved disagreements by discussion.

Conclusions

The requisite knowledge of late effects following OPS is still not available for unambiguous recommendations. This narrative review has elucidated the knowledge and has reached a conclusion based on review of the existing literature of this item.

We found that the risk of decreased shoulder function caused by OPS—volume displacement as well as volume replacement—does not exceed the risk of shoulder problems seen after BCS and mastectomy with or without immediate reconstruction. Therefore, OPS can be considered if conventional BCS is not possible. But the knowledge of shoulder function after OPS is limited, and studies comparing shoulder function after OPS, BCS and mastectomy with or without immediate reconstruction are warranted.

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Footnote

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