Review

Immediate breast reconstruction after mastectomy for cancer

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Background: **Immediate breast reconstruction after mastectomy has increased over the past decade following the unequivocal demonstration of its oncological safety and the availability of reliable methods of reconstruction. Broadly, it is undertaken in the treatment of breast cancer, after prophylactic mastectomy in high-risk patients, and in the management of treatment failure after breast-conserving surgery and radiotherapy. Immediate breast reconstruction can be achieved reliably with a variety of autogenous tissue techniques or prosthetic devices. Careful discussion and evaluation remain vital in choosing the correct technique for the individual patient.**

Methods: **This review is based primarily on an English language Medline search with secondary references obtained from key articles.**

Results and conclusion: **Immediate breast reconstruction is a safe and acceptable procedure after mastectomy for cancer; there is no evidence that it has untoward oncological consequences. In the appropriate patient it can be achieved effectively with either prosthetic or autogenous tissue reconstruction. Patient selection is important in order to optimize results, minimize complications and improve quality of life, while simultaneously treating the malignancy. Close cooperation and collaboration between the oncological breast and reconstructive surgeons is desirable in order to achieve these objectives.**

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Introduction

In the UK, breast cancer is the commonest malignancy in women with around 26 000 new cases diagnosed annually[1]. About 40 per cent of these patients require mastectomy because of diffuse multifocal disease, tumour size or site, concern about the desirability of radiotherapy, or merely strong patient preference for mastectomy. Additionally, a number of women initially undergoing breast-conserving surgery later have a mastectomy because of incomplete resection margins or local recurrence. Breast reconstruction may, therefore, be required in a significant proportion of all patients with breast cancer. Breast reconstruction after mastectomy has become popular over the past 20 years for several reasons. The evolution of safe and predictable reconstructive techniques has been coupled with an increased availability of plastic surgical expertise. Simultaneously, there has been heightened patient awareness of, and demand for, the various reconstructive options, and widespread recognition by surgeons and oncologists of the psychological benefits of reconstruction.

Historically, almost all breast reconstructions were delayed for months or years after mastectomy. It was feared that immediate breast reconstruction would compromise adjuvant treatment and that such therapy would increase the risk of postoperative complications. There was further concern that it would mask locoregional recurrence and render treatment of such disease difficult. However, there are several obvious benefits such as the potential for a single operation and period of hospitalization, better psychological adjustment to the loss of the breast, and better aesthetic results. Drawbacks include the increased length of procedure, difficult logistics (between ablative and reconstructive surgeons) and more complex surgery.

Not all candidates are suitable for immediate breast reconstruction, for instance those with significant cardiopulmonary or other systemic disease. The surgical risk factors for individual operations, for example the transverse rectus abdominis myocutaneous (TRAM) flap, are well understood and include chronic obstructive airway disease, severe cardiovascular disease, uncontrolled hypertension, morbid obesity, insulin-dependent diabetes mellitus and

general debility. Oncologically, patients with diffuse metastatic disease are not candidates for breast reconstruction, but those with locally advanced or aggressive cancers may undergo successful reconstruction.

This article reviews the literature on immediate breast reconstruction after mastectomy and provides a pragmatic approach for the oncological breast and reconstructive surgeon.

Techniques of immediate reconstruction

Modern breast reconstruction techniques have evolved steadily since the introduction of the silicone gel-filled implant in the early 1960s. Today they comprise the use of prosthetic materials, autogenous tissue or a combination of the two. Because of the variable needs of individual patients, the reconstructive surgeon must be able to provide all options to patients[2]. In general the aesthetic results from autogenous tissue reconstruction are superior to those of prosthetic reconstruction[3,4]. The latter may involve a simple breast implant, a tissue expander followed by an implant, a permanent expander–implant or an adjustable prosthesis[5–16]. Autogenous tissue for immediate breast reconstruction can be supplied by the TRAM flap, latissimus dorsi (LD) myocutaneous flap, inferior and superior gluteal flaps, and the lateral transverse thigh flap[17–25]. Prostheses and autogenous tissue are not mutually exclusive, however, and expanders or implants are often used in combination with LD flaps[26], or occasionally with TRAM flaps[27,28].

Prosthetic reconstruction (*Figs 1–5*)

Implant reconstruction

Primary implant reconstruction was commonly performed in the 1980s but its popularity has waned. Today its role is limited to patients with small volume requirement (A/B cup size or volume below 400 ml) who have adequate soft tissue coverage, especially skin. This stringent requirement occurs most often in delayed reconstruction or immediate reconstruction with short healthy skin flaps or with the aid of a LD flap. The ideal patient is a young non-smoker with good chest wall musculature[29].

Notwithstanding the above, the insertion of a gel- or saline-filled prosthesis under the pectoralis major–serratus anterior musculofascial complex is undoubtedly the simplest method of immediate reconstruction. The placement of a gel-filled prosthesis subcutaneously under mastectomy flaps[6,7,30] should be of only historical interest because of the high incidence of flap necrosis, wound dehiscence, implant extrusion, infection and peri-implant capsular contracture[31,32]. In contrast, the submuscular position[33–35] protects against exposure, malposition and capsular contracture[5,33,36–38]; a direct comparison of subcutaneous and submuscular implants has demonstrated the superiority of the subpectoral position[31]. Furthermore, implants deep to muscle theoretically minimize the possibility of the device masking recurrent disease[39]. Total muscular coverage may not, however, prevent implant loss entirely, and may result in poorer projection of the reconstructed breast[40–42].

The commonest and least predictable complication of breast implant surgery is capsular contracture[35,43,44]. Submuscular placement of silicone gel-filled implants consistently decreases the incidence of significant contracture from 60 to 30 per cent[31,45–49], although this often may be confounded by the effect of preoperative or postoperative irradiation[47–49]. It has also been demonstrated unequivocally that the use of saline-filled rather than silicone gel-filled implants decreases the incidence of contracture without reducing the degree of patient satisfaction with the procedure[37,38,50]. Similarly, in retrospective and prospective trials of breast augmentation, textured-surface prostheses have been shown significantly to diminish the incidence of adverse capsule formation to around 10 per cent or less[51–54]. Implant surface texturing by inducing tissue adherence also decreases the risk of malposition of breast prostheses[55]. Finally, in addition to capsular contracture, a common problem with implant reconstruction is the presence of palpable and sometimes visible ripples, especially in slim women.

Patients with silicone gel implants do not appear to be oncologically disadvantaged. In a study of 146 women, who had undergone breast reconstruction with silicone gel-filled implants after mastectomy, the risks of distant metastasis and breast cancer-related death were actually lower than in matched controls. Furthermore, reconstruction did not significantly increase the risk of local recurrence, second breast cancer or second primary tumour at another site[56].

Classical expander–implant reconstruction

Breast reconstruction by tissue expansion was pioneered by Radovan[8]. In its classical form it entails the submuscular placement of an inflatable silicone balloon which is subsequently expanded by a series of postoperative saline injections through a remote port to create a breast mound of the desired dimensions; this takes several weeks[9,57]. The temporary expander is then removed at a second stage (4–6 months later) and replaced with a permanent implant.

The main advantage of tissue expander reconstruction is the use of local tissues with similar colour, texture and subcutaneous tissues to the surrounding chest wall. Initially,

Fig. 1 Mentor Contour Profile anatomical tissue expander with integrated valve

Fig. 2 McGhan anatomical expandable implant style 150 with permanent remote fill tube and injection port

Fig. 3 Mentor Siltex Becker 50 expander–implant with fill tube and injection port

delayed placement of the tissue expander was preferred in an attempt to decrease local complications[58,59], but immediate tissue expander reconstruction after mastectomy is now well established[4,11–15]. The ideal candidates for immediate reconstruction are those with smaller, minimally ptotic breasts, and those having immediate bilateral reconstruction when radiotherapy is not anticipated. Following placement of the expander in the submuscular pocket at the time of mastectomy, expansion is carried out at intervals of 1 week on an outpatient basis. The volume at which the breast mound looks equal to the contralateral breast is noted (to guide the choice of size of the permanent implant). The expander is then overinflated to about 150–200 per cent of the desired final breast volume[12,57,60,61]. Subsequent volume reduction results in a more naturally shaped breast[10,16,59], and may result in a lower incidence of capsular contraction[57].

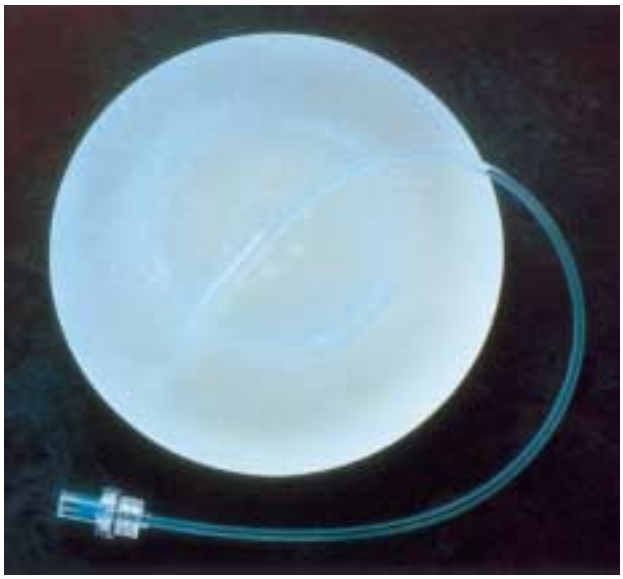

Fig. 4 Mentor Spectrum postoperatively adjustable expander–implant with fill tube

Fig. 5 McGhan anatomical cohesive gel breast implant demonstrating the semisolid gel

Although completion of expansion usually takes 6–8 weeks, expander-to-implant exchange is usually delayed for some months after achieving the desired size. This delay may not be necessary as Foo *et al.*[62], in a prospective randomized controlled trial comparing the insertion of the definitive prosthesis at 2 weeks and 6 months after completion of expansion, found no difference in adverse capsular contracture rates (24 *versus* 26 per cent). To achieve maximum symmetry in tissue expander reconstruction may require significant alteration of the contralateral breast by mastopexy, reduction or augmentation. Nipple-areolar reconstruction is also usually undertaken at this second stage. In summary, the indications for immediate breast reconstruction by tissue expansion include: (a) patients with small volume requirements (small, preferably non-ptotic breasts); (b) patients who have not been irradiated previously or in whom no postoperative radiotherapy is anticipated; (c) bilateral reconstructions as it is easy to achieve symmetry with any technique; and (d) patients who are unfit or unwilling to undergo major surgical procedures for reconstruction.

The main advantages of breast reconstruction by tissue expansion are its simplicity, and shorter operating, hospitalization and recovery times. The main drawbacks are difficulty in achieving ptosis[42,63], projection in the nipple area, lack of natural consistency especially with saline implants, and an almost 30 per cent incidence of adverse capsular contracture[16,60,62,64,65]. The incidence of capsular contracture has, however, been dramatically decreased with the use of textured-surface expanders[55,66,67] and implants[53,54]. Breast implant rupture with time, common in second-generation gel prostheses[68], is not a major issue with the new-generation implants.

The most devastating complication of tissue expander breast reconstruction is exposure and extrusion of the prosthesis which inevitably leads to a failed reconstruction. Historically, the reported rates of implant loss were as high as 30–50 per cent[11,12,16,29,40,41,45,69,70]. It results from wound dehiscence secondary to mastectomy skin flap necrosis, infection, erosion of the overlying skin and tissues by a fold in the expander, poor soft tissue coverage, and expanding irradiated tissue[47]. The recent advances that have simplified breast reconstruction by tissue expansion and made it more predictable are the use of textured-surface[55,66,67] and anatomical breast-shaped expanders with integrated injection ports[11,71–74].

Adjustable implant reconstruction

In order to avoid the need for a second stage in expander–implant reconstruction, permanent expander–implants were developed[14,16,61]. The Becker expander/mammary prosthesis (Mentor Medical Systems, Wantage, Oxford, UK) and the McGhan style 150 expandable breast implant (Inner Medical, Wokingham, UK) have an adjustable saline-filled inner lumen surrounded by a silicone gel outer lumen (25–50 per cent of the nominal implant size). The gel renders the implants more natural-feeling while the saline compartment allows volume adjustment. More recently Mentor Medical Systems has developed the Spectrum postoperatively adjustable prosthesis which is entirely saline filled (i.e. with no gel component) and is being used increasingly in the USA. The indications for adjustable implant reconstruction are similar to those for simple prosthetic reconstruction. The ideal candidates are those with: (a) anticipated or actual skin deficiency at mastectomy which precludes simple implant reconstruction; (b) contralateral ptosis that cannot be matched with a simple permanent implant (the overexpansion followed by deflation to the ideal volume achieves a good cosmetic result); and (c) large chest wall diameters with moderate obesity and hypertrophy or ptosis not severe enough to warrant mastopexy or breast reduction.

Autogenous tissue reconstruction

Immediate reconstruction using autologous tissue yields the most durable and natural-appearing results with the greatest consistency[75]. It has several general advantages.

1 A large volume of the patient's own tissue is available.
2 No prosthesis is required, obviating problems such as infection, extrusion, malposition and capsular contracture.
3 It is suitable for patients who do not want implants.
4 It offers unrivalled versatility, including creation of excellent ptosis and fill of the infraclavicular hollow and anterior axillary fold.
5 These tissues can withstand postoperative radiotherapy and can also be used in previously irradiated patients undergoing completion mastectomy for recurrence.
6 The excellent vascularity of the tissues leads to improved wound healing.

The autogenous tissues available in decreasing order of frequency of use are the TRAM, LD, superior gluteal, inferior gluteal, lateral transverse thigh and Taylor–Rubens peri-iliac flaps.

Transverse rectus abdominis myocutaneous flap (*Fig. 6*)

The TRAM flap, the most widely used autogenous tissue, was first described by Hartrampf *et al.*[18] in 1982 in Atlanta.

Fig. 6 Cosmetic result of immediate breast reconstruction with pedicled transverse rectus abdominis myocutaneous flap

Conventionally, it relies on the blood flow through the deep superior epigastric pedicle within the rectus abdominis muscles to supply a horizontal ellipse of overlying abdominal wall skin and fat. The TRAM flap can be raised either as a conventional pedicled flap (based on the deep superior epigastric vessels) or as a microvascular free flap (based on the larger deep inferior epigastric vessels). Pedicled TRAM flaps can be ipsilateral or contralateral, unipedicled or bipedicled, unilateral or bilateral, surgically delayed or immediate. Free TRAM flaps can utilize the full width of the muscle[19,76], be partial muscle sparing[77,78] or, more recently, be total muscle-sparing perforator flaps[79–84].

The TRAM flap has become established as the 'gold standard' for breast reconstruction[75,85]. It gives the most natural-appearing breast with the most natural feel, and is associated with the fewest complications compared with all other reconstructive techniques[4,86]. It also has excellent reliability and donor site cosmesis and so may be used preferentially unless there are compelling reasons not to do so. Its specific advantages are: (a) availability of a large volume of well vascularized autogenous tissue; (b) ability to withstand postoperative radiotherapy; (c) utility in sites of previous irradiation or tight chest wall skin; (d) good ptosis (versatility in balancing the opposite breast even in the presence of ptosis or a large contralateral breast); and (e) concomitant beneficial reduction of excess abdominal tissue ('tummy tuck') and the highly favourable donor site scar.

Contraindications include patients who do not want or cannot withstand a major operation, elderly patients, and the lack of adequate tissue from the abdomen such that implants are needed. Adverse risk factors include weight more than 25 per cent over the ideal, smoking, diabetes mellitus, autoimmune disease, psychological problems, abdominal scars and an inexperienced surgeon[87]. Disadvantages of the TRAM flap include: (a) a major operation 'requiring exacting training and technique of the surgeon'[17]; (b) a longer operation (3–8 h depending on the variant) and longer hospital stay (5–10 days) compared with prosthetic or other reconstructions[3]; (c) risk of partial or total flap loss; (d) increased possibility of blood transfusion[3]; (e) risk of abdominal wall hernia and bulges; (f) frequent need for prosthetic mesh reinforcement of the abdominal wall; (g) a long transverse abdominal scar; and (h) increased general complications of major surgery such as deep vein thrombosis, pneumonia and adult respiratory distress syndrome[87].

Significant complications may occur with the TRAM flap[87] and their incidence is increased dramatically by obesity[66,88], especially if more than 25 per cent above the ideal body-weight, smoking[89], underlying systemic disease (diabetes, collagen vascular disease, hypertension), previous abdominal surgery and scars, and prior irradiation[87,90].

There are a number of options in TRAM flap technique designed to maximize its success and consistency while minimizing morbidity[91,92]. The two main variants are the conventional (pedicled) and the free flap, with the latter relying on microvascular tissue transfer. In general, the free flap is preferred to the pedicled variant because of its reduced risk of localized fat necrosis and partial flap loss, owing to its more reliable blood supply[77,93].

Single-pedicled TRAM flap

This is indicated in patients who are non-smokers, not obese, with no peripheral vascular disease or diabetes mellitus. It is generally reserved for those aged below 60 years and, ideally, with a small-to-moderate volume requirement. It is also a good choice for bilateral reconstruction when a hemi-TRAM flap is used for each side.

Double-pedicled TRAM flap[91,94]

The use of two rectus muscle pedicles increases the blood flow to the overlying skin and fat, thereby increasing the reliability and size of the flap. Its indications are limited because of the morbidity associated with abdominal wall damage and the effect on cardiorespiratory function. Because of its effect on the abdominal wall, young women are unsuitable for this procedure; it is also better avoided in the elderly because of compromise of respiratory function. It is used primarily to augment the circulation in obese patients, smokers, diabetics, and in those with peripheral vascular disease, chest wall irradiation and other microvascular risk factors. It is especially useful for patients in

whom a large amount of tissue is needed on the chest wall[91], for example those with previous irradiation, inflammatory carcinoma, chest wall spread or recurrence. It is also useful in patients with midline scars from previous surgery. It is very controversial, however, with some claiming that it amounts to medical malpractice to use such a flap[95] and others justifying it on grounds of reliability[74,87,94].

Conventional TRAM flap with preoperative surgical delay

In the surgically delayed TRAM flap, the dominant deep inferior epigastric pedicle is ligated or divided, thus increasing the blood flow through the deep superior epigastric vessels[96,97]. This has the effect of increasing the viable dimensions of the pedicled flap, and decreasing flap necrosis in the high-risk patient. It also decreases the need for double-pedicled TRAM flaps and reduces venous congestion within the flap[98]. It is indicated in high-risk patients who do not want a free flap, or when the reconstructive surgeon has no microsurgical skill or equipment. Specific indications for preoperative TRAM flap delay are: (a) smoker; (b) greater than 20 per cent of ideal body-weight (obese patients with abdominal pannus); (c) history of chest wall irradiation; (d) diabetes mellitus; (e) hypertension or cardiovascular disease; (f) patients with high volume requirements; and (g) autoimmune disease.

Although it is a simple and effective technique, it nevertheless carries some morbidity. It is often associated with asymptomatic localized seromas; infection, dehiscence and hernia are rare. The standard technique involves ligation and division of the ipsilateral deep and superficial inferior epigastric vessels[96,97]. Sometimes the deep inferior and superior epigastric vessels on both sides are divided either through two separate incisions or one extended suprapubic incision. Classically this is undertaken 2–3 weeks before flap elevation, although 3 days may be all that is really needed to increase viability and reliability.

Mid-abdominal TRAM flap

In this variant, the horizontal location of the abdominal ellipse is moved up towards the mid or even upper abdomen in order to increase the blood flow to the overlying skin and fat[99]. It exploits the concentration of the musculocutaneous perforating vessels in the periumbilical region[96] and the location of the choke vessels just above the umbilicus[97,100]. It has not achieved widespread use, perhaps because of the highly visible scar and the availability of other reliable TRAM flap variants. The mid-abdominal TRAM flap may avoid fascial closure below the umbilicus and so decrease the risk of weakness of the abdominal wall.

'Supercharged' pedicled TRAM flap

This involves reconnection of the opposite deep or superficial inferior epigastric vessels by microvascular anastomoses to recipient vessels in the axilla, while maintaining the other pedicle based superiorly[2,101,102]. Its main use is to rescue 'struggling' flaps, especially those with venous congestion as sometimes occurs in borderline high-risk patients undergoing immediate conventional TRAM flap reconstruction.

'Turbocharged' pedicled TRAM flap

In this variant the two deep inferior epigastric vessels are joined to each other by microvascular anastomosis as a loop to increase the circulation to the side contralateral to the pedicle[103]. Its main use is to augment the blood flow of single-pedicled TRAM flaps in patients with lower midline abdominal scars.

Free TRAM flap

First described in 1979 by Holmstrom[19], the inferiorly based free TRAM flap relies on the more robust deep inferior epigastric vessels[96]. It thus has better vascularity and less risk of ischaemia to its peripheral zones (and consequently less fat necrosis and partial flap loss)[77,93,104–106] than the pedicled TRAM flap. It is the preferred TRAM flap technique in many centres[77,105–108].

This flap reliably carries a larger amount of skin and subcutaneous fat than the conventional TRAM flap. It is therefore desirable when large volumes of tissue are required and delay or bipedicled techniques are not feasible or desirable. It is the TRAM flap of choice in patients with risk factors (obesity, smoking, diabetes, peripheral vascular, autoimmune, and cardiovascular disease), and is ideal for those who have abdominal scars, especially upper abdominal scars. Its drawbacks are added theatre time, increased difficulty in performance and the possibility of total flap failure. The chances of total flap failure are 5–6 per cent, with a re-exploration rate of 10–15 per cent[107,108]. With increasing experience of the operating team, these values should decrease to 1 and 3 per cent respectively[105,109]. Although one of its key indications is cigarette smoking, patients who smoke have an increased risk of partial flap and fat necrosis, pneumonia and atelectasis. Ideally they should stop smoking several weeks before surgery and for 6 weeks thereafter. However, to avoid delay in cancer treatment, immediate free TRAM flap breast reconstruction is routinely undertaken even in those who continue to smoke up to the day of operation.

Free TRAM flaps may be used for both unilateral and bilateral reconstructions, and the former may be ipsilateral or contralateral. In immediate reconstruction, the choice of which side to base the vessels on depends largely on the recipient vessels for the microvascular anastomoses. Usually the vessels in the axilla (thoracodorsal or circumflex scapular) are preferred for microvascular anastomoses because they have been exposed by the breast surgeon during axillary dissection; the contralateral flap vessels are then preferred. If no axillary dissection is planned, either the internal mammary or axillary vessels may be used, depending on the preference and experience of the surgeon[81,110–112].

Comparisons with pedicled TRAM flaps show distinct advantages in favour of the free flap. Schusterman *et al.*[106] reported 7 per cent partial flap loss or fat necrosis for the latter *versus* 13–41 per cent for pedicled flaps[3,18,66,77,88,90,104,105,113,114]. Fat necrosis is a common occurrence in pedicled flaps, with an incidence 10–50 per cent. This manifests as subcutaneous firmness which often causes anxiety in patients and surgeons in view of its differential diagnosis as recurrent cancer. There is also less rectus muscle and fascia harvested with free flaps and so a reduced incidence of abdominal wall bulges and hernias[77,106]; there is less functional muscle weakness[115]. The incidence of abdominal wall hernia after free flap reconstruction is 3–6 per cent[77,106] compared with 12 per cent for pedicled flaps[4,66,105,113]. Free TRAM flaps avoid the bulge in the epigastrium that is often caused by tunnelling of pedicled flaps. In immediate breast reconstruction Elliott *et al.*[104] found shorter hospital stays and a decreased incidence of fat necrosis with free flaps. However, in sharp contrast to all of the above, one study has shown no significant difference in outcome and complications between 53 pedicled and 72 free flaps after a 20-month follow-up[116].

Free deep inferior epigastric perforator flap

The deep inferior epigastric perforator (DIEP) flap is the latest innovation in TRAM flap breast reconstruction which, in contradistinction to all the above variants, preserves the whole of the rectus muscle and sheath[79–81,84]. This flap is composed only of the essential parts required for reconstruction, i.e. skin and fat. It is based on one, two or three perforators of the deep inferior epigastric vessels. Vascularity is not compromised and the incidence of fat necrosis is no different from that of the standard free TRAM flaps[80,83,84]. The advantages of perforator flaps in general, and of DIEP flaps in particular, are the avoidance of muscle sacrifice, hernias and bulges, and decreased postoperative pain and hospital stay. It also avoids a tight fascial closure and the use of synthetic mesh. The former reduces pain and allows the patient to be mobilized on the first postoperative day with only oral analgesia[80,117].

The operation involves a tedious and somewhat nerve-racking dissection that typically adds 1·5 h to the free TRAM flap harvest[82]. Despite current enthusiasm for this procedure to the extent that it is the main or only TRAM flap procedure undertaken in pioneering centres[80,82,84], the indications are still being refined. It should, however, be the procedure of choice in: (a) young women (less than 55 years) requiring free TRAM flap breast reconstruction as they will benefit from an intact and previously unviolated abdominal wall for many years of their remaining life; (b) those who may later become pregnant and distend the abdomen (prevents hernia formation) even though pregnancy can be successful after pedicled TRAM flap surgery[118]; (c) athletic patients for whom abdominal wall integrity is important; and (d) those having simultaneous bilateral breast reconstruction, because the avoidance of sacrifice of the anterior rectus sheath and the rectus abdominis muscle significantly decreases donor site morbidity.

Latissimus dorsi musculocutaneous flap (*Fig.* 7)

The LD musculocutaneous flap was previously widely used for coverage of mastectomy defects. More recently it has regained popularity with advances in tissue expander and implant design[51,52,54,55], the description of the total autologous LD breast reconstruction technique[86,119–123] and endoscopic techniques of harvest[124].

The flap is based on the thoracodorsal vessels and it may be transposed anteriorly for breast reconstruction as a musculocutaneous flap with a variable skin paddle, a muscle flap (unusual even for immediate reconstruction) or as an extended completely autogenous flap with overlying fat. Initially developed to provide cover for breast implants, it can provide enough soft tissue on its own to reconstruct small to moderately sized breast defects. Indications in immediate breast reconstruction include: (a) coverage of an expander–implant reconstruction (main use); (b) patients with skin insufficiency after mastectomy but who have insufficient lower abdominal tissue or are medically unfit for a TRAM flap; (c) previously irradiated patients undergoing completion mastectomy; and (d) reconstruction in patients who have already undergone an abdominoplasty or a TRAM flap procedure for the contralateral breast.

In immediate reconstruction following skin-sparing mastectomy the skin requirement is small or none, thereby allowing most or all of the LD skin paddle to be de-epithelialized and buried for increased projection. It is also an excellent option for salvaging partial TRAM flap necrosis in which debridement has left the patient with a distorted reconstructed breast[125].

Fig. 7 Latissimus dorsi flap skin paddle utilizing a natural skin fold and demonstrating the angle of the scapula, surface marking of the latissimus dorsi muscle and its arterial supply

Standard latissimus dorsi myocutaneous flap

This is the commonest type of LD flap. The skin paddle on the back may be variously sited or oriented depending on the mastectomy defect. The oblique (superolateral to inferomedial) skin paddle column has the best blood supply as it is centred over the anterolateral border of the muscle. It is the easiest to design, raise and insert. The resultant low oblique scar can be easily hidden. This low oblique orientation ideally suits the chest requirements of modified radical mastectomy as the skin island and muscle both need to be located inferiorly. The transverse (horizontal) skin paddle column results in a higher transverse scar that can be easily hidden in the bra-line, unlike the preceding type. Patient input in the choice of scar is important. This design is ideal for radical mastectomy defects in which muscle replacement of the pectoralis major is required. It also places the scar inconspicuously in the bra-line. The oblique (superomedial to inferolateral) skin paddle (skin crease) is more appropriate for patients undergoing skin-sparing mastectomy because the orientation at flap inset is not a problem. The scar sits along the crease line producing the best cosmetic donor site. The excess skin is de-epithelialized and buried under the skin-sparing mastectomy skin flaps. In this situation, where little skin is required, the scar on the back can be reduced dramatically by endoscopically-assisted LD flap harvest.

Extended total autogenous latissimus dorsi myocutaneous flap

In this variety, most or all of the fat overlying the whole of the LD muscle is used to increase the bulk of the flap and so form a larger breast. In its classical form the harvest is at the level of Scarpa's fascia. Another form, to increase further the bulk, involves a harvest at subdermal level. Significant obesity is one of the key indications for the autogenous LD musculocutaneous flap. Although obese patients have more than enough TRAM tissue, they are at high risk of abdominal wall complications and partial TRAM flap loss. Additionally, the obese have adequate thickness of fat on the back. The pedicled LD flap can be rapidly and safely harvested but it is important to leave enough subdermal or subcutaneous fat under the back skin to avoid skin flap necrosis. There is an increased incidence of seroma formation in obese patients but this is short lived and can be treated simply by aspiration.

The skin paddle in the total autogenous technique for immediate breast reconstruction can be a small straight ellipse that is oriented according to the patient's preferred back donor site. The total autogenous technique is especially suitable for immediate reconstruction because the excess muscle and fat, which are folded underneath the skin paddle, contribute to the breast volume and this increased amount of tissue can be buried under the chest wall flaps to obtain projection ptosis. Although simpler than the TRAM flap and with a shorter recovery time, the volume obtained is often not as large. The final result is not as natural, and the donor site and contour deformity are not as well tolerated. The autogenous LD flap may be combined with an implant in extremely thin patients lacking adequate tissue at any other donor site. An expander technique is preferable because of the greater flexibility in choosing the final implant size and second-stage adjustment of the breast mound.

Muscle flap

In immediate breast reconstruction, the pure muscle flap alone is feasible only for skin-sparing mastectomy or subcutaneous mastectomy where no extra skin is required. It is especially amenable to endoscopic harvest, thereby avoiding large back scars. Its commonest use is to provide muscle coverage for an implant or expander. The advantages of the LD flap are its reliable robust blood supply, associated with the versatility of the skin paddle orientation, and the ease and speed with which it can be performed. The hardy blood supply allows it to be used safely in patients who are high-risk candidates for a pedicled TRAM flap. It involves a much smaller operation than the TRAM flap and gives predictable results with few complications. The scar on the back may be minimized with endoscopic techniques or counterincisions in the axilla.

The drawbacks of the LD flap of specific relevance to immediate reconstruction relate to the donor site, the flap and the (often associated) prosthesis. The commonest postoperative complication is seroma formation at the back

donor site and this often requires repeated aspiration before it settles. Its reported incidence ranges from 9 to 33 per cent[123,126–129]. Significant flap necrosis is rare and is nearly always associated with recognized or unrecognized injury to the vascular pedicle[126,130,131]. Partial flap necrosis occurs in up to 7 per cent of cases, but is more common in the extended total autogenous variant, or when the skin paddle is placed too distally over the aponeurotic part[22,121,123,126,127,131]. Capsular contracture in association with combined LD flap and silicone gel breast implant reconstruction was historically common (up to 40 per cent)[126,127,132,133]. When the LD flap is used with saline-for-gel substitution and prosthetic surface texturing, significant capsular contracture is unusual[26,134]. Slippage of the expander or implant through the axilla and into the back is rare but is more likely to occur in immediate reconstruction because of the wide communication between the mastectomy, axillary dissection and back donor sites[126]. It can be prevented by suturing the LD muscle to the lateral chest wall.

Other autogenous tissue techniques

Although these all require microvascular surgical transfer, they are important secondary choices. Because of the uniform requirement for microsurgical expertise and the excellent results obtained from TRAM and LD flap reconstruction, their use is restricted to patients seeking autogenous tissue reconstruction who: (a) have insufficient abdominal or back tissue; (b) do not want scars on the back or abdomen; (c) have had numerous previous abdominal or chest wall operations precluding the use of TRAM or LD flaps; (d) have previously used the TRAM flap for an earlier unilateral breast reconstruction or an abdominoplasty; and (e) have had a failed pedicled or free TRAM flap.

Superior gluteal free flap

The gluteus maximus myocutaneous free flap for breast reconstruction was first introduced in 1983 by Shaw[110,135]. The superior gluteal free flap is based on the superior gluteal artery and vein. Although a large amount of vascularized fat and overlying skin can be reliably moved to the chest wall to create a new breast, its size depends on the size of the patient's buttocks. The donor site is well hidden and matches the opposite side quite well in individual cases.

Inferior gluteal free flap

The inferior gluteal free flap[23,24,136] is preferred to the superior version because of its longer vascular pedicle, which is easier to dissect, and because even in the thin patient it has more available tissue. The natural breast contour and shape obtained stem from its thickness, consistency and the large amounts of fat and skin available. It has excellent vascularity and only a small amount of muscle is needed to provide musculocutaneous perforators for the much larger overlying skin and fat island. Its drawbacks include the need for microsurgery, repositioning during the operation and (frequently) the need for vein grafts to establish microanastomoses on the chest wall. It also requires a more difficult dissection than free TRAM flap harvest. The inferior gluteal donor site scar can sometimes be painful. Sciatica may result from taking too much muscle with the flap, thereby leaving the sciatic nerve devoid of a suitable pad. Seroma is also frequent at the donor site.

Gluteal perforator free flaps

Both the superior and inferior gluteal flaps can be raised as perforator flaps, totally preserving the muscles and utilizing only the skin and fat[117]. The superior gluteal perforator flap has been used successfully for immediate reconstruction.

Lateral transverse thigh flap

The lateral transverse thigh flap uses skin and fat from the upper lateral thigh based on the lateral circumflex femoral vessel blood flow into the tensor fascia lata muscle[17,25]. It may be utilized either unilaterally or bilaterally. In the latter, the two transfers may be performed simultaneously or staged from a few days to a month apart. Its disadvantages are the more visible scar on the lateral thigh compared with TRAM or gluteal flap scars, the need for microsurgery, and donor site seromas which can be persistent[17]. It also creates a contour deformity in the upper thigh. As for the Taylor–Rubens flap, the unilateral donor site usually requires a balancing procedure on the opposite side; this may be achieved with liposuction.

Taylor–Rubens peri-iliac free flap

This consists of the skin and soft tissue portion of the deep circumflex iliac artery flap described by Taylor *et al.* in 1979[137,138]. Its indications are the same as for the other non-TRAM, non-LD, autogenous tissue reconstructions. It is an ideal alternative when the TRAM flap is not available because the patient has previously undergone a TRAM flap procedure or abdominoplasty. Another specific indication is in patients in whom there is insufficient lower abdominal fat, but adequate fat in the flank and peri-iliac crest area. Its

main drawback is the violation of the integrity of the lateral abdominal wall and the possibility of flank herniation if the donor site is not closed properly.

Inframammary fold

The inframammary fold is a key landmark in defining the breast contour and it is very important that it is not destroyed during mastectomy. Marking its position, such that it is clearly visible during operation, helps to avoid its unnecessary violation. However, if it is destroyed it may be recreated during surgery before insertion of the prosthesis using the internal suturing technique, carefully avoiding inadvertent exteriorization of the sutures (an infection risk). Other techniques of recreating the inframammary fold are more appropriate for delayed reconstruction or expander-to-implant exchange; such detail is beyond the scope of this review.

Aesthetic, oncological and psychological considerations

Skin-sparing mastectomy

Skin-sparing mastectomy was introduced in 1991 by Toth and Lappert[140]. It entails the careful preoperative planning of mastectomy skin incisions with the express aim of maximizing skin preservation in order to facilitate reconstruction of the breast mound and enhance its aesthetics[141–145]. It removes the breast, nipple–areolar complex, previous biopsy incisions (if feasible) and skin overlying superficial tumours[140,145–148]. The use of skin-sparing incisions does not increase the complication rate or compromise local disease control. Kroll *et al.*[141], for instance, reported only one local recurrence after a 2-year follow-up of 100 patients with breast cancer treated by skin-sparing mastectomy and immediate reconstruction.

Preoperative and peroperative communication and co-operation between the oncological surgeon and the reconstructive surgeon is vital to ensure success of skin-sparing techniques[85,140]. The reconstructive advantages are that preservation of the native skin reduces the amount of tissue transfer required, while preservation of the inframammary fold and native skin envelope facilitates breast shaping during reconstruction and reduces the extent of balancing surgery on the contralateral breast needed to achieve symmetry. In addition, the periareolar incisions are inconspicuous. It is technically more demanding and time consuming than a modified radical mastectomy. The skin flaps must be handled gently to avoid ischaemic complications and the procedure should be used with caution in smokers or those who have had chest wall irradiation. A recent review of the Emory University experience of 331 cases of skin-sparing mastectomy described a 10 per cent incidence of native skin flap necrosis[143]. In practice, most skin-sparing mastectomies are followed by autogenous tissue reconstruction, especially with the TRAM flap[85,147]. When tissue expander reconstruction is used, it is often possible to close the circular periareolar incision completely with a purse-string suture.

Oncological considerations

Breast reconstruction after mastectomy was traditionally performed as a delayed procedure because it was feared that immediate reconstruction would delay or increase the complications following adjuvant treatment, such as radiotherapy or chemotherapy. An additional concern was that the presence of a reconstructed breast might delay or interfere with the diagnosis of local recurrence. The incidence of local recurrence following mastectomy and immediate reconstruction of all types ranges from 0 to 11 per cent[45,104,113,149–158]. Several of the relevant studies compared patients who had reconstruction with those who did not have immediate reconstruction, and no significant difference in local recurrence was detected once the groups had been corrected for tumour size, grade and node positivity[149,151,155]. It is well documented that the majority of local recurrences are located in the skin flaps following mastectomy[156,159]. Slavin *et al.*[156] reported that all local recurrences following reconstruction were detected on follow-up clinical examination, and that no delay in diagnosis was due to the reconstructed breast. Furthermore, the presence of a reconstruction did not compromise the treatment of recurrence. Women undergoing immediate breast reconstruction have similar survival rates to women who do not have reconstruction[150,153]. Furthermore, there is no significant difference in survival between patients who undergo immediate or delayed reconstruction[151].

Immediate reconstruction does not delay the administration of adjuvant radiotherapy or chemotherapy[156,160–162]. It has been suggested by some that early complications of reconstruction might delay chemotherapy[163], but others have found that this is not so[4,64,155,160]. Rosen *et al.*[4], for instance, found no delay in administering adjuvant chemotherapy in 23 patients following reconstruction with either tissue expansion or myocutaneous flaps. In a non-randomized comparison of pedicled and free TRAM flaps, Schusterman *et al.*[93] found a non-significant trend towards less delay in chemotherapy in patients who had had free TRAM flaps. Significant additional morbidity with delay of chemotherapy has not been noted with either breast implants[161] or autogenous tissue[158].

The morbidity associated with reconstruction may be increased by the various adjuvant therapies for breast cancer, and the cosmetic results may be worse than in those not subjected to adjuvant treatment[47,164]. This is especially so with radiotherapy and prosthetic reconstruction. Dickson and Sharpe[47] found a significantly increased risk of capsular contracture in prosthetic recipients who had postoperative radiotherapy. This has been confirmed independently by others[41,49,60,163,165–168]. Barreau-Pouhaer *et al.*[163] reported an increased risk of implant failure in patients undergoing postoperative radiotherapy where 'failure' was defined as implant removal. Expanding irradiated tissues is more difficult and painful, and the final reconstructed breast is often too small and hard, without natural ptosis[164,169]. Patients who undergo adjuvant chemotherapy and radiotherapy also have worse cosmetic results than those not subjected to adjuvant treatment[164]. The effect of radiation on reconstruction performed using myocutaneous flaps has been the subject of recent attention[162,169–171]. Hunt *et al.*[171] found no significant increase in complications following TRAM flap reconstruction and radiotherapy in a group of 19 patients. Zimmerman *et al.*[170] studied 21 patients who had free TRAM flap reconstruction followed by radiotherapy. They found no flap-related complications, and the cosmetic results were rated good to excellent by 90 per cent of the patients. In contrast, the Emory University group found radiation changes in ten of 19 TRAM flaps subjected to postreconstruction radiotherapy and six of these patients consequently required surgery to the flap[169]. In general, however, TRAM flaps tend to tolerate irradiation well and so, if radiotherapy is required, it is sensible to avoid prosthetic reconstruction and preferentially resort to autogenous reconstruction.

Contralateral breast

When the reconstructed breast cannot match its partner, reduction mammoplasty and mastopexy are routinely undertaken to improve symmetry; this is done at the time of mastectomy and immediate breast reconstruction. This allows greater flexibility for second-stage revision and should reduce the overall cost of breast reconstruction. The breast reduction technique should avoid fat necrosis or excessive internal scarring. Liposuction of the breast during the reduction should be avoided because of the possibility of inducing macrocalcification. Occasionally breast augmentation to achieve symmetry is indicated. While mastopexy and reduction cause some alteration of the mammographic image of the normal breast, such change does not generally interfere with surveillance[172]. In contrast, augmentation mammoplasty (especially subglandular placement) changes the ability to interpret postoperative mammograms and implant displacement mammography techniques are required[173].

Immediate nipple reconstruction

Creating a nipple–areolar complex is an integral part of breast reconstruction. It enhances the final cosmetic result, creates a more realistic and more natural-looking reconstructed breast, and significantly increases patient satisfaction[174]. There are numerous techniques for nipple reconstruction[2]. Free grafts of tissue may be taken from the contralateral nipple (nipple sharing), ear lobule, labia minora or toe pulp[175–177].

Nipple sharing allows a perfect match of colour and texture, but may overly reduce and distort the otherwise normal donor nipple, and reduce its sensation, while producing only slight projection of the new nipple. It is reserved for patients willing to sacrifice 50 per cent of the height of a prominent nipple on the normal breast. Worldwide, the commonest method of nipple reconstruction is the use of local flap techniques based on the new breast mound such as the skate/quadrapod, modified skate, mushroom, star, C–V, S, maltese cross and other flaps[175,178,179]. The choice of technique is largely dependent on the experience of the surgeon. It is important to remember that, with time, almost all flap techniques lose more than 50 per cent of their size in terms of projection.

Immediate nipple reconstruction is feasible but requires well vascularized autogenous tissue such as the free TRAM flap or the total autogenous LD flap[73,180,181]. It involves creating a central 'dog ear', i.e. leaving excess tissue on the flap at the proposed location of the nipple. At present it cannot be recommended because exact nipple location is difficult. In addition, it may compromise the blood supply to the breast flap or to the nipple flap.

Immediate areolar reconstruction with a skin graft from the inner thigh, labia minora, opposite areolar or trunk dog ears has now been superseded by later intradermal tattooing of the skin that surrounds the newly reconstructed nipple. This is carried out 2–3 months after nipple reconstruction[2,61,182,183]. Areolar sharing, unless is it carried out at the time of a planned contralateral breast reduction, can significantly distort the otherwise normal-looking nipple–areolar complex[16]. Although tattooing of the nipple–areolar complex can be undertaken before nipple reconstruction, it is mostly undertaken afterwards, as popularized by Spear *et al.*[183]. Artificial nipples may be used; although they look realistic they have not gained popularity with patients.

Psychological considerations

Although this is a complex subject, it is well recognized that early breast reconstruction significantly reduces the psychological morbidity of mastectomy[174,184–187]. There are many psychological effects of mastectomy[188–193]. Notable among these are feelings of mutilation and altered body image, diminished self-worth, loss of a sense of femininity, decrease in sexual attractiveness and function, anxiety, depression, hopelessness, guilt, shame, fear of recurrence and abandonment[188–193]. Most difficulties in the long term, however, relate to body image and sexual functioning[193].

It is anticipated that immediate reconstruction will spare women the pain of disfigurement and loss that accompanies mastectomy[194]. Women undergoing immediate reconstruction not only have high levels of satisfaction with the surgical results, but also significantly less psychosocial morbidity than those undergoing mastectomy alone[174,184,185,187,194,195]. They are less depressed, and experience less impairment of their sense of femininity, self-esteem and sexual attractiveness than their peers who delayed or did not seek reconstruction. They also tend to accept the new breast as an integral part of their body[185]. They have significantly less 'distress' in recalling the surgery[174], are less likely to be 'repulsed' by their own naked appearance, and have more freedom to dress than women who do not have reconstruction[184,185]. However, there may be a selection bias in these results in that patients who want and demand immediate breast reconstruction may be a self-selected and well-motivated group who therefore show the most benefit.

The psychological benefits of immediate breast reconstruction are greater than those of delayed reconstruction and compare favourably with breast conservation therapy in psychosocial outcome. In one comparison of immediate *versus* delayed breast reconstruction, there was lower postoperative psychological morbidity in the former[185]. In an uncontrolled study, Noone *et al.*[194] found improved self-image and less psychological turmoil following immediate reconstruction. In another non-randomized study, Dean *et al.*[184] demonstrated significant psychological advantages to immediate reconstruction compared with delayed reconstruction. Schain[187] found that women who underwent immediate or early reconstruction (less than 1 year after mastectomy) had significantly less recalled distress regarding the mastectomy than women who had a delayed reconstruction. Patients seeking reconstruction after mastectomy are primarily motivated by a desire for wholeness[187]. Handel *et al.*[196] examined the reasons why women did not have reconstruction following mastectomy, and found that advanced age, concern about complications from more extensive surgery, uncertainty about the outcome and anxiety about the effect of reconstruction on breast cancer all deterred women from reconstruction. Marital status, need for adjuvant therapy, or personal experience of poor results from reconstruction did not influence decision-making. More recently, Rosenqvist *et al.*[150] found high levels of patient satisfaction following immediate reconstruction, although they point out that high levels of preoperative information and psychological support were necessary.

However, the advantages of breast reconstruction may not be universal. It was suggested in one early study that the initial differences in adjustment between reconstructed and non-reconstructed patients might be minimal and disappear with time[187]. Similarly, Rolland[197] suggested that satisfaction with the technical aspects of the reconstructive outcome might be slightly lower among earlier than later reconstructed patients[197]. This large prospective study of women's response to reconstruction found that the greater the time since mastectomy, the greater the patient's satisfaction with the overall results of the reconstruction.

Health economics

This area is poorly addressed in the literature. In a direct comparison of costs to hospitals, delayed breast reconstruction was 62 per cent more expensive to perform than immediate breast reconstruction after completion of the entire reconstruction process, including nipple–areolar reconstruction[198]. Although the initial costs of prosthetic reconstruction are lower than those of autogenous tissue reconstruction, with time the costs of the former increase significantly for a number of reasons. The prime reason is the need for revisional surgery with prosthetic surgery. Tissue expanders need to be exchanged for permanent implants, capsular contracture needs reoperation plus implant exchange, and deflated or ruptured implants need replacement. A study comparing the cost of TRAM flaps and prosthetic reconstructions found that the long-term cost of TRAM flap reconstruction did not increase as much as that of implant-based reconstruction and was cumulatively lower than that of tissue–expander implants. This differential cost is likely to increase with time[199].

Conclusion

Immediate breast reconstruction is a safe and acceptable procedure after mastectomy for cancer. There is no evidence that it has oncologically untoward consequences. In the appropriate patient it can be achieved effectively with either prosthetic or autogenous tissue, but careful patient selection is important to optimize results and minimize

complications. Careful counselling of the patient about available options and the need for future revisional surgery, particularly with prosthetic reconstruction, is important. Ideally, the oncological and reconstructive surgeons should discuss and plan surgery together, and communicate closely during the operation (especially in skin-sparing mastectomy and autogenous reconstruction). Although autogenous tissue techniques give the best aesthetic and most natural results, they are a more significant surgical undertaking. Finally, it should be appreciated that recent innovations in expander and implant design have made the results of prosthetic reconstruction more predictable.

References

1 Parkin DM, Muir CS, Whelan SL, Gao Y-T, Ferlay J, Powell J, eds. Cancer incidence in five continents. *IARC Sci Publications* 1992; **120:** 809.
2 Bostwick J III. *Plastic and Reconstructive Breast Surgery*. St Louis, Missouri: Quality Medical Publishing, 1990.
3 Eberlein TJ, Crespo LD, Smith BL, Hergrueter CA, Douville L, Eriksson E. Prospective evaluation of immediate reconstruction after mastectomy. *Ann Surg* 1993; **218:** 29–36.
4 Rosen PB, Jabs AD, Kister SJ, Hugo NE. Clinical experience with immediate breast reconstruction using tissue expansion or transverse rectus abdominis musculocutaneous flaps. *Ann Plast Surg* 1990; **25:** 249–57.
5 Hartwell SW Jr, Anderson R, Hall MD, Esselstyn C Jr. Reconstruction of the breast after mastectomy for cancer. *Plast Reconstr Surg* 1976; **57:** 152–7.
6 Logan H. The insertion of prostheses at mastectomy for carcinoma of the breast – a preliminary report. *Br J Surg* 1980; **67:** 69–70.
7 Vandamme J-P. Single-stage subcutaneous breast-prosthesis implantation and modified radical mastectomy for invasive carcinoma. *Int Surg* 1985; **70:** 297–300.
8 Radovan C. Breast reconstruction after mastectomy using the temporary expander. *Plast Reconstr Surg* 1982; **69:** 195–208.
9 Argenta LC, Marks MW, Grabb WC. Selective use of serial expansion in breast reconstruction. *Ann Plast Surg* 1983; **11:** 188–95.
10 Dickson MG, Sharpe DT, Dickson WA, Wilde GP, Brennan TG, Roberts AH. Breast reconstruction by tissue expansion. *Ann R Coll Surg Engl* 1987; **69:** 19–21.
11 Cohen IK, Turner D. Immediate breast reconstruction with tissue expanders. *Clin Plast Surg* 1987; **14:** 491–8.
12 Ward J, Cohen IK, Knaysi GA, Brown PW. Immediate breast reconstruction with tissue expansion. *Plast Reconstr Surg* 1987; **80:** 559–66.
13 Schuster RH, Rotter S, Boonn W, Efron G. The use of tissue expanders in immediate breast reconstruction following mastectomy for cancer. *Br J Plast Surg* 1990; **43:** 413–18.
14 Becker H. Breast reconstruction using an inflatable breast implant with detachable reservoir. *Plast Reconstr Surg* 1984; **73:** 678–83.
15 Becker H, Maraist F. Immediate breast reconstruction after mastectomy using a permanent tissue expander. *South Med J* 1987; **80:** 154–60.
16 Gibney J. Use of a permanent tissue expander for breast reconstruction. *Plast Reconstr Surg* 1989; **84:** 607–17.
17 Elliott LF, Hartrampf CR Jr. Breast reconstruction: progress in the past decade. *World J Surg* 1990; **14:** 763–75.
18 Hartrampf CR, Scheflan M, Black PW. Breast reconstruction with a transverse abdominal island flap. *Plast Reconstr Surg* 1982; **69:** 216–25.
19 Holmstrom H. The free abdominoplasty flap and its use in breast reconstruction. An experimental study and clinical case report. *Scand J Plast Reconstr Surg* 1979; **13:** 423–7.
20 Drever JM, Hodson-Walker NJ. Immediate breast reconstruction after mastectomy using a rectus abdominis myodermal flap without an implant. *Can J Surg* 1982; **25:** 429–31.
21 Schneider WJ, Hill HL Jr, Brown RG. Latissimus dorsi myocutaneous flap for breast reconstruction. *Br J Plast Surg* 1977; **30:** 277–81.
22 Bostwick J III, Nahai F, Wallace JG, Vasconez LO. Sixty latissimus dorsi flaps. *Plast Reconstr Surg* 1979; **63:** 31–41.
23 Le-Quang C. Two new free flaps developed from aesthetic surgery. II. The inferior gluteal flap. *Aesthetic Plast Surg* 1980; **4:** 159–168.
24 Paletta CE, Bostwick J III, Nahai F. The inferior gluteal free flap in breast reconstruction. *Plast Reconstr Surg* 1989; **84:** 875–83.
25 Elliott LF, Beegle PH, Hartrampf CR Jr. The lateral transverse thigh free flap: an alternative for autogenous-tissue breast reconstruction. *Plast Reconstr Surg* 1990; **85:** 169–78.
26 Fisher J, Hammond DC. The combination of expanders with autogenous tissue in breast reconstruction. *Clin Plast Surg* 1994; **21:** 309–20.
27 Miller MJ, Rock CS, Robb GL. Aesthetic breast reconstruction using a combination of free transverse rectus abdominis musculocutaneous flaps and breast implants. *Ann Plast Surg* 1996; **37:** 258–64.
28 Serletti JM, Moran SL. The combined use of the TRAM and expanders/implants in breast reconstruction. *Ann Plast Surg* 1998; **40:** 510–14.
29 Bailey MH, Smith JW, Casas L, Johnson P, Serra E, de la Fuente R *et al*. Immediate breast reconstruction: reducing the risks. *Plast Reconstr Surg* 1989; **83:** 845–51.
30 Watts GT. Reconstruction of the breast as a primary and secondary procedure following mastectomy for carcinoma. *Br J Surg* 1976; **63:** 823–5.
31 Gruber RP, Kahn RA, Lash H, Maser MR, Apfelberg DB, Laub DR. Breast reconstruction following mastectomy: a comparison of submuscular and subcutaneous techniques. *Plast Reconstr Surg* 1981; **67:** 312–17.
32 van Smitten K. Breast reconstruction. *Acta Oncol* 1995; **34:** 685–8.
33 Regnault P. Partially submuscular breast augmentation. *Plast Reconstr Surg* 1977; **59:** 72–6.
34 Little JW III, Golembe EV, Fisher JB. The 'living bra' in

immediate and delayed reconstruction of the breast following mastectomy for malignant and nonmalignant disease. *Plast Reconstr Surg* 1981; **68:** 392–403.
35 Jarrett JR, Cutler RG, Teal DF. Aesthetic refinements in prophylactic subcutaneous mastectomy with submuscular reconstruction. *Plast Reconstr Surg* 1982; **69:** 624–31.
36 Robles JM, Zimman OA, Lee JC. A larger subpectoral pocket for breast implants. *Plast Reconstr Surg* 1978; **62:** 78–80.
37 Asplund O. Capsular contracture in silicone gel and saline-filled breast implants after reconstruction. *Plast Reconstr Surg* 1984; **73:** 270–5.
38 Gylbert L, Asplund O, Jurell G. Capsular contracture after breast reconstruction with silicone-gel and saline-filled implants: a 6-year follow-up. *Plast Reconstr Surg* 1990; **85:** 373–7.
39 Horton CE, Rosato FA, McCraw JB, Dowden RV. Immediate reconstruction following mastectomy for cancer. *Clin Plast Surg* 1979; **6:** 37–46.
40 Paul MD. Primary breast reconstruction with a subpectoral silicone tissue expander. *Ann Plast Surg* 1985; **15:** 404–14.
41 Dowden RV. Selection criteria for successful immediate breast reconstruction. *Plast Reconstr Surg* 1991; **88:** 628–34.
42 Slavin SA, Colen SR. Sixty consecutive breast reconstructions with the inflatable expander: a critical appraisal. *Plast Reconstr Surg* 1990; **86:** 910–19.
43 Biggs TM, Yarish RS. Augmentation mammaplasty: a comparative analysis. *Plast Reconstr Surg* 1990; **85:** 368–72.
44 Malata CM, Sharpe DT. On the safety of breast implants. *The Breast* 1992; **1:** 62–75.
45 Noone RB, Murphy JB, Spear SL, Little JW III. A 6-year experience with immediate reconstruction after mastectomy for cancer. *Plast Reconstr Surg* 1985; **76:** 258–69.
46 Palmer BV, Mannur KR, Ross WB. Subcutaneous mastectomy with immediate reconstruction as treatment for early breast cancer. *Br J Surg* 1992; **79:** 1309–11.
47 Dickson MG, Sharpe DT. The complications of tissue expansion in breast reconstruction: a review of 75 cases. *Br J Plast Surg* 1987; **40:** 629–35.
48 Bayet B, Mathieu G, Lavand-Homme P, Vanwijck R. Primary and secondary breast reconstruction with a permanent expander. *Eur J Plast Surg* 1991; **14:** 73–9.
49 Rosato RM, Dowden RV. Radiation therapy as a cause of capsular contracture. *Ann Plast Surg* 1994; **32:** 342–5.
50 Gutowski KA, Mesna GT, Cunningham BL. Saline-filled breast implants: a Plastic Surgery Educational Foundation multicenter outcomes study. *Plast Reconstr Surg* 1997; **100:** 1019–27.
51 Burkhardt BR, Demas CP. The effect of Siltex texturing and povidone–iodine irrigation on capsular contracture around saline inflatable breast implants. *Plast Reconstr Surg* 1994; **93:** 123–8.
52 Burkhardt BR, Eades E. The effect of Biocell texturing and povidone–iodine irrigation on capsular contracture around saline-inflatable breast implants. *Plast Reconstr Surg* 1995; **96:** 1317–25.
53 Malata CM, Feldberg L, Coleman DJ, Foo IT, Sharpe DT. Textured or smooth implants for breast augmentation? Three year follow-up of a prospective randomised controlled trial. *Br J Plast Surg* 1997; **50:** 99–105.
54 Hakelius L, Ohlsen L. Tendency to capsular contracture around smooth and textured gel-filled silicone mammary implants: a five-year follow-up. *Plast Reconstr Surg* 1997; **100:** 1566–9.
55 Maxwell GP, Falcone PA. Eighty-four consecutive breast reconstructions using a textured silicone tissue expander. *Plast Reconstr Surg* 1992; **89:** 1022–34.
56 Petit JY, Le MG, Mouriesse H, Rietjens M, Gill P, Contesso G *et al.* Can breast reconstruction with gel-filled silicone implants increase the risk of death and second primary cancer in patients treated by mastectomy for breast cancer? *Plast Reconstr Surg* 1994; **94:** 115–19.
57 Woods JE, Mangan MA. Breast reconstruction with tissue expanders: obtaining an optimal result. *Ann Plast Surg* 1992; **28:** 390–6.
58 Radovan C. Breast reconstruction after mastectomy using the temporary expander. *Plast Reconstr Surg* 1982; **69:** 195–208.
59 Argenta LC. Reconstruction of the breast by tissue expansion. *Clin Plast Surg*; **11:** 257–64.
60 Holmes JD. Capsular contracture after breast reconstruction with tissue expansion. *Br J Plast Surg* 1989; **42:** 591–4.
61 Becker H. The use of intradermal tattoo to enhance the final result of nipple–areola reconstruction. *Plast Reconstr Surg* 1986; **77:** 673–6.
62 Foo IT, Coleman DJ, Holmes JD, Palmer JH, Sharpe DT. Delay between expansion and expander/implant exchange in breast reconstruction – a prospective study. *Br J Plast Surg* 1992; **45:** 279–83.
63 Thompson AM, Chetty U. Appraisal of breast reconstruction with the tissue expansion technique. *J R Coll Surg Edinb* 1990; **35:** 4–6.
64 Hoffman JP, Kusaik J, Boraas M, Genter B, Steuber K, Weese JL *et al.* Risk factors for immediate prosthetic postmastectomy reconstruction. *Am Surg* 1991; **57:** 514–21.
65 Mandrekas AD, Zambacos GJ, Katsantoni PN. Immediate and delayed breast reconstruction with permanent tissue expanders. *Br J Plast Surg* 1995; **48:** 572–8.
66 Beasley ME. The pedicled TRAM as preference for immediate autogenous tissue breast reconstruction. *Clin Plast Surg* 1994; **21:** 191–205.
67 Wickman M, Jurell G. Low capsular contraction rate after primary and secondary breast reconstruction with a textured expander prosthesis. *Plast Reconstr Surg* 1997; **99:** 692–7.
68 Peters W, Keystone E, Smith D. Factors affecting the rupture of silicone-gel breast implants. *Ann Plast Surg* 1994; **32:** 449–51.
69 Cooper GG, Webster MH, Bell G. The results of breast reconstruction following mastectomy. *Br J Plast Surg* 1984; **37:** 369–72.
70 Armstrong RW, Berkowitz RL, Bolding F. Infection following breast reconstruction. *Ann Plast Surg* 1989; **23:** 284–8.
71 Spear SL, Majidian A. Immediate breast reconstruction in two

stages using textured, integrated-valve tissue expanders and breast implants: a retrospective review of 171 consecutive breast reconstructions from 1989 to 1996. *Plast Reconstr Surg* 1998; **101:** 53–63.
72 Hammond DC, Perry LC, Maxwell GP, Fisher J. Morphologic analysis of tissue-expander shape using a biomechanical model. *Plast Reconstr Surg* 1993; **92:** 255–9.
73 Colen LB. One-stage reconstruction of the breast using autologous tissue with immediate nipple reconstruction. In: Spear SL, Little JW, Lippman ME, Wood WC, eds. *Surgery of the Breast: Principles and Art*. Philadelphia, Pennsylvania: Lippincott–Raven, 1998: 491–509.
74 Spear SL, Hartrampf CR Jr. The double pedicle TRAM flap and the standard of care. *Plast Reconstr Surg* 1998; **102:** 586–7 (Letter).
75 Miller MJ. Immediate breast reconstruction. *Clin Plast Surg* 1998; **25:** 145–56.
76 Arnez ZM, Smith RW, Eder E, Solinc M, Kersnic M. Breast reconstruction by the free lower transverse rectus abdominis musculocutaneous flap. *Br J Plast Surg* 1988; **41:** 500–5.
77 Grotting JC, Urist MM, Maddox WA, Vasconez LO. Conventional TRAM flap *versus* free microsurgical TRAM flap for immediate breast reconstruction. *Plast Reconst Surg* 1989; **83:** 828–41.
78 Nieminen T, Asko-Seljavaara S, Suominen E, Kuekkanen H, von Smitten K. Free microvascular tram flaps: report of 185 breast reconstructions. *Scand J Plast Reconstr Surg Hand Surg* 1999; **33:** 295–300.
79 Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. *Br J Plast Surg* 1989; **42:** 645–8.
80 Allen RJ, Treece P. Deep inferior epigastric perforator flap for breast reconstruction. *Ann Plast Surg* 1994; **32:** 32–8.
81 Blondeel PN, Boeckx WD. Refinements in free flap breast reconstruction: the free bilateral deep inferior epigastric perforator flap anastomosed to the internal mammary artery. *Br J Plast Surg* 1994; **47:** 495–501.
82 Blondeel N, Vanderstraeten GG, Monstrey SJ, Van Landuyt K, Tonnard P, Lysens R *et al.* The donor site morbidity of free DIEP flaps and free TRAM flaps for breast reconstruction. *Br J Plast Surg* 1997; **50:** 322–30.
83 Blondeel PN. One hundred free DIEP flap breast reconstructions: a personal experience. *Br J Plast Surg* 1999; **52:** 104–11.
84 Hamdi M, Weiler-Mithoff EM, Webster MH. Deep inferior epigastric perforator flap in breast reconstruction: experience with the first 50 flaps. *Plast Reconstr Surg* 1999; **103:** 86–95.
85 McCraw JB, Papp CTh. Latissimus dorsi myocutaneous flap. In: Hartrampf CR, ed. *Hartrampf's Breast Reconstruction with Living Tissue*. Norfolk, Virginia: Hampton Press, 1991: 211–48.
86 Hartrampf CR Jr. The transverse abdominal island flap for breast reconstruction. A 7-year experience. *Clin Plast Surg* 1988; **15:** 703–16.
87 Watterson PA, Bostwick J III, Hester TR Jr, Bried JT, Taylor GI. TRAM flap anatomy correlated with a 10-year clinical experience with 556 patients. *Plast Reconstr Surg* 1995; **95:** 1185–94.
88 Kroll SS, Netscher DT. Complications of TRAM flap breast reconstruction in obese patients. *Plast Reconstr Surg* 1989; **84:** 886–92.
89 Nolan J, Jenkins RA, Kurihara K, Schultz RC. The acute effects of cigarette smoke exposure on experimental skin flaps. *Plast Reconstr Surg* 1985; **75:** 544–51.
90 Hartrampf CR Jr, Bennett GK. Autogenous tissue reconstruction in the mastectomy patient. A critical review of 300 patients. *Ann Surg* 1987; **205:** 508–19.
91 Ishii CH Jr, Bostwick J III, Raine TJ, Coleman JJ III, Hester TR. Double-pedicle transverse rectus abdominis myocutaneous flap for unilateral breast and chest-wall reconstruction. *Plast Reconstr Surg* 1985; **76:** 901–7.
92 Codner MA, Bostwick J III. The delayed TRAM flap. *Clin Plast Surg* 1998; **25:** 183–9.
93 Schusterman MA, Kroll SS, Weldon ME. Immediate breast reconstruction: why the free TRAM over the conventional TRAM flap? *Plast Reconstr Surg* 1992; **90:** 255–61.
94 Wagner DS, Michelow BJ, Hartrampf CR Jr. Double-pedicle TRAM flap for unilateral breast reconstruction. *Plast Reconstr Surg* 1991; **88:** 987–97.
95 Jensen JA. Is double pedicle TRAM flap reconstruction of a single breast within the standard of care? *Plast Reconstr Surg* 1997; **100:** 1592– 3 (Editorial).
96 Boyd JB, Taylor GI, Corlett R. The vascular territories of the superior epigastric and the deep inferior epigastric systems. *Plast Reconstr Surg* 1984; **73:** 1–16.
97 Moon HK, Taylor GI. The vascular anatomy of rectus abdominis musculocutaneous flaps based on the deep superior epigastric system. *Plast Reconstr Surg* 1988; **82:** 815–32.
98 Codner MA, Bostwick J III, Nahai F, Bried JT, Eaves FF. TRAM flap vascular delay for high-risk breast reconstruction. *Plast Reconstr Surg* 1995; **96:** 1615–22.
99 Slavin SA, Goldwyn RM. The midabdominal rectus abdominis myocutaneous flap: review of 236 flaps. *Plast Reconstr Surg* 1988; **81:** 189–99.
100 Harris NR II, Webb MS, May JW Jr. Intraoperative physiologic blood flow studies in the TRAM flap. *Plast Reconstr Surg* 1992; **90:** 553–61.
101 Harashina T, Sone K, Inoue T, Fukuzumi S, Enomoto K. Augmentation of circulation of pedicled transverse rectus abdominis musculocutaneous flaps by microvascular surgery. *Br J Plast Surg* 1987; **40:** 367–70.
102 Beegle PH. Microvascular augmentation of TRAM flap circulation ('supercharged' TRAM). In: Hartrampf CR Jr, ed. *Hartrampf's Breast Reconstruction with Living Tissue*. Norfolk, Virginia: Hampton Press, 1991: 175–82.
103 Semple JL. Retrograde microvascular augmentation (turbocharging) of a single-pedicle TRAM flap through a deep inferior epigastric arterial and venous loop. *Plast Reconstr Surg* 1994; **93:** 109–17.
104 Elliott LF, Eskenazi L, Beegle PH Jr, Podres PE, Drazan L.

Immediate TRAM flap breast reconstruction: 128 consecutive cases. *Plast Reconstr Surg* 1993; **92:** 217–27.
105 Baldwin BJ, Schusterman MA, Miller MJ, Kroll SS, Wang BG. Bilateral breast reconstruction: conventional *versus* free TRAM. *Plast Reconstr Surg* 1994; **93:** 1410–16.
106 Schusterman MA, Kroll SS, Miller MJ, Reece GP, Baldwin BJ, Robb GL *et al.* The free transverse rectus abdominis musculocutaneous flap for breast reconstruction: one center's experience with 211 consecutive cases. *Ann Plast Surg* 1994; **32:** 234–41.
107 Arnez ZM, Bajec J, Bardsley AF, Scamp T, Webster MH. Experience with 50 free TRAM flap breast reconstructions. *Plast Reconstr Surg* 1991; **87:** 470–8.
108 Banic A, Boeckx W, Greulich M, Guelickx P, Marchi A, Rigotti G *et al.* Late results of breast reconstruction with free TRAM flaps: a prospective multicentric study. *Plast Reconstr Surg* 1995; **95:** 1195–204.
109 Grotting JC. Immediate breast reconstruction using the free TRAM flap. *Clin Plast Surg* 1994; **21:** 207–21.
110 Shaw WW. Breast reconstruction by superior gluteal microvascular free flaps without silicone implants. *Plast Reconstr Surg* 1983; **72:** 490–501.
111 Arnez ZM, Valdatta L, Tyler MP, Planinsek F. Anatomy of the internal mammary veins and their use in free TRAM flap breast reconstruction. *Br J Plast Surg* 1995; **48:** 540–5.
112 Dupin CL, Allen RJ, Glass CA, Bunch R. The internal mammary artery and vein as a recipient site for free-flap breast reconstruction: a report of 110 consecutive cases. *Plast Reconstr Surg* 1996; **98:** 685–9.
113 Noguchi M, Earashi M, Ohta N, Kitagawa H, Kinoshita K, Thomas M *et al.* Mastectomy with and without immediate breast reconstruction using a musculocutaneous flap. *Am J Surg* 1993; **166:** 279–83.
114 Fung KW, Lau Y, Nyunt K, Chan CM, Ho CM. Immediate breast reconstruction in Chinese women using the transverse rectus abdominis myocutaneous (TRAM) flap. *Aust NZ J Surg* 1996; **66:** 452–6.
115 Feller AM. Free TRAM. Results and abdominal wall function. *Clin Plast Surg* 1994; **21:** 223–32.
116 Serletti JM, Moran SL. Free *versus* the pedicled TRAM flap: a cost comparison and outcome analysis. *Plast Reconstr Surg* 1997; **100:** 1418–24.
117 Allen R, Guarda H, Wall F, Dupin C, Glass C. Free flap breast reconstruction: the LSU experience (1984–1996). *J La State Med Soc* 1997; **149:** 388–92.
118 Chen L, Hartrampf CR Jr, Bennett GK. Successful pregnancies following TRAM flap surgery. *Plast Reconstr Surg* 1993; **91:** 69–71.
119 Hokin JA. Mastectomy reconstruction without a prosthetic implant. *Plast Reconstr Surg* 1983; **72:** 810–18.
120 Marshall DR, Anstee EJ, Stapleton MJ. Soft tissue reconstruction of the breast using an extended composite latissimus dorsi myocutaneous flap. *Br J Plast Surg* 1984; **37:** 361–8.
121 Hokin JA, Silfverskiold KL. Breast reconstruction without an implant: results and complications using an extended latissimus dorsi flap. *Plast Reconstr Surg* 1987; **79:** 58–66.
122 Papp C, Zanon E, McCraw J. Breast volume replacement using the de-epithelialized latissimus dorsi myocutaneous flap. *Eur J Plast Surg* 1988; **11:** 120–5.
123 Barnett GR, Gianoutsos MP. The latissimus dorsi added fat flap for natural tissue breast reconstruction: report of 15 cases. *Plast Reconstr Surg* 1996; **97:** 63–70.
124 Bostwick J III, Carlson GW. Reconstruction of the breast. *Surg Oncol Clin North Am* ; **6:** 71–89.
125 Serletti JM, Higgins J, Carras AJ. Free latissimus dorsi myocutaneous flap for secondary breast reconstruction after partial loss of a TRAM flap. *Plast Reconstr Surg* 1997; **100:** 690–4.
126 De Mey A, Lejour M, Declety A, Meythiaz AM. Late results and current indications of latissimus dorsi breast reconstructions. *Br J Plast Surg* 1991; **44:** 1–4.
127 Moore TS, Farrell LD. Latissimus dorsi myocutaneous flap for breast reconstruction: long-term results. *Plast Reconstr Surg* 1992; **89:** 666–72.
128 Kroll SS, Baldwin B. A comparison of outcomes using three different methods of breast reconstruction. *Plast Reconstr Surg* 1992; **90:** 455–62.
129 Slavin SA, Love SM, Sadowsky NL. Reconstruction of the radiated partial mastectomy defect with autogenous tissues. *Plast Reconstr Surg* 1992; **90:** 854–65.
130 Song R, Yang P, Yu H, Huang H. Breast reconstruction without a silicone implant. *Clin Plast Surg* 1982; **9:** 85–9.
131 Mendelson BC. Latissimus dorsi breast reconstruction–refinement and results. *Br J Surg* 1983; **70:** 145–9.
132 McCraw JB, Maxwell GP. Early and late capsular 'deformation' as a cause of unsatisfactory results in the latissimus dorsi breast reconstruction. *Clin Plast Surg* 1988; **15:** 717–26.
133 Tschopp H. Evaluation of long-term results in breast reconstruction using the latissimus dorsi flap. *Ann Plast Surg* 1991; **26:** 328–40.
134 Luce PA, Hammond DC. Latissimus dorsi musculocutaneous flaps and tissue expanders/implants in immediate breast reconstruction. *Plast Surg Forum 64 (ASPRS)* 1995; **18:** 133 (abstract).
135 Shaw WW. Microvascular free flap breast reconstruction. *Clin Plast Surg* 1984; **11:** 333–41.
136 Boustred AM, Nahai F. Inferior gluteal free flap breast reconstruction. *Clin Plast Surg* 1998; **25:** 275–82.
137 Taylor GI, Townsend P, Corlett R. Superiority of the deep circumflex iliac vessels as the supply for free groin flaps. *Plast Reconstr Surg* 1979; **64:** 595–604.
138 Taylor GI, Townsend P, Corlett R. Superiority of the deep circumflex iliac vessels as the supply for free groin flaps. *Plast Reconstr Surg* 1979; **64:** 745–59.
139 Hartrampf CR Jr, Noel RT, Drazan L, Elliott FL, Bennett GK, Beegle PH. Ruben's fat pad for breast reconstruction: a peri-iliac soft-tissue free flap. *Plast Reconstr Surg* 1994; **93:** 402–7.
140 Toth BA, Lappert P. Modified skin incisions for mastectomy:

the need for plastic surgical input in preoperative planning. *Plast Reconstr Surg* 1991; **87:** 1048–53.
141 Kroll SS, Ames F, Singletary SE, Schusterman MA. The oncologic risks of skin preservation at mastectomy when combined with immediate reconstruction of the breast. *Surg Gynecol Obstet* 1991; **172:** 17–20.
142 Singletary SE. Skin-sparing mastectomy with immediate breast reconstruction: the M.D. Anderson Cancer Center experience. *Ann Surg Oncol* 1996; **3:** 411–16.
143 Carlson GW, Bostwick J III, Styblo TM, Moore B, Bried JT, Murray DR *et al.* Skin-sparing mastectomy. Oncologic and reconstructive considerations. *Ann Surg* 1997; **225:** 570–8.
144 Carlson GW, Grossl N, Lewis MM, Temple JR, Styblo TM. Preservation of the inframammary fold: what are we leaving behind? *Plast Reconstr Surg* 1996; **98:** 447–50.
145 Carlson GW. Skin-sparing mastectomy: anatomic and technical considerations. *Am Surg* 1996; **62:** 151–5.
146 Bensimon RH, Bergmeyer JM. Improved aesthetics in breast reconstruction: modified mastectomy incision and immediate autologous tissue reconstruction. *Ann Plast Surg* 1995; **34:** 229–33.
147 Góes JCS. Mastectomy by periareolar approach with immediate breast reconstruction. *Rev Soc Bras Cir Plast* 1995; **10:** 44–55.
148 Gabka CJ, Maiwald G, Bohmert H. Immediate breast reconstruction for breast carcinoma using the periareolar approach. *Plast Reconstr Surg* 1998; **101:** 1228–34.
149 Webster DJT, Mansel RE, Hughes LE. Immediate reconstruction of the breast after mastectomy. Is it safe? *Cancer* 1984; **53:** 1416–19.
150 Rosenqvist S, Sandelin K, Wickman M. Patients' psychological and cosmetic experience after immediate breast reconstruction. *Eur J Surg Oncol* 1996; **22:** 262–6.
151 Johnson CH, van Heerden JA, Donohue JH, Martin JK Jr, Jackson IT, Ilstrup DM. Oncological aspects of immediate breast reconstruction following mastectomy for malignancy. *Arch Surg* 1989; **124:** 819–24.
152 Kroll SS, Ames F, Singletary SE, Schusterman MA. The oncologic risks of skin preservation at mastectomy when combined with immediate reconstruction of the breast. *Surg Gynecol Obstet* 1991; **172:** 17–20.
153 Noguchi M, Fukushima W, Ohta N, Koyasaki N, Thomas M, Miyazaki I *et al.* Oncological aspect of immediate breast reconstruction in mastectomy patients. *J Surg Oncol* 1992; **50:** 241–6.
154 O'Brien W, Hasselgren PO, Hummel RP, Coith R, Hyams D, Kurtzman L *et al.* Comparison of postoperative wound complications and early cancer recurrence between patients undergoing mastectomy with or without immediate breast reconstruction. *Am J Surg* 1993; **166:** 1–5.
155 Noone RB, Frazier TG, Noone GC, Blanchet NP, Murphy JB, Rose D. Recurrence of breast carcinoma following immediate reconstruction: a 13-year review. *Plast Reconstr Surg* 1994; **93:** 96–106.
156 Slavin SA, Love SM, Goldwyn RM. Recurrent breast cancer following immediate reconstruction with myocutaneous flaps. *Plast Reconstr Surg* 1994; **93:** 1191–204.
157 Kroll SS, Schusterman MA, Tadjalli HE, Singletary SE, Ames FC. Risk of recurrence after treatment of early breast cancer with skin-sparing mastectomy. *Ann Surg Oncol* 1997; **4:** 193–7.
158 Hidalgo DA, Borgen PJ, Petrek JA, Heerdt AH, Cody HS, Disa JJ. Immediate reconstruction after complete skin-sparing mastectomy with autologous tissue. *J Am Coll Surg* 1998; **187:** 17–21.
159 Bruce J, Carter DC, Fraser J. Patterns of recurrent disease in breast cancer. *Lancet* 1970; **i:** 433–5.
160 Furey PC, Macgillivray DC, Castiglione CL, Allen L. Wound complications in patients receiving adjuvant chemotherapy after mastectomy and immediate breast reconstruction for breast cancer. *J Surg Oncol* 1994; **55:** 194–7.
161 Clough KB, Bourgeois D, Falcou MC, Renolleau C, Durand JC. Immediate breast reconstruction by prosthesis: a safe technique for extensive intraductal and microinvasive carcinomas. *Ann Surg Oncol* 1996; **3:** 212–18.
162 Yule GJ, Concannon MJ, Croll G, Puckett CL. Is there liability with chemotherapy following immediate breast reconstruction? *Plast Reconstr Surg* 1996; **97:** 969–73.
163 Barreau-Pouhaer L, Le MG, Rietjens M, Arriagada R, Contesso G, Martins R *et al.* Risk factors for failure of immediate breast reconstruction with prosthesis after mastectomy for breast cancer. *Cancer* 1992; **70:** 1145–51.
164 von Smitten K, Sundell B. The impact of adjuvant radiotherapy and cytotoxic chemotherapy on the outcome of immediate breast reconstruction by tissue expansion after mastectomy for breast cancer. *Eur J Surg Oncol* 1992; **18:** 119–23.
165 Caffee HH, Mendenhall NP, Mendenhall WM, Bova FJ. Postoperative radiation and implant capsule contraction. *Ann Plast Surg* 1988; **20:** 35–8.
166 Ryu J, Yahalom J, Shank B, Chaglassian TA, McCormick B. Radiation therapy after breast augmentation or reconstruction in early or recurrent breast cancer. *Cancer* 1990; **66:** 844–7.
167 Kuske RR, Schuster R, Klein E, Young L, Perez CA, Fineberg B. Radiotherapy and breast reconstruction: clinical results and dosimetry. *Int J Radiat Oncol Biol Phys* 1991; **21:** 339–46.
168 Victor SJ, Brown DM, Horwitz EM, Martinez AA, Kini VR, Pettinga JE *et al.* Treatment outcome with radiation therapy after breast augmentation or reconstruction in patients with primary breast carcinoma. *Cancer* 1998; **82:** 1303–9.
169 Williams JK, Carlson GW, Bostwick J III, Bried JT, Mackay G. The effects of radiation treatment after TRAM flap breast reconstruction. *Plast Reconstr Surg* 1997; **100:** 1153–60.
170 Zimmerman RP, Mark RJ, Kim AI, Walton T, Sayah D, Juillard GF *et al.* Radiation tolerance of transverse rectus abdominis myocutaneous-free flaps used in immediate breast reconstruction. *Am J Clin Oncol* 1998; **21:** 381–5.
171 Hunt KK, Baldwin BJ, Strom EA, Ames FC, McNeese MD, Kroll SS *et al.* Feasibility of postmastectomy radiation therapy

after TRAM flap breast reconstruction. *Ann Surg Oncol* 1997; **4:** 377–84.
172 Mitnick JS, Roses DF, Harris MN, Colen SR. Calcifications of the breast after reduction mammoplasty. *Surg Gynecol Obstet* 1990; **171:** 409–12.
173 Silverstein MJ, Gamagami P, Handel N. Missed breast cancer in an augmented woman using implant displacement mammography. *Ann Plast Surg* 1990; **25:** 210–13.
174 Wellisch DK, Schain WS, Noone RB, Little JW III. Psychological correlates of immediate *versus* delayed reconstruction of the breast. *Plast Reconstr Surg* 1985; **76:** 713–18.
175 Little JW III. Nipple–areola reconstruction. *Clin Plast Surg* 1984; **11:** 351–64.
176 Wiemer DR, Freeman BS. Bilateral reconstruction of the nipple–areola complex. *Plast Reconstr Surg* 1976; **58:** 310–13.
177 Klatsky SA, Manson PN. Toe pulp free grafts in nipple reconstruction. *Plast Reconstr Surg* 1981; **68:** 245–8.
178 Eskenazi L. A one-stage nipple reconstruction with the 'modified star' flap and immediate tattoo: a review of 100 cases. *Plast Reconstr Surg* 1993; **92:** 671–80.
179 Hartrampf CR Jr, Culbertson JH. A dermal-fat flap for nipple reconstruction. *Plast Reconstr Surg* 1984; **73:** 982–6.
180 McCraw JB, Papp C, Edwards A, McMellin A. The autogenous latissimus breast reconstruction. *Clin Plast Surg* 1994; **21:** 279–88.
181 Beegle PH Jr. Immediate single-stage TRAM and nipple–areola reconstruction. *Clin Plast Surg* 1994; **21:** 321–6.
182 Rees TD. Reconstruction of the breast areola by intradermal tattooing and transfer. Case report. *Plast Reconstr Surg* 1975; **55:** 620–1.
183 Spear SL, Convit R, Little JW III. Intradermal tattoo as an adjunct to nipple–areola reconstruction. *Plast Reconstr Surg* 1989; **83:** 907–11.
184 Dean C, Chetty U, Forrest APM. Effects of immediate breast reconstruction on psychosocial morbidity after mastectomy. *Lancet* 1983; **i:** 459–62.
185 Stevens LA, McGrath MH, Druss RG, Kirster SJ, Gump FE, Forde KA. The psychological impact of immediate breast reconstruction for women with early breast cancer. *Plast Reconstr Surg* 1984; **73:** 619–28.
186 Goin MK, Goin JM. Psychological reactions to prophylactic mastectomy synchronous with contralateral breast reconstruction. *Plast Reconstr Surg* 1982; **70:** 355–9.
187 Schain WS. Breast reconstruction. Update of psychosocial and pragmatic concerns. *Cancer* 1991; **68**(Suppl 5)**:** 1170–5.
188 Lewis FM, Bloom JR. Psychosocial adjustment to breast cancer: a review of selected literature. *Int J Psychiatry Med* 1978–1979; **9:** 1–17.
189 McGuire GP, Lee EG, Bevington DJ, Kuchemann SC, Crabtree RJ, Cornell CE. Psychiatric problems in the first year after mastectomy. *BMJ* 1978; **i:** 963–5.
190 Bransfield DD. Breast cancer and sexual functioning; a review of the literature and implications for future research. *Int J Psychiatry Med* 1982; **12:** 197–211.
191 Meyerowitz BE. Psychosocial correlates of breast cancer and its treatment. *Psychol Bull* 1980; **87:** 108–31.
192 Hopwood P, Maguire GP. Body image problems in cancer patients. *Br J Psychiatry* 1988; **153**(Suppl 2)**:** 47–50.
193 Irvine D, Brown B, Crooks D, Roberts J, Browne G. Psychosocial adjustment in women with breast cancer. *Cancer* 1991; **67:** 1097–117.
194 Noone RB, Frazier TG, Hayward CZ, Skiles MS. Patient acceptance of immediate reconstruction following mastectomy. *Plast Reconstr Surg* 1982; **69:** 632–40.
195 Franchelli S, Leone MS, Berrino P, Passarelli B, Capelli M, Baracco G *et al.* Psychological evaluation of patients undergoing breast reconstruction using two different methods: autologous tissues *versus* prostheses. *Plast Reconstr Surg* 1995; **95:** 1213–18.
196 Handel N, Silverstein MJ, Waisman E, Waisman JR. Reasons why mastectomy patients do not have breast reconstruction. *Plast Reconstr Surg* 1990; **86:** 1118–22.
197 Rolland JH. Psychological impact of treatments for breast cancer. In: Spear SL, Little JW, Lippman ME, Wood WC, eds. *Surgery of the Breast: Principles and Art*. Philadelphia, Pennsylvania: Lippincott–Raven, 1998: 295–313.
198 Khoo A, Kroll SS, Reece GP, Miller MJ, Evans GR, Robb GL *et al.* A comparison of resource costs of immediate and delayed breast reconstruction. *Plast Reconstr Surg* 1998; **101:** 964–8.
199 Kroll SS, Evans GR, Reece GP, Miller MJ, Robb GL, Baldwin BJ *et al.* Comparison of resource costs of free and conventional TRAM flap breast reconstruction. *Plast Reconstr Surg* 1996; **98:** 74–7.

