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Thierry TONDU

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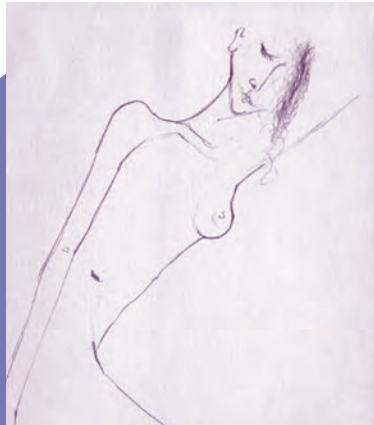
The delayed preshaped-breast principle after nipple-sparing mastectomy:

A safe two-staged breast reconstruction in the anatomically challenging breast



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The delayed preshaped-breast principle after nipple-sparing mastectomy:

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Thierry TONDU

Antwerp, 2022
Thesis submitted in fulfilment of the requirements for the degree of Doctor in Medical Sciences at the University of Antwerp

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Het voorgevormde tepelsparende borsthuid-principe:

Een veilige borstreconstructie in twee fasen in de anatomisch uitdagende borst

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Thesis submitted in fulfilment of the requirements for the degree of Doctor in Medical Sciences at the University of Antwerp

Proefschrift voorgelegd tot het behalen van de graad van doctor in de Medische Wetenschappen aan de Universiteit Antwerpen

Antwerp, 2022
Promotors: Prof Dr. Wiebren Tjalma
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The delayed preshaped-breast principle after nipple-sparing mastectomy: A safe two-staged breast reconstruction in the anatomically challenging breast / Thierry Tondu
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List of Abbreviations

ASCO	American Society of Clinical Oncology
ADM	Acellur Dermal Matrix
ALT	Antero Lateral Thigh flap
BAD	Breast Animation Deformity
BCT	Breast Conserving/Conservation Therapy
BMI	Body Mass Index
BRC	Breast ReConstruction
BRCA	BReast CAncer gene
BW	supra-areolar BatWing mastopexy
CCA	Complete CircumAreolar complex lift
CTA	Computer Tomography Angiography
DCIA	Deep Circumflex Iliac Artery flap
DCIS	Ductal Carcinoma In Situ
DIEP/DIEAP	Diep Inferior Epigastric artery Perforator flap
DTI	Direct-To-Implant
FI	Fluorescence Intensity
ICG	Indo-Cyanine Green
IGAP	Inferior Gluteal Artery Perforator flap
IMF	InfraMammary Fold
IR	InfraRed
IV	IntraVenous
LAP	Lumbar Artery Perforator flap
LCIS	Lobular Carcinoma In Situ
LD	Latissimus Dorsi flap
MRI	Magnetic Resonance Imaging
NAC	Nipple-Areola Complex
NCCN	National Comprehensive Cancer Network guidelines
NIR	Near-InfraRed
NIMF	Nipple-to-Inframammary Fold Distance
NS	Not Specific
NSM	Nipple-Sparing Mastectomy
PFAP	Profunda Femoris Artery Perforator flap
POD	PostOperative Day
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
SCA	Superior CircumAreolar delay
SGAP	Superior Gluteal Artery Perforator flap
SIEA	Superficial Inferior Epigastric Artery flap
SNI	Sternum-to-NIpple distance
SR	Skin Reduction
SSM	Skin Sparing Mastectomy
STROBE	Strengthening the Reporing of Observational studies in Epidemiology
TDAP	ThoracoDorsal Artery Perforator flap
TDLU	Terminal Duct Lobular Units
TE	Tissue Expander
TMG	Transverse Myocutaneous Gracilis flap
TRAM	Transverse Rectus AbdoMinis flap
TL	Tumor Location
TS	Tumor Size
TUG	Transverse Upper Gracilis flap
VM	Vertical Mastopexy
WP	Wise Pattern mastopexy

General Introduction

Breast cancer and nipple sparing mastectomy

Breast cancer

Breast cancer is endemic in the industrialized world. It has become the most commonly occurring cancer in women and the second most common cancer overall. In 2020 there were more than 2.3 million new cases registered (1).

Belgium has the highest incidence rates of breast cancer in the world with an age-standardized cancer index of 113.2 per 100.000 females, which totals to almost 11.000 women each year (2).

Approximately 5%–7% of breast cancer cases are due to a genetic defect. Women with mutations have a significant lifetime risk of developing breast cancer. Due to the increasing awareness, more women undergo genetic testing. If tested "positive", women can opt for intense screening, preventive medication, or prophylactic surgery in order to reduce the risk of developing breast cancer. Evans et al (3) note an increase in enquiries for risk reducing mastectomy in the UK due to the Angelina Jolie effect. In a recently performed study among seven countries, 69.5% of the BRCA-1 and -2 mutation-positive women elected for breast reconstruction after preventive mastectomy. Young women (77.6% of women were younger than 35 years) and those without a previous diagnosis of breast cancer were more likely to have breast reconstruction than older women (4).

Anatomical and scientific basis

This doctoral thesis is not about oncological guidelines. This thesis is about the anatomical and surgical feasibility of nipple-sparing mastectomy (NSM) in anatomical high-risk patients, women with large and ptotic breasts.

The three anatomical features of a breast are the footprint, the conus and the skin envelope. Recreation of a breast after mastectomy addresses these three features (5). Ideally when breast's footprint and skin envelope are preserved, the only remaining reconstruction is the conus. This is exactly how NSM is thought of in general: replace the glandular volume by another volume while skin envelope, nipple and footprint remain undisturbed. Skin envelope and nipple will cover the new conus. Decennia of clinical experience in mastectomy showed otherwise (6). Mastectomy turns the skin envelope into randomly perfused skin flaps (7). Random flaps experience vascularisation problems at their distal ends: no exact clinical sign exists that indicates where we trespass the distal vascularisation problem zone. This is not completely correct: delay of random skin flaps (i.e. complete flap incision without transposition in the defect) will clearly show this transition zone in a time-span of 2 to 4 weeks (8).

What about the preservation of the nipple-areola complex (NAC)? Again, the pro's and con's of preserving NAC are beyond the scope of this surgical thesis. When the multidisciplinary decision has been made that NAC can be preserved, I, as a surgeon, have to provide a reliable, safe technique to do so. To fully understand my technique, the reader needs to understand the dynamic vascular anatomy behind it. All the above were not discovered overnight: as history makes us learn from the past to avoid the same problems in the future, an historical overview will explain the ideas that have lead to the surgical technique.

History of flap delay

The history of two-staged NSM is a story of new light through old windows. Long before we had an exact idea of the vascularisation of the skin, delay was already a renown reconstructive technique. As early as 700 BC in India, Sushruta Samshita contains a description of nose reconstruction with the use of a delayed forehead flap (9). Translated to Arabic in the 8th century AD this technique travels from Baghdad to 12th century Arab-oc-

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cupied Sicily. One would expect it to be spread over medieval Europe, but instead it is kept as a "family secret" in the south of Italy. Described in the 15th century in "das Buch der Bündth-Ertznei" by Heinrich von Pfolspeundt as „Antonio Branca's procedure", it takes until the late 16th century to be used as a new and exceptional procedure for nose reconstruction (10). In those days one could recognize thieves or women accused of adultery, by their cut noses. In Bologna, 1597, Gasparo Tagliacozzi describes the Indian nose reconstruction by delay in "de Curtorum Chirurgia per Insitionem Libri Duo"(11). Its use remains exceptional and it takes more than 200 years before the "Indian technique" is reintroduced by Joseph Carpue in 1814 (12). He did not find the "Indian technique" in the Bologna university library, but read about it in the Gentleman's Magazine of Calcutta. Almost 2500 years after its first description, the technique of this specific flap delay finds its way back to Europe, directly from its origin, India. The Western breakthrough of flap delay as a standard technique for reconstruction only comes another century later, with the First World War where Sir Harold Gillies introduces tubed pedicled flaps for facial reconstruction (13).

History of nipple-sparing mastectomy in large and/or ptotic breasts

NSM in large breasts with important ptosis is still considered a contraindication because of the increased risk of NAC necrosis. Early reports on subcutaneous mastectomy in large ptotic breasts date from the 1970's. Although efforts were made to obtain adequate skin flap thickness and reliable nipple areola bearing pedicles, using the remaining glandular tissue to ensure overlying dermal perfusion (14,15,16,17), these techniques do not comply with current surgical criteria for NSM (18,19).

Using careful oncological selection criteria as well as anatomical parameters, breast reconstruction after NSM can be safely considered in prophylactic as well as therapeutic settings (20). In 2009 Spear recommended not to perform NSM on patients with positive lymph nodes, with tumors closer than 2 cm to the nipple and in patients with large or ptotic breasts (the Georgetown algorithm) (21). Jensen counterargues the contraindications of positive lymph nodes as well as a tumor to nipple distance less than 2 cm, based on the results of the National Surgical Adjuvant Breast and Bowel Project B.06 randomized trial in 1851 women (22). Jensen states that initial removal of the nipple does not prolong survival in the treatment

of breast cancer: there is no difference in 20 years survival between the mastectomy, the lumpectomy alone or the lumpectomy with irradiation group (23). To ensure nipple perfusion Jensen describes staged NAC delay in 2012 (24). Patients with a large body mass index (BMI), a larger mastectomy weight or an increased sternal nipple index (SNI) are at higher risk for skin envelope necrosis (25,26).

Since Palmieri (27) described the principle of staged nipple delay in 2005, two major approaches have been developed trying to secure perfusion. The idea of delaying the NAC by circumareolar dermal perfusion in larger breasts by Jensen in 2012 (24) has gained popularity after Angelina Jolie's bilateral risk-reducing procedure (28). In the same year, Spear (29) proposed a technique of preshaping the breast by a staged circumareolar dermal mastopexy before NSM. However, NAC perfusion is also kept on a large, mainly superior glandular pedicle and only a small reduction is added in the first stage. In 2013, Alperovich (30) and Vaughn (31) targeted the reliability of reperfusion through existing circumareolar scars by performing NSM in patients with a history of breast reduction with Wise pattern incisions. Until 2016 the focus remained on circumareolar dermal perfusion. Only Spear (29) focused on the absolute importance of only superior dermal supply. Schwartz (32) combined the idea of delayed dermal NAC perfusion with the delay of an inferior NAC bearing dermal pedicle. Delaying the NAC on a pedicled approach makes NAC repositioning easier and more reliable in a second stage. Our preliminary series in 2016 described a fixed inferior pedicle approach using a first stage glandulodermal delay of the NAC followed by an immediate bilateral prosthesis reconstruction (33). In 2017, Gunnarson used the preshaped principle where the NAC is supplied by a dermoglandular central, superior or superomedial pedicle (34).

All the above made us conclude that a two staged approach with a robust direct perforator-perfused pedicle was the best strategy. NAC delay alone necessitates the prepectoral placement of large prostheses because of the large remaining skin envelope. Nevertheless the staged approach without Wise pattern skin envelope reduction, is beneficial for NAC perfusion. Wise pattern skin envelope reduction has the advantage of skin envelope delay as we know from breast reduction. In the best of both worlds, a robust perforator-perfused pedicle delays NAC at its distal end. The same reduction pattern also delays and reduces the skin envelope. Retropectoral expander to prosthesis placement creates a capsule that will support and

protect the definite prosthesis. The last remaining question was whether the circumareolar full thickness scars around NAC will be reliable enough to reperfuse the nipple on a completely dermal basis. The results of Spear, Alperovich and Schwartz (29,30,32) support this reliability. Our reported retrospective case series shows the clinical reliabity and outcome.

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Aim and Outline

Aims

Nipple sparing mastectomy (NSM) followed by reconstruction is a challenging procedure. The outcome is seen as unpredictable with regards to its possible complications (1). The unreliability lies within the anatomy of the breast skin and nipple perfusion. This is due to the fact that the breast skin flaps in NSM are randomly perfused through intercostal perforators (2). Primary reconstruction after NSM reduces the nipple-areola complex perfusion to a strictly dermal one. The key question is: "Can we rely on dermal NAC perfusion in continuity with random dermal skin flap perfusion ?".

It is advised to avoid NSM in women with large and/or ptotic breasts. Because these women are considered anatomically high-risk due to their overall complication rate of 29 percent (3,4). Is it acceptable to refuse NSM in those patients? The surgical challenge is to overcome these anatomical contra-indications.

The goal of this doctoral thesis is to search for a risk reducing NSM approach in patients with large and/or ptotic breasts. The basis for this research was the complication analysis of NSM. The preliminary results of our new NSM approach were published in 2016. Based on these findings a standard of care for anatomical high-risk indications was developed. In 2021 we reported our findings of 41 successful procedures without permanent necrotic complications.

In our porcine model we try to explain the anatomical basis of this successful approach. The basis is the dynamic anatomical changes created by the

double delay within an unique vascular territory (perforasome) (5) and the neo-angiogenesis initiated by circumareolar NAC scars. This neoperfusion creates new dermal perfusion patterns, which could be nicely visualised by near-infrared fluorescence videography examination. The anatomical basis for the absence of necrosis are these new perfusion patterns. Present thesis will present the result in a step by step way in an order to support the theory that the dermal NAC neovascularisation through intentionally created full skin thickness NAC scars is in continuity with the random dermal skin flap perfusion.

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Chapter 1

Breast reconstruction: Current state-of- the-art and future perspectives

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Chapter 1: Contents

Abstract

Reconstructive surgery aims to improve quality of life by recreating a natural-looking breast that is warm to touch. To obtain symmetry and body contour alignment, restoration of volume within the skin envelope is mandatory. The chosen reconstruction technique depends on the characteristics of the diseased breast, the shape and volume of the contralateral breast, and the technical skills of the surgical team. Timing, type and different possibilities of breast reconstruction are discussed.

Introduction

Surgery has an important role to play in breast cancer treatment. The survival after breast conservative surgery with radiotherapy is equal to mammectomy. A quality indicator project in Belgium revealed that approximately 40% of women with breast cancer will undergo a mastectomy (1). This figure can be explained in part by the use of breast MRI. Breast MRI allows a better staging, thereby increasing the mammectomy rate (2, 3). A mammectomy is a lifesaving but mutilating procedure. It is important not only to survive but also life (4). Therefore, the quality of life and good cosmetic outcome is mandatory after breast cancer treatment (4). Reconstructive surgery aims to improve quality of life by recreating a natural-looking breast that is warm to the touch. To obtain symmetry and body contour alignment, restoration of volume within the skin envelope is mandatory. The chosen reconstruction technique depends on the characteristics of the diseased breast, the shape and volume of the contralateral breast, and the technical skills of the surgical team. Importantly, the patient's expectations also need to be considered, as the reconstructed breast will never have a normal appearance.

Primary, secondary and tertiary breast reconstruction

Reconstruction can occur immediately following mastectomy in a one-stage procedure or be delayed. Primary breast reconstruction is an option when it is oncologically safe and when adjuvant therapy has no influence on the final result. This has a psychological advantage for the patient, who will thus never have the experience of breast amputation. Nevertheless, unrealistic expectations about the final shape and appearance may arise.

Secondary breast reconstruction can be performed years after mastectomy. Due to the loss of a skin envelope, a staged procedure is often indicated. In contrast with primary reconstruction, post-operative quality of life improves dramatically when a second breast is reconstructed.

Tertiary procedures are salvage procedures that try to solve the complications of the initial breast reconstruction (e.g. prosthetic breast distortion of flap necrosis).

Prosthetic, autologous and composite reconstructions

The advantages and disadvantages of the different types of breast reconstructions are shown in Table 1.1.

Prosthetic reconstruction

Prosthetic breast reconstruction remains the most performed method worldwide (5). Operating time is shorter and concerns with donor site scars, or morbidity, and flap perfusion can be avoided. Implants can be round or anatomical; they can be filled with saline or a cohesive silicone gel, have a textured or micro-textured surface, or be covered in poly-urethane. A lack of breast skin makes a staged approach involving skin expansion necessary.

In order to produce symmetry with the contralateral breast, modern implants are available in varying heights, projections and base widths. Very satisfying results are obtained when used in non-ptotic breasts. In ptotic

Table 1.1. *Advantages and disadvantages of different types of breast reconstruction.*

Reconstruction type/ pro-con's	**Prosthetic**	**Autologous free flap**	**Autologous pedicled flap**
Primary reconstruction	Yes	Yes	Yes
Secondary reconstruction	2 or more stages	1 stage possible	1 stage possible
Procedure Length	1-2h	6h	2-3h
Breast behaviour	Static	Dynamic	Dynamic
Capsular contraction risk	Yes	No	No (yes when composite)
Pre-reconstruction radiotherapy	Higher complication risk	Low (at least 6 months after RTH)	Low
Hospital stay	Day case	4-5 days	2-3 days
Permanent result	No	Yes	Yes
Temperature	Less warm	Body temperature	Body temperature
Donor site scars	No	Yes	Yes
Donor site morbidity	No	Yes	Yes
Flap perfusion	No	Yes	Yes
Symmetry	Small non-ptotic breasts	Moderate ptosis and volume	Small non-ptotic breasts
Ptosis solution	No	Yes	No
Rippling	Yes	No	No
Emptiness upper breast pole	No	Sometimes	Sometimes

breasts, however, a contralateral corrective procedure is necessary. Relatively larger implants can be used, if placed above the pectoral muscle and result in more ptotic breasts. The disadvantages of this technique are a higher risk of rippling in the upper breast pole and the need for sufficient skin to cover a larger prosthesis. A sub-pectoral prosthesis often lacks a natural ptotic lower breast pole (Figure 1.1). Radiotherapy results in a higher risk of postoperative infection and late capsular contracture (6).

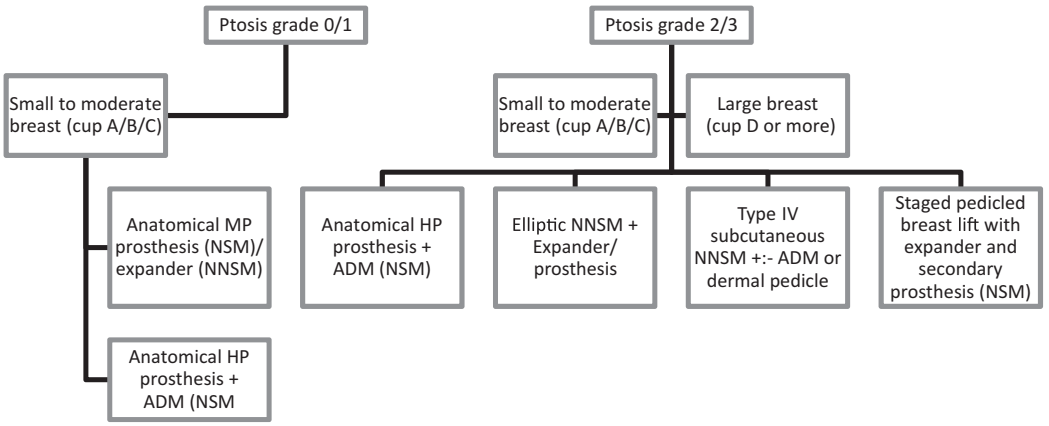

Figure 1.1. *Primary prosthetic reconstruction.*

NSM: nipple sparing reconstruction; NNSM: non nipple-sparing reconstruction; MP: moderate profile; HP: high profile; ADM: acellular dermal matrix; type IV subcutaneous mastectomy: Weiss pattern incision subcutaneous mastectomy.

Autologous reconstruction (pedicled and free flaps)

Pedicled flaps

The musculocutaneous latissimus dorsi (LD) flap and thoracodorsal artery perforator (TDAP) flap

Once the workhorse of breast reconstruction, the LD-flap is nowadays no longer the first choice. Instead, the Deep Inferior Epigastric artery Perforator (DIEP), which is harvested without muscle damage and provides a greater quantity of vascularized tissue, has taken it place. Furthermore, a reliable vascular supply can be derived from the descending and transverse branches of the thoracodorsal artery. The TDAP flap is a muscle-sparing flap usually harvested on a perforating vessel overlying the descending branch of the thoracodorsal artery (7).

The large skin paddle can be positioned transversely of more obliquely, such that the donor scar lies along a natural crease. Subcutaneous bevelling will provide more fatty tissue and the medial breast mound can be adequately reached. The transveres diameter of the flap is as large as the base of the amputated breast.

As tissue expander or prosthesis can add extra volume to the breast. Another possibility for augmenting volume is fat grafting, immediately before harvesting the flap or as a secondary procedure (8). If a prosthesis is used, greater latissimus dorsi muscle volume can be included in the flap to provide complete muscle coverage of the prosthesis of expander. Prepared with only one perforator, the muscle-sparing thoracodorsal artery perforator flap is used in the same manner as the LD-flap (9).

Free flaps

The idea of "like by like" replacement refers to reconstruction of a natural-looking, warm and ptotic breast that resembles the contralateral side. Evolution in microsurgery now allows transplantation and replacement of large volumes of autologous tissue, even from anatomically remote areas

The transverse rectus abdominis (TRAM) flap

As microsurgical skills and experience have advanced, the rates of flap loss in high volume centres have diminished. The TRAM flap uses the deep inferior epigastric artery and vein to supply and drain the transplanted musculocutaneous tissue. Additional preparation and anastomosis of the superficial inferior epigastric vein improves venous drainage, thus improving safety with the technique. Although the results of reconstruction are satisfactory, considerable donor site morbidity can occur. Rectus muscle damage with consequent abdominal wall herniation and bulging is frequently reported (10).

The deep inferior epigastric artery perforator (DIEP) flap

The main goal of the perforator flap is to diminish donor site morbidity by sparing the muscles and improving function and strength. Although the DIEAP flap has become the golden standard in microsurgical breast reconstruction, a recent review was unable to demonstrate any superiority compared with pedicled abdominal flaps (11). Nevertheless, sparing of abdominal wall strength is preferred to muscle weakness. Due to its vascular supply and microvascular branching, sufficient tissue can be provided in

most patients. A bilateral blood supply allows for simultaneous bilateral reconstruction and conservation of abdominal wall integrity diminishes the complications rate significantly (10). The length of the skin paddle and volume of the flap allows creation of a ptotic breast, which avoids contralateral surgery. Recently, lymph node transplants have been included in the flap. Specific shaping of the breast with positioning of nodes in the axilla, creates lymphatic drainage in a lymph-oedema-affected arm (12) (Figure 1.2).

Figure 1.2. *Preoperative and postoperative view after 1 year of a subcutaneous mastectomy left and primary DIEAP flap reconstruction left, left nipple and areola reconstruction, bilateral tattouage of nipple and areola-complex and a contralateral breast reduction with inferior pedicle.*

Preoperative evaluation of the flap microvasculature by ultrasound or by computed tomografphic angiography allows evaluation of the pedicle anatomy as well as the perforators and their distribution within the flap (13). Per-operative indocyanine mapping is an important tool for identifying poorly vascularized distal flap areas, thus helping to prevent fat necrosis or partial flap necrosis (14).

The superficial inferior epigastric artery (SIEA) flap

The SIEA flap can be an alternative to the DIEAP flap, although these vessels dominate in only 30% of patients (15). A shorter pedicle is obtained due to distal positioning of the vessels. The principle advantage is the ab-

sence of any abdominal wall morbidity, but flap shaping is less versatile and distal necrosis occurs more easily due to the more superficial vascular supply.

The SGAP (Superior gluteal artery perforator) flap and the IGAP (Inferior gluteal artery perforator) flap

The SGAP and IGAP flaps are baded on cutaneous perforators of the superior and inferior gluteal arteries respectively. These are terminal branches of the internal iliac artery. If the abdominal wall cannot be used, these flaps provide a satisfactory alternative. In a series of 170 GAP flaps, Guerra described a 6% rate of vascular complications requiring anastomotic revision. Total flap failure rate was 2% (16). This technique is ideally suited to reconstruction of small to moderately sized breasts. Donor site scar visibility and morbidity are minimal. Dissection can be tedious, however and may give rise to limited pedicle length. The procedure also requires a change in body positioning during surgery.

The anterolateral thigh (ALT) flap

The anterolateral thigh (ALT) flap is based on septocutaneous or musculocutaneous perforators of the descending branch of the lateral circumflex artery, a branch of the deep femoral artery. Extensively used in head and neck reconstruction, its pliability and large skin paddle makes it an alternative for breast reconstruction in moderately sized breast, although the position of the scar may not be acceptable to some patients. The pedicle length is up to 10 cm and Wei described a total failure rate of 1.79% (17).

Transverse myocutaneous gracilis (TMG) flap – transverse upper gracilis (TUG) flap

The TMG or TUG flap is perfused by the ascending branch of the medial circumflex femoral artery supplying the gracilis muscle. The pedicle is short (6 cm) and the flap size is limited by the volume of tissue available on the inner thigh. The skin paddle is transverse or combined with a vertical part (fleur-de-lis). Coning of the flap results in an acceptable projecting breast shape. The thigh adductor muscles compensate for functional morbidity with loss of the gracilis muscle. Anterior dissection with disruption of lymphatic vessels in the femoral triangle must be avoided. Donor site dehiscence may prolong healing and as is observed in inner thigh lift procedures, the scar may sag beneath the bikini-line. These flaps are an alternative for

small to moderate breast reconstructions in women who want to avoid scars on the abdomen, the back or the buttocks, or for patients who have previously undergone abdominoplasty or liposuction. Slim patients who lack sufficient abdominal tissue or who are unable to have an implant reconstruction are also appropriate candidates (18).

Profunda femoris artery perforator (PFAP) flap

The PFAP flap has a long pedicle (10-13 cm) and is prepared using the proximal musculocutaneous perforator of the first medial branch of the profunda femoris artery. Excess tissue on the posteromedial inner thigh is used. The skin paddle is elliptical with a maximal width of 10 cm allowing primary closure. This technique is used for small to moderately sized breasts. As in the TUG flap, there is an elevated risk of wound dehiscence. The donor site is well hidden in the crease although sagging occurs (19).

Lumbar artery perforator (LAP) flap

The LAP flap contains excess skin and fat tissue extending from the lower back to upper buttock. In a series of 35 LAP flaps by Peters, a vessel interposition graft was necessary in 80% to correct pedicle length or recipient vessel mismatch. Larger flaps can be harvested by gluteal extension (20).

The deep circumflex iliac artery (DCIA) flap or Rubens flap – the dog ear flap

The DCIA flap uses fatty tissue in the region overlying or just above the iliac crest. It is a second choice after previous abdominoplasty, as a salvage procedure after failed free flap breast reconstruction or as a second free flap in case of contralateral breast cancer. Donor site morbidity is minimal when the abdominal wall musculature is closed correctly. Recently, Colebunders has use the lateral dog ears remaining after DIEAP breast reconstruction donor site closure, as a DCIA perforator flap (21).

Composite reconstruction

Combining autologous tissue with foreign material has been used for decades (e.g. LD-flap with a prosthesis). Skin flap thickness for prosthesis coverage is a problem in a pre-pectoral position or in the lower lateral quadrant in a sub-pectoral position. An acellular dermal matrix is an additional tool for resolving these problems (22). Recently, fat graftin has been used to improve upper pole prosthesis coverage in a staged procedure (serial deflation-lipofilling), allowing use of a much smaller prosthesis (23).

Bilateral prophylactic surgery and primary breast reconstruction

5%-7% of breast cancer cases are due to a genetic defect. Women with mutations have an elevated lifetime risk of developing breast cancer. Immediate prosthesis reconstruction after bilateral preventive skin and/or nipple sparing mastectomy is challenging due to poor dermal vascularization of the mastectomy flaps. Changing nipple position results in a higher risk of nipple necrosis (24). Figure 1.3 shows a successfully staged technique with bilateral nipple and areola sparing mastectomy. Immediate prosthetic reconstruction should only be considered in small, non-ptotic breasts.

Bilateral DIEAP flaps are the autologous golden standard. Secondary correction of ptosis or removal of the monitoring free flap skin island is usually necessary.

***Figure 1.3**. Preoperative and postoperative view after 1,5 year of a staged prophyllactic procedure with bilateral reduction mammaplasty followed by bilateral nipple and areola sparing mastectomy, skin expansion and definite bilateral subpectoral prosthesis reconstruction*

Conclusion

Over the last three decades, a multidisciplinary surgical approach has resulted in an exponential growth in breast reconstruction possibilities. A breast that appears and feels realistic should be created using low-risk surgery, especially in genetically predisposed young women. Perforator flap surgery is nowadays the ultimate tool for reducing functional donor site morbidity. Evolution in prosthesis types and materials such as acellular matrices is largely responsible for the increased number of prosthetic reconstructions worldwide.

The trained plastic microsurgeon has a vast armamentarium for dealing with challenging tertiary procedures in case of flap loss or late major prosthetic complications such as severe recurrent capsular fibrosis. Secondary morbidities such as lymph-oedema can simultaneously be addressed in specific autologous procedures. Finally, artistically performed composite surgeries can sculpt a definite breast shape. 3D bio-printing by tissue engineering and stem cell technology are promising techniques for the future.

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