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Breast Reduction Mammoplasty a Review of Literature and Presentation of a Novel Technique with Dual Vascular Supply

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Introduction

In Plastic Surgery, breast reduction is one of the most frequently performed procedures, with more than 112.000 procedures perfo-rmed in 2016 in the United States of America alone [1] .

Apart from functional improvement, the aesthetic result is impo-rtant as well. Beside reducing the size of the breast tissue, the objective of any current surgical technique is to create a long-lasting appealing breast shape, to reposition the nipple, and to preserve its sensation [2].

Numerous established surgical techniques are available to acco-mplish breast reduction, each having their benefits and drawbacks. Every procedure has its unique combination of skin incision, pedicle planning and resection pattern in order to achieve an aesthetically and functionally pleasing breast.

In general, there are three main objectives in breast reduction mammoplasty:

1. Removing excess parenchyma.
2. repositioning the nipple areola complex (NAC), maintaining its viability, breast feeding ability as well as sensitivity.
3. tailoring the skin to fit the new shape.

Regardless of which reduction technique is performed, two fundamental aspects must be considered in reduction mammoplasty: First, which pattern of skin excision is to be used, and second, which pedicle for vascularization of the nipple areola complex is to be chosen [3]. The pedicle selected by the surgeon will have a distinct vascular and nerve supply and is essential for determining final breast shape, since each pedicle technique has its strengths and weaknesses.

To create an overview, Wong et al. reviewed the multiple techni-ques of pedicle orientation and skin excision patterns [4]. The choice is between a superior pedicle, supero medial (medio cranial) pedicle, inferior pedicle, medial pedicle, lateral pedicle, central mound, vertical bipedicle or horizontal bipedicle. Achievement of a well-shaped breast with good function has been reported with use of any of these pedicles [3].

We hereby report a novel technique, which is based not only on a superomedial, but also on a septal blood supply. As a result of this dual blood supply, the viability of the nipple of the breast is ensured and increased sensation of the nipple can be expected, preserving breast feeding ability and breast shape stability.

The hereby presented technique was performed in 564 patients with various breast shapes and tissue weights over a period of 6 years by a single surgeon.

Review of breast anatomy

Vascular Supply

Knowledge of the vascular supply of the breast is of great impo-rtance in breast reduction surgery and ensures safe surgical planning. Several publications over the last decades have addressed this particular subject, specifically focusing on the blood flow to the Nipple Areolar Complex (NAC), as nipple necrosis is an appalling complication and may occur due to insufficient arterial blood flow or venous stasis [5, 6]. There are many descriptions of the vascular supply of the breast dating back to Carl Manchot in 1889, who identified the internal mammary artery and the lateral thoracic artery, as well as the third to the seventh aortic intercostal arteries as the main blood supply to the NAC [7]. After subsequent investigations by Marcus in 1934 [8] and Maliniac in 1943 [9] current knowledge concerning vascular supply can be summarized as follows [10, 11].

- Internal mammary perforators, most notably the second to fifth perforators (most reliable, medially and inferiorly)
- Lateral thoracic artery (laterally)
- Thoracoacromial artery (superiorly)
- Terminal branches of the third to eighth intercostal perforators (laterally)

The internal mammary perforators and the lateral thoracic artery provide the main supply, and it is well known that the main vascular supply is stable to a greater extent. In contrast, Van Deventer et al. delineate considerable variations in vascular supply due to aberration or lack of branches of the main arteries: 27 cadaveric female breasts were dissected and considerable variation within vascular patterns was found, even when two breasts of the same cadaver were compared [11]. In the 1990's, Würinger described a separate fibrous septum of the breast, which can reliably be encountered and which displays a constant morphology [12-14]. The septum originates at the pectoral fascia along the 5th rib, merging into vertical ligaments along the sternum medially and along the lateral border of pectoralis minor laterally. Cranially and in an anterior direction, the vertical ligaments are connected by the superficial fascia. This topographical finding was proven to be of clinical relevance as the vessels and the nerves, following the Würinger septum, have been shown to reach the NAC

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Venous drainage

In 1840, Cooper found that the veins of the breast could be divided into superficial and deep systems, with the deep veins running alongside the arteries [16]. Corduff et al. later on specified that only the deep artery travels with its venae comitantes and the other arteries course separately from the veins [17]. Furthermore, they found the main drainage of the venous system to lay superomedially.

Sensibility of the nipple areola complex

Preserving sensitivity of the nipple and areola is crucial in reduction mammaplasty. It is established that the main innervation of the nipple is warranted by the anterior and lateral cutaneous branches of the third through fifth intercostal nerves, most frequently the fourth lateral cutaneous branch, which runs along the horizontal septum described by Würinger [17]. Several authors have described the loss or decrease of nipple sensitivity as due to the weight of resection rather than the surgical technique [18-21]. Schlenz et al. analyzed this hypothesis and described that any breast reduction technique avoiding a resection of the central parenchyma, detachment of the central part of the breast from the thoracic wall, or injury of the lateral part of the pectoral fascia had a low risk of injury to the dominant nerves of the nipple-areola complex [22].

Techniques

There have been numerous pioneers in reduction mammoplasty during the last decades, and several pedicle techniques have been published [Table 1].

The lateral pedicle technique for example, first published by Skoog in 1963, has been proven to be a safe technique [23]. Although this approach showed favorable results concerning sensibility of the NAC and breast feeding ability, a fundamental downside of the lateral pedicle technique is the limited possibility to reduce the lateral aspect of the breast, which is the quadrant most often in need of debulking [24, 25]. This may lead to impaired aesthetic outcome [3]. Furthermore, resection of the lateral quadrant is desirable as this is the quadrant with the highest incidence for carcinoma [26].

Several years later, at the end of 1970's, the first publications appeared by Ribeiro and Courtiss, presenting the inferior pedicle technique [27]. Georgiade and colleagues refined the approach, which seemed to maintain not only the nipple sensation, but also enabled the resection of both large and small volumes of breast tissue [27, 28]. Today, it is still a frequently utilized technique, usually combined with an inverted T or Wise pattern skin excision, in particular for the resection of great breast–tissue volume, while the sensibility of the Nipple areolar complex is well preserved [29]. However, a major disadvantage of the inferior pedicle technique is the elevated risk of development of the bottoming out phenomenon over time [4].

The medial pedicle has its base along the sternal margin and is based on internal mammary perforators and anteromedial intercostal nerves. It is modified from the superomedial pedicle and is a suitable breast reduction technique in severe mammary hypertrophy cases, as sensation and viability of the NAC is reportedly maintained in 94% of patients [30, 31, 32]. In addition, it has been associated with a lower degree of bottoming out compared to the inferior pedicle technique.

The superior pedicle breast reduction technique was first described by Arie et al. in 1957 [33]. Pitanguy refined this technique in the 1960s [34], followed by McKissock, who introduced the vertical bipedicle in 1972 [35].

Table 1: Benefits and drawbacks of different pedicle techniques

	Benefits	Drawbacks
Lateral pedicle	- Large volume resection - Breast feeding ability	- Limitation of lateral debulking - Inferior aesthetic outcome - No dual blood supply
Inferior pedicle	- Increased NAC Sensibility NAC - Large volume resection possible	- High risk of bottoming out - No dual blood supply
Superior pedicle	- Leaves upper-pole fullness and maintains breast projection	- Impairment of NAC sensibility - limited to small resection weights/risk of pedicle kinking in larger resections - No dual blood supply
Medial pedicle	- Increased NAC Sensibility - Large volume resection possible - Less risk of bottoming out	- No dual blood supply
Superomedial Pedicle	- Increased NAC Sensibility - Large volume resection possible - Less risk of bottoming out	- No dual blood supply
Central pedicle	- Increased NAC Sensibility - Large volume resection possible - Breast feeding ability - Less risk of bottoming out	- No dual blood supply
Novel technique	- Increased NAC Sensibility - Large volume resection possible - Breast feeding ability - Dual blood supply - No NAC deformation - No risk of fat tissue necrosis (no pillar sutures required) - Minimized risk of bottoming out - No risk of dog ears (due to 90° intersection lines)	- unknown

Several authors have described the superior pedicle as a safe procedure. However, there is a risk for kinking of the pedicle in larger breast reductions. Superior pedicles are therefore most commonly applied in patients with a smaller resection volume, and are best used in resections of less than 1000g [3]. Another described drawback of the superior pedicle technique is the higher risk of sensory loss at the nipple-areolar complex following surgery [36]. Schlenz et al. demonstrated that the loss of nipple sensitivity was not associated with the

weight of resected breast tissue, but rather with the surgical technique – the risk of impairment of nipple sensitivity was shown to be higher in superior pedicle techniques. In line with this finding, Tairych et al reported impaired sensitivity following breast reduction using a superior pedicle technique [37].

In 1975, Orlando and Guthrie described the superomedial pedicle with complete NAC viability and preserved sensibility of the nipple in a series of 12 patients [30]. The merely vertical reduction-superomedial pedicle method was described by Lassus and modified by Lejour and Hall-Findlay [38-40]. Using this vertical reduction mammoplasty with a superomedial pedicle, Hall-Findlay reported improved contour and decreased scar burden compared to prior techniques. The technique has been found to be safe and reliable [3] even for resection of great tissue volume, since the most reliable source of blood supply to the nipple-areola complex is the internal thoracic artery via the first to fourth intercostal perforators [41]. However, there is still a risk of inadequate blood supply to the NAC if the pedicle does not include at least one of the four upper perforators [42]. It was in the 90's, when Würinger first described a breast retaining ligament as guiding structure for neurovascular supply [43]. Based on that anatomic discovery, Würinger developed a new central pedicle breast reduction technique. The principle of this technique is the conservation of the above mentioned ligament or septum, as the main plain for neural and vascular supply of the breast. Würinger's description of a breast supporting ligament that consists of a horizontal septum serving as guiding structure for neurovascular supply is of great importance. The main nerve to the nipple, the deep branch of the lateral cutaneous branch of the fourth or sometimes the fifth intercostal nerve, consistently runs along the horizontal septum. During the last decade, several authors described their experience with reduction mammoplasties based on the central Würinger septum and presented satisfactory results regarding blood supply and sensitivity of the NAC and breast shape [5, 10, 42].

Materials & Methods

The study was conducted according to the principles of the Declaration of Helsinki, all patients agreed to scientific analysis and publication of their patient data. A retrospective analysis was perfo-rmed including patients undergoing breast reduction surgery by the senior author between January 2010 and December 2016. The senior author performed a novel breast reduction technique as described below in 564 patients (bilateral breast reductions). All patients underwent the same surgical procedure irrespective of breast size, shape or comorbidities. However, the senior author did not perform surgery in patients with a BMI greater than 30kg/m^2, as higher complication rates have been reported in literature [44, 45]. All patients received standardized postoperative thromboembolic prophylaxis for 2 days. Age, body mass index (BMI), operation time, resection weight and complications were documented routinely in the patient's file. Twelve months postoperatively, patients were examined by an independent plastic surgeon regarding NAC sensibility and breast shape.

Preoperative drawings

Markings on the patient were carried out preoperatively in the standing position. The complete intersection lines, including the inverted T resection pattern and the areolar opening, were designed and strictly followed during the surgical procedure. First, the midline, inframammary fold, and axis of the breast were drawn. For the latter, a line from the midclavicular point (7 cm from jugulum) was drawn, considering that the ideal breast meridian is not associated with the position of the NAC, but with the middle of the footprint of the breast.

On the axis line, the new position of the nipple was marked at the height of the inframammary fold. As it is known that the nipple appears more aesthetically pleasing in the lower rather than in the upper half of the breast, and lowering of the NAC is notoriously difficult, placement of the new nipple position slightly below the middle position of the breast mound or at midpoint of the lateral upper arm is recommended [46]. Next, the breast is manually displaced from side to side in virtue of the Lejour maneuver. On those lines, 5 cm are subsequently measured, and the periareolar marking is drawn as a circular pattern. The areolar opening is planned for a diameter of the NAC of 3.8 to 4.2 cm, which is equivalent to a circumference of 12-13.2 cm, depending on the breast size. The senior author's drawn NAC circumference measures 14 cm in total as, according to experience, it causes the right amount of tension on the areolar complex. Vertical limbs are traced from the NAC border, measuring 5-7 cm [Figure 1]. The inverted-T resection is now planned in a 90° angle to the Lejour drawings medially and laterally. To achieve a narrowing of the breast mound one has to mind that the meeting point of a and b is delineated in a 90°angle as well [Figure 1]. This prevents dog-ears medially and laterally, and gives the breast a rounder shape in the caudal contour. The surgeon also has to pay attention that the resection lines do not reach the visible decolletée.

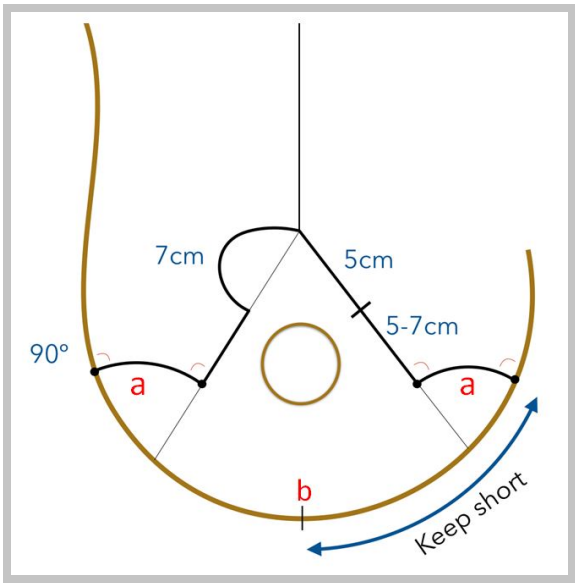

Figure 1: Preoperative drawing

Surgical procedure

The procedure is performed under general anesthesia; the arms are in a 90° abducted position. First, the NAC is marked with a 38-42mm mammilotom and circumcised superficially. Following this, de-epithelialisation of the medio-cranial pedicle is carried out while preserving the dermis and the subdermal plexus. A full thickness skin incision is made at the lateral areolar opening, the Lejour lines', and the inverted-T resection pattern. To allow the following rotation of the glandular tissue, it is fundamental to perform the full-thickness incision in the area of the complete medial, Lejour line as well, including approximately 1 cm of the medial periareolar opening [Figure 2]. The skin flaps medially and laterally are dissected along the Scapha fascia down to the fascia of the major pectoral muscle. The dissection of the breast tissue is carried out medially, laterally and caudally to the level of the pectoral fascia with use of monopolar cautery. The breast tissue is now resected enbloc laterally, caudally and medially, while preserving the central pedicle based on the Würinger septum and its

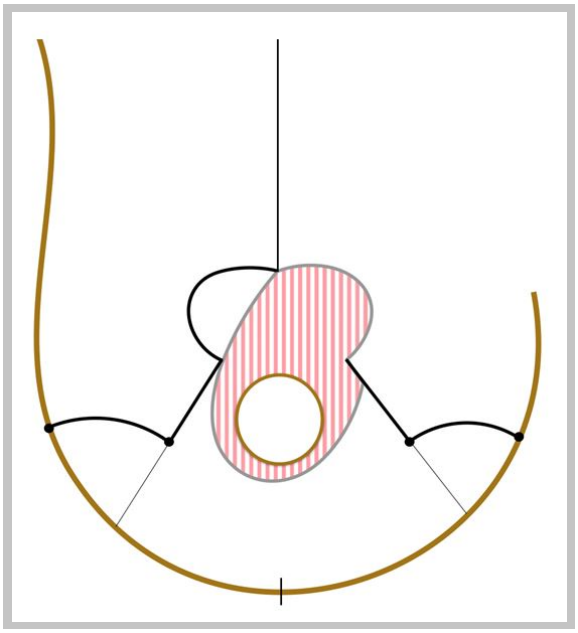

Figure 2: Superomedial pedicle, full-thickness incision including approximately 1 cm of the medial periareolar opening.

and its neurovascular structures [Figure 3]. The remaining breast tissue, containing the cranio-medial pedicle and the central pedicle, can easily be rotated 90° cranio-laterally into the areolar opening as the breast tissue in the area cranio-lateral areolar pattern has previously been resected. Since the breast mound is rotated cranio laterally, no pillar sutures to fixate the breast mound are needed. Following this, the inverted-T incision is sutured subcutaneously with 3/0 Monocryl and intracutaneous sutures. Periareolar and subcutaneous sutures are made at the 12, 3, 6, and 9 o'clock position and the periareolar incision is closed with 4/0 absorbable sutures (Monocryl, Ethicon US, LLC. 2010 - 2016). Drainage is inserted and diverted in the submammary incision laterally. The senior author mostly ends up with an inverted-T scar, but all patterns of skin resection can be performed [Figure 4].

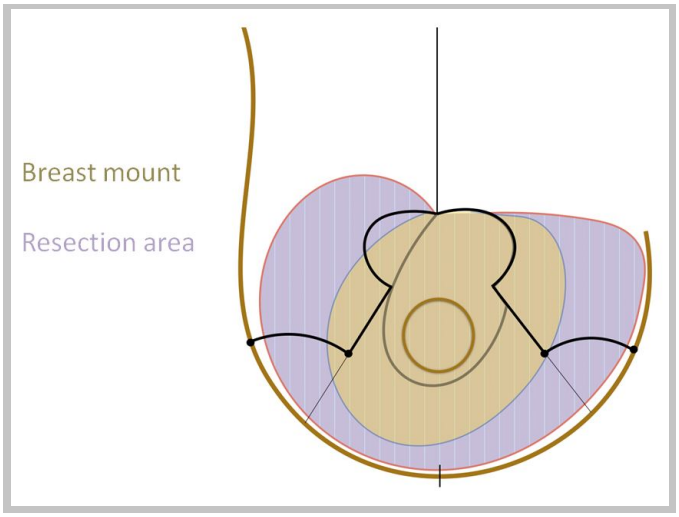

Figure 3: Resection pattern. Inverted-T incision with designed 90° angle for a narrowing of the footprint of the breast

Results

Mean age was 40 years (range 19 to 60). Average Body mass index was 25.7 kg/m^2 (range 19.6 kg/m^2 to 30 kg/m^2). The average operation time was 74 min (range 45 min to 90 min) for bilateral breast reduction and submitted tissue weights were recorded with a mean weight of 438.5g [min 110g, max 980g, Table 2]. One patient sustained a partial nipple and skin necrosis as well as an infection. There were 2 cases of postoperative hemorrhaging, with surgical revision required in one case. Partial anaesthesia of the nipple occurred bilaterally in one patient. There were no cases of fatty tissue necrosis or seroma. Delayed wound healing at the inverted-T intersection was recorded in 24 patients (4.3%); there was no need for revision or secondary correction in those cases. No dog-ear corrections were necessary. No case of thrombosis or thromboembolism occurred [Table 3].

Table 2: Patient characteristics and operative data

No of patients	564
No of breasts	1128
Age	
Mean	40
Range	19 - 60
BMI	
Mean	25.7 kg/m^2
Range	19.6 – 30 kg/m^2
Weight of resected tissue	
Mean	438 g
Range	110 – 980 g
Operation time	
Mean	74 min
Range	45 – 90 min

Table 3: Complications

Delayed wound healing	24	4.3%
Infection	1	0.2%
Bleeding	2	0.4%
Seroma	0	0%
Nipple necrosis	1	0.2%
Fat necrosis	0	0%
Dog earrevision	0	0%
Loss of sensitivity	2	0.4%
Thrombosis	0	0%

Discussion/Author's approach

A brief review of literature regarding reduction mammoplasty reveals that several different techniques have been published over the last few decades, and no single superior procedure seems to exist. In consideration of the drawbacks and incertitudes of the different surgical procedures, the senior author decided to modify the surgical approach, and developed a breast reduction technique with a dual blood supply warranted by a supero-medial as well as septal-based pedicle. Due to standardized preoperative drawings, the mean operation time could be kept short with an average of 74 minutes. This reduces risk of infection, and the operation can be performed under daycare conditions.

Complications in this retrospective case series were few in number as well as predominantly minor in severity, and excellent results were found using the above described cranio-medial pedicle combined with a septal base as the main arteries responsible for blood supply can hereby be preserved.

Combining the supero-medial and the central pedicle is a safe surgical approach even for large tissue volume resection without risk of pedicle kinking, as folding of the pedicle is not required, and the remaining breast mound is rotated latero cranially instead [41, 47, 48, 49]. As mentioned in the surgical technique, the full-thickness incision in the area of the complete medial, Lejour line has to include approximately 1 cm of the medial periareolar opening to enable rotation of the breast mound. In merely cranio-medial based breast reduction techniques, one would compromise the blood supply of the nipple, but as this reduction technique is based on a septal blood supply as well, there is no risk of nipple necrosis. Furthermore, as a supero-medial in combination with a central pedicle is being used, approximately one third of the gland remains connected to the ducts and nipple, which suggests that breast-feeding should be possible, although this has not been specifically investigated in this study [50]. One case of insufficient blood supply to the nipple with loss of NAC sensibility emerged this complication was possibly attributed to an existing MRSA infection. This compares favorably to similar studies in literature, which generally describe higher rates of loss of NAC sensibility. With the above mentioned technique, even large resections of breast tissue were able to be successfully carried out: the mean resection weight of 438.5g, where of 37% of specimens weighed more than 500g, did not compromise the postoperative result concerning viability or sensitivity of the NAC and breast shape.

As mentioned above, the skin flaps medially and laterally are dissected along the Scapha fascia. This ensures safe skin flaps and facilitates a direct visibility of all areas for ease of resection and hemostasis. Accordingly, only one case of hematoma formation requiring surgical revision was recorded.

Another benefit of the presented operation technique is the tension-free insertion of the areola due to the rotation of the glandular tissue, leading to less retraction of the areola and avoiding NAC deformation. A tension-free rotation of the pedicle can be achieved in any breast size as a full skin incision of the complete medial, Lejour line' is performed including 1 cm of the medial periareolar opening. There is no risk of insufficient blood perfusion as the additional blood supply is warranted by the Würinger septum. In the senior author's experience, long-term fixation of the glandular tissue can be found in the cranial area, which can be explained by formation of stabilizing scar tissue. Hence, the risk of bottoming out is minimized and the cranial breast volume is sustained. This is one of the main advantages compared to the inferior pedicle technique. Furthermore, since no sutures for fixation of the breast mound are used, the risk to develop fatty tissue necrosis is lowered [41, 51].

Although any kind of skin resection pattern can be applied in this technique, the senior author mainly uses an inverted-T skin pattern, as the scar is inconspicuous and well hidden in the inframammary crease. In general, in the senior author's experience, patients neglect the scar in the submammary fold as it is in favour of a well-shaped breast. Furthermore, patients are satisfied by receiving a stable breast shape through one single surgery without need of subsequent surgeries for scar correction. This compares directly to a reported rate of scar correction of around 20% for vertical breast reductions [38]. Furthermore, the mentioned 90° angle designed at the inverted-T resection line causes a narrowing of the footprint of the breast, which results in a round breast shape and eliminates the risk of dog ears [Figure 4 and 5].

Figure 4: Intraoperative wound closing. Round breast shape and no risk of dog ears due to 90° angle at inverted-T insertion

Figure 5: Above: preoperative pictures. Below: postoperative result 9 months after surgery

Figure 6: Above: preoperative pictures. Below: postoperative result 9 months after surgery

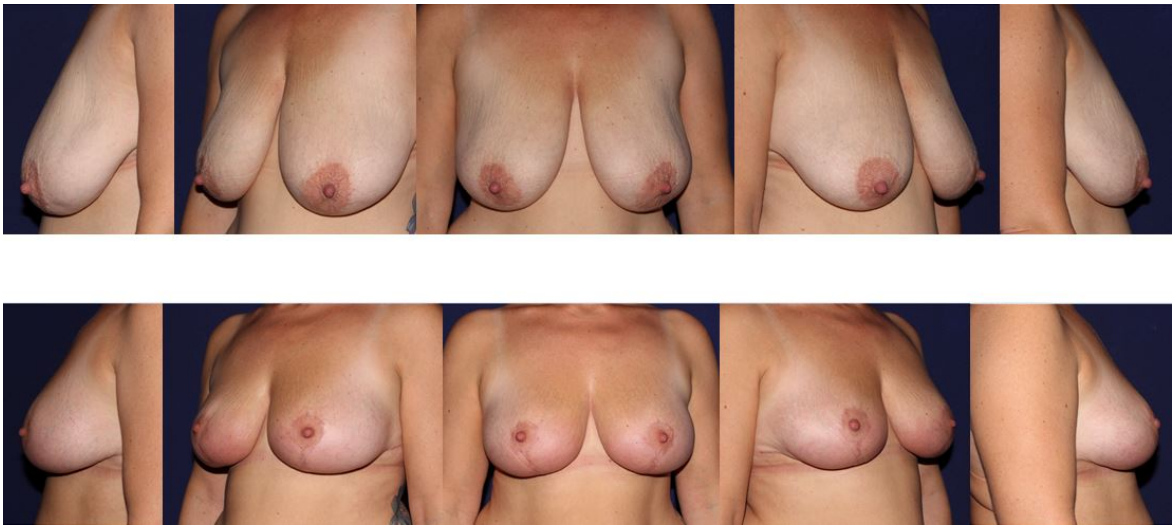

Figure 7: Above: preoperative pictures. Below: postoperative result 12 months after surgery

Conclusion

Most plastic surgeons perform breast reductions on a regular basis. The surgical technique used by each surgeon is chosen based on a combination of the surgeon's comfort level with a specific technique and patient characteristics. By reviewing the literature, our report highlights that there are numerous surgical techniques that can achieve a satisfying aesthetic and functional outcome. The senior author believes that most disadvantages of the described techniques may be overcome by using a dual blood supply operation technique. Combining the supero-medial and the central pedicle is a safe surgical approach revealing excellent results concerning sensation, blood supply as well as an aesthetically pleasing long-term outcome. Based on this study, further investigation is warranted to evaluate long-term results.

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