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An overview of Deep Inferior Epigastric Artery Perforator Flap Breast Reconstruction

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ABSTRACT
Breast cancer is a major health care problem that affects more than one million women yearly. While it is traditionally thought of as a disease of the industrialized world, around 45% of breast cancer cases and 55% of breast cancer deaths occur in low and middle income countries. Breast reconstruction has evolved greatly during the last 2 decades. It can be autologous breast reconstruction (ABR) or implant based. It can be done immediately post mastectomy or delayed reconstruction or in a 2-stage reconstruction according to the need to post mastectomy radiation therapy (PMRT) called delayed immediate reconstruction. ABR is considered the gold standard for post mastectomy breast reconstruction. Since the illustration of the muscle sparing TRAM and its perforator version deep inferior epigastric artery perforator flap (DIEAP) the autologous techniques for breast reconstruction expanded greatly and many choices are available for the patient after mastectomy for natural aesthetic reconstruction. Enhancing quality of life and obtaining a natural aesthetic result after breast reconstruction are the utmost purpose for every surgeon. Techniques of autologous breast reconstruction are being evolving till the present time to achieve these goals. DIEP flap has been adopted by center of excellence all over the world as the gold standard technique for breast reconstruction. For the sake of better outcomes, multiple perforator DIEP was considered as trial to improve the perfusion of DIEP flap while minimizing the donor site morbidity. This study aimed to review the DIEP flap Breast Reconstruction.

Keywords: Breast Reconstruction; DIEP flap; Risk Factors

INTRODUCTION

Breast cancer is the most common cancer in female and its percentage in Lower, Middle, and Upper Egypt were (33.8%, 26.8% and 38.7% of cancers**(1).**Numbers of women diagnosed with and surviving breast cancer are increasing **(2)**. However, Less than half of all women who require mastectomy are offered breast reconstruction surgery, and fewer than 20% elect to undergo immediate reconstruction **(3).** In spite of that reports indicated that there's 39 % increase in procedural volume since 2000 **(4)**.To date, multiple series in the literature have shown no detrimental effect of breast reconstruction on the detection of cancer recurrence.

Breast reconstruction options and popularity according to Socio-economic standards

Autologous breast reconstruction (ABR) facilitates the primary goals of breast reconstruction. These include creation of a mound that matches preoperative dimensions, position, and contour; has natural consistency; and is long lasting. Refinements in autologous techniques have enhanced the current reconstructive options to a stage where outcomes closely parallel the presurgical form**.** Harvest techniques and flap viability have improved to the point where focus has shifted toward improving breast and donor-site aesthetics mirroring those seen in elective cosmetic surgery**(5)**.

Reconstruction options and timing differs between developed and developing countries. This is attributed to social and cultural problems, which are the most important impediment to the provision of adequate care for both breast cancer care and reconstruction in developing countries **(6)**. Also, many women are unaware about breast reconstruction or there's limited insurance coverage. Comprehensive and appropriate patient education remains paramount to deliver the best possible care and improve it. In addition, Breast Reconstruction rate is also affected by the density of well-trained plastic and reconstructive surgeons in different geographical areas **(7)**.

In The US where there has been a gradual rise in both immediate and delayed breast reconstruction over the past few decades **(8).** Some recent studies showed that there's a surge in implant based breast reconstruction especially after popularity of skin sparing mastectomy and the introduction

of Acellular Dermal Matrix (ADM) **(9)**.However, the high failure rate associated with implant-based reconstruction in the setting of PMRT has led some plastic surgeons to favor autologous techniques **(10)**. Also, some studies had showed increased patient reported satisfaction with autologous breast reconstruction as compared to that with implant-based technique **(11,12)**.

In a study conducted in Iran, as an example of middle economy countries, Implant-based reconstruction has surpassed ABR in recent years **(13).** In our developing countries with limited resources, ABR has the advantage of being able to create an aesthetic result with no need for periodical revisions as in cases of implant reconstructions, and if feasible, would be the most cost benefit option **(14)**. There's evidence of superior long-termsatisfaction and improved health-related quality of life (HR-QoL) associated with autologous techniques **(15).**

Specifically,DIEAP flap has been the gold standard for breast reconstruction in many centers and has been rapidly becoming a more widely employed method that provide a large amount of well vascularized tissue similar to the consistency to the breast and achieve natural, lifelong breast reconstruction **(16)**.

Cost-effectiveness of DIEAP flaps:

DIEAP flaps are cost-effective compared with implants, especially for unilateral reconstructions **(17)**. Cost-effectiveness of autologous techniques is maximized in women with longer life expectancy **(18)**. DIEAP flap reconstruction is recommended in prophylactic bilateral mastectomy because in the long term it gives better tissue replacement than breast reconstruction with implants **(19)**.

Limitations of DIEAP flap as autologous tool for breast reconstruction

Even in developed countries, there's limitation of free tissue transfer. This is mainly due to an insufficient supply of surgeons to perform free flaps. Moreover, the demanding preperative and intraoperative and post-operative logistics in addition to lack of residents in non-academic medical centers to assist intra-operatively or to help with postoperative care is another reason why some hospitals may not offer autologous transfer. Another potential impediment to autologous transfer is physician payment **(2)**.

DIEAP flap anatomy and classification

The deep inferior epigastric artery arises medially from the distal external iliac artery and courses superiorly, entering the rectus sheath just below the arcuate line. The artery then passes between the posterior layer of the rectus sheath and the rectus muscle. Three branching patterns of the deep inferior epigastric artery have been described: a single trunk, bifurcation, and division into three or more branches **(Fig. 1)**. The deep inferior epigastric perforating vessels arise anteriorly from the main artery, traverse the rectus muscle, and pierce the anterior rectus sheathto supply a variable area of abdominal wall fat and skin. The course of a perforating artery is divided into intramuscular, subfascial, and subcutaneous segments **(20).**

Communication between the superficial and deep venous systems via linking veins thus becomes a critical component of adequate venous drainage and contributes to a full spectrum of venous outflow ranging in varying degrees from superficial to deep venous dominance **(21)**.We acknowledge that many of the problems with blood supply in the DIEAP flap are related to flow through the venous system.

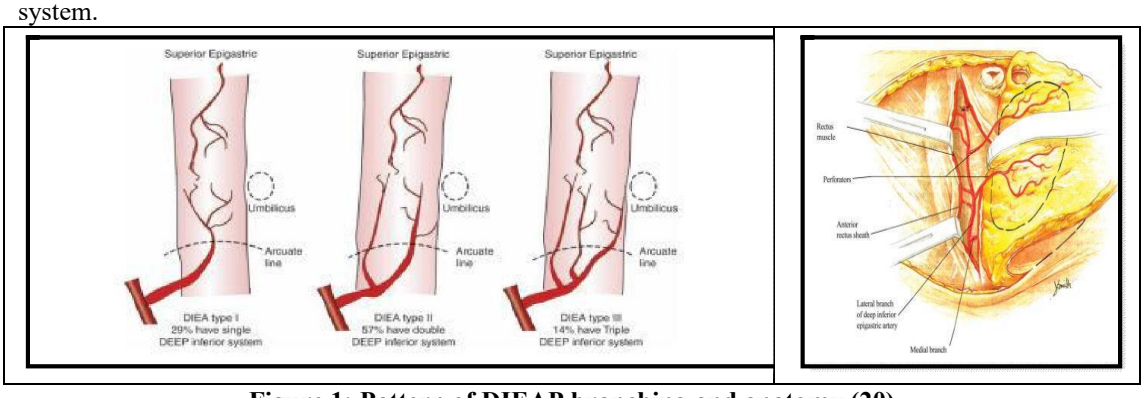

Figure 1: Pattern of DIEAP branching and anatomy (20)

In most people, the superficial inferior epigastric artery arises from the common femoral artery approximately 1 cm below the inguinal ligament and ascends in front of the rectus sheath. In approximately one-third of people, the superficial inferior epigastric artery shares a common origin with the superficial circumflex iliac artery; in another third, the two arteries have separate origins; and in the remaining third, the superficial inferior epigastric artery is absent **(22)**.

Multiple Perforators DIEAP flap

A new MS-TRAM zone classification including zone I is the main perforasome area because it is directly nourished on the ipsilateral side by both medial and lateral row perforators; zone II is the perforasome area adjacent to zone I. Zone II shows ipsilateral SIEA territory and contralateral medial row perforasome territory. Zone III is a more lateral area, in which venous shadows are visible, whereas zone IV is an avascular area in which the contralateral lateral side of the flap is located. In MS-TRAM and DIEAP-2 flaps, the arterial perfusion area decreases as it moves from zone I to zone II, to zone III, and zone IV**(Fig. 2) (23)**.

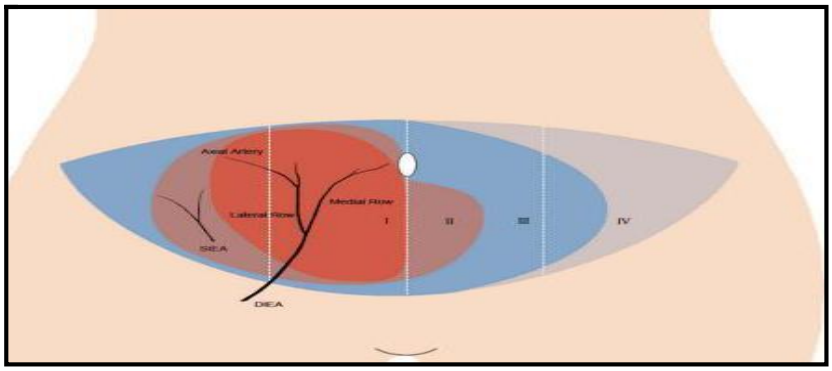

Figure (2):Perforator concentric concept in DIEAP flap zones (23).

In perforator flaps, the cross sectional area of the vessels reduces rapidly from the size of the source vessels to the perforator, while in a conventional flap the cumulative cross sectional area of the many branches of the source vessel increases. These cross-sectional area differences remain the same for arteries and veins. The narrowest point in the venous drainage would be where the venous architecture within the flap joins the perforator vein outside the flap **(Fig. 3) (24).**

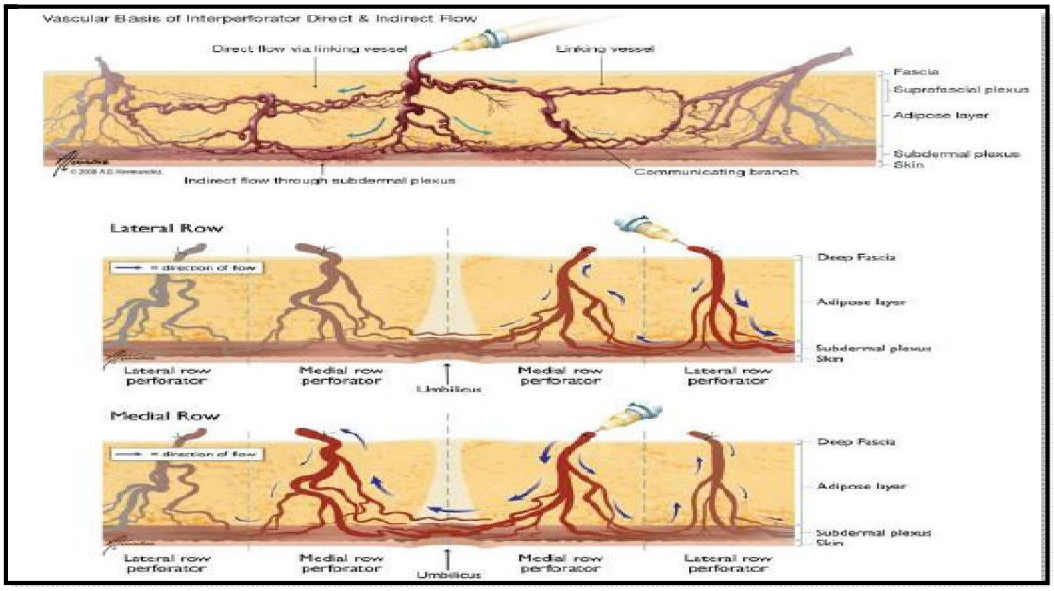

Figure (3):Vascular basics of direct and indirect flow (above) and illustration of lateral vs. medial row perfusion (25).

Free DIEAP flaps for breast reconstruction with increasing weight are at a significantly increased risk of fat necrosis, with odds increasing by 1.5 for every 100 g increase in flap weight. Incidence of fat necrosis was also highly correlated with wound healing complications at the recipient site. Among large flaps in this study, flaps with more than 1 perforator had a lower incidence of fat necrosis compared to single perforator flaps. As such, DIEAP flaps may be optimized when balancing perforator number and increasing flap weight **(26)**.

Breast cancer management should be done by a multidisciplinary team **(27)**. Expert team discussion to consider all factors; the patient's wish and expectation, risks of recurrence, preoperative therapy and disease implication in case of delay in systemic or radiation therapy **(28)**.

The considerations for the type of mastectomy are mainly based on tumor features and disease stage (size, location, proximity to the nipple and focality, etc.), body habitus (including breast size, breast appearance, physical tissue aspects, body mass index), medical history (e.g., smoking, diabetes mellitus, previous chest wall irradiation), surgeon's expertise and patient's preference **(29,30)**.

Patient expectations play a major role in postoperative satisfaction, and realistic outcomes must be discussed from the outset. Patients deemed to have inadequate preparatory information before embarking on breast reconstruction have been shown to have a higher rate of decisional regret and dissatisfaction **(31)**. A thorough preoperative evaluation of the patient's expectations and suitability for a particular reconstruction is therefore essential.

Clinical Aspects for Multiple perforators DIEAP flap for Breast reconstruction

Tamoxifen is a selective estrogen receptor (ER) modulator (SERM) that blocks the ability of estrogen to bind the nuclear ER. Normally, Estrogen binding to ER leads to stimulation of nitric oxide production and stimulation of the COX pathway which leads to inhibits contractile prostanoids, like thromboxane, and promotes vasodilation. Many studies should increase risk of microvascular thrombosis in patient using tamoxifen**(32).**So it's considered to temporarily stop tamoxifen 14-days before microsurgical breast reconstruction **(33)**.

The coronavirus disease 2019 (COVID-19) pandemic dramatically changed the landscape of plastic surgery across the globe. Deldayed breast reconstruction was paused during COVID pandemic in many countries **(34)**.

Patient involvement in co–decision-making about breast reconstruction leads to higher satisfaction; independent of the reconstruction type.15 Sufficient information improves knowledge and lessens decision regret **(35)**. Preconsultation educational group interventions are one method of reducing decisional conflict **(36)**.

Carbohydrate loading reduces the catabolic effects of surgery, including losses of nitrogen and protein, lean body mass, and muscle strength, which has translated into shorter hospital, stays **(37)**. In patients with well-controlled type 2 diabetes, a carbohydrate drink given up to 3 hours before surgery alongside their normal medication does not appear to delay gastric emptying and will allow glucose concentrations the additional time required (i.e., 180 minutes versus 120 minutes in healthy subjects) to return to baseline **(38)** .

Patients undergoing mastectomy and immediate reconstruction meet the criteria for "higher" risk of venous thromboembolism and may be considered "highest" risk if they are obese or elderly, according to the American Society of Plastic Surgeons Executive Committee–approved Caprini Risk Assessment Module **(39)**.

In delayed breast reconstruction, there are several factors related with potential vascular thrombosis: radiation, chemotherapy, hormone therapy, obesity and maybe for us the most important is the preoperative radiation which directly affects the state of the vessels **(40)**.

Complex wounds associated with mastectomy flap, DIEAP flap, or abdominal skin necrosis is recognized complications of breast reconstruction. Negative-pressure wound therapy is an effective aid in wound management after surgical débridement, with a systematic review of breast wounds showing that 97 % receiving negative-pressure wound therapy in conjunction with débridement healed completely**(41)**.

Early physical rehabilitation improves physical and emotional recovery after mastectomy and axillary dissection. Postoperative physical rehabilitation programs in breast cancer patients improve mobility, reduce pain, and improve quality of life **(42)**. Randomized controlled trial data on the effect of early supervised exercise have demonstrated that exercise leads to quicker recovery, earlier mobility, and enhanced patient comfort, but fails to improve lymphedema **(43)**.

A broad range of different technologies has been described for postoperative monitoring of free flap such as laser Doppler flowmetry, implantable Doppler probes, quantitative fluorescein fluorescence, fluorescent angiography, near-infrared spectroscopy (NIRS), visible light spectroscopy (VLS), and microdialysis. Nowadays, there is no evidence of better salvage rate related to any monitoring technique over another **(44).**

The timing of surgical reexploration in microanastomosis thrombosis is directly related to the salvage rate **(45)**. Clinical evaluation by an experience microsurgeon is considered the gold standard for perfusion assessment. Clinical evaluation requires no specialized equipment, but does rely heavily on the experience of the evaluator **(44)**.

Stacked/conjoined flaps were associated with a lower risk of fat necrosis compared with non-stacked/conjoined flaps and had a lower rate of contralateral symmetrizing reductions in patients undergoing unilateral abdominally-based breast reconstruction **(46)**.

Bilateral breast free flap reconstruction obligates the surgeon to use both hemiabdomen flaps and leaves little room for error in terms of perforator and pedicle dissection and for variation in arterial perfusion or venous drainage. Patience is critical for observing flaps for a period before inset because this time interval can identify problems while they are intraoperative and not postoperative, as we found that most of the thromboses in the bilateral flap procedures were intraoperative and on the second flap **(16,46)**. A Single Set of Internal Mammary Recipient Vessels can be used in Bilateral Free FlapBreast Reconstruction **(47)**.

Correspondingly, in plastic surgery, patient centered outcomes data is of particular importance as the majority of operative interventions aim to improve appearance, function and/or quality of life **(48)**.

CONCLUSION

Improvement of multiple perforator DIEP approach can occur through better and sustained practice, better patient health education and future studies that can compare this new technique to the ordinary primary repair in a randomized controlled trial.

No Conflict of interest.

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