

MICROSURGERY AND FLAP

The Deep Inferior Epigastric Perforator (DIEP) Flaps in Breast Reconstruction After Mastectomy

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Background: The continuing advances in breast reconstruction surgery allows for high expectation of excellent outcomes and long-term aesthetic appearance. Transverse rectus abdominis muscle (TRAM) flap has been the flap of choice in breast reconstructions for decades, however it sacrifices muscle and causes donor site complication. Deep inferior epigastric perforator (DIEP) flap is now the preferred flap for microsurgical breast reconstruction, because it holds some advantages over TRAM. This study aim to review, summarize, and discuss the current knowledge of DIEP flap in breast reconstruction.

Method: Literature research conducted through Pubmed, Medline, and SCOPUS databases for published articles up to the year 2009. A total of 808 articles were found, and 60 articles reviewed.

Result: Women with thick subcutaneous fat and skin on the lower abdomen are the most appropriate candidates for autologous breast reconstruction. Patients might be given oral analgesics instead of intravenous, because DIEP results in less postoperative pain than TRAM. Patients are commonly discharged on the 6–7th day post operation after DIEP flaps. In spite of several reports that DIEP flap has low complication rates, necrosis is the most common and often leads to poor cosmetic outcome.

Conclusion: DIEP flap essentially combines all the advantages of TRAM flap without most of its disadvantages. Some complications may occur in smaller percentage. Although DIEP flap has a high patient satisfaction score, it does not mean that it is definitely superior to other methods of autologous breast reconstruction.

Keywords: *Deep inferior epigastric perforator, DIEP, TRAM, breast reconstruction, mastectomy*

Latar belakang: Kemajuan ilmu bedah dalam bidang rekonstruksi payudara memberikan ekspektasi tinggi terhadap hasil dan tampilan estetik yang dicapai. Selama lebih satu dekade TRAM merupakan flap pilihan untuk rekonstruksi payudara mengorbankan otot dan menyebabkan komplikasi pada area donor. DIEP flap merupakan flap yang saat ini terpilih dalam rekonstruksi payudara, dengan teknik bedah mikro, dengan keuntungan tanpa mengorbankan otot. Studi ini merangkum pengetahuan terkini tentang rekonstruksi payudara dengan teknik DIEP.

Metode: Literatur dikumpulkan dari Pubmed, Medline, dan SCOPUS atas artikel yang sudah dipublikasi hingga tahun 2009. Didapati 808 artikel, dan 60 artikel yang dipilih.

Hasil: Wanita dengan jaringan lemak dan kulit yang tebal pada bagian perut bawah merupakan kandidat yang paling tepat untuk dilakukan rekonstruksi payudara autologus. Pasien dapat diberikan hanya analgesik oral, karena nyeri setelah operasi dengan teknik DIEP lebih rendah dibandingkan dengan TRAM. Rata-rata, pasien dapat pulang pada hari ke 6–7 setelah operasi. Nekrosis jaringan adalah komplikasi tersering dari DIEP yang mempengaruhi hasil kosmetik.

Kesimpulan: Flap DIEP memiliki semua keuntungan flap TRAM tanpa memiliki kerugiannya. Komplikasi masih dapat terjadi dalam jumlah yang sedikit. Meskipun tingkat kepuasan DIEP flap memiliki tingkat kepuasan pasien yang tinggi, namun tidak berarti teknik ini superior dibandingkan dengan teknik rekonstruksi payudara lainnya.

The highest incidence of breast cancer is found in more developed regions of the world, in urban populations, and in Caucasian women. In 2002, the age-standardized rate (ASR) of breast cancer incidence indicated by The Globocan database was 67.8 per 100,000 in more developed regions

(e.g: Europe, Australia, New Zealand, North America and Japan) in contrast with 23.8 per 100,000 in less-developed regions (e.g: Africa, Central America, South America, all regions of Asia except Japan, the Caribbean, Melanesia, Micronesia and Polynesia). The lowest incidence of ASR occurs in Asia (22.1), while

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Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

the highest occurs in North America (99.4 per 100,000).¹

The analyses of genetic markers BRCA (Breast Cancer) gene 1 and 2 are predictive tools for breast cancer. BRCA-positive patients have up to 85% chance of developing breast cancer up to the age of 70.² Caucasian women have a lifetime risk of developing breast cancer of approximately 10%.³

Mastectomy remains one of the most vital surgical options, either to effectively manage the disease or to minimize the extensively increased risk in genetically susceptible women with developing breast cancer.^{4,5} The incidence of breast cancer can be decreased by 87% to 93% with bilateral prophylactic mastectomy in high-risk patients and it has become a realistic option for many individuals when a subsequent reconstruction can offer tolerable morbidity and superior esthetic result.³

The main function of breast reconstruction is to rebuild patient's quality of life and body image after mastectomy.⁶ Almost all patients with breast cancer will be treated surgically, with 25% having a mastectomy.⁷ However, a recent study by Wanzel et al. specified that only about 7.5% of postmastectomy patients underwent any type of breast reconstruction.⁸

There are many different breast reconstruction procedures, such as using autologous tissue, implants and expanders or a combination of both. Although the most popular methods for breast restoration after mastectomy are implants and expanders, results of breast reconstruction using these methods depreciate over time.³ Breast reconstruction may be performed immediately (during mastectomy) or delayed (after radiation and chemotherapy).⁶ A study by Sullivan et al. reported that despite saving the patient an extra operation and time, immediate reconstruction using tissue expander/implant may not be a better solution after mastectomy because the procedure has a higher overall complication and capsular contracture rate compared to delayed reconstruction.⁹ The use of autologous tissues is becoming more common because it allows the reconstructed breast to look and feel

more like a normal breast.¹⁰ In addition, breast reconstructions using the patient's own tissue would make the breast behave naturally thus becoming less inflamed and softer as the patient ages.³ Several studies have reported the impact of breast reconstruction in psychological, social, emotional, and functional benefits, such as improved psychological health, self-esteem, sexuality, and body image.¹¹⁻¹⁴ Surgical breast reconstructions are preferred by many patients and are also suggested by law in many countries.¹⁰

Breast reconstruction after mastectomy with transverse rectus abdominis flap (TRAM) was popularized in the early 1980s by Hartrampf.¹⁵ The author used the superior epigastric artery and the rectus abdominis muscle as carrier for breast reconstruction using the pedicle concept to transfer abdominal tissue to the chest.¹⁶ Because of tunneling and folding of the flap to reach the chest wall, and also because of a circuitous and difficult blood supply, TRAM flap has a rate of partial necrosis of about 25%.¹⁵ One of the drawbacks from TRAM flap is the need to sacrifice the rectus abdominis muscle to make the breast, causing donor site complication, such as abdominal wall weakness which may be caused by motor innervation damage in the rectus abdominis.^{7,17}

In 1992, Allen and Treece performed the first successful DIEP flap for breast reconstruction by transferring the same donor site as TRAM, but sparing the rectus muscle.^{18,19} DIEP flap is now the gold standard management for microsurgical breast reconstruction.²⁰⁻²² Bilateral DIEP flap has the benefit of matching contralateral breast using only autologous tissue from one donor site.²⁰ There is also an additional advantage for patients with abdominal donor site, which is improved abdominal shape after flap harvest that mimics an abdominoplasty or "tummy tuck" while, at the same time, diminishing donor site morbidity.^{10,19,23}

The DIEP flap has advantages over the pedicled TRAM flap in view of the fact that the rectus abdominis muscle and fascia are preserved. When using pedicled TRAM flap, often there are poor blood supply to the skin and fat that will become the new breast. This



can cause fat necrosis that will leave the breast hard and painful.^{18,24,25} Furthermore, loss of muscle from the abdomen can lead to abdominal bulging and hernia.^{18,24-27} DIEP flap was also found to have some disadvantages, for example; greater technical difficulties for flap harvest, greater incidence of venous congestion, additional clinical expertise for perforator selection, developing fat necrosis, and if a DIEP procedure fails, the tissue flap may die and have to be completely removed.²²

One study counters the problem of venous congestion by venous augmentation where the superficial inferior epigastric vein (SIEV) was anastomosed to the proximal end of the other deep inferior epigastric vein (DIEV) comitantes to provide anterograde drainage.²⁸ Another study reported that expanders and secondary mammary implants were used for flaps with more than 10% necrosis to achieve an exceptional result.²⁹

The objective of this study is to understand the whole aspect of breast reconstruction using DIEP method, including: criteria for candidates, post-operative managements, complications, and patient's satisfaction rate. This study is aimed to summarize current knowledge about breast reconstruction using DIEP flap procedure.

METHODS

Literature were searched using Pubmed, Medline, and SCOPUS databases for published articles up to the year 2009 with key terms: breast reconstruction AND DIEP flap, breast reconstruction AND mastectomy, DIEP flap AND mastectomy, and breast reconstruction AND DIEP flap with REFINED term mastectomy. The literature search included randomized controlled trials, observational studies, case reports, clinical reviews, and editor reviews. The bibliography of each article was reviewed for relevant references. From those searches, 808 articles were found and 60 articles were chosen. The journals were limited to articles: (1) in English, (2) that used humans as subjects, (3) which used DIEP flap procedure as breast reconstruction. Other breast reconstruction procedures and breast surgery for cosmetic purposes were excluded.

RESULTS

During mastectomy, periareolar approach is suitable for patients with small/medium breasts and medium/large areola. On the other hand, a periareolar incision with lateral extension or elliptical method is appropriate for patients with small areola (less than 3.0 cm) and have a large breast.³⁰

Women with extra fat and skin in their lower abdomen are the most appropriate candidates for autologous breast reconstruction.³¹ Most women who have breast cancer and are suitable for a mastectomy or women who have had a mastectomy are possible candidates for a DIEP flap.^{10,32} This procedure can also be used for women who have congenital breast deficiency that require an additional breast tissue, a lumpectomy defect or autologous breast augmentation.¹⁰

Active smokers are not suitable candidates because nicotine can inhibit capillary blood flow, thus causing the abdominal scar to heal slowly and the abdominal fat is a risk of becoming scar tissues, i.e. fat necrosis.³⁰ In such conditions, patients may need to refrain from smoking 4 weeks pre and post surgery.³³

Patients who have previous abdominoplasty or abdominal liposuction, and are actively smoking within 1 month before surgery are contraindicated for these procedures.^{10,32} Relative contraindication includes large transverse or oblique abdominal incisions.¹⁰

The patient is kept in the High Dependency Unit (HDU) postoperatively for 1 night. Flap color, capillary blood flow, and temperature are factors that should be assessed regularly.²⁷ The next morning, the patient is transferred to the ward for the first postoperative day. Oral analgesics are given from the 1st postoperative day onwards, because the pain is considerably less comparing to TRAM flap reconstruction.¹⁰ The patients is then discharged between the 6-7th postoperative day and suggested to have a followed up in an outpatient clinic every week for the first postoperative month, then once every 3 months afterwards.¹⁵

DIEP flap has various early to late complications (Table 1). Several early

complications include: 1) Partial Flap loss: ischemic tissue within the first 30 days after the surgery that involves the loss of skin and underlying tissue, 2) Abdominal Seromas: palpable fluid that gathered within 30 days of the surgery, which may requires intervention, 3) Breast Flap Dehiscence: any lesion of the DIEP flap which includes infection, and 4) Abdominal Apron Necrosis: any abdominal wound or skin necrosis that requires I.V. antibiotics and involves at least 5 cm² area.³ Late complications may differ from different size of fat necrosis (any sign of subcutaneous firmness which characterized ischemic soft tissue loss) to hernia formation (a facial defect that presents with abdominal herniation).³ Problems related to vein or venous anastomosis were almost eight times more likely to happen compare to artery or arterial anastomosis.^{10,32} In spite of several report that DIEP flap has a low complications, necrosis is the most common, which often leads to poor cosmetic outcome.²⁹

Several conditions that will increase flap morbidity includes; smoking, chemotherapy, pre-reconstruction radiotherapy, post-reconstruction radiotherapy, hypertension, diabetes mellitus, abdominal scarring, obesity, age, flap size, number of venous anastomoses, and number of perforators.^{29,33}

One study by Damen et al. reported that 90% of patients were adequately informed about the method and its consequences, the preoperative expectations have been meet, their new reconstructed breast felt like their own, they would undergo the procedure again, and they would recommend the procedure to other friends.⁶ Patients also said that they were comfortable regardless of wearing cloths, in general, V-neck tops, bathing suits or no cloths. From the 40% of patients reported of having peri- or postoperative complications, only 6% of patients continued experiencing limitations in daily life. In this study, the mean satisfaction score for DIEP flap breast reconstruction was 8.5 on a 10-point scale.

Another study by Munhoz et al. evaluated 27 patients who went through 30 immediate DIEP flap, three of which had bilateral breast reconstruction.³⁰ Patients were evaluated at minimal period of 6 months

postoperative (6 to 10 months). 25 patients (92.5%) were satisfied with the results. Only 2 patients (7.4%) were disappointed, but none regretted their operation. All patients attained an improved abdominal contour, as confirmed by preoperative and postoperative photograph. As a result of the operation, over 90% of the patients reported their abdomens had became firmer. Two patients however, gained weight after the surgery and chemotherapy resulting in recurrence of previous abdominal contour.

Although DIEP has improved breast reconstruction by preserving the rectus abdominis muscle, it has several limitations. One study by Lasso et al. stated increased time of dissection and damage to the intercostal nerves during dissection, and inadequate flap perfusion as some of these limitations.³⁹ In addition, other studies reported the difficulty in solving inadequate flap perfusion or vein drainage can only be clarified by intraoperative observation because it is important to observe the flap, caliber, anatomy and flow of the vessel.^{28,40,41} To counter these limitations, Pacifico et al. suggested the use of CT-A as preoperative procedure. This imaging device may improve outcome of surgery, as mentioned previously CT-A may support preoperative decision-making in free abdominal flap breast reconstruction and increase precision of preoperative planning.⁴²

DISCUSSION

DIEP flap essentially combines all the advantages of TRAM flap without most of its disadvantages. The procedure offers tremendous amounts of well-perfused soft tissue and the complication rate is almost the same to other free tissue transfer. The first and most important advantage in DIEP flap is decrease of donor site morbidity. Because no muscle is sacrificed, late hernia and abdominal weakness rarely occur. Postoperative pain and the hospitalization time are reduced thus decreasing the health care costs. These factors enable patients to return quickly to work and physical activities. Furthermore, the patient benefits from an abdominal contour with a well-concealed scar.

**Table 1.** Complications of *DIEP flap* surgery in various studies.

References	Number of flaps	Partial flap loss	Abdominal seroma	Breast flap dehiscence	Venous congestion	Abdominal apron necrosis	Fat necrosis	Hernia formation
Guerra <i>et al.</i> (3)	280	5 (1.8%)	30 (10.7%)	16 (5.7%)	1 (0.4%)	6 (2.15%)	30 (10.7%)	3 (1.07%)
Lundberg <i>et al.</i> (29)	50	5 (10.0%)	n/a	n/a	7 (14.0%)	n/a	0 (0.0%)	n/a
Cheng <i>et al.</i> (15)	74	2 (2.7%)	1 (1.4%)	n/a	1 (1.4%)	n/a	10 (13.5%)	n/a
Granzow <i>et al.</i> (10)	758	19 (2.5 %)	38 (5.0%)	n/a	n/a	n/a	99 (13.0%)	5 (0.7%)
Gill <i>et al.</i> (33)	758	19 (2.5%)	35 (4.6%)	n/a	29 (3.8%)	103 (13.6%)	98 (12.9%)	5 (0.7%)
Figus <i>et al.</i> (21)	14	2 (14.2%)	0 (0.0%)	n/a	11 (6.3%)	n/a	n/a	0 (0.0%)
Munhoz <i>et al.</i> (30)	30	2 (7.4%)	0 (0.0%)	1 (3.7%)	n/a	n/a	1 (3.7%)	0 (0.0%)
Granzow <i>et al.</i> (32)	750	19 (2.5%)	38 (5.0%)	n/a	n/a	n/a	98 (13.0%)	5 (0.7%)
Blondeel <i>et al.</i> (34)	100	7 (7.0%)	n/a	n/a	4 (4.0%)	n/a	6 (6.0%)	1 (1.0%)
Hamdi <i>et al.</i> (35)	50	3 (6.0%)	n/a	n/a	2 (4.0%)	n/a	3 (6.0%)	0 (0.0%)
Kroll <i>et al.</i> (36)	23	2 (8.7%)	n/a	n/a	n/a	n/a	4 (17.4%)	n/a
Keller <i>et al.</i> (37)	148	n/a	n/a	n/a	3 (2.0%)	n/a	10 (6.8%)	2 (1.4%)
Nahabedian <i>et al.</i> (38)	20	0 (0.0%)	n/a	n/a	0 (0.0%)	n/a	2 (10.0%)	0 (0.0%)

n/a: not available

The complication rate for DIEP flap is relatively low because it does not sacrifice the abdominal muscle. Nevertheless, some complications may occur in small percentage. Necrosis is the most common complication, which may lead to poor cosmetic outcome. A study by Gill *et al.* supported this fact by showing 13.6% abdominal apron necrosis and 12.9% fat necrosis, with a total of 103 and 98 cases, respectively.⁽³³⁾ Other studies also reported having necrosis as the main complication.^(3,10,15,36-38) While several studies reported having other major complications, such as: partial flap loss, abdominal seroma, and venous congestion.^(21,29,30,34) Surgeon's skill and knowledge, and also patient's condition may affect the outcome of the surgery and have effect on complication rates.

Previous comparison between autologous and non-autologous breast reconstruction resulted equal satisfaction rates, while only minority of study stated significantly

higher satisfaction rate after autologous breast reconstruction.^(13,43-45) Although the DIEP flap has a high patient satisfaction score, it does not mean that the procedure has a higher score compared to other autologous breast reconstruction. This is due to lack of study in comparing different satisfaction rate between various autologous breast reconstruction procedures. Therefore, significant differences in, for example, patient's satisfaction, continuing complaints, and whether or not the reconstructed breast felt like their own cannot be depended solely to the type of breast reconstruction.⁽⁶⁾

CONCLUSION

The goal of breast reconstruction is to improve the patient's quality of life after mastectomy. The DIEP flap is now the gold standard management for microsurgical breast reconstruction because it is safe and dependable. The advantages of *DIEP flap* are

decreased donor site morbidity and shorter recovery time. In addition, it may offer the patients reconstructed breast that feels like their own. The *DIEP flap* has disadvantages, such as greater technical difficulties for flap harvest, greater incidence of venous congestion, the need for additional clinical expertise for perforator selection, developing of fat necrosis which may lead to poor cosmetic outcome and if a *DIEP flap* procedure fails, the tissue flap may die and have to be completely removed. In *DIEP flap*, to choose and dissect perforators is crucial because it eradicates practically all-major abdominal morbidity, decreases postoperative pain and discomfort, and may cut down postoperative hospital stay.

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