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Outcomes of Deep Inferior Epigastric Artery Perforator (DIEP) Flap in Indian Population—A Prospective Single-Institute Study

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Abstract

Introduction Breast reconstruction has become integral part of breast cancer treatment. Deep inferior epigastric perforator (DIEP)-based flap is considered the gold standard in autologous breast reconstruction.

Aims and Objectives The aim of this study was to evaluate the patient satisfaction and the incidence of complications in DIEP flaps in an Indian setup for breast reconstruction.

Materials and Methods This is a prospective, nonrandomized study at a single institute—Manipal Hospitals, Old Airport Road, Bangalore. Eligible patients were women aged between 28 and 60 years with primary breast cancer requiring mastectomy and radiotherapy, who consented for DIEP flap reconstruction.

Results The study includes subjects who had autologous breast reconstruction after mastectomy with DIEP flap between January 2019 and August 2021 that included 31 patients with a minimum follow-up of 2 years. Four flaps were turbocharged and 17 flaps were superdrained primarily. The average operative time for the whole procedure by adopting a two-team approach is 353.8 ± 43.793 minutes. About 94.1% patients had excellent aesthetic score results. Six patients developed mastectomy flap necrosis, one had fat necrosis that was managed conservatively, whereas one patient had donor site re-exploration for hematoma. We had no DIEP flap necrosis, seroma, flap site hematoma, or flap failure. Physical well-being module of Breast-Q indicated an average of 83 points, psychosocial well-being module indicated 80 points, whereas sexual scores reverted an average of 77 points. Among satisfaction module, aesthetic outcomes for breast showed an average of 94 points, whereas the donor site had 96 points. Satisfaction with information, surgeon, medical staff each gained more than 87 points.

Conclusion Breast reconstruction with DIEP flap yields good aesthetic outcomes and quality of life in Indian population. The incidence of fat necrosis, flap and donor site complications is less over time and will enhance the patient satisfaction score further.

Keywords
- deep inferior epigastric perforator flap
- autologous breast reconstruction
- Breast-Q
- patient satisfaction

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Introduction

Breast reconstruction has become an integral part of multimodal breast cancer treatment and it has shown to reduce the impact of cancer diagnosis and therapy on patient's psychological status, improve quality of life (QoL), promote social well-being, and increase self-esteem.[1] There are many other reconstructive approaches that can be adopted like local oncoplastic techniques, pedicled flap reconstruction, and free flap reconstruction.

Deep inferior epigastric perforator (DIEP) flap has evolved from transverse rectus abdominis myocutaneous (TRAM) pedicled flap, which was first described by Hartrampf in 1982.[2] TRAM flap has rectus abdominis muscle as a component and is associated with high morbidity due to ventral hernia and bulge. Due to this, muscle sparing techniques developed and Koshima and Soeda performed the first DIEP flap for breast reconstruction in 1989.[3] Allen and Treece for the first time used a large DIEP flap with dimension equal to TRAM flap for breast reconstruction.[4] DIEP flap is based on perforators of deep inferior epigastric artery(DIEA) and its venae commitantes that are identified intraoperatively on the rectus sheath and are traced to its pedicle, where it is disconnected and reconnected to the chest for breast reconstruction.[5]

Primary breast reconstruction at the time of mastectomy is the treatment of choice in most cases.[6] Studies have shown that there is no negative impact on patient survival or recurrence even in patients with advanced disease.[7] Clinical outcome indicators including morbidity, complications, and/or recurrence rates are insufficient to evaluate the efficacy and quality of breast reconstruction. Additionally, correlation between patient expectations and patient satisfaction should be made as well as the procedure's effect on health-related quality of life (HRQoL) should be considered post-reconstruction of breast.[8,9]

This study has been conducted with the aim of evaluating patient satisfaction and the incidence of complications in Indian patients having breast reconstruction with DIEP flap.

Aims and Objectives

The aim of this study was to evaluate the following parameters post-breast reconstruction with DIEP flap:

1) Incidence of complications
2) Aesthetic outcome
3) Patient satisfaction and QoL

Materials and Methods

We conducted a prospective, nonrandomized study at a single institute—Manipal Hospitals, Old Airport Road, Bangalore. All patients aged between 28 and 60 years who were qualifying the eligibility criteria, presented to the Department of Plastic, Reconstructive and Aesthetic Surgery, and underwent autologous breast reconstruction using DIEP flap between January 2019 and August 2021 with a minimum follow-up period of 2 years were included in the study. All included patients were subjected to standard preoperative workup and have undergone similar intraoperative surgical steps. All patients were sent a questionnaire 2 years post-reconstruction with instructions and a consent form. A month later, reminders were sent for getting the response.

Eligibility Criteria

Following are the eligibility criteria:

1) Women aged between 28 and 60 years.
2) Confirmed case of primary breast cancer requiring mastectomy with or without radiotherapy.

Exclusion Criteria

Following are the exclusion criteria:

1) Local recurrence, contralateral breast cancer, or metastatic cancer.
2) Death.
3) Inability to answer the questionnaire.
4) DIEP flap for nonbreast cancer.
5) DIEP flap as a second flap.

Surgical Technique

Preoperatively with the help of computed tomographic angiogram of the abdomen (►**Fig. 1**), perforator is identified and reconfirmed with a hand held doppler. Medial perforators in the periumbilical region are preferred over the lateral ones and the flap is marked with the upper border taken approximately 2cm above the umbilicus and the lower border till pinchable skin for tension free closure. Flap is

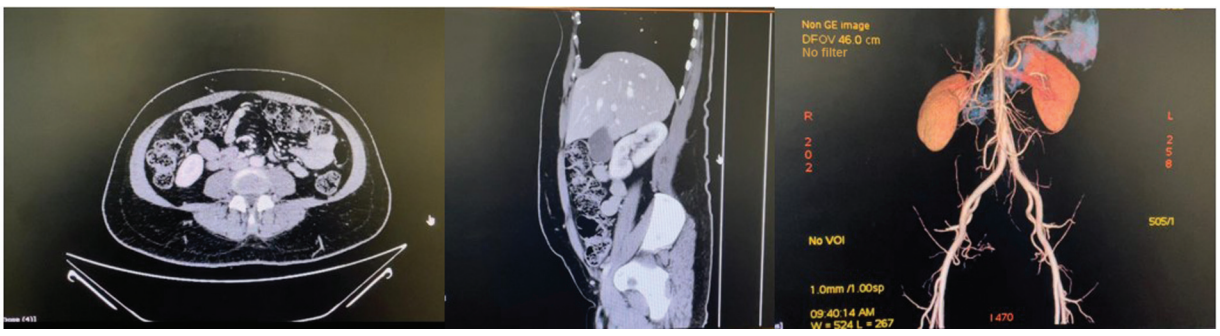

Fig. 1 Preoperative computed tomography angiogram to locate the perforator for deep inferior epigastric perforator flap.

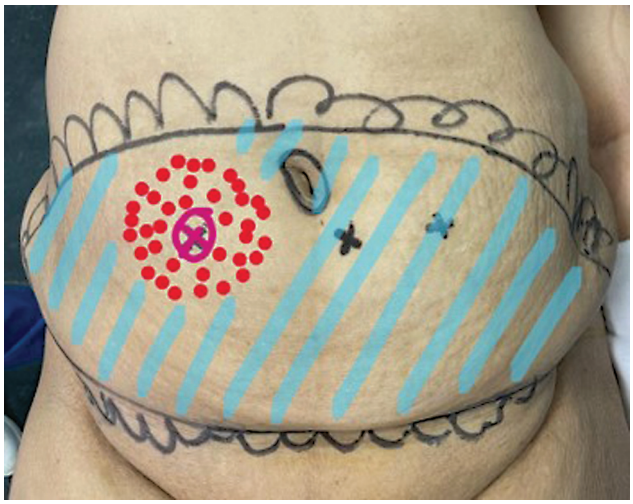

Fig. 2 Hot(red) and cold(blue) zones in deep inferior epigastric perforator harvest.

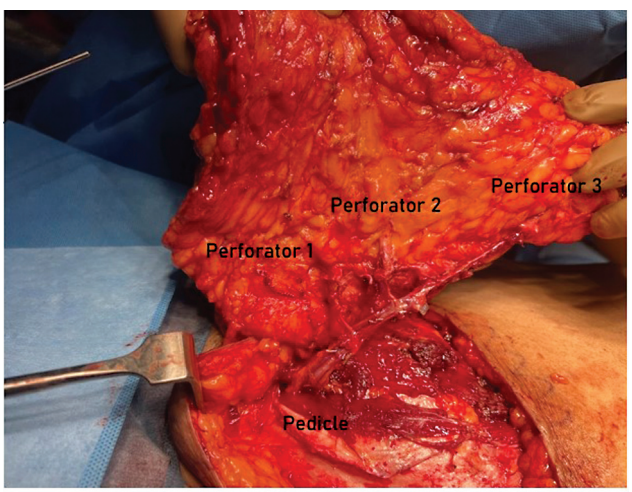

Fig. 3 Perforators (3) and main pedicle post-deep inferior epigastric perforator flap elevation.

divided into cold and hot zones (►**Fig. 2**) for speed and safe harvest. Hot zone is a circular area of approximately 3 cm around the perforator where cautery settings are reduced and careful dissection is done.

Full length of superficial inferior epigastric vein (SIEV) is dissected always and clipped for later use, if required. Umbilical stalk is preserved. Perforator is dissected through the sheath and muscle to gain as much length as possible for ease of anastomosis, while preserving the motor nerves to rectus muscle (►**Fig. 3**). Ipsilateral side is preferred to harvest as we orient the flap with the lateral triangular apex pointing to the infraclavicular region so the SIEV comes to the axilla. Flap vessels were anastomosed to the internal mammary artery and vein and sometimes to internal mammary perforator, whereas SIEV, if required, is anastomosed to lateral thoracic vein. Turbocharging if required is done by intraflap anastomosis. Intraflap anastomosis is done either with the flap in situ on the abdomen or as bench surgery post-division of the pedicle to the side branch or anastomosis is done to the distal run-off of the main pedicle (►**Fig. 4A–C**). Anastomosis is done using 8–0 or 9–0 Ethilon suture or couplers. The inframammary crease is delineated by taking dermal stitches from the skin flap to the pectoral fascia to obtain symmetry to the opposite side, prevent flap migration, and gain a good definition and projection of the breast. Intraoperative perfusion scan using indocyanine green (ICG) is done post-anastomosis to check the perfusion of DIEP flap and the mastectomy skin flap and revision done accordingly. Recipient site closure is done in layers over negative suction drains. Abdomen is also closed in layers and umbilical stalk is taken out through an elliptical incision in the center and excising a donut of fat around for better cosmesis. Elastic adhesive bandage is used for breast support in postoperative period. Postoperatively flap is monitored clinically and by Doppler till postoperative day 5. Patient is advised mobilization from day 2 onward with an abdominal binder. Advice on discharge includes wearing a sports bra or custom-made supportive bra for 2 to 3 months for breast support.

Patients

Between January 2019 and August 2021, 31 consecutive patients with laboratory confirmed breast cancer diagnosis undergoing mastectomy followed by standard immediate or secondary breast reconstruction using DIEP flap were recruited from our department. The patients are followed up for a minimum period of 2 years postoperatively.

During the 2 years follow-up period, none of the patients died or were lost to follow-up.

Questionnaire

Patients received questions that were study specific picked from previous studies after breast reconstruction.[10] Patients

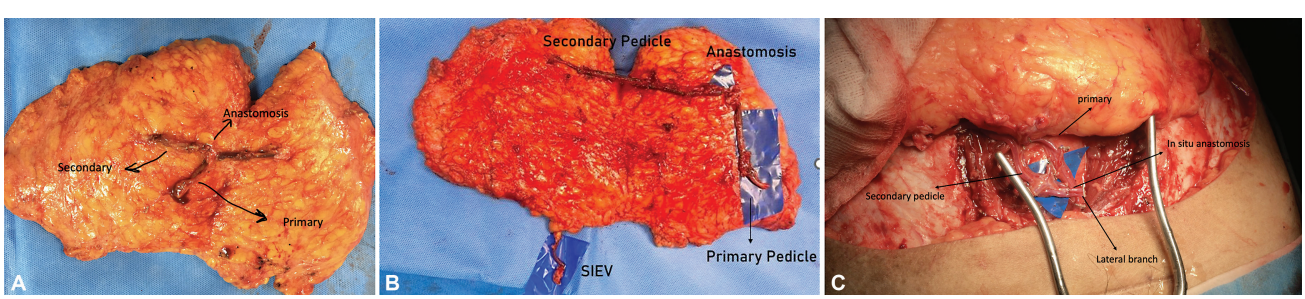

Fig. 4 Turbocharging of flap. (**A**) In situ intraflap anastomosis. (**B**) Intraflap anastomosis by bench surgery to side branch of the first pedicle. (**C**) Intraflap anastomosis to distal run off of the first pedicle. SIEV, superficial inferior epigastric vein.

used visual analogue scales (VAS) to assess their cosmetic outcome.[11] All patients also received a standardized demographic questionnaire and Breast-Q form.

Breast-Q is a standardized tool for evaluating patient satisfaction and HR-QoL after breast reconstruction. Breast-Q includes two separate modules namely the wellness module and satisfaction module. Wellness module includes three subunits that are physical well-being, psychosocial well-being, and sexual well-being; the satisfaction module includes various subunits like satisfaction with breast, satisfaction with donor site, satisfaction with preoperative information and care from the surgeon, nursing staff, and administrative staff. Each rating is based on a 3- to 5-point Likert-scale (from 1 "very dissatisfied," "disagree," etc. to 3–5 "very satisfied," "definitely agree," etc.).[12,13] The score from each scale is then converted into a 100-point scale, the Q-score. Higher scores indicate greater satisfaction.[13]

We have used this questionnaire after permission from the authors Drs. Klassen, Pusic and Cano that was made under license from Memorial Sloan Kettering Cancer Center, New York, United States.

VAS was used to assess cometic outcome under five different headings (shape, symmetry, volume, position, and consistency of the breast). Each heading ranged from 0 (complete dissatisfaction) to 10 (complete satisfaction).[11]

Statistical Analysis

The Q-score software program was used to convert responses to obtain the domain score of BREAST-Q. The converted scores ranged from 0 to 100. Higher scores indicated greater satisfaction or better QoL.[14] All continuous variables are represented by an average percentage.

Results

All patients (31/31) completed the postoperative questionnaire, giving a response rate of 100% (►**Table 1**).

Of 31 patients, 4 (12.9%) patients underwent bilateral mastectomy and DIEP flap reconstruction, whereas 20 (64.5%) underwent left breast reconstruction and 7 (22.5%) right breast reconstruction. Flaps were harvested from ipsilateral side in all patients. Among 31 patients, 94.2% patients underwent immediate breast reconstruction, whereas 2 (5.7%) patients underwent delayed reconstruction. Out of total 35 mastectomies where 4 patients had bilateral and 27 underwent unilateral mastectomy, 23 patients (65.7%) underwent total mastectomy, 5 had nipple sparing mastectomy, and 7 patients underwent skin sparing mastectomy. Primary DIEP flap reconstruction procedure took an average of 353.85 ± 43.79 minutes, with ischemia time being 50.42 ± 10.78 minutes. Among 35 flaps, 4 flaps (11.4%) that required zone 4 also for reconstruction were turbocharged to the opposite pedicle. Seven flaps where significant portion of zone 3 was used were superdrained primarily to either thoracodorsal or lateral thoracic veins accounting to 48.5%. Also post-elevation, if the clipped SIEV looks filled, tense, and dark, that is considered as an indication for superdraining the flap. The recipient vessel used was internal mammary artery/perforator in all patients, whereas an additional venous drainage was used in 17 patients. The additional venous drainage was into thoracodorsal or lateral thoracic veins. Majority of the patients (26; 83.8%) were mobilized on postoperative day 3 and the average duration of hospital stay was 6 days (►**Table 2**).

Complications post-reconstruction with DIEP flap included six patients with mastectomy flap necrosis that required

Table 1 Demographics and clinical characteristics

	n		Percentage/Mean
Total patients	31		31
Age	31		51 ± 8.4 years
BMI	31		28.9 ± 3.2
Smoking status	0		0
Comorbidities	16		51.6%
	Diabetes	11	35.4%
	Hypertension	7	22.5%
	Others	3	9.6%
BRCA status	BRCA 1	0	0
	BRCA 2	4	12.9%
T status	Tis, T1	3	8.5%
	T2-T4, Tx	28	91.4%
Adjuvant Rx	Neoadjuvant chemotherapy	4	12.9%
	Chemo-radiation	31	100%
Recurrence, metastasis & C/L CA Breast	0		0
Lost to follow-up	0		0

Abbreviation: BMI, body mass index.

Table 2 Perioperative details

		n	Percentage
Side of mastectomy	Left	20	64.5
	Right	7	22.5
	Bilateral	4	12.90
Side of flap harvesting	Ipsilateral side	35	100
	Contralateral side	0	0
Reconstruction time	Primary	33	94.2
	Secondary	2	5.7
Mastectomy types	Nipple sparing	5	14.2
	Skin sparing	7	20
	Simple mastectomy	23	65.7
Operative time (Min)	–		353.8 ± 43.793
Ischemia time	–		50 ± 10
Flaps turbocharged	4		11.4
Flaps superdrained	17		48.5
Recipient vessel	Internal mammary artery	34	97.1
	Internal Mammary Perforator	1	2.8
	Thoracodorsal / lateral thoracic vein	17	48.5
Postoperative mobilization	POD-1	0	0
	POD-2	0	0
	POD-3	26	83.8
	POD-4	2	6.4
	POD-5	3	9.6
Hospital stay (days)	–		6 ± 1

Abbreviation: POD-1, postoperative day 1.

debridement and resuturing, one patient with fat necrosis was managed conservatively, and one patient had donor site hematoma that necessitated re-exploration of the donor site. None of the patients had DIEP flap necrosis, anastomosis-related complications, flap loss, or other complications that necessitated revision surgery. Similarly, complications like infection, wound healing disturbances, or other general medical complications were not observed. (►**Table 3**)

Cosmetic outcomes of the breast were analyzed using VAS for five different dimensions with highest points rated by the patients in breast position and breast shape, with each being an average of 8.6 ± 1.1 and 8.1 ± 1.2, respectively, and lowest scores 6.1 ± 2.5 in breast consistency were given post-reconstruction (►**Table 4**).

Breast-Q scores were calculated in wellness module and satisfaction module. All patients were able to answer the questionnaire. Patients had scored higher in physical wellness (83.8 ± 6.6) subunit as compared with psychosocial or sexual wellness, with each being 80.7 ± 12.3 and 77.6 ± 8.2, respectively. In general, among various subunits of satisfaction module, patients had reported lower satisfaction with medical staff and other staff. Whereas their satisfaction with breast, donor site, surgeon and information provided to them regarding the surgery, postoperative care and lifestyle were satisfactory (►**Table 5**).

Discussion

This study includes complications, patient-reported aesthetic outcomes of breast and their satisfaction post-reconstruction with DIEP flap in 31 patients. Out of 31 patients, 4 patients underwent bilateral reconstruction using DIEP flap.

Among 35 breast reconstruction using DIEP flap, 1 (2.8%) patient had some fat necrosis based on physical examination only that was managed conservatively. This incidence is less compared with the study published by Peeters et al that demonstrated 35% incidence that included both physical and ultrasonic examination.[15] We do not prefer ultrasound for small firm area of scar tissue because it is mostly managed conservatively with massage and compression. This difference can be attributed to the additional anastomosis to avoid venous congestion and use of ICG scan for perfusion testing post-anastomosis. Out of 6 patients, 4 patients of nipple sparing and 2 of skin sparing mastectomies had necrosis of the mastectomy flap in our study. This incidence of necrosis of mastectomy flap was seen before the ICG scan era, post

Table 3 Complications of deep inferior epigastric perforator flap reconstruction

	n		Percentage	
Flap loss	0		0	
Anastomotic complications	0		0	
Flap necrosis	0		0	
Fat necrosis of the flap	1		2.8%	
Mastectomy flap necrosis	6		17.14%	
Infection	Recipient	0	Recipient	0
	Donor	0	Donor	0
Wound healing disturbances	Recipient	0	Recipient	0
	Donor	0	Donor	0
Hematoma	Recipient	0	Recipient	0
	Donor	1	Donor	3.2%
Patients requiring revision surgery	2		6.4%	
Medical complications	0		0	

Table 4 Patient-reported visual analogue score

Components	Patient related
Breast shape	8.1 ± 1.2
Breast symmetry	7.9 ± 1.9
Breast volume	7.7 ± 1.6
Breast position	8.6 ± 1.1
Breast consistency	6.1 ± 2.5

0 = Complete dissatisfaction; 10 = Complete satisfaction (mean ± standard deviation).

Table 5 Patient-reported breast Q scores

Wellness module Q scores	
Physical wellness	83.8 ± 6.6
Psychosocial wellness	80.7 ± 12.3
Sexual wellness	77.6 ± 8.2
Satisfaction module Q scores	
Satisfaction with breast	94.2 ± 3.1
Satisfaction with donor site	96.1 ± 1.5
Satisfaction with information	95.3 ± 1.1
Satisfaction with surgeon	96.7 ± 1.2
Satisfaction with medical staff	88.2 ± 3.4
Satisfaction with other staff	90.1 ± 1.8

which the incidence came down to zero, as perfusion testing led to revision of native skin margins and under-perfused fat before flap inset, as tissues with reduced vascularity looked dark under the infrared camera. In our study, the incidence of donor site hematoma was noted in one (3.2%) patient that may be attributed to altered vessel microanatomy due to neoadjuvant chemotherapy or inadequate hemostasis and required re-exploration on postoperative day 2.

The modality of reconstruction significantly impacts patient-reported QoL mainly due to re-establishment of a soft, supple, and warm breast mound. Increased patient reported breast satisfaction with autologous or abdominal reconstruction as compared with alloplastic reconstruction that has been noted in some previous studies.[16–19] However. other studies have shown DIEP flap breast reconstruction to be far superior compared with other autologous or alloplastic modalities.[20] High satisfaction with overall outcomes has been noted in our study. In another study by Damen et al[21] and Hunsinger et al[22] who assessed satisfaction rate in women undergoing immediate or delayed flap reconstruction using 36-Item Short Form Health Survey found high satisfaction rate without any clinically relevant differences in QoL between a random sample of Dutch females and the study population at 0 and 8 to 20 years postoperatively.

Since the formulation and publication of Breast-Q in 2009, it has been increasingly used to measure patient satisfaction following breast reconstruction. Our study has shown the physical well-being and psychological well-being of our subjects and it was observed to be an average of 83.8 and 80.7 on Q scores as reported by 31 patients. This is similar to the study published by Razzano et al in 2018 with sample size of 70 patients.[23] The sexual well-being questionnaire average score was noted to be 77.6 that is comparable to an average Q score of 66 in a study by Razzano et al.[23]

Best aesthetic outcomes were reported after reconstruction post-nipple sparing mastectomy, followed by skin sparing mastectomy and are worst in secondary reconstruction of breast. The results post-DIEP reconstruction following different mastectomies are shown in ►**Figs. 5**–**6** to **7**.

►**Fig. 5** shows preoperative and postoperative outcome of bilateral DIEP flap reconstruction in which the patient underwent nipple sparing mastectomy on right side

Fig. 5 (**A**) Preoperative and postoperative outcome of unilateral deep inferior epigastric perforator (DIEP) flap reconstruction of left side post-mastectomy. (**B**) Preoperative and postoperative outcome of unilateral DIEP flap reconstruction of left side post-skin sparing mastectomy.

for secondary reconstruction post-tissue expansion of the breast pocket, skin sparing mastectomy on left side for immediate reconstruction. Good symmetry and volume match were achieved, but due to inconsistency in placement of DIEP flap skin paddles, the results do not look pleasing to the eye. Care must be taken to perhaps place flaps at similar levels as donor site skin is abundant that is de-epithelized normally before inset.

Patient-reported satisfaction with the appearance of the breast after reconstruction was significantly high in our study with related Q-score of 94.2. It is in contrast to the study published by Pusic et al[14] who studied 294 patients undergoing immediate DIEP flap reconstruction and calculated Q-scores preoperatively and 1 year postoperatively, which revealed a satisfaction with breast score of 67.8. Zhong et al published their study results with a high satisfaction scoring for breast and similar breast Q scores.[24]

Proper patient selection (smoking, body mass index, comorbidities) and intraoperative measures like low threshold for increasing the flap vascularity by doing intra-flap anastomosis and superdraining have helped improve the patient satisfaction scores. Use of ICG to identify and excise ischemic mastectomy flaps and underperfused fat in the flap have also contributed to low complications and high patient satisfaction.

Cosmetic outcomes of breast when analyzed using VAS in five different components such as breast shape, breast symmetry, breast volume, breast position, and breast consistency show similar results to the study published by Tønseth et al in 2007 who compared breast reconstruction using DIEP flap and breast implant.[25] This comparison suggests superior results of DIEP flap aesthetic outcomes as compared with breast implants.

Dividing the subunit satisfaction with information in Breast-Q into 15 questions gives a more reliable result. Preoperatively patients are given oral information and a printed format by the surgeon so the patients could choose either autologous or allogenic reconstruction with advantages and disadvantages of each mentioned in a tabular form. This helped patients select the procedure with shared decision making and without any bias. The Q-score for the same in our study has been noted to be 95.3. This observation is in contrast to the study published by Thorarinsson et al[19] and

Fig. 6 (**A**) Preoperative and postoperative outcome of bilateral deep inferior epigastric perforator flap reconstruction post-skin sparing mastectomy and adjuvant radiotherapy. (**B**) Preoperative and postoperative outcome of bilateral breast reconstruction post-nipple sparing mastectomy on the right and skin sparing mastectomy on the left side for immediate reconstruction.

Skraastad et al[26] who showed a lower score of 60s. The difference is attributed to the shared decision-making process, good quality of information, and sensitizing about realistic outcomes of the procedure.

Patient satisfaction with donor site appearance was observed to be 96 on Q-score in our study. This is comparable to the study published by Razzano et al[23] who in 70 consecutive patients undergoing DIEP flap reconstruction showed the Q

Fig. 7 Preoperative and postoperative outcome of bilateral deep inferior epigastric perforator flap reconstruction—nipple sparing mastectomy on right side for secondary reconstruction post-tissue expansion of the breast pocket, skin sparing mastectomy on left side for immediate reconstruction.

score of 87 for satisfaction with abdomen.[23] Our study has shown contrasting results to the study published by Niddam et al who showed that only 52% of patients were happy or very happy; however, they have not used Breast-Q scores.[27]

Patient satisfaction with surgeon, medical staff, and other administrative staff has shown higher values with Q scores being 96.7, 88.2, and 90.1, respectively, which is comparable to the study published by Razzano et al in 70 patients undergoing DIEP flap reconstruction.[23]

Limitations of the current study are that it includes a small sample size and short follow-up period.

Conclusion

In our experience, autologous breast reconstruction post-mastectomy with DIEP flap yields a good aesthetic outcome and offers the patients a good QoL by reporting a high degree of satisfaction among Indian patients. With betterment of knowledge and improvement in surgical technique and technologies, the complication rates post-breast reconstruction with DIEP flap are decreasing in number.

However, there is a need of longer follow-up period to scrutinize whether the aesthetics and the QoL remain satisfactory.

Authors' Contributions

A.B.C, S.V., and A.Y.N. conceptualized the study. A.M. collected the data, curated the graphics, did the statistics, and wrote the article. D.S., P.S., and S.B. helped with data collection. S.S.P. was involved surgically with mastectomy. All eight authors have read and approved the final manuscript and declare no conflicts of interest.

Conflict of Interest

None declared.

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