

ISSN: 2164-5213 Volume 10, Number 1, January 2020



# Modern Plastic Surgery

ISSN: 2164-5213



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ISSN: 2164-5213 (Print) ISSN: 2164-5280 (Online)

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# Forehead Flap in Coverage of Nasal Defects: Our Experience

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**How to cite this paper:** Mohamed, M.E.M. and Eldehn, A.F.M. (2020) Forehead Flap in Coverage of Nasal Defects: Our Experience. *Modern Plastic Surgery*, 10, 1-8. <https://doi.org/10.4236/mps.2020.101001>

**Received:** October 19, 2019

**Accepted:** November 5, 2019

**Published:** November 8, 2019

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## Abstract

**Background:** Coverage of post-traumatic or post-oncosurgical nasal defects is a very challenging procedure. Small nasal defects may be covered by skin grafts or small local flaps while larger nasal defects require more complex flap coverage techniques as using tissue expanders, prefabricated flaps or free flaps. The forehead flap has been used for centuries and remains a workhorse flap for reconstruction of large and complex nasal defects. **Aim:** evaluate the feasibility and versatility of forehead flap for resurfacing nasal defects. **Materials and Methods:** 12 patients underwent coverage of nasal defects after trauma or tumor excision using forehead flaps. All flaps needed a second stage for flap separation 3 weeks after the time of operation. The size of the harvested flap, the harvesting time, results of transferred flaps, patient satisfaction and flap-related complications were analyzed. **Results:** 12 patients (10 males and 2 females) underwent reconstruction of different nasal defects using 12 forehead flaps. The overall complications occurred in 2 patients. The remaining 10 patients showed no complications and passed an uneventful follow-up period. 7 Patients were very satisfied, 4 were satisfied and only one patient was not satisfied as she was 23 years old young female and was subjected to human bite. Follow-up periods ranged from 6 to 12 months. **Conclusion:** Nasal defects can successfully be managed with the forehead flap. Probably, the flap provides the best result due to the good matching of the skin in terms of color, texture, and thickness. Also, despite the increasing use of free flaps, the forehead flap is still a valid and safe option for nasal defects coverage that allows good aesthetics and functional outcomes.

## Keywords

Nasal Defects, Forehead Flap, Flap Coverage, Nasal Reconstruction

## 1. Introduction

Nose is frequently vulnerable to trauma and skin cancers due to its prominent position in the center of the face [1].

The technique of nasal reconstruction originated almost 3000 years ago in India, where nasal amputation was a common way of social punishment for various crimes. This required methods of total or subtotal nasal reconstruction [2].

In the late 18th century, Carque found a description of this Indian technique, which gave rise to the modern era of nasal resurfacing with the use of a pedicled forehead flap. His basic technique was the start-up for modern nasal reconstruction for the next century. These techniques were later modified and popularized by other surgical pioneers [3].

Burget & Menick introduced the concept of aesthetic units of the nose, claiming that the incisions should be located at the limits of these aesthetic units. If it is necessary to remove more than one third of a unit, then the whole aesthetic unit must be completely removed and reconstructed [4].

There are several options to cover nasal defects. Among the available methods, the median forehead flap has been used for centuries and remains a workhorse flap for reconstruction of major and complex nasal defects [5] [6].

The forehead flap has undergone a high level of development and improvement, making it the optimal choice for large nasal defects. It is traditionally limited to use for nasal defects that are too large to repair with other smaller local flaps or full-thickness or composite grafts. It is considered the gold standard for all nasal reconstruction. Additional principles that have improved outcomes include maintaining an axial pattern whenever possible, utilizing the ipsilateral pedicle to the defect and extension of the flap at right angles across the forehead for additional reach when necessary [7] [8].

This study aims to demonstrate the versatility of the flap in the forehead flap in nasal defects coverage, which provides adequate contour and good aesthetic outcome.

## 2. Material and Methods

From July 2015 to April 2019, patients who suffered from nasal trauma with skin loss and malignancy affecting nasal skin were admitted to undergo nasal resurfacing using the forehead flap. During this period 12 patients agreed to cover their defects using this method. Preoperative preparation was done for all patients, and consent was taken to use this flap for reconstruction, while other patients who did not agree were treated with other reconstructive methods.

Template was done for each case intraoperatively. The pedicle was located about 2 cm lateral to the midline near the medial eyebrow. The base of the flap was designed 2.5 cm wide to include the pedicle. Flap was elevated from distal to proximal direction. Dissection was done in subgaleal plane distally then near the pedicle, dissection was done in subperiosteal plane to include the vessel in the flap. Flap donor site was closed directly or using split thickness skin graft.

All flaps needed a second stage for flap separation 3 weeks after the time of operation. The size of the harvested flap, the harvesting time, results of transferred flaps, patient satisfaction and flap-related complications were analyzed.

Severe complications were defined as more than one-fourth to the total loss of the flap. Moderate complications were defined as loss of less than one-fourth of the entire flap. A dehiscence or hematoma leading to impairment of wound healing was defined as a minor complication. Patient satisfaction was defined as very satisfied (VS), satisfied (S) and not satisfied (NS).

### 3. Results

12 patients (10 males and 2 females) underwent reconstruction of different nasal defects using 12 median forehead flaps. The nasal defects involved the nasal side walls, dorsum of the nose, nasal tip and alar nose areas caused by malignancy, trauma, burn and bites due to human or animal origin. Patient data are summarized in **Table 1**.

The average times of flap harvest were between 30 minutes to 75 minutes according to the experience of the surgeon and his hand craft. Mean flap sizes ranged from (2 cm × 10 cm) to (3 cm × 12 cm).

The overall Complications occurred in 2 patients (2 minor complications) represented 16% in the form of distal flap wound dehiscence, as shown in **Table 2**. The two cases underwent conservative treatment till complete healing of the wound dehiscence. The remaining patients representing 84% of total number showed no complications and passed an uneventful follow-up period. Characteristics of the flaps transferred are shown in **Table 2**.

Patient satisfaction is shown in **Table 3**:

**Table 1.** Demographic data of the patients with forehead flap nasal reconstruction.

Patient	Sex	Age	Diagnosis	Area Reconstructed
1	M	65	Tumor	Side Wall
2	F	23	Bite (Human)	Tip + Ala
3	M	63	Tumor	Side Wall
4	M	69	Tumor	Side Wall + Ala
5	M	70	Tumor	Side Wall + Dorsum
6	F	22	Trauma	Side Wall + Tip
7	M	33	Trauma	Side Wall + Dorsum
8	M	44	Trauma	Side Wall + Tip
9	F	68	Tumor	Side Wall
10	M	66	Tumor	Side Wall + Ala
11	M	33	Bite (Animal)	Tip + Ala
12	F	55	Tumor	Side Wall + Dorsum

**Table 2.** Forehead flap characteristics and complications of flap reconstruction.

<b>Estimated Flap Dimensions (cm × cm)</b>	2 cm × 10 cm to 3 cm × 12 cm
<b>Estimated Harvest Time (min) (mean)</b>	30 min to 90 min
<b>Severe Complications</b>	-
<b>Moderate Complications</b>	-
<b>Minor Complications</b>	2

**Table 3.** Patient satisfaction after forehead flap separation (the second stage).

<b>Patient</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b>Satisfaction</b>	VS	NS	VS	S	VS	VS	S	VS	VS	S	VS	S

7 patients were very satisfied, 4 patients were satisfied and only one patient was not satisfied. She was 23 years old and was subjected to human bite by one of her coworkers. This represented about (8%) of all cases operated. Follow-up periods ranged from 6 to 12 months.

#### 4. Discussion

The forehead is known as the ideal donor site for nasal resurfacing due to its skin quality, size, and vascularity. The forehead is perfused inferiorly from the supratrochlear and supraorbital vessels and superiorly and laterally from the superficial temporal, post auricular, and occipital vessels [8].

During our study, 12 defects of the nose were reconstructed using forehead flap with its variants. All patients accomplished successful nasal resurfacing although 2 patients representing (18%) suffered from minor complication in the form of dehiscence along the distal 2-mm border of the skin paddle. This area was treated by secondary sutures and re-epithelialized uneventfully.

No flaps suffered full-thickness necrosis or congestion that required intervention. This conforms to the results of Stephen and park, who repaired 10 patients with single-stage forehead flap reconstruction and only 1 patient suffered epidermolysis while the rest of patients passed uneventful postoperative period [9].

We also agree with Millard, who stated that for nasal reconstructions, the midline forehead skin flap can serve as a cover for any nasal reconstruction from severe tip and alar loss to a total nasal defect. Using this flap, aesthetic and functional reconstruction can be achieved by creating a nose that blends well with the face [10].

It appears that in the recent history of head and neck reconstruction, pedicled and free flaps have concurred for the same indications and that their use, in some cases, can be mutually exclusive [1].

Still, free flaps are considered the reference standard for many cases of head and neck reconstruction; however, a significant body of data has been increasing slowly but steadily in which pedicled flaps have been used in comparable settings. In many instances, pedicled regional or micro-vascular soft tissue flaps compete for

the same indication, each technique with its advantages and disadvantages [11].

Different case series with each other conclude that pedicled and free flaps are equally reliable [1] [8].

Out of the 12 patients underwent nasal defect coverage only one patient was not satisfied with the result. This might be due to the cause of nasal defect and her young age (23 years old). The patient had no time to experience the nasal defect which was due to a bite by one of her coworkers.

We need larger numbers of patients to be included in wider scales of studies to evaluate the versatility and feasibility of the flap for nasal reconstruction.

The use of forehead flap can successfully cover different nasal defects with good results and minimal or no complications. Even in the presence of free flap reconstructions, the regional flaps still have a great rule and still compete with the free flaps in coverage of the nasal defects with a good aesthetic outcome.

## 5. Conclusion

Nasal defects can successfully be managed with the forehead flap with its variants. Probably, the flap provides the best result due to the good matching of the skin in terms of color, texture, and thickness. Also, despite the increasing use of free flaps, the forehead flap is still a valid and safe option for nasal defects coverage that allows good aesthetics and functional outcomes.

## Ethical Approval

- The manuscript has not been submitted to any other journals for simultaneous consideration.
- The manuscript has not been published previously (partly or in full).
- No data have been fabricated or manipulated (including images) to support our conclusions
- No data, text, or theories by others are presented as if they were our own.
- Consent to submit has been received from all co-authors.
- Authors whose names appear on the submission have contributed sufficiently to the scientific work and therefore share collective responsibility and accountability for the results.
- All procedures performed in this study involving patients were in accordance with the ethical standards of our research committee.
- Informed consent was obtained from the patient herself for surgical intervention and also for publication of photos.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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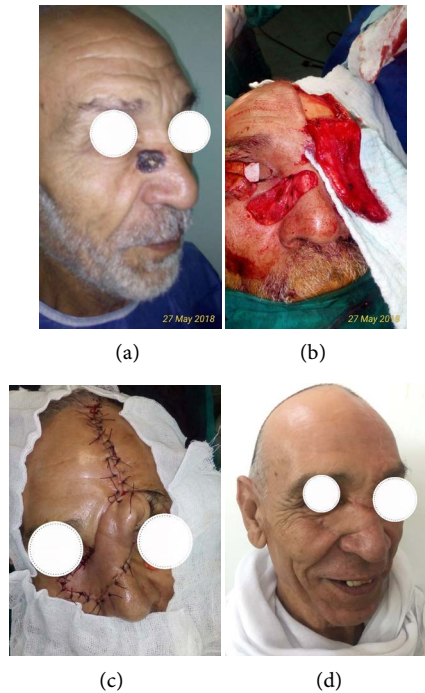
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<https://doi.org/10.1097/01.PRS.0000138596.57393.05>

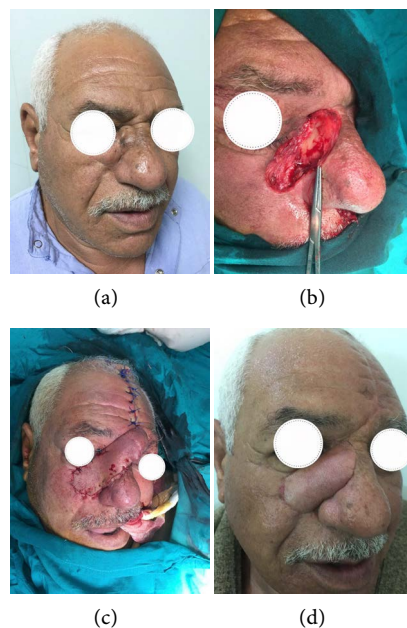
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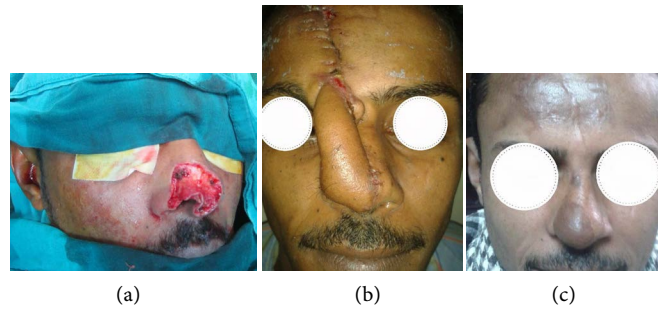
## Cases Figures Legends



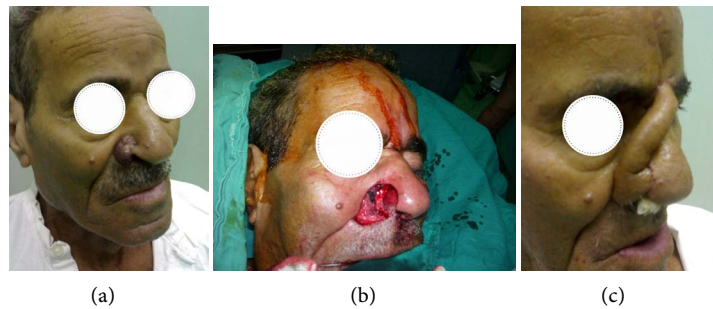
**Case 1.** A 68-year-old male with basal cell carcinoma of the right upper medial cheek and lateral nasal wall. (a) Pre-operative Antero-lateral view of the face showing the tumor. (b) Intra-operative view, after tumor excision. (c) Immediate post-operative view after flap inset. (d) Four month post-operative view.



**Case 2.** A 70-year-old male with basal cell carcinoma of the right upper medial cheek and lateral nasal wall and part of the upper dorsum. (a) Pre-operative Antero-lateral view of the face showing the tumor. (b) Intra-operative view, after tumor excision and flap elevation. (c) Immediate post-operative view after flap inset. (d) Eight month post-operative view.



**Case 3.** A 33-year-old male with trauma to the nose with loss of part of the tip and right ala. (a) Intra-operative view, after wound debridement. (b) One week post-operative view. (c) One year post-operative view.



**Case 4.** A 66-year-old male with basal cell carcinoma of the right medial cheek and lateral nasal wall and part of the right ala. (a) Pre-operative Antero-lateral view of the face showing the tumor. (b) Intra-operative view, after tumor excision. (c) Two weeks post-operative view.

# Trillium Flap for Postmastectomy Neo-Nipple Reconstruction (A Novel Technique)

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**How to cite this paper:** Alsayed, A.A. (2020) Trillium Flap for Postmastectomy Neo-Nipple Reconstruction (A Novel Technique). *Modern Plastic Surgery*, 10, 9-16. <https://doi.org/10.4236/mps.2020.101002>

**Received:** November 26, 2019

**Accepted:** December 21, 2019

**Published:** December 24, 2019

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## Abstract

**Introduction:** Breast cancer cases, mastectomy and following reconstruction procedures are growing in numbers. Despite being lifesaving, mastectomies have a destructive psychological impact on the patients. On the other hand, breast reconstruction improves psychological damages within the same population. Various techniques for nipple reconstruction were described in literature. Trillium flap is an innovative technique to reconstruct neo-nipple with several advantages that make it superior to other popular flaps. **Objectives:** To come up with an innovative design for reconstructing a neo-nipple post mastectomy, that is superior to other popular flaps. **Results:** The Trillium flap design has less visible and easily camouflaged scars, is geometry-based, specific, well-detailed and flexible to produce a tailored nipple with any desired height and diameter and ensures the flaps good vascularity and the neo-nipple projection sustainability. **Conclusion:** Trillium flap is an innovative technique to reconstruct neo-nipple with several advantages that make it superior to other popular flaps. The results shown in the study are for experimental procedures done on human tissue samples of excised flaps from abdominoplasties and brachioplasties. Further application on actual cases is needed with monitoring of neo-nipple projection sustainability on the long term.

## Keywords

Trillium, Flap, Breast, Nipple, NAC, Reconstruction, Neo-Nipple, Mastectomy

## 1. Introduction

It is estimated that there are more than 3.8 million women living in the United States with a history of invasive breast cancer, and 268,600 women will be newly diagnosed in 2019. More than 150,000 breast cancer survivors are living with

metastatic disease, three-quarters of whom were originally diagnosed with stage I through III cancer [1].

Mastectomy is done for 34% of patients with early-stage (stage I or II) breast cancer, more than two-thirds (68%) of patients with stage III disease and only 12% of patients with stage IV [2] (Figure 1).

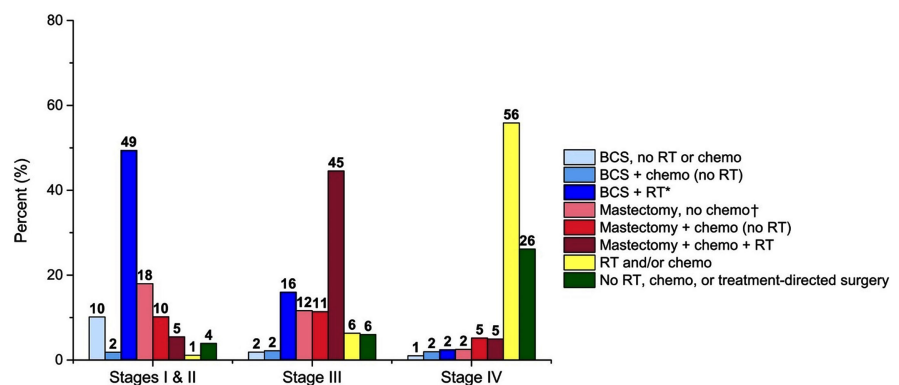
Being diagnosed with breast cancer and undergoing mastectomy lead to serious psychological issues regarding self-esteem, self-consciousness and sexual intimacy suggesting the need for cognitive interventions [3] [4] [5] [6] [7]. On the other hand, breast reconstruction was found to have a benefit for improving the psychological damages in patients with breast cancer [8] [9].

There are various reports of nipple areola complex (NAC) reconstruction with flaps in the medical literature [10]. Without significant differences, all techniques have nearly an equal rate of complications e.g. flap vascular compromise on the short term and loss of projection on the long term [11].

## 2. Ideal Nipple Areola Complex (NAC)

### • Height and diameter:

In a morphologic study of nipple-areola complex in 600 breasts, Sanuki *et al.* analyzed the results statistically to come up with the findings shown in Table 1. They also found that the mean diameter of the areola in women who gave birth was 0.5 cm larger than that of those who did not. They classified the sample according to the relation between nipple height and diameter as shown in Table 2 [12].









**Figure 1.** Female Breast Cancer Treatment Patterns (%) by Stage, 2016. \*A small number of these patients received chemotherapy. †A small number of these patients received radiation therapy (RT). BCS indicates breast-conserving surgery; chemo, chemotherapy (includes targeted therapy and immunotherapy) [2].

**Table 1.** Diameter of the nipple-areola complex and height of the nipple found by Sanuki *et al.* [12].

	Mean	Range (Max - Min)	Standard Deviation (cm)
Diameter of areola	4.0	(7.0 - 2.0)	1.0
Diameter of nipple	1.3	(2.3 - 0.6)	0.3
Height of nipple	0.9	(2.0 - 0)	0.3

**Table 2.** Classification of nipple shape according to the relation between nipple height and diameter found by Sanuki *et al.* [12].

Finding	Classification	Relation between Diameter (d) and Height (h)	600 Breasts (%)
	I s	$d \leq h$	39 (6.5%)
	I sp	$d \leq h$ +constriction	25 (4.2%)
	II s	$d > h$	361 (60.2%)
	II sp	$d > h$ +constriction	152 (25.3%)
	III	Inverted nipple	21 (3.5%)
	IV	Unclassified	2 (0.3%)

- **Position:**

The optimal NAC proportions were found by **Hauben *et al.*** to be with the proportion of the upper to the lower pole at a ratio of 45:55. The angulation of the nipple was upward at a mean angle of 20° from the nipple meridian. The areola-breast and nipple-areola proportions were 1:3.4 and 1:3, respectively [13].

**Schiffman**, with the patient standing or sitting, utilizes a line from the mid-clavicular point (MC) to the mid-nipple (N). At the same time, a line is marked in the center of the chest wall from the center of the sternum superiorly to the mid-xiphoid process. The inframammary fold is palpated from underneath the breast inferiorly and the tip of the finger palpated superficially and marked on the MC to N line [10].

Another study by **Lewin *et al.*** determined the preferences for the nipple-areola complex on the female breast in our study population. The NAC placement preferred by both genders had a ratio of 40:60x and 50:50y (**Figure 2**), which means that it was best situated in the middle of the breast gland vertically and slightly lateral to the midpoint horizontally [14].

### 3. Geometric Basics

Circle circumference can be calculated as follows:

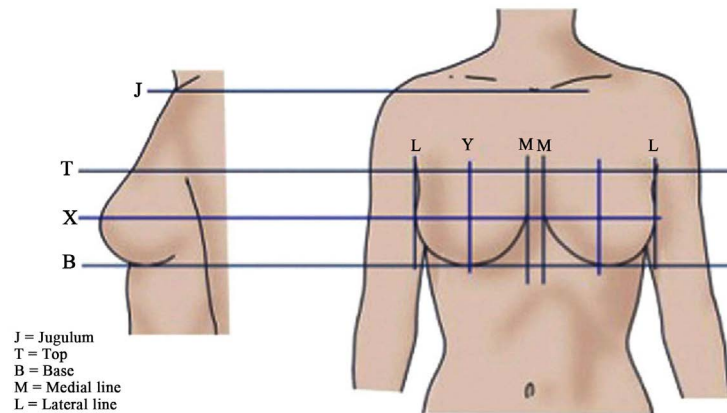
C: Circumference,  $\pi$ : Pi (22/7),  $r$ : Radius,  $\varnothing$ : Diameter.

$$C = 2\pi r = \pi \varnothing = \frac{22\varnothing}{7} \approx 3\varnothing$$

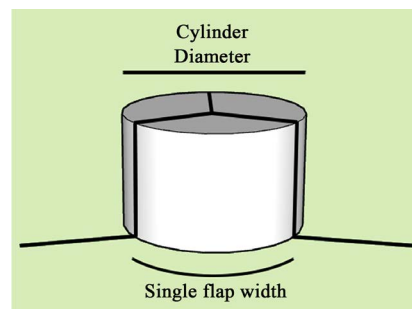
Circle/cylinder circumference nearly equals three times its diameter.

Supposing that a nipple is a cylinder, and my design depends on building that

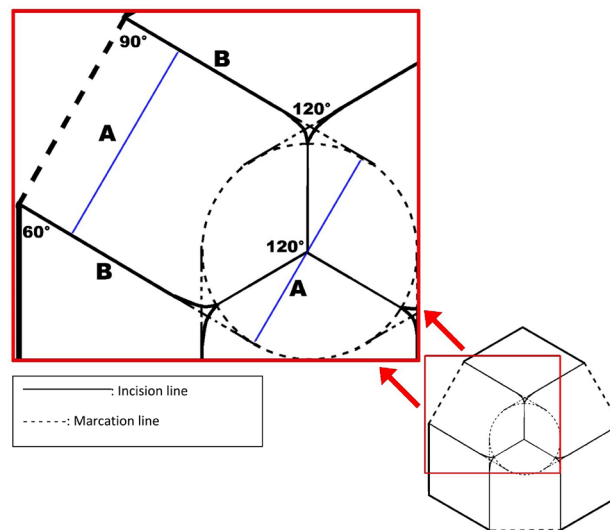
cylinder out of three equal vertical flaps, the width of one flap equals 1/3 of its circumference equals the cylinder diameter. To make that possible, the length sides of each one of the three equal flaps should be parallel tangential lines to the circle that forms the cylinder roof (Figure 3 and Figure 4).



**Figure 2.** The coordinate system of the breast [14].



**Figure 3.** The width of one flap equals 1/3 of its circumference equals the cylinder diameter.

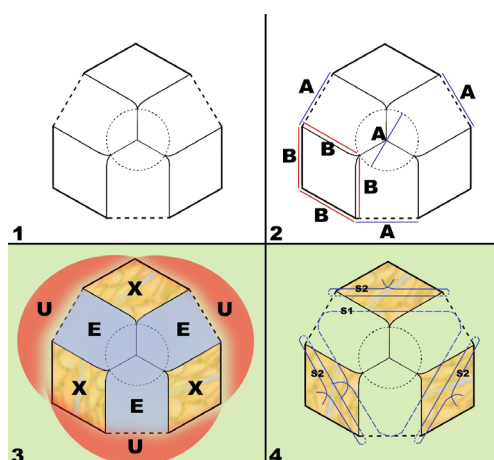


**Figure 4.** The length sides (B, B) of each one of the three equal flaps should be parallel tangential lines to the circle that forms the cylinder roof. The width of one flap equals the cylinder diameter.



## 4. Advantages

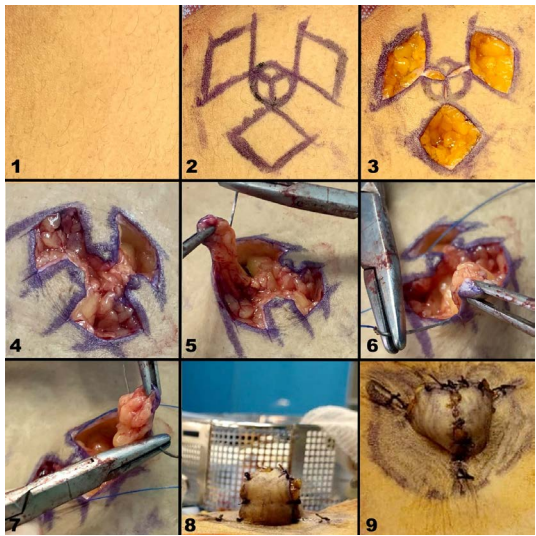
- 1) Visually, scars on the areola are three short scars in three different directions and less noticeable than one long scar in the same direction like most of other popular nipple reconstruction flaps.
- 2) Visually, scars on the areola are three short scars that will never exceed the areola region. After camouflage tattooing, scars will be well-hidden.
- 3) The design is flexible to be rotated to partially include any previous scars, *i.e.* mastectomy scar, in the excision diamond shaped area (X).
- 4) The design is geometry-based, specific, well-detailed (**Figure 5** and **Figure 6**) and flexible to produce a tailored nipple with any desired height and diameter according to guidelines illustrated in ideal nipple areola complex section above.
- 5) Building the nipple by three random flaps ensures the flaps good vascularity more than most of the popular nipple reconstruction flaps that makes the vascularity of the neo-nipple components depend on one base.
- 6) Choosing the flaps to be three not more or less is a balance point that has both advantages of preventing flaps vascular compromise, by being not more than three flaps, and defying/redistributing the retraction forces that will oppose the neo-nipple projection, by being not less than three flaps.
- 7) Projection is held in place by four Polydioxanone sutures that will dissolve after nearly 180 days, the thing that ensures the neo-nipple projection sustainability.
- 8) The flap design looks like Trillium Grandiflorum flower for having a significant center (pistil) and reciprocating three petals and three sepals (**Figure 7**).



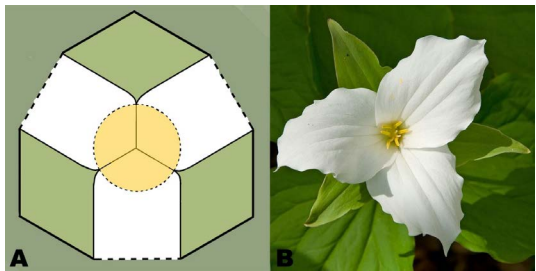
**Figure 5.** 1. The general flap design. 2: Details regarding the equal sides (A)s or (B)s. A: Neo-nipple diameter, B: Neo-nipple height. 3: The three diamond-shaped skin excision zones (X) (Excision direction to be vertical on sides between (X) and (U) zones and bevelled outwards, from (X), on sides between (X) and (E) zones to ensure that the neo-nipple will look cylindrical not prismatic), The three flap elevations zones (E), The three undermining zones for easy flap mobilization (U). 4: Subcutaneous 3/0 Polydioxanone approximation purse string suture that holds the three flaps bases together (S1) (Approximation is preferred to be done while retracting the tip of each flap vertically upwards), Three 3/0 Polydioxanone sutures that hold base corners of each two adjacent flaps (S2).

### 5. Lookalikes

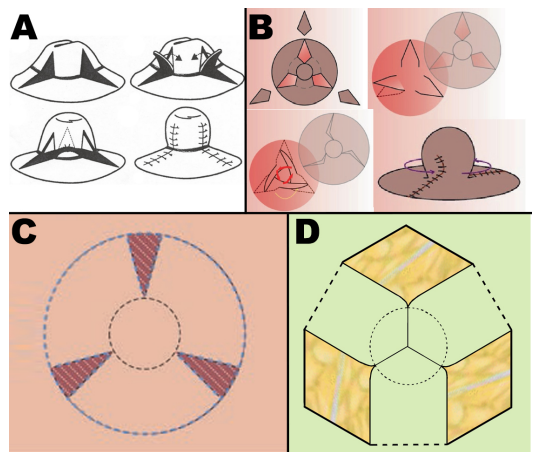
Three designs found in the literature can be mixed up with Trillium flap. Differences are shown in **Table 3** and **Figure 8** below:



**Figure 6.** A guide for the main steps of Trillium flap.  
8: The neo-nipple projection.



**Figure 7.** The flap (A) looks like Trillium Grandiflorum flower (B) [15] for having a significant center (pistil) and reciprocating three petals and three sepals.



**Figure 8.** Trillium Flap (D) and its lookalikes (A [10], B [18], C [20]).  
Essential differences are still there in technique and indications of use.

**Table 3.** Trillium Flap and its lookalikes. Essential differences are still there in technique and indications of use.

	Huang [16] and modifications [17]	Kim and Singh [18]	Berson [19]	Trillium Flap
<b>Purpose</b>	Inverted nipple repair	Inverted nipple repair	Neo-nipple reconstruction	Neo-nipple reconstruction
<b>Main differences</b>	Three diamond-shaped flaps to pass through tunnels under the nipple while the nipple was retracted, and the lactiferous ducts and fibrous tissue were transected ( <b>Figure 8(A)</b> ).	The elevated dermal flaps are passed through the tunnels created and sutured to the adjacent deepithelialized dermal region. Design depends on twisting and locking principle ( <b>Figure 8(B)</b> ).	It may be considered as one of the first attempts to reconstruct a neo-nipple. Elevation of three thin split thickness flaps based on a central undisturbed skin disk. The three flaps were bunched centrally creating an umbilicated nipple and leaving a deepithelialized zone that was allowed to heal as the areola ( <b>Figure 8(C)</b> ).	<ul style="list-style-type: none"> <li>• Mainly targets Neo-nipple reconstruction.</li> <li>• No dermal flaps tunneled</li> <li>• No twisting</li> <li>• Flaps separately depend on three peripheral bases not one central base (<b>Figure 8(D)</b>).</li> </ul>

## 6. Discussion and Conclusion

Trillium flap is an innovative technique to reconstruct neo-nipple with several advantages that make it superior to other popular flaps. The photos of results included in **Figure 6** are for experimental procedures done on excised flaps from abdominoplasties and brachioplasties.

Further application on actual cases is needed with monitoring of neo-nipple projection sustainability on the long term.

## Data Availability

The author confirms that the data supporting the findings of this study are available within the article and its supplementary materials.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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