Keywords

Nasal reconstruction; Island forehead flap; Basal cell carcinoma; Single-stage; Head and neck oncoplastic surgery.

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Evaluation of surgical outcomes of wide local excision and nasal reconstruction using forehead island flaps for skin cancer management

Abstract

Background: Nasal defects resulting from oncological resection present significant reconstructive challenges due to complex facial anatomy and physiological demands. This study evaluated the clinical efficacy, aesthetic and functional outcomes, and complication profiles of the single-stage island forehead flap for nasal reconstruction following skin cancer excision.

Methods: A descriptive, non-controlled clinical trial was conducted at Ho Chi Minh City Oncology Hospital (January 2023–December 2025). Thirty-four patients with AJCC 8th edition stage T1–T4a nasal skin cancer underwent wide local excision followed by immediate single-stage island forehead flap reconstruction based on a unilateral supratrochlear vascular pedicle.

Results: The cohort predominantly presented with basal cell carcinoma (94.1%). The mean defect area was 6.68 ± 4.34 cm², with 58.8% exceeding 4 cm². The mean operative time was 52.25 ± 12.57 minutes, which significantly correlated with defect size ($p = 0.039$) and estimated blood loss ($p = 0.006$). All patients achieved negative surgical margins (R0) with zero local recurrence or regional nodal metastasis during a mean follow-up of 24.74 ± 2.67 months. The flap survival rate was 100%. Early minor complications occurred in 8.82% of cases (venous congestion and wound dehiscence), all managed conservatively. At 6 months postoperatively, 94.1% of patients achieved excellent or good aesthetic outcomes, and 100% reported long-term subjective functional satisfaction.

Conclusion: The single-stage island forehead flap is an oncologically safe, reliable, and highly efficient modality for extensive nasal reconstruction. It offers superior structural contour restoration and high patient satisfaction while eliminating the need for a secondary staged procedure.

Introduction

Skin cancer predominantly occurs in the head and neck region, accounting for 90% of all skin cancer cases.[1] Head and neck skin cancers comprise two main histological types: basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), with BCC constituting the majority (approximately 80% of all cases).[2] Nasal skin cancer accounts for about 25% of head and neck skin cancers.[4] The primary treatment modality is wide local excision to achieve complete tumor clearance while ensuring oncologically safe surgical margins. The nose is a complex three-dimensional structure located in the midface, playing a vital role in both facial architecture and aesthetics. Consequently, nasal defects attract greater attention compared to other facial regions, posing significant reconstructive challenges. Functionally, the nose serves as the gateway to the respiratory system, responsible for warming, humidifying, and filtering inspired air.

Therefore, surgical reconstruction of nasal defects is imperative to restore anatomical contour and maintain physiological nasal breathing. Overall, nasal defects present a formidable challenge for reconstructive surgeons due to their profound impact on patient aesthetics and function.

Currently, the forehead flap is one of the most widely used and reliable options for nasal reconstruction. However, the conventional pedicled forehead flap typically requires a two-stage surgical procedure. The second stage, involving pedicle division and inset, is performed after an interval of 3 to 4 weeks. This conventional technique has several limitations, including prolonged wound healing, extended postoperative recovery, increased healthcare costs, and significant postoperative care inconvenience for patients, which can potentially delay adjuvant therapies. The island forehead flap is an innovative modification of the conventional forehead flap. Its greatest advantage lies in its single-stage execution, which shortens postoperative recovery, accelerates wound healing, preserves aesthetic outcomes, and reduces both financial costs and treatment duration. The island forehead flap is primarily based on the supratrochlear vascular pedicle, which provides a robust blood supply, ensuring high flap viability. The flap offers excellent mobility with a wide rotation arc, which can be further enhanced by meticulous skeletonization and narrowing of the pedicle. Additionally, compared to other regional flaps, it provides superior skin quality and color match for nasal reconstruction.

We conducted this study to evaluate the clinical efficacy of this approach. Currently, international literature focusing specifically on the evaluation of this flap design remains limited.

Objectives: To evaluate the aesthetic outcomes, functional results, and complication rates of nasal reconstruction using the island forehead flap in the management of nasal skin cancer.

Materials and Methods

Study Design: A descriptive, non-controlled clinical trial.

Patient Population: Patients diagnosed with nasal skin cancer, stages T1 to T4a (according to the AJCC 8th Edition, 2017), [20] who underwent wide local excision followed by nasal reconstruction using the island forehead flap at Ho Chi Minh City Oncology Hospital between January 2023 and December 2025.

Inclusion Criteria:

- Patients with nasal skin cancer who underwent wide local excision and island forehead flap reconstruction at Ho Chi Minh City Oncology Hospital from January 2023 to December 2025.
- Patients with indications for radical surgical resection.
- Histologically confirmed basal cell carcinoma (BCC) or squamous cell carcinoma (SCC).

Exclusion Criteria:

- Presence of distant metastasis.
- History of prior forehead surgery.
- Synchronous or metachronous secondary primary head and neck malignancies.

Surgical Technique

- **Preoperative Planning:** First, the resection margins of the lesion are delineated using a sterile surgical marker. The dimensions of the defect are then measured. The island forehead flap is designed with dimensions equal to or slightly larger than the defect, ensuring its shape matches the contour of the defect. The length of the flap is calculated to ensure that its distal end can comfortably reach the furthest point of the wound bed.
- **Tumor Resection and Margin Assessment:** Wide local excision of the skin cancer is performed along the pre-marked boundaries. Intraoperative margin assessments are conducted at five specific locations: superior, inferior, lateral (medial and lateral sides), and the deep bed of the lesion. In cases with clinical suspicion of perineural, osseous, or vascular invasion, additional margin biopsies are obtained from the suspected sites to evaluate oncological risks.
- **Flap Harvesting and Elevation:** The flap is elevated in a plane subperiosteal to the frontal bone. Dissection proceeds in a superior-to-inferior direction. Meticulous care is taken when dissecting within 1 to 2 cm superior to the eyebrow to avoid injuring the supratrochlear artery as it exits above the corrugator supercilii muscle. Once the artery is identified and preserved, dissection continues down to the nasal root to achieve adequate pedicle length. Following complete mobilization, the flap is rotated 180° around its pedicle base. Flap viability is assessed by puncturing or incising a minor portion of the flap margin to observe active bleeding, or by evaluating capillary refill time via digital pressure.
- **Flap Inset and Donor Site Closure:** The skin between the eyebrows is carefully dissected to create a subcutaneous tunnel. This tunnel is widened toward the nasal defect, ensuring there is no compression on the tunneled vascular pedicle. The flap is anchored to the recipient site using deep dermal 3-0 or 4-0 Vicryl sutures. The donor site is similarly closed in layers using 3-0 or 4-0 Vicryl for deep tissues, and a Penrose drain may be placed to prevent hematoma or seroma formation. Finally, both the recipient and donor site skin edges are closed with 4-0 Nylon sutures. A second flap viability assessment is performed and documented photographically at three stages: flap harvest, flap transposition, and completion of skin closure.
- **Histopathological Evaluation:** The resected specimen is submitted to the Department of Pathology for formal fixation, processing, and histological evaluation. Postoperative histopathological findings are recorded to correlate with preoperative biopsy results. Surgical margins are thoroughly reviewed to determine the necessity of re-excision or adjuvant postoperative radiotherapy.
- **Postoperative Care:** Patients are monitored closely during the inpatient postoperative period until discharge. Standard prophylactic antibiotics are administered for 3 to 5 days, along with analgesics and anti-inflammatory

medications. Flap perfusion, wound healing progress, and early postoperative complications are assessed daily.

- **Follow-up Protocol:** Scheduled outpatient follow-up and post-treatment evaluations are conducted at 1, 3, and 6 months postoperatively, and at the final conclusion of the study.

Surgical Margin Criteria

According to the National Comprehensive Cancer Network (NCCN) Guidelines (Version 2/2022), low-risk basal cell carcinoma (BCC) requires a peripheral surgical margin of 4 mm, which increases to 5–6 mm for high-risk lesions. For squamous cell carcinoma (SCC), a 4-mm margin is indicated for low-risk disease, whereas a 6–10 mm margin is required for high-risk cases. [21,22] Notably, there was no change in the NCCN-recommended surgical margin guidelines for either malignancy between 2021 and 2022. [23,24]

Table 1. Oncologically safe margins in wide local excision of skin cancer.

Histopathology	Low Risk	High / Very High Risk
Basal Cell Carcinoma	4 mm	5–6 mm
Squamous Cell Carcinoma	4 mm	6–10 mm

Data Collection Criteria

- **Demographic and Administrative Information:** Full name, biological sex, and year of birth.
- **Occupational History**
- **History of Prior Head and Neck Skin Malignancies**
- **Clinical Characteristics:** Primary tumor features, regional lymph node status, and overall disease stage.
- **Intraoperative and Reconstructive Characteristics:** Operative specifics, post-ablative defect characteristics, and flap dimensions.
- **Postoperative Histopathological Findings**
- **Early Postoperative Assessments:**
  - *Local Oncological Outcomes:* Positive or negative surgical margins.
  - *Regional Nodal Oncological Outcomes:* Positive or negative regional lymph nodes.
  - *Length of Hospitalization*
  - *Flap-Related Postoperative Complications during Inpatient Stay:*
    - **Absent** (Uneventful recovery).
    - **Present:** [33,35] Including postoperative wound pain, surgical site infection, wound dehiscence, surgical site hemorrhage, nasal airway obstruction, alar collapse, and pedicle venous congestion.
  - *Severity of Complications:* Requiring surgical/medical intervention versus conservative observation only.
- **Assessment Criteria for Island Forehead Flap Status:** [34]
  - *Flap Viability:* Categorized into three progressive tiers:
    - **Complete Survival (No Necrosis):** Flap is pink and healthy; absent or minimal tissue tension/swelling.
    - **Partial Necrosis:** Flap hypoperfusion characterized by superficial blistering or necrosis encompassing less than one-third of the flap surface area; may require supplementary skin grafting.
    - **Major Necrosis:** Tissue necrosis encompassing more than one-third of the surface area up to total flap failure; fails to cover deep subdermal structures.
  - *Wound Healing Status:* [34]
    - **Primary Healing:** Wound edges are well-approximated; suture removal performed within 7–10 days.
    - **Delayed Healing:** Partial dehiscence involving 5–10 broken sutures; delayed suture removal performed after 12–15 days.
    - **Non-Healing:** Total suture line disruption accompanied by active infection.
- **Postoperative Follow-up Protocol (at 1, 3, and 6 months):** Consists of monitoring long-term oncological control, aesthetic outcomes, and functional adaptation of the island forehead flap.
  - *Oncological Outcomes:*
    - Recurrence rate.
    - Anatomical site of recurrence: Local (tumor bed) versus regional (lymph nodes).
    - Adjuvant therapy: Radiotherapy, chemotherapy, or none.
  - *Aesthetic Status:* Evaluated using a comprehensive scoring matrix that combines patient self-reported aesthetic satisfaction with objective surgeon assessments of four key variables: flap thickness, scar cosmesis, color match uniformity, and preservation of natural nasal contours. [36]
  - *Functional Status:* Evaluated through patient self-reported subjective functional abnormalities combined with objective clinical screening of nasal physiological parameters (including nasal airway obstruction, snoring, olfactory dysfunction, epistaxis, speech impairment, and nasal dryness). [37]
  - *Predictive Factors Influencing Reconstructive Outcomes:* Age, T-stage classification, and the dimension/extent of the post-ablative defect.

Outcome Variables

Table 2. Assessment of treatment outcome variables.

Variable	Definition / Value	Variable Type
Oncological Outcomes		
Postoperative surgical margins	Positive / Negative	Nominal

Local tumor recurrence	Yes / No	Dichotomous
Regional nodal recurrence	Yes / No	Dichotomous
Adjuvant therapy	Radiotherapy / Chemotherapy / None	Nominal
Immediate Postoperative Outcomes		
Postoperative complications	None / Present	Dichotomous
Severity of complications	Requiring intervention / Observation only	Dichotomous
Flap viability	No necrosis / Partial necrosis / Total or near-total necrosis	Ordinal
Wound healing status	Primary intention healing / Delayed healing / Non-healing	Ordinal
Length of hospital stay	Duration from completion of surgery to discharge (days)	Continuous
Follow-up Outcomes (1, 3, and 6 months)		
Functional Outcomes		
Nasal airway obstruction	Yes / No	Dichotomous
Snoring	Yes / No	Dichotomous
Olfactory dysfunction	Yes / No	Dichotomous
Nasal dryness	Yes / No	Dichotomous
Epistaxis	Yes / No	Dichotomous
Speech impairment	Yes / No	Dichotomous
Patient functional satisfaction	Satisfied / Dissatisfied	Dichotomous
Aesthetic Outcomes		
Flap thickness	Appropriate thickness (1 point) / Bulky or excessively thin (0 points)	Dichotomous
Color match	Harmonious with surrounding skin (1 point) / Mismatched (0 points)	Dichotomous
Scarring status	Non-distorting scar (1 point) / Severe scar distortion (0 points)	Dichotomous
Nasal contour	Preserved contour (1 point) / Significantly altered contour (0 points)	Dichotomous
Patient aesthetic satisfaction	Very satisfied (4 points) / Satisfied (3 points) / Neutral (2 points) / Dissatisfied (1 point)	Ordinal
Overall aesthetic outcome	Excellent (>6 points) / Good (5–6 points) / Fair (4–5 points) / Poor (<4 points)	Ordinal

Statistical Analysis

Data were encoded, managed, and analyzed using IBM SPSS Statistics software, version 25.0.

Statistical analyses were performed using the following methods:

- **Descriptive Statistics:** Normally distributed continuous variables are expressed as mean ± standard deviation (SD). Continuous variables with non-normal distributions are presented as median and interquartile range (IQR). Histograms and frequency distribution tables are used to describe ordinal and nominal categorical variables.
- **Inferential Statistics:** Differences in means for normally distributed continuous variables between groups are evaluated using the Student's t-test (for two groups) or one-way analysis of variance (ANOVA) (for three or more groups). Categorical variables and proportions are compared using the Chi-squared (χ^2) test or Fisher's exact test, as appropriate. For all statistical tests, a p-value < 0.05 is considered statistically significant.
- **Correlation and Regression:** Correlations between parameters are analyzed using Pearson's correlation test to determine correlation coefficients, followed by the construction of linear regression models.
- **Risk Factor Analysis:** Univariate and multivariate analysis are performed to identify independent factors influencing treatment outcomes.

Results

Clinical Characteristics of the Patient Cohort

- **Demographics:** The study cohort comprised 34 patients, including 18 males (52.9%) and 16 females (47.1%). The mean age of the patients was 46.04 ± 9.35 years.
- **History of Treatment:** A history of previously treated nasal skin cancer was identified in 5 patients (14.7%). All recurrent cases underwent re-excision in this study.
- **Histopathology:** Basal cell carcinoma (BCC) was diagnosed in 32 cases (94.1%), while squamous cell carcinoma (SCC) was reported in 2 cases (5.9%).
- **Staging:** According to the AJCC 8th Edition criteria, 7 patients (20.6%) presented with stage T3 tumors characterized by nasal cartilage invasion. Stage T2 was observed in 20 cases (58.8%), and stage T1 in 5 cases (14.7%). Two patients (5.9%) presented with stage T4a

tumors showing invasion into the nasal bone and maxilla. No patients presented with regional nodal involvement or distant metastasis (N0M0).

Table 3. Distribution of disease stages according to the AJCC 8th Edition (n = 34).

Disease Stage	Number of Cases (n)	Percentage (%)
Stage I	5	14.7
Stage II	20	58.8
Stage III	7	20.6
Stage IV	2	5.9
Total	**34**	**100.0**

- **Anatomical Subsite Distribution:** A total of 52 nasal aesthetic subunits were involved across the 34 patients. The nasal dorsum was the most common site of involvement. No lesions were located on the columella or the soft triangle. Multi-subunit involvement (more than one aesthetic subunit) was observed in 12 patients (35.29%).

Table 4. Distribution of lesions by nasal aesthetic subunits (n = 52).

Nasal Subunit	Number of Affected Subunits (n)	Percentage (%)
Tip	10	19.2
Dorsum	18	34.6
Lateral wall	12	23.1
Alar	12	23.1
Total	**52**	**100.0**

Surgical Characteristics of the Patient Cohort

Operative Time and Estimated Blood Loss (EBL)

- The mean operative time was 52.25 ± 12.57 minutes (range: 35–90 minutes).
- The mean estimated blood loss was 59.57 ± 49.05 mL (range: 5–150 mL).

Defect Dimensions

- The mean defect diameter was 2.96 ± 0.95 cm (range: 1.0–6.0 cm).
- The mean defect area was 6.68 ± 4.34 cm² (range: 0.5–21.5 cm²).

Table 5. Distribution of patients by defect surface area (n = 34).

Defect Area (cm²)	Number of Cases (n)	Percentage (%)
< 2 cm²	8	23.6
2 - 4 cm²	6	17.6
> 4 cm²	20	58.8
Total	**34**	**100.0**

- **Correlations with Defect Area:** Statistical analysis revealed that a larger defect surface area was significantly correlated with both prolonged operative time (p = 0.039) and increased intraoperative blood loss (p = 0.006).

Table 6. Association between defect surface area and mean operative time.

Defect Area (cm²)	Number of Cases (n)	Mean Operative Time (minutes)	*p*-value
< 2 cm²	8	36.72	0.039
2 - 4 cm²	6	43.66	
> 4 cm²	20	61.04	
Total	**34**	**52.52**	

Table 7. Association between defect surface area and intraoperative blood loss.

Defect Area (cm²)	Number of Cases (n)	Mean Blood Loss (mL)	*p*-value
< 2 cm²	8	6.53	0.006
2 - 4 cm²	6	30.62	
> 4 cm²	20	91.04	
Total	**34**	**59.57**	

Island Forehead Flap Characteristics

- The flap surface area ranged from a minimum of 2.25 cm² to a maximum of 21.5 cm², with a mean flap area of 6.43 ± 4.44 cm². The cohort included 19 cases with a flap size < 6.5 cm² and 15 cases with a flap size ≥ 6.5 cm².
- All reconstructions were successfully performed utilizing a unilateral supratrochlear vascular pedicle. The mean vascular pedicle length was 2.95 ± 0.87 cm (range: 1.5–5.0 cm).
- **Correlations with Flap Area:** Flap surface area demonstrated a statistically significant association with both operative time (p = 0.007) and estimated intraoperative blood loss (p < 0.0001).

Table 8. Association between flap surface area and mean operative time.

Flap Area (cm²)	Number of Cases (n)	Mean Operative Time (minutes)	*p*-value
< 6.5 cm²	19	42.22	0.007
≥ 6.5 cm²	15	60.00	
Total	**34**	**52.52**	

Table 9. Association between flap surface area and intraoperative blood loss.

Flap Area (cm²)	Number of Cases (n)	Mean Blood Loss (mL)	*p*-value
< 6.5 cm²	19	25.00	< 0.0001
≥ 6.5 cm²	15	103.13	
Total	**34**	**59.57**	

Postoperative Outcomes

Oncological Outcomes

Postoperatively, all cases achieved negative surgical margins (R0 resection), with no close margins reported. During the study period, there were no instances of local tumor recurrence or regional nodal progression. None of the patients required adjuvant therapy. At the final follow-up, the overall survival rate was 100% (all 34 patients were alive), with a mean follow-up duration of 24.74 ± 2.67 months (range: 6–36 months).

Early Postoperative Outcomes

In our cohort, early postoperative complications occurred in 3 patients (8.82%), while 31 patients (91.18%) experienced an uneventful recovery. The reported complications included venous congestion (n = 2) and wound dehiscence (n = 1). All complications were managed conservatively via medical therapy without requiring surgical re-intervention.

Regarding flap viability, a 100% flap survival rate was achieved, with no partial or total flap necrosis observed in any case. One patient experienced wound dehiscence at the 1-month follow-up that required specialized wound care; however, the wound successfully developed healthy granulation tissue and achieved complete secondary healing by the 3-month and 6-month evaluations. The mean length of hospital stay was 3.86 ± 0.76 days (range: 3–5 days).

Table 10. Distribution of early postoperative outcomes (n = 34).

Early Postoperative Parameter	Classification	Number of Cases (n)	Percentage (%)
Postoperative complications	Present	3	8.82
	Absent	31	91.18
Wound healing status	Primary healing	32	94.12
	Delayed healing	2	5.88
	Non-healing	0	0.00
Flap viability	Complete survival (No necrosis)	34	100.00
	Partial necrosis	0	0.00
	Total / Near-total necrosis	0	0.00

Aesthetic Outcomes

At the 3-month postoperative evaluation, aesthetic outcomes were rated as excellent in 29 cases (85.3%), good in 2 cases (5.9%), fair in 2 cases (5.9%), and poor in 1 case (2.9%). By the 6-month follow-up, the aesthetic outcomes shifted to excellent in 29 cases (85.3%), good in 3 cases (8.8%), fair in 2 cases (5.9%), and no cases were rated as poor (0%).

Table 11. Distribution of aesthetic outcomes at 3 and 6 months postoperatively (n = 34).

Aesthetic Outcome Rating	3 Months Postoperatively n (%)	6 Months Postoperatively n (%)
Excellent	29 (85.3%)	29 (85.3%)
Good	2 (5.9%)	3 (8.8%)

Fair	2 (5.9%)	2 (5.9%)
Poor	1 (2.9%)	0 (0.0%)
Total	**34 (100.0%)**	**34 (100.0%)**

Statistical analysis demonstrated no significant correlation between the aesthetic outcomes at 3 months and either the defect surface area ($p = 0.29$) or the flap surface area ($p = 0.31$).

Table 12. Association of aesthetic outcomes at 3 months with defect area and flap area.

Aesthetic Outcome	Number of Cases (n)	Mean Defect Area (cm²)	*p*-value	Mean Flap Area (cm²)	*p*-value
Excellent	29	5.78	0.29	5.89	0.31
Good	2	6.35		6.25	
Fair	2	6.43		7.22	
Poor	1	18.00		18.00	
Total	**34**	**6.68**		**6.43**	

When evaluating the relationship between aesthetic outcomes at 6 months and the occurrence of postoperative complications using Fisher's exact test, a trend toward a higher complication rate was observed in the lower-rated aesthetic groups. However, this association did not reach statistical significance ($p = 0.050$), which may be attributed to the limited sample size (n = 34) and the low absolute number of complications (n = 3).

Table 13. Correlation between 6-month aesthetic outcomes and postoperative complications.

Aesthetic Outcome	Without Complications (n)	With Complications (n)	Total (n)	*p*-value
Excellent	28	1	29	0.050
Good	2	1	3	
Fair	1	1	2	
Total	**31**	**3**	**34**	

Functional Outcomes

Nasal functional alterations were observed during the follow-up period. At 1 month postoperatively, olfactory dysfunction and nasal dryness were the most frequent complaints, each reported by 14 patients (41.2%). By the 3-month follow-up, the majority of patients expressed satisfaction with their nasal function, with nasal airway obstruction and nasal dryness remaining the most common residual abnormalities (17.6% each).

By 6 months postoperatively, nasal function showed substantial improvement, with only 4 patients remaining symptomatic: 2 cases (5.9%) reported persistent nasal airway obstruction and 2 cases (5.9%) reported olfactory dysfunction. Ultimately, 100% of the patient cohort reported subjective satisfaction with their long-term functional outcomes.

Table 14. Evolution of nasal functional outcomes at 1, 3, and 6 months postoperatively.

Functional Abnormality	1 Month (n = 34) n (%)	3 Months (n = 34) n (%)	6 Months (n = 34) n (%)
Nasal airway obstruction	10 (29.4%)	4 (11.8%)	2 (5.9%)
Snoring	0 (0.0%)	0 (0.0%)	0 (0.0%)
Olfactory dysfunction	14 (41.2%)	6 (17.6%)	2 (5.9%)
Nasal dryness	14 (41.2%)	6 (17.6%)	0 (0.0%)
Epistaxis	8 (23.5%)	0 (0.0%)	0 (0.0%)
Speech impairment	2 (5.9%)	0 (0.0%)	0 (0.0%)

Discussion

Clinical Characteristics and Histopathological Profiles

- **Histopathology:** Basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) represent the most ubiquitous histological variants of non-melanoma skin cancer, accounting for approximately 80% of all cases. In the head and neck region, BCC represents the predominant histological subtype. Our study demonstrated a high preponderance of BCC at 94.1%, whereas SCC constituted only 5.9%. In a comprehensive meta-analysis of 75 studies by A. Lomas et al., the reported BCC-to-SCC ratio was 5:2 in Australia, compared to approximately 4:1 across other global geographic regions. In contrast, our study yielded a substantially higher BCC-to-SCC ratio of 16:1. [48] This statistical variance is most likely attributable to our relatively small sample size, which may not fully represent the broader epidemiological population.

- **Tumor Staging:** TNM staging represents a critical determinant in formulating therapeutic strategies and predicting recurrence risks in skin malignancies. In this study, staging was established in strict accordance with the AJCC 8th Edition guidelines, which integrate tumor characteristics, regional lymph node involvement, and distant metastasis. Clinical staging primarily relied on meticulous physical measurement of tumor dimensions and assessment of deep structural invasion, supplemented by computed tomography (CT) and ultrasonography in cases with suspected deep tissue infiltration or regional metastasis.

Our cohort included 7 cases of stage T3 disease characterized by nasal cartilage invasion, 20 cases of stage T2, 5 cases of stage T1, and 2 cases of stage T4a demonstrating cortical invasion of the nasal bone and maxilla. According to Brantsch et al. (2008), a tumor diameter exceeding 2 cm serves as an independent prognostic indicator, correlating with a 2.22-fold increase in the risk of regional nodal metastasis. [17] Similarly, Brougham et al. (2012) substantiated that primary tumor size is a pivotal prognostic factor governing lymphatic dissemination. [49]

Characteristics of Post-Ablative Defect and Flap Selection

In the surgical management of nasal malignancies, post-ablative defects are systematically categorized based on nasal aesthetic subunits. The nose is anatomically compartmentalized into six distinct subunits: the dorsum, lateral walls, tip, alae, soft triangles, and columella. In the present study, the majority of patients presented with single-subunit involvement (64.71%), while multi-subunit defects encompassing more than one aesthetic zone were observed in 35.29% of cases. The nasal dorsum was the most frequently affected anatomical subsite, accounting for 34.6% of the lesions. In comparison, a study by Park et al. involving 10 patients noted that defects were predominantly localized to the superior two-thirds of the nose, with a strong predilection for the nasal dorsum and lateral walls. [30] Adel Tolba et al. reported highly congruent findings, where the lateral nasal wall (40%) and the nasal dorsum (33%) constituted the most frequent sites of involvement. [50] Cumulatively, these data suggest that defects located at the dorsum and lateral walls represent highly favorable anatomical regions for the application of the island forehead flap, as these locations facilitate an uninhibited arc of rotation and effortless transposition of the flap into the wound bed.

Table 15. Comparative analysis of nasal defect dimensions across different clinical studies.

Study	Number of Cases (n)	Mean Defect Diameter (cm)	Range (cm)
Park (2000) [30]	10	1.8	1.2 – 2.2
Adel Tolba (2015) [50]	15	2.3	1.5 – 3.0
N. Blázquez-Sánchez (2015) [51]	41	2.2	1.5 – 4.0
Fernando Moro-Bolado (2023) [52]	7	2.9	2.4 – 3.4
Present Study	**34**	**2.96**	**1.0 – 6.0**

In our study, the mean defect diameter was 2.96 ± 0.95 cm (range: 1.0–6.0 cm), with a mean post-ablative surface area of 6.68 ± 4.34 cm² (range: 0.5–21.5 cm²). Stratified analysis revealed that 23.6% of defects were smaller than 2 cm², 17.6% ranged between 2–4 cm², and 58.8% exceeded 4 cm².

Notably, the mean defect diameter in our series demonstrated a marked escalation compared to the island forehead flap studies reported by Adel Tolba, Park, and Blázquez-Sánchez, while remaining comparable to the cohort evaluated by Fernando Moro-Bolado. This disparity underscores the definitive utility and versatility of the island forehead flap in reconstructing extensive soft tissue defects. [30,50,51,52]

In a study by Manh NT et al. evaluating 48 patients who underwent nasal reconstruction using conventional pedicled forehead flaps, 18.8% of defects were under 2 cm², 39.6% ranged from 2–4 cm², and 41.6% were greater than 4 cm². [34] Our cohort presented with a significantly higher proportion of defects exceeding 4 cm² (58.8% vs. 41.6%). This variation is fundamentally driven by the oncological nature of our study population, where wide local excision mandates larger, cancer-free perimeter margins, in contrast to defects resulting from trauma, scar contractures, or the excision of benign tumors.

Aesthetic Outcomes and Flap Morphological Characteristics

The restoration of facial symmetry and natural nasal contour represents a pivotal benchmark in evaluating head and neck oncoplastic surgeries. At the 3-month postoperative follow-up, our cohort demonstrated highly encouraging aesthetic results, with 85.3% of cases rated as excellent and 5.9% as good. Notably, by the 6-month evaluation, the proportion of cases yielding favorable aesthetic outcomes remained robust, with the single patient previously rated as "poor" improving into a higher category due to ongoing scar maturation and continuous tissue remodeling.

When analyzing the impact of defect and flap dimensions on final cosmesis, our statistical analysis revealed no significant correlation between 3-month aesthetic satisfaction and either defect surface area (p = 0.29) or flap surface area (p = 0.31). This lack of statistical significance highlights a critical clinical advantage of the island forehead flap: its intrinsic tissue characteristics—including excellent color match, complementary skin texture, and adjustable thickness via meticulous peripheral thinning—allow it to

seamlessly integrate into the midface recipient site regardless of the initial defect size. Even in extensive reconstructions, such as the case presenting with an 18 cm² defect, the flap successfully replicated the structural contour without causing severe cosmetic distortion.

Furthermore, we observed a strong clinical trend regarding the correlation between 6-month aesthetic outcomes and early postoperative complications using Fisher's exact test ($p = 0.050$). Patients who experienced uneventful initial recovery consistently achieved superior long-term aesthetic ratings, whereas those with early adverse events showed lower cosmetic scores. Although this relationship borderline approached statistical significance, the lack of a definitive statistical association is primarily driven by our restricted sample size (n = 34) and the low absolute incidence of complications (n = 3).

Postoperative Complications and Flap Viability

Flap necrosis remains one of the most critical challenges in regional tissue transposition. In our series, we achieved a 100% flap survival rate with zero instances of partial or total necrosis. This finding highlights the outstanding vascular reliability of the single-stage island forehead flap design, where the fully skeletonized supratrochlear artery provides sufficient arterial inflow and adequate venous outflow to sustain a large skin paddle, up to 21.5 cm² in our study.

Early postoperative complications were documented in only 3 patients (8.82%), comprising transient venous congestion (n = 2) and localized wound dehiscence (n = 1). All three cases were successfully managed using conservative medical protocols, including close clinical observation, warmth application, and targeted wound care, completely eliminating the need for urgent surgical re-exploration.

The low rate of adverse events and the absence of microvascular or macrovascular failure corroborate the findings of Fernando Moro-Bolado et al. and Adel Tolba et al., confirming that complete mobilization and a wide 180-degree rotation of the pedicle base do not compromise axial perfusion. Additionally, our mean length of hospital stay was optimized at 3.86 ± 0.76 days, which is substantially shorter than the combined hospitalization time typically required for the conventional two-stage pedicled forehead flap, thereby confirming the financial and clinical efficiency of this single-stage modification.

Evolution of Nasal Functional Recovery

In addition to aesthetic restoration, maintaining the physiological functions of the nose—specifically airway patency, humidification, and olfaction—is essential for patient quality of life. Our longitudinal data captured a distinct chronological pattern of functional recovery from 1 to 6 months postoperatively.

At the 1-month follow-up, minor functional disturbances were frequently reported, with olfactory dysfunction and nasal dryness being the most common subjective complaints (41.2% each), followed by nasal airway obstruction (29.4%). These early symptoms are primarily attributed to localized mucosal edema, postoperative inflammatory responses, and temporary disruption of local nerve endings during wide local excision and subcutaneous tunnel creation.

By the 3-month mark, significant physiological adaptation was observed, with the incidence of airway obstruction and dryness dropping to 17.6%. This recovery trend continued linearly, and by the 6-month evaluation, only 4 patients (11.8% of the total cohort) remained mildly symptomatic, experiencing residual low-grade airway obstruction or minor olfactory alterations. Ultimately, despite these minor residual physiological changes, 100% of the patient population reported long-term subjective satisfaction with their functional outcomes, demonstrating that the single-stage island forehead flap effectively preserves the respiratory gateway without inducing permanent structural narrowing or severe functional deficits.

Surgical and Intraoperative Characteristics

Oncological Resection and Surgical Margin Philosophy

The current therapeutic paradigm for nasal skin cancer implemented in our study mandates wide local excision integrated with intraoperative margin assessment, synchronous defect reconstruction, and elective or therapeutic neck dissection if clinical evidence of regional nodal metastasis is present. According to the National Comprehensive Cancer Network (NCCN) guidelines, the nose is classified as a high-risk anatomical site, thereby requiring more aggressive perimeter margins compared to other facial or bodily regions.

In this cohort, we selected a wide local excision margin of 5 mm for all basal cell carcinoma (BCC) cases. For squamous cell carcinoma (SCC) cases, given that the tumors presented with diameters exceeding 2 cm, a more extensive surgical margin of 9 mm was utilized to achieve complete oncological clearance. [21, 22]

Operative Time and Estimated Blood Loss

The mean operative time in our series was 52.25 ± 12.57 minutes (range: 35–90 minutes), which represents a highly acceptable and efficient surgical duration. The mean estimated intraoperative blood loss was minimal at 59.57 ± 49.05 mL (range: 5–150 mL). Consequently, the physiological impact regarding blood loss was negligible, and no patient required intraoperative or postoperative blood transfusion.

The maximum operative duration and the highest volume of blood loss were documented in a patient with stage III SCC characterized by extensive nasal cartilage infiltration, multi-subunit destruction (encompassing the nasal ala, lateral wall, and dorsum), and localized osseous invasion. This clinical presentation necessitated an extended, complex structural resection, thereby prolonging the overall operative time.

Flap Morphological Dimensions and Correlations

The harvested flap surface area ranged from a minimum of 2.25 cm² to a maximum of 21.5 cm², with an overall mean area of 6.43 ± 4.44 cm². To facilitate granular analysis, the cohort was stratified into two cohorts based on flap dimensions: < 6.5 cm² (n = 19) and ≥ 6.5 cm² (n = 15).

A statistically significant variance was observed between these two groups regarding both operative time (p = 0.007) and estimated blood loss (p < 0.0001). Parallel significant correlations were mirrored when comparing these intraoperative parameters across different defect surface area classifications (p = 0.039 for operative time; p = 0.006 for blood loss). Cumulatively, these data substantiate that an escalation in defect size directly expands the required flap geometry, fundamentally demanding more meticulous, prolonged dissection and resulting in a concomitant increase in intraoperative blood loss.

Vascular Pedicle Design and Perfusion Dynamics

The supratrochlear and supraorbital arteries represent the most ubiquitous vascular pillars leveraged for forehead flap designs. According to Kleintjes, designing the flap based on a unilateral supratrochlear vascular pedicle can be strategically extended to recruit branches of the angular and supraorbital arteries depending on the required flap width, thereby optimizing the rotation arc and maximizing the defect coverage capacity. [53]

In our study, a unilateral supratrochlear vascular pedicle was consistently utilized in 100% of cases. Microvascular perfusion analyses in the literature have established that axial arteries with a diameter of 0.5 mm provide robust and sufficient perfusion to sustain a forehead skin paddle; furthermore, micro-arterioles as small as 0.2 mm can adequately fulfill the metabolic demands of the flap without inducing ischemic compromise. [54]

The mean vascular pedicle length in our cohort was 2.95 ± 0.87 cm (range: 1.5–5.0 cm). The pedicle length was customized intraoperatively to match the specific anatomical location and dimensions of the nasal defect, ensuring an adequate and tension-free reach to achieve successful structural reconstruction.

Surgical Outcomes and Clinical Efficiency

Length of Hospitalization

The duration of postoperative inpatient care is primarily dictated by the complexity of the surgical intervention and the kinetics of wound healing. The conventional pedicled forehead flap inherently demands a staged approach, requiring a secondary operation for pedicle division and aesthetic refinement after an interval of 3 to 4 weeks. Conversely, our single-stage island forehead flap technique successfully fulfilled the oncological and reconstructive goals within a single surgical procedure, markedly optimizing the clinical workflow.

In the present study, the mean length of hospital stay was 3.86 ± 0.76 days (range: 3–5 days), allowing the vast majority of patients to resume their activities of daily living immediately upon discharge. In comparison, Park et al. reported a mean hospitalization duration of 6.6 days (range: 3–14 days) in a cohort of 10 patients undergoing island forehead flap reconstruction. Our protocol yielded a substantially accelerated discharge timeline compared to Park's series. [30] Thus, the implementation of the single-stage island forehead flap effectively compresses the inpatient recovery timeline, translating into a profound reduction in healthcare expenditures and enhanced patient convenience.

Comparative Postoperative Complication Analysis

Evaluating the safety profile of tissue transposition requires direct comparison with contemporary international literature. Our complication rate and adverse event profile demonstrate favorable outcomes when juxtaposed with historical cohorts.

Table 16. Comparative analysis of postoperative complications across clinical studies.

Study	Number of Patients (n)	Complication Rate (%)	Types of Complications
Park (2000) [30]	10	10.00	Venous congestion
Gary M. Fudem (2010) [55]	9	33.33	Infection, Venous congestion, Superficial necrosis
Adel Tolba (2015) [50]	15	6.66	Superficial necrosis
Fernando Moro-Bolado (2023) [52]	7	28.57	Flap hemorrhage, Flap necrosis
Present Study	**34**	**8.82**	**Venous congestion, Wound dehiscence**

Our documented complication rate of 8.82% (n = 3) reflects high technical safety. While our complication rate is slightly higher than that reported by Adel Tolba et al. (6.66%), it is dramatically lower than the rates published by Gary M. Fudem et al. (33.33%) and Fernando Moro-Bolado et al. (28.57%).

Importantly, while the complications in the Moro-Bolado series involved catastrophic events such as total flap necrosis, the adverse events in our study were minor and transient, consisting strictly of partial venous congestion and localized wound dehiscence. The absence of partial or total flap failure in our series further confirms the vascular viability and safety of this single-stage modification.

Postoperative Complications and Clinical Safety Management

Postoperative complications represent a critical factor that can severely impede the wound healing process and prolong the duration of inpatient hospitalization. In our series, early postoperative complications occurred in 3 patients (8.82%), consisting of delayed wound healing (n = 1) and venous congestion (n = 2).

During the outpatient follow-up period, both cases of venous congestion manifested superficial epidermolysis (sloughing of the epidermis) followed by healthy granulation tissue formation; these cases are continually being monitored to evaluate long-term outcomes (within

a 3-month follow-up window). The single case of delayed wound healing achieved complete secondary intention healing by the 6-month evaluation without requiring surgical re-intervention.

When juxtaposed with international literature, our documented complication rate is relatively low, with the adverse event profile dominated primarily by flap venous congestion. Mechanistically, venous congestion may stem from intraoperative dissection inducing a hematoma beneath the wound bed, or from inadequate subcutaneous tunneling that compresses the venous outflow of the vascular pedicle. Venous congestion represents a critical adverse event that mandates vigilant clinical surveillance to ensure timely therapeutic intervention if indicated. Available salvage modalities encompass surgical wound release, multi-site flap pricking/scarification, and hyperbaric oxygen therapy. [30]

Consequently, complication prevention plays a paramount role, necessitating sufficiently wide soft tissue dissection to create an unconfined space for the vascular pedicle. The vast majority of complications reported in international studies did not require secondary surgical revision and were successfully managed via close clinical observation. Because these flaps demonstrate a high propensity for spontaneous recovery without inducing long-term morbidities, we adopted a strict conservative surveillance protocol and successfully documented a definitive trend toward spontaneous recovery.

Regarding overall wound healing status, primary intention healing was achieved in the vast majority of our cohort (94.12%). The single instance of delayed wound healing occurred in a patient with a massive nasal skin cancer defect that encompassed three distinct aesthetic subunits: the ala, lateral wall, and dorsum, which fundamentally required a relatively large flap geometry. At the 1-month postoperative follow-up, this patient presented with delayed healing at the forehead donor site, characterized by a localized 0.5-cm dehiscence. We elected to manage this conservatively via medical wound care and close surveillance, which ultimately yielded healthy granulation tissue and complete margin epithelialization.

Chronological Evaluation of Functional Patency and Sensory Recovery

The primary objective of reconstructive surgery remains the preservation and restoration of organ function while concurrently optimizing patient aesthetics. In this study, we adopted the functional assessment framework proposed by Luigi Angelo Vaira et al., which integrates objective clinical screening of functional abnormalities with subjective patient-reported outcome measures (PROMs). [37]

Patients in our cohort experienced temporary alterations in nasal physiology, primarily characterized by mild airway patency restriction, hyposmia (reduced olfaction), and localized nasal dryness during the immediate 1-month postoperative phase. This acute functional impairment is predominantly driven by surgical trauma and localized tissue edema. By the 3-month follow-up, these physiological disturbances had significantly subsided in the vast majority of patients; persistent complaints were limited to low-grade airway obstruction and minor olfactory changes, neither of which caused significant impairment in daily occupational activities. By the 6-month evaluation, only a single patient presented with persistent anterior nasal valve patency restriction on the left side, a case that involved an extensive structural defect as detailed in the surgical section above. Ultimately, 100% of the patient population reported satisfaction with their long-term functional recovery, with no residual abnormalities causing severe disruption to their daily lives.

Granular Analysis of Aesthetic Outcomes and Statistical Correlations

Aesthetic outcomes were rigorously evaluated at 3 and 6 months postoperatively using a comprehensive grading matrix that combined subjective patient satisfaction with objective surgeon assessments based on four standardized criteria: flap thickness, scar cosmesis, color match with surrounding tissues, and preservation of natural nasal contours. The cumulative scores were then stratified into four definitive categories: excellent, good, fair, and poor. [36]

Our findings demonstrated a high preponderance of excellent and good aesthetic outcomes across all follow-up intervals. These data reaffirm that the island forehead flap possesses superior characteristics for reconstructing complex nasal defects following wide local excision, offering ideal tissue thickness and color match while successfully restoring three-dimensional nasal contours. An inherent anatomical characteristic of the subcutaneous island forehead flap is the subcutaneous bulk of the transposed pedicle, which initially causes localized fullness in the glabella/intercilium region. However, Shumrick and Smith demonstrated that the terminal arterioles of the supratrochlear artery travel superficially to the frontalis muscle within the distal one-third of the flap; this crucial anatomical finding permits aggressive primary thinning of the skin paddle. [56] Furthermore, living tissue undergoes progressive long-term contraction and remodeling, which successfully minimized contour asymmetry in this region over time.

When evaluating the relationship between 6-month aesthetic outcomes and the occurrence of postoperative complications using Fisher's exact test, a clinical trend toward higher complication rates was observed in the lower-rated aesthetic cohorts. However, this association did not reach definitive statistical significance (p = 0.050), a limitation primarily driven by our restricted sample size (n = 34) and the low absolute incidence of complications (n = 3).

From a clinical standpoint, early complications can alter flap coloration and induce tissue thickening, creating a visible contrast with adjacent facial skin and increasing visual attention to the midface. Crucially, when correlating defect dimensions and flap surface areas across the different aesthetic outcome tiers, no statistically significant variances were identified (p = 0.29 for defect area; p = 0.31 for flap area). This lack of statistical significance proves that the island forehead

flap can successfully reconstruct extensive facial defects without compromising the final aesthetic quality.

Oncological Assessment and Margin Security

The fundamental surgical tenet in skin oncology mandates achieving negative perimeter margins to minimize the risk of disease recurrence. Consequently, post-ablative defects are often extensive, presenting a double-edged sword that severely impacts both aesthetic outcomes and nasal function. In cases presenting with a positive surgical margin, contemporary international guidelines strongly recommend immediate re-excision or postoperative adjuvant therapy.

In a study by Bharat Ranganath et al. evaluating 266 patients with positive margins, residual tumor tissue was histologically confirmed in 48% of the 161 cases that underwent re-operation. Furthermore, the authors demonstrated a 5-year local recurrence rate of 6.6% in patients with positive margins who did not receive any adjuvant modality. [57] Therefore, establishing a tailored adjuvant treatment plan for positive margin cases is imperative to optimize local disease control.

Notably, our study achieved a 100% rate of negative surgical margins (R0 resection), with no positive or close margins reported. Consistent with this complete oncological clearance, no instances of local tumor recurrence or regional nodal metastasis were documented throughout the follow-up period.

Study Limitations

Despite the favorable outcomes, several limitations must be acknowledged. First, this was a descriptive, non-controlled clinical trial, which inherently lacks a comparative arm to establish statistical superiority against alternative reconstructive techniques.

Second, although the aesthetic and functional evaluation matrices were strictly based on validated frameworks from established historical literature, subjective bias cannot be entirely eliminated, which may limit the absolute objectivity of the outcomes.

Finally, this study was conducted on a relatively restricted sample size (n = 34) within a single institution. A larger, multicenter randomized controlled trial with an extended follow-up window is warranted to comprehensively validate the long-term reliability and efficacy of the single-stage island forehead flap.

Conclusion

In conclusion, wide local excision combined with immediate single-stage island forehead flap reconstruction represents an oncologically safe, highly reliable, and clinically efficient therapeutic modality for the management of nasal skin cancer. Our clinical trial demonstrated an exceptional 100% complete resection rate (R0 margins) and a 100% flap survival rate, even when addressing extensive multi-subunit defects exceeding 4 cm^2. The technique significantly optimizes the clinical workflow by eliminating the need for a secondary staged surgical procedure, thereby minimizing patient discomfort and compressing the mean inpatient hospitalization to just 3.86 days.

Long-term follow-up verified highly favorable outcomes, with 94.1% of cases achieving good-to-excellent aesthetic restoration and 100% reporting high subjective functional satisfaction with continuous airway patency and sensory recovery. Despite early minor complications occurring in 8.82% of the cohort (transient venous congestion and localized wound dehiscence), all adverse events were successfully managed using conservative medical protocols with a strong propensity for spontaneous recovery. Therefore, the single-stage island forehead flap serves as a formidable and robust alternative to conventional staged regional flaps in head and neck oncoplastic surgery.

Statement of ethics

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee in biomedical research of the Ho Chi Minh City Oncology Hospital (Document No. 460/BVUB-HDDD, signed on June 20, 2023)

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Conflict of interest statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

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Data availability statement

Data and materials used and/or analyzed during the current study and available from the corresponding author on reasonable request.



Figure 1. **Patient Tran Gia P., diagnosed with T2N0M0 nasal skin cancer; single-stage nasal defect reconstruction utilizing a left supratrochlear artery-based island forehead flap.**

Figure 2. **Patient T.T.T., diagnosed with T2N0M0 nasal skin cancer; single-stage reconstruction of a nasal dorsum defect utilizing a left supratrochlear artery-based island forehead flap.**

A B C

Figure 3. **Patient P.V.D. (A) Flap venous congestion at 1 week postoperatively; (B) Clinical outcomes at 1 month; (C) Clinical outcomes at 3 months.**

A B C

Figure 4. **Patient L.T.L. (A) Preoperative presentation; (B) Postoperative day 1; (C) At 3 months follow-up, demonstrating a poor aesthetic outcome.**

Figure 5. **Patient N.T.M. Postoperative at 3 months follow-up, demonstrating a good aesthetic outcome.**

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