



Reconstruction of Scalp Defects: A 10-year Experience

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Abstract: *Background:* Scalp defects, whether from trauma, burns, or congenital causes, present significant challenges for reconstructive surgery due to the inelasticity of the scalp tissue, complicating both functional and aesthetic restoration. *Objective:* This study aims to evaluate various methods of scalp defect reconstruction over a 10-year period at Rajshahi Medical College Hospital, Bangladesh, with a focus on patient demographics, defect characteristics, and surgical outcomes. *Methods:* A retrospective review of patients undergoing scalp reconstruction between 2013 and 2023 was conducted. Data on patient age, gender, etiology, defect location, size, depth, bone exposure, and reconstructive techniques used were analyzed. Various reconstructive methods such as local flaps, skin grafts, and tissue expanders were employed based on the defect characteristics. Surgical outcomes, including complications, healing rates, and aesthetic results, were evaluated over a follow-up period of 6 months to 2 years. *Results:* A total of 150 patients (120 male, 30 female) were included. The majority (80%) of defects were caused by trauma, followed by burns (15%) and congenital anomalies (5%). Local flaps were the most common reconstructive technique (65%), followed by skin grafts (25%) and tissue expansion (10%). Success rates for wound healing were 90%, with a complication rate of 10%, including infections and partial graft failure. Aesthetic outcomes were rated as good or excellent in 85% of patients, while 10% had moderate results, and 5% had poor cosmetic outcomes. *Conclusion:* Scalp reconstruction using local flaps offers the highest success rates and aesthetic outcomes. Early intervention and careful selection of techniques based on defect characteristics are critical for optimal results.

Original Research Article

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Article at a glance:

Study Purpose: The study aimed to evaluate and share experiences with different reconstructive techniques for scalp defects, offering guidance to surgeons based on patient factors and surgical outcomes.

Key findings: The study found an 85% success rate with various techniques like local flaps and skin grafts. However, complications occurred in 15% of cases, including partial graft loss and infections.

Newer findings: The study highlighted the effectiveness of combining tissue expansion with local flaps, especially for larger scalp defects.

Abbreviations: SCALP – Soft tissue covering the skull (or Scalp), RCT – Randomized Controlled Trial, BMI – Body Mass Index, FLAP – Flexible Local Advancement Plasty, STSG – Split-Thickness Skin Graft.



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INTRODUCTION

Scalp is an important structure both functionally and aesthetically. Functionally it covers the cranial bones and protects the brain from external factors.¹ It is aesthetically important in respect of all sex as it is hair bearing structure. Damage to this structure due to any cause like trauma, burn, infection, radiation, tumor excision, malignancy can result in poor quality of life as

patient may suffer from alopecia, deformity or even chronic osteomyelitis of skull bone. Scalp consists of a complex anatomy as some part is loose and some are tight. Surgeon must consider them while planning of reconstruction.¹ Surgeon should also consider the hairline before choosing a flap to minimize scar, alopecia or deformity.² Previous scars or fibrosis may adversely affect the reconstruction for a local or regional flap.³

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Reconstructive surgeons should choose the best option for each patient considering factors like defect size, depth, location, hairline, and alopecia risk. The purpose of this study is to compare and analyze the cases of scalp reconstruction performed in our center over the last 10 years. Using our experiences, we aimed to provide better surgical choices for scalp reconstructions, through the compilation of an algorithm.

METHODS

This was a retrospective study; the study period was November 2014 to September 2024. Patient's data was collected from medical database. Patients underwent excision of lipoma, osteoma or sebaceous cysts were excluded because there were no or minimal skin defects after surgery. This study was reviewed and approved by the Institutional Review Board of Rajshahi Medical College Hospital and patient data was obtained by informed consent. We examined selected patients through chart review and collected the following data: etiology, defect location, defect size, depth, reconstructive procedure, postoperative complications, revision surgery needed or not. Etiology was classified into electric burn (E.B.) defect, traumatic, postoperative defect, defect after tumor excision, congenital naevus, AVM over scalp (Table 1) Defect location was classified into four categories: frontal, frontoparietal/vertex, temporal/temporoparietal, or occipital area.

Defect size was classified into small (<10 cm²), medium (10–50 cm²), or large (>50 cm²) [1]. Defect depth was classified into soft-tissue defects without cranial bone exposure, and with cranial bone or dura mater exposure. Reconstructive procedures were categorized into primary closure, skin graft, local advancement flap, modified bilobed flap, double opposing flap, rotation flap, transposition flap (Table 2).

With respect to the defect location, we evaluated the skin laxity whether a tight or loose scalp determined if primary closure was performed. The tight scalp is over the region where the galea is located. We included the frontoparietal/vertex and occipital areas in this

region for the purpose of this study.¹ The loose scalp is over the region where the temporalis muscle and fascia are located. For this study, we included the temporal/temporoparietal area and lateral occipital areas in this region.^{5,6}

RESULTS

After applying the exclusion criteria, from November 2014 to September 2024, 141 patients are operated in our department for scalp reconstruction. Among them skin grafting performed on 12 patients, advancement flap on 09 patients, modified bilobed flap done on 05 patients, Double opposing flap on 21 patients, Rotation flap done on 32 patients and Transposition flap on 62 patients (along with Skin graft). All the post traumatic scalp defect patients were referred from Neurosurgery Department as exposed skull bone. Electric burn patients were admitted as acute burn and other patients were attended at outpatient department as routine cases. Reconstructive procedures were planned according to Size of the defect, anatomical site, and surrounding skin laxity.

(Table 1) shows the etiology of the scalp reconstructions. Post electric burn scalp defect (67.37%) was the most common etiology, followed by posttraumatic soft-tissue defect (17.02%), soft-tissue defect after tumor excision (10.63%). There were 139 soft-tissue defects without cranial bone exposure, and 02 soft-tissue defects with cranial bone or dura mater exposure. There was no free flap procedures performed in this group. Within the medium size defect group, Transposition flaps were most common, followed by Rotation flaps, Double opposing flaps (Figure: 3), primary closure and skin graft. When there were large size defects where no option of local flap, Skin grafts were applied after drilling of skull bone as secondary procedure.

These patients needed long duration hospital stay. And as a result, he or she developed alopecia and they always complained of headache in a long run. The choice of scalp reconstruction method was affected significantly by defect size, surrounding skin laxity and area of defect.

Table 1: Demographic and Clinical Characteristics of Patients Undergoing Scalp Reconstruction at Rajshahi Medical College Hospital (2013-2023)

Year	E.B.	Trauma	Benign/Malignant Lesion	Naevus	AVM	Total
2014 (Nov-Dec)	02	-	-	-	-	02
2015	08	02	02			12
2016	18	04	02			24
2017	10	02		01		13
2018	11	01		01	01	14
2019	10	03	04	01		18
2020	08	02	02		01	13
2021	04	01	01		01	07
2022	02	01	02		01	06
2023	09	04	01			14
2024(Jan-September)	13	04	01			15
Total	95	24	15	03	04	141

Table 2: Reconstructive Techniques and Outcomes in Scalp Defect Surgery (2013-2023)

Procedure Performed	No. of patients
Split Thickness skin Graft	12
Advancement Flap	09
Modified Bilobed Flap	05
Double opposing Flap	21
Rotation Flap	32
Transposition Flap	62
total	138

Table 3: Surgical Outcomes and Complications in Scalp Reconstruction (2013-2023)

Complications	No.	Secondary procedure needed
Hematoma	29	None
Marginal flap necrosis (2-4mm)	27	Healed secondarily
Marginal Flap necrosis (>4mm without exposed bone)	07	Split thickness skin graft needed
Flap necrosis with underlying bone exposed	04	Needed further flap coverage
Dog-ear Deformity (negligible)	21	none
Dog-ear deformity (large)	11	Correction surgery done after 6 weeks
Ectropion	02	Ectropion correction by multiple Z-plasty
Alopecia (negligible/hidden by Hair from other side)	50	needed no other procedure
Alopecia (Large area)	21	Advised Tissue Expander/ referred to Hair transplant center

(Table 3) We experienced complications like hematoma, marginal flap necrosis (2-4mm), marginal Flap necrosis (>4mm without exposed bone), flap necrosis with underlying bone exposed, Dog-ear Deformity (negligible), Dog-ear deformity (large), Ectropion (Figure:8), Alopecia (negligible/hidden by Hair from other side), Alopecia (Large area) (Table: 30). Some of the complications needed no intervention, in some

cases secondary procedure needed like split thickness skin graft, further flap coverage, correction of ectropion by multiple Z-plasty or full thickness skin graft, Dog-ear correction. In our study groups, we tried to correct the Dog-ear deformity per-operatively without hampering the flap viability (Figure: 5,7). We found it more acceptable by the patient as many patients did not come for secondary surgery. In all cases, secondary

procedures were performed at least after 06 weeks post-operative. In alopecia cases, advise given for tissue expander application or referred to Hair transplant center.

DISCUSSION

Understanding of scalp anatomy is essential in planning of reconstructing scalp defects. Most of the scalp area has tight and inelastic properties, including the underlying galea and periosteum. When the scalp defect includes the tighter scalp, it is more difficult to perform a primary closure. This is a significant when choosing the better reconstruction procedure. Additionally, the surgeon must consider the defect size and depth, as well as prevention of alopecia, because the hair-bearing scalp affects the patient's general appearance. The choice of reconstruction method can vary significantly. There are multiple methods applied as the surgical treatment of scalp defects, with various surgical algorithms proposed.¹⁻⁶ To our knowledge, however, there is no established reconstructive algorithm.

This study shares our experiences of scalp reconstruction performed in a single center for the last 10 years. A primary closure is the first surgical method to consider for small defects. If there is little tension at the time of primary closure after undermining the subcutaneous tissue around the defect, this can be considered as the first choice, because it reduces operation duration and minimizes alopecia.¹ In our study, we observed that primary closure was better in small size defects <10 cm². However, if primary closure is performed when the defect size is larger or the tension is great, the possibility of dehiscence of the surgical site or widening of the lineal alopecia cannot be excluded. In this case, other surgical treatments should be considered.⁷

A skin graft usually should not be the first choice for scalp reconstructions, since it can cause poor cosmetic outcome such as alopecia, color mismatch, and height discrepancy. However, in some cases skin graft can be considered as an alternative if a well-vascularized tissue bed remains.⁸ For example, in patients who are already bald, a flap operation such as a local flap, regional flap, or free flap, may not be appropriate because there would be no significant benefit and

considering the possibility of flap necrosis, hematoma, and donor site morbidity. If the scalp defect is too large, the vascular condition of the patient is poor due to severe comorbidities such as old age, cardiovascular disease, or diabetes, or if the flap procedure threatens the life of the patient, a skin graft is an appropriate alternative to reduce invasiveness and duration of therapy. In cases involving radiation therapy or bone exposure, flap surgery should be considered first because the healthy tissue is not suitable for skin grafting.

A local flap is the most preferable surgical treatment for reconstructing scalp defects. A study found that a local flap is the most feasible method for reconstructing scalp defects less than 150 cm² with a low complication rate (3.4%).¹ If the local flap can be performed on healthy tissue, it can be useful in compromised conditions such as with radiotherapy, infection, and postoperative skin necrosis.³ Additionally, a local flap minimizes alopecia by covering defects using hair-bearing tissue and it provides "like with like" tissue, which can result in a favorable appearance by minimizing height discrepancy and color mismatch, even in patients without hair.¹ For a local flap to be successful, it is important to design one that is much larger than the defect size, and has a wide base, and to avoid suture lines in critical areas.⁹ However, as the defect size increases, the likelihood that a skin graft on the donor site is the best procedure increases, and alopecia may be inevitable.¹⁵

A regional flap is a surgery used to dissect the vascular pedicle and cover the scalp defect by using the vascularized flap. This operation is often used in large-size scalp defects. There are several types, including the lower island trapezius flap, latissimus dorsi musculocutaneous flap and the temporoparietal fascia flap.¹ Like a local flap, a regional flap can be performed in patients with compromised conditions, such as radiation therapy, infection, and postoperative skin necrosis.¹ Invariably regional flaps were performed more frequently in conjunction with a skin graft than were local flaps.¹³⁻¹⁵

A free flap can be useful with medium or large size defects, especially in cases with previous radiation therapy, chronic infection, and

neurocranial morbidity.¹ One study showed that a scalp free flap can survive postoperative radiation therapy after a malignant tumor resection and reconstruction surgery.¹¹ In another study, the free flap procedure was shown to be as safe and efficient in the elderly population as it is in other age groups, which means that age alone should not be considered a contraindication for a free flap.¹² But unfortunately, we have no instrumental support in our center for free flap procedure. So, there is no case undergone free flap was included in our study. A tissue expander was not used in this center for several reasons. First, due to the socioeconomic status of many of the patients that come to this center, patients generally refuse this option because of the high cost of the tissue expander coupled with

the secondary surgery. Second, patients are understandably concerned with their appearance caused by the expander prior to the second surgery and, third, they do not want to be inconvenienced by repeatedly having to go to the hospital for inflation of the tissue expander. Most importantly, there is a risk of infection or inflammation due to the reaction to a foreign body, and this may ultimately necessitate removal of expander before performing the second surgery. Especially in patients with previous radiotherapy, chronic wound infection, or alloplastic material, tissue expanders should not be recommended due to the high complication rate.^{1,12,13} The procedure should be considered for patients with scalp alopecia acquired after other reconstruction surgeries.^{14, 15}

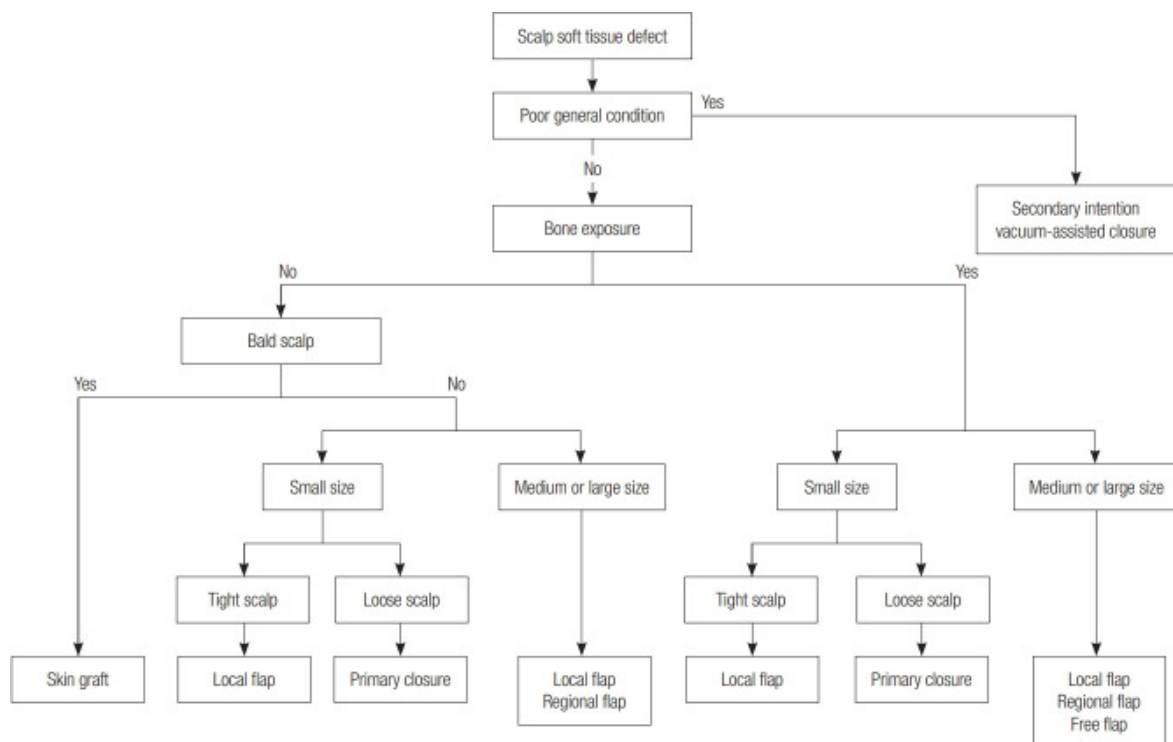


Figure 1: Algorithm for reconstruction of scalp defect.

To summarize, it is possible to select a reconstruction method for scalp defects based on the following algorithm (Fig. 1).¹³⁻¹⁵ If the patient's condition is good enough for a reconstruction, defect depth should be evaluated first. If cranial bone is not exposed but the patient is bald, a skin graft should be performed if primary closure is not possible. If the patient's scalp is hair-bearing, the size of the defect should also be evaluated. The ratio of primary closure to no primary closure was significantly higher in defect sizes of <10 cm² and on loose scalps than in the other categories.

Therefore, if the scalp defect is on the loose scalp and the size is <10 cm², primary closure should be the first choice. Even in the tight scalp, primary closure can be considered in small size defects where tension is not too tight to close the wound. However, if the tension is too great, a flap operation should be performed. In medium to large size scalp defects a primary closure is rarely performed, so, a local flap, regional flap, or free flap should be considered. In the case of a regional flap, a skin graft was more often accompanied than in a local flap. In other words, alopecia is often involved after

a regional flap so, if possible and even if the flap incision is large, a local flap should be considered first to cover the scalp defect. Finally, a reconstruction can be performed using a free flap

when the local tissue is poor vascularity due to radiotherapy, or when a skull deformity is severe and a volume supplement is required.¹³⁻¹⁵

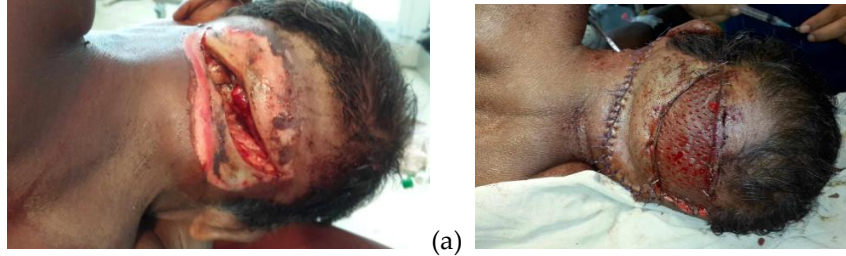


Figure1: (a) Post electric burn defect over Occipital area, (b) After Transposition flap coverage

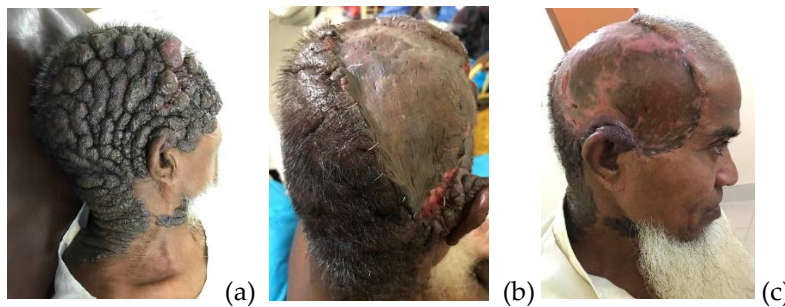


Figure 2: (a) 65 years man came with infected Congenital Naevus with maggots, (b) Debulking surgery done, (c) Split thickness skin grafting done, one month post operative pic

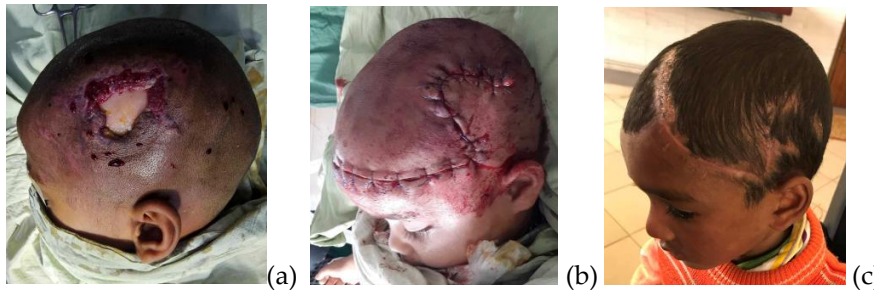


Figure 3: (a) Post Traumatic defect with exposed Skull bone <6cm, (b) covered by Double opposing Rotation Flap, (c) 3months after operation



Figure 4: (a) Post Traumatic defect >1/3rd of Scalp area: (3 years baby), (b) Double Rotation Flap coverage done after Chiseling of dead part of bones, (c) 2 weeks after operation

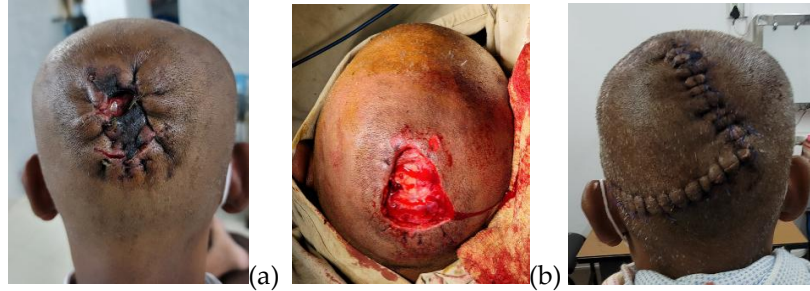


Figure 5: (a) Exposed bone after excision of Sebaceous cyst (H/O operation by an unskilled Surgeon), (b) after wound excision, (c) Rotation flap coverage, dog-ear deformity corrected per-operatively



Figure 6: (a) Post E.B. Defect with exposed skull bone: 18x13 cm defect over frontal bone and 18x9 cm defect over left parietal area. (b) Three Flap Technique + STSG done, (c) 03 months after surgery

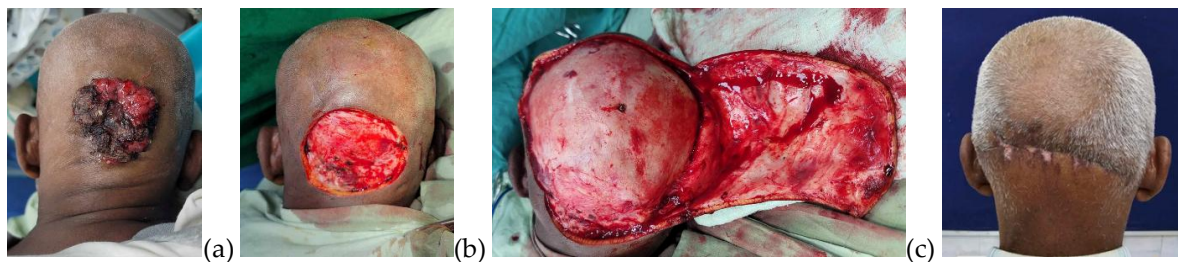


Figure 7: (a) BCC over Occipital Bone, (b) after wide local excision, (c) Harvesting Rotation Flap, (d) 03 months after surgery (dog-ear deformity corrected per-operatively)

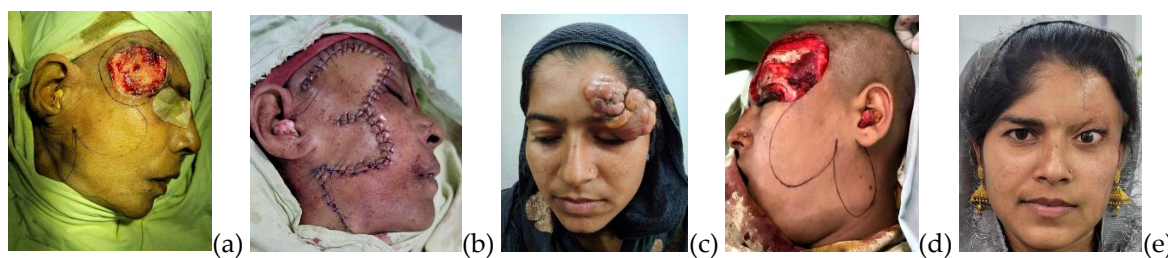


Figure 8 : (a) BCC over forehead, (b) Bilobed flap planned from cheek to avoid hair growth over forehead, (c) Recurrent Sarcoma over forehead, (d) Bilobed flap coverage, (e) post-operative ectropion

There are some limitations in this study. First, in this center we did not perform reconstructions strictly following this algorithm. This was because we evaluated the data retrospectively and the choice of reconstruction method was affected somewhat by the surgeon's preference. There were also considerations for patients with cardiovascular disease, diabetes

mellitus, or other comorbidities as well as socioeconomic status that could not be factored into our study. Additionally, the number of patients in the large size defect group was much larger than in the other defect size groups. As we were working at a peripheral Medical College Hospital of a developing country, we had too many logistic limitations and huge patient load as we are the only

plastic surgery center at this area. Last of all, in our center patients came lately after their incidence as infected case. Despite these limitations, this study may assist surgeons in their choice of reconstruction method. In conclusion, multiple factors affect the choice of scalp reconstruction method. Based on our 10 years of experience, this study will help surgeons choose successful surgical managements for these patients.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Patient consent

The patients provided written informed consent for the publication and the use of their images.

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