8-1-2020

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Kongkrit Chaiyasate MD, FACS
Beaumont Health

Lauren N. Oliver DO
Baylor College of Medicine

Scott A. Kreitzberg DO
Beaumont Health

Mitchell Lyons MD
University of Nevada, Las Vegas, mitchell.lyons@unlv.edu

Joshua Goldman MD
University of Nevada, Las Vegas, joshua.goldman@unlv.edu

Authors

Kongkrit Chaiyasate MD, FACS; Lauren N. Oliver DO; Scott A. Kreitzberg DO; Mitchell Lyons MD; Joshua Goldman MD; Stephen M. Lu MD; Tracey Bastiaans DO; Christopher Lumley DO; and Neil S. Sachanandani MD

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ORIGINAL ARTICLE
Reconstructive

Use of Pericranial Flaps with Dermal Substitute for Scalp Reconstruction: A Case Series

Kongkrit Chaiyasate, MD, FACS*
Lauren N. Oliver, DO*
Scott A. Kreitzberg, DO†
Mitchell Lyons, MD‡
Joshua Goldman, MD‡
Stephen M. Lu, MD, MDiv*
Tracey Bastiaans, DO†
Christopher Lumley, DO†
Neil S. Sachanandani, MD*

Background: Skin cancer incidence has been rapidly increasing over the past 2 decades, and the resulting defects from excision have significant aesthetic and functional implications. In particular, wound coverage for large scalp and forehead defects with calvarial exposure can lead to hairline distortion, contour irregularities, and alopecia. We describe a 2-stage technique for scalp reconstruction, which preserves the normal hairline, covers exposed bone with vascularized tissue, and restores an aesthetic soft-tissue contour.

Methods: This is a retrospective case series of 13 adults with ages ranging from 50 to 89 years. All patients underwent Mohs surgery on the forehead or scalp between July 2014 and April 2017. Patients underwent a 2-staged reconstruction with an initial pericranial flap and dermal substitute placement followed by the placement of a split-thickness skin graft within 4–6 weeks.

Results: Over a 3-year period, 13 patients had successful reconstruction of the scalp defect without alteration of the hairline or contour irregularity. Two patients had minor complications after the first-stage procedure with successful aesthetic reconstruction.

Conclusions: Full-thickness defects of the scalp and forehead with bone exposure provide a reconstructive challenge for plastic surgeons. Reconstructive algorithms continue to evolve and should be tailored to best suit patients' needs and medial comorbidities. Two-staged reconstruction with local pericranial flap provides a safe and efficacious reconstruction that minimizes hairline distortion, contour irregularity, and donor site morbidity. *(Plast Reconstr Surg Glob Open 2020;8:e3011; doi: 10.1097/GOX.0000000000003011; Published online 17 August 2020.)*

INTRODUCTION

The need for oncologic reconstruction of the scalp is on the rise, in part due to the increasing prevalence of scalp malignancies in the aging population. The rate of nonmelanoma skin cancers, which predominantly affect the elderly due to genetics and cumulative sun exposure, showed a 35% increase from 2006 to 2012, and 3,315,554 patients were treated in 2012.[1] For scalp and forehead defects that are too large for primary closure and have exposed calvaria, reconstructive options include large rotational flaps, pedicled flaps, microvascular tissue transfers, bone burring with the use of a dermal substitute, and/or skin grafting.[2,3] The safety of microvascular tissue transfer in the elderly is often complicated by multiple medical comorbidities, resulting in difficulty in tolerating a prolonged general anesthesia and an extensive recovery process. Large local flaps can lead to distortion of the hairline, which should not be ignored regardless of age. Bone trephination and split-thickness skin grafting on the diploe can cause a crater-like contour deformity relative to the surrounding soft tissues.

When the calvaria is exposed, vascularized tissue must be brought into the area to provide a reliable coverage. Due to the anastomosing blood supply to the scalp, large axial patterned pericranial flaps can be elevated and rotated to cover nonvascularized defects providing thin, yet robust bone coverage. The pericranial flap has been widely used in the obliteration of the frontal and mastoid

*From the *Plastic and Reconstructive Surgery Department, Beaumont Health, Royal Oak, Mich.; †Plastic and Reconstructive Surgery Department, Beaumont Health, Farmington Hills, Mich.; and ‡Department of Plastic and Reconstructive Surgery, University of Nevada Las Vegas School of Medicine, Las Vegas, Nev.*

Received for publication March 28, 2020; accepted June 10, 2020.

Presented at the Michigan Academy of Plastic Surgeons, July 20, 2014, Mackinac Island, MI.

DOI: 10.1097/GOX.0000000000003011

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

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sinuses as well as coverage of skull base tumor resections.[4–6] In our experience, additional tissue thickness is necessary to avoid contour irregularity even with pericranial flaps. Dermal substitutes (Integra LifeSciences Corporation, Plainsboro, N.J.) provide a bed of granulation tissue that is similar in thickness to adjacent skin and a reliable platform to receive a split-thickness skin graft.[7]

We describe a 2-stage technique for scalp reconstruction that preserves the normal hairline position, covers bone with vascularized tissue, creates a normal contour of the soft tissue, ensures similar texture and color of the reconstructed area, and has low morbidity.

METHODS

After Institutional Review Board approval was obtained in accordance with the Declaration of Helsinki, a retrospective analysis of all patients with scalp and forehead full-thickness, non–hair-bearing Mohs defects with exposed calvaria who underwent 2-stage reconstruction by means of a pericranial flap with dermal substitute and a subsequent split-thickness skin graft by the senior surgeons between July 2014 and April 2017 was done. Patients with a follow-up of <90 days were excluded. Demographic data, medical comorbidities, operative details, and complications were retrospectively gathered and analyzed. Thirteen patients who met the inclusion criteria were identified. For each patient, a 2-staged procedure was performed by a senior surgeon as follows.

Stage I Reconstruction

The Mohs wound is debrided to clean bleeding tissue peripherally. The scalp is elevated in the subgaleal plane circumferentially around the defect to allow full visualization and independent rotation of the pericranial flap. A wide pericranial flap, based on axial blood supply, is raised from the skull with a periosteal elevator. Next, the scalp flap is elevated with retractors (lighted if needs), and back cuts are made in the pericranial flap with Bovie cautery or scissors to gain flap length as needed. The pericranial flap is rotated and fixated to cover the exposed bone. A contralateral pericranial flap is elevated if a single flap is insufficient for total coverage. The scalp is positioned back to its original position without movement of the hairline. The pericranial flap is covered with a bilayer dermal substitute (Integra LifeSciences Corporation, Plainsboro, N.J.) and secured with a bolster dressing. Closed suction drains are placed under the scalp flaps as needed and removed 5–7 days postoperatively (**See Video [online]**, which displays the pedicled pericranial flap technique).

Stage II Reconstruction

Four to 6 weeks after the initial procedure, the area of the dermal substitute is debrided down to the level of the surrounding soft tissue. A 10/1000- to 12/1000-inch split-thickness, nonmeshed skin graft is harvested from an anterior thigh and secured over the defect with a bolster dressing, which is removed 7 days postoperatively.

RESULTS

The retrospective review found 13 patients who met the inclusion criteria, including 8 men and 5 women. Table 1 provides the details of the patients' age, sex, number of pericranial flaps raised, size of the defects, complications, and length of time to last follow-up from the time of surgery. Patients' ages ranged from 50 to 89 years, with a mean age of 73 years. The defects ranged from 36 to 440 cm^2, with a mean surface area of 230 cm^2. Time from initial surgery to the last follow-up ranged from 3 to 12 months, with an average of 5.5 months. Two patients had complications following the first-stage reconstruction, with both patients achieved a successful reconstruction with good aesthetic appearance. One patient had a scalp hematoma following the first-stage reconstruction and resolved before the second surgery with no additional surgical intervention. A second patient had a small area of pericranial flap necrosis that was managed with local wound care and healed by secondary intent before skin grafting. All patients in follow-up reported satisfaction with the appearance of the reconstruction, and the hairline position was not altered. Two sample cases are discussed below for reference (Table 1).

Case 1

A 79-year-old woman presented with a 15 × 15 cm full-thickness defect of the central forehead after Mohs surgery for cutaneous malignancy (Fig. 1). The patient had a medical history, including dementia, hyperlipidemia, cerebrovascular accident, hypertension, and gastroesophageal reflux disease. At her first stage of reconstruction, the bilateral pericranial flaps were mobilized and sutured together in the midline. A piece of bilateral dermal substitute (Integra LifeSciences Corporation, Plainsboro, N.J.) was placed over the pericranial flaps and sutured into place (Fig. 2). At 4 weeks, second stage, excess granulation tissue was debrided, a 10/1000-inch split-thickness skin graft harvested from the anterior thigh was sutured in place, and bolster dressing secured over the wound. She is pictured at 2 weeks after the second stage (Fig. 3) of reconstruction and at 6 months (Fig. 4).

Case 2

A 65-year-old man presented with a 12 × 12 cm full-thickness defect of the forehead and scalp after Mohs surgery for cutaneous malignancy (Fig. 5). The patient had a medical history of coronary artery disease status post coronary angioplasty × 5 stents, hyperlipidemia, and hypertension. At his first stage of reconstruction, debridement was performed followed by the elevation of bilateral pericranial flaps, which were mobilized and sutured together (Fig. 6). A bilayer dermal substitute (Integra LifeSciences Corporation, Plainsboro, N.J.) was placed over the pericranial flaps and sutured into place. The patient had a small area of pericranial flap necrosis that was treated with local wound care. At 4 weeks, the second stage was performed in which the silicone sheet was removed, excessive granulation tissue was debrided, a 10/1000-inch split-thickness skin graft harvested from the anterior thigh was sutured over the wound, and a bolster dressing was applied for 7 days. He is pictured at 12 months after the last stage of reconstruction (Fig. 7).

Table 1. Details of Patients' Age, Sex, Comorbidities, Defect Size, Complications, and Follow-up Time from the Date of Last Surgery

Age and Sex	Comorbidities	No. Pericranial Flaps Raised	Defect Dimensions (cm)	Complications	Follow-up from the Date of Last Surgery (mo)
89-y-old man	Chronic obstructive pulmonary disease	1	10 × 10	None	3
65-y-old man	Coronary artery disease, hypertension	2	12 × 12	Small area of pericranial flap necrosis	12
79-y-old woman	Dementia, hyperlipidemia, cerebral vascular disease, hypertension	2	15 × 15	None	6
61-y-old woman	Tobacco abuse, anxiety	1	6 × 6	None	6
87-y-old man	Coronary artery disease, deep venous thrombosis, hypertension	1	10 × 10	None	6
56-y-old man	Hypertension, dyslipidemia	2	11 × 11	None	4
68-y-old man	Hypertension, dyslipidemia	2	18 × 20	None	6
69-y-old man	Bell's palsy	2	20 × 20	None	3
88-y-old woman	Chronic obstructive pulmonary disease, dyslipidemia, arthritis, arrhythmia	2	12 × 12	None	3
89-y-old man	Hypertension, coronary artery disease, metastatic squamous cell carcinoma, dementia, arthritis, anxiety, carotid artery disease	2	22 × 20	None	4
62-y-old woman	Hypothyroidism	2	20 × 20	None	4
81-y-old woman	Hypertension	1	10 × 10	None	5
50-y-old man	Diabetes mellitus, hypertension, dyslipidemia	2	20 × 20	None	9

Fig. 1. Case 1: Mohs surgical defect before stage I reconstruction.

Fig. 3. Case 1: 2 weeks after stage II reconstruction.

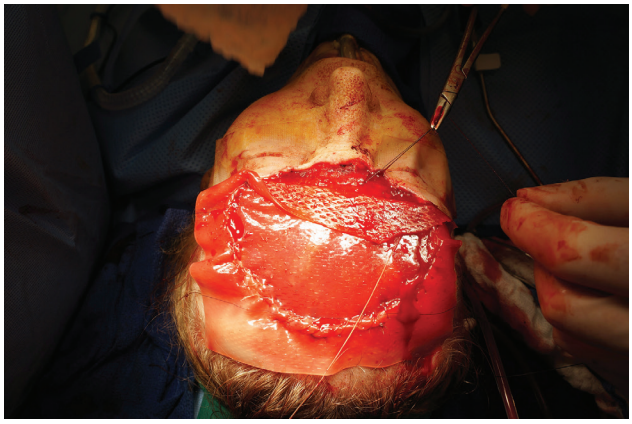

Fig. 2. Case 1: bilayer dermal substitute wound dressing (Integra LifeSciences Corporation) placed over a pericranial flap.

Fig. 4. Case 1: 6 months after stage II reconstruction.

DISCUSSION

Reconstruction of the scalp and forehead can be a complex process and should be individualized. In choosing the best option, defect-related factors—including size, location, quality of the remaining tissue bed and bone, proximity to hardware, and radiation—and patient-centered factors—such as medical comorbidities and aesthetic outcome—should be taken into account. Standard

Fig. 5. Case 2: Mohs surgical defect before stage I reconstruction.

Fig. 6. Case 2: defect with bilateral pericranial flaps suture fixated over the calvarial defect.

Fig. 7. Case 2: 12-month follow-up after stage II reconstruction.

options for scalp reconstruction with exposed calvaria include primary closure with or without tissue advancement, outer table calvarial burring followed by grafting (skin or dermal substitute), local or regional rotational flap with galeal scoring (ie, orticochea or pinwheel), pedicled flap, and free flap reconstruction.[2] Each of these reconstructions has its own set of advantages and drawbacks. Tissue advancement and large local flaps can lead to distortion of the hairline. Bone trephination and split-thickness skin grafting on the diploe can cause a crater-like contour deformity relative to the surrounding soft tissue. Pedicled flaps have a drawback of additional scarring and donor site morbidity. Although tissue expansion is used in scalp reconstruction, it is not an ideal option for Mohs reconstruction due to the presence of an open wound and a high likelihood of extrusion and infection.

Microvascular free tissue transfer for scalp defects can be performed using a variety of flaps, including latissimus dorsi muscle, anterolateral thigh, and serratus anterior muscle.[3] Microvascular surgery may be safely and successfully performed in the elderly, with major complications ranging from 7% to 10% and flap survival rates of 96%.[3,8] These authors did agree that the use of free flaps has to be individualized and patient centered.[3,8] Although free flap and pedicled flap reconstructions provide good vascularized tissue, they do involve a more prolonged general anesthesia, additional donor sites, and more extensive recovery, which patients may not be willing to endure. Yet, certain defect-related factors benefit from microvascular reconstruction with either myocutaneous or fasciocutaneous flap. Free flap is our preferred reconstructive technique for patients with exposed hardware, defects that are too large to provide coverage of exposed bone with pericranial flaps, and those in need of future radiation treatment.

The pericranial flap technique provides a reconstructive option with limited donor site morbidity and provides vascularized tissue. The scalp is supplied by 5 paired arteries, including supratrochlear artery, supraorbital artery, superficial temporal artery, posterior auricular artery, and occipital artery. Potparić et al[9] described the technique of using a pericranial flap and galeal-frontalis flap for the coverage of large forehead defects. They delineate that the blood supply for the pericranial flap remains axial as far as 7 cm, at which point the blood supply becomes random.[9] This reconstruction further expanded the development of pericranial flaps, as described by Karsidag et al[10] with the use of bipedicled pericranial flaps for reconstruction of anterior scalp defects due to skin cancer, and by Newman et al[11] with the use of pericranial flaps for closure of nasocutaneous fistulas.

The axial and anastomosing blood supply of the pericranial tissue makes these flaps very versatile. Within our study, the flaps were wide and axially based. The shape, size, and location of the pericranial flap can be customized so that sufficient pedicle width can be fashioned to maintain a reliable blood supply. Back cuts in the pericranial flap are often needed to gain length. A lighted retractor can aid flap harvest and avoid further incisions; though when necessary, the scalp can be split to aid in exposure. The dermal substitute provides the additional thickness needed under the final split-thickness skin graft to avoid contour deformity. It also allows a second look at the wound bed to ensure vascularity to maximize the final split-thickness skin graft viability.

There are inherent weaknesses to this study, including small sample size, lack of integration of multiple institutional experiences, inability to delineate complications relative to defect size, and lack of control to determine the true impact of the dermal substitute. In the future, we hope to prospectively compare our described

reconstruction at multiple institutions for defects measuring <200 and >200 cm^2 to determine if there are any differences in complications. We also intend to compare the cosmesis and efficacy of our 2-stage pericranial flap with a dermal substitute in a control group undergoing the first-stage outer table calvarial burring instead of a pericranial flap with a dermal substitute for different defect sizes.

CONCLUSIONS

Scalp reconstruction continues to evolve, as new techniques and technology become available. With the population living longer, we are seeing an increased incidence of scalp defects due to malignancy. Larger cutaneous pedicled or free flaps can leave the patient with disfiguring results and distortions of the hairline. By rotating a pericranial flap into the defect, the native hairline is not distorted, and a vascularized wound bed is achieved to accept a split-thickness skin graft. This provides a viable reconstructive option with good efficacy, minimal donor site morbidity, and avoidance of contour defects and hairline distortion.

Kongkrit Chaiyasate, MD, FACS
Division of Reconstructive Microsurgery, Craniofacial Surgery
Plastic and Reconstructive Surgery Department
Beaumont Health
3555 W. 13 Mile Rd
Suite N120
Royal Oak, MI
E-mail: kongkrit.chaiyasate@beaumont.org

PATIENT CONSENT

Patients provided written consent for the use of their images.

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