ELSEVIER SAUNDERS

CLINICS IN PLASTIC SURGERY

Clin Plastic Surg 32 (2005) 377–390

Scalp and Forehead Reconstruction

Claire L.F. Temple, MD, FRCSC*, Douglas C. Ross, MD, MEd, FRCSC

- Causative factors
- Anatomy of the scalp and forehead
  - *Scalp*
  - *Forehead*
- Defect analysis and treatment algorithm
- Forehead and scalp reconstruction: nonmicrosurgical techniques
  - *Primary/undermining and advancement flap closure*
  - *Secondary intention healing*
  - *Skin grafting and tissue expansion*
  - *Local flaps*
  - *Regional flaps*
  - *Cranial vault reconstruction*
- Microsurgical reconstruction
  - *Muscle flaps*
  - *Fasciocutaneous flaps*
  - *Other flap choices*
  - *Replantation*
- Recipient vessels
  - *Arterial supply*
  - *Venous supply*
  - *The "frozen neck"*
- The future
- Summary
- References

The management of extensive forehead and scalp defects is challenging because of the paucity of adjacent extensible tissue, the critical nature of underlying structures, the aesthetic importance of the involved subunits, and the challenge of finding suitable recipient vessels when free tissue transfer is required. Microsurgery techniques have a pivotal role in achieving healed wounds when defects are massive, complex, and compromised. Detailed evaluation of the defect, appropriate flap and recipient vessel selection, meticulous microsurgical technique, and appropriate postoperative care are crucial to uncomplicated healing.

When selecting a reconstruction for the forehead and scalp, important goals include maintaining brow symmetry and a natural hairline, camouflaging scars in wrinkles or hairlines, and preserving nerve supply (when possible) to the forehead [1]. Specific aesthetic requirements of this area further increase the complexity of reconstruction. The plastic surgeon needs to possess a full armamentarium of wound closure options when dealing with these defects, because even small resections of scalp can be surprisingly difficult to close. The galea resists advancement because of its tough, inelastic composition, and its position over the skull's natural convexity further diminishes the advancement attained from a given amount of undermining, relative to other areas of head and neck skin.

Causative factors

Scalp and forehead defects as discussed in this article primarily arise after oncologic resection. These defects include partial-thickness wounds that result from Mohs excision of cutaneous cancers and massive, full-thickness defects involving cutaneous structures, bone, and brain that result from cranial

Division of Plastic Surgery, University of Western Ontario, Hand and Upper Limb Centre, London, Ontario, Canada
* Corresponding author. Division of Plastic Surgery, University of Western Ontario, St. Joseph's Health Care Centre, 268 Grosvenor Street, London, Ontario N6A 4L6, Canada.
E-mail address: ctemple4@uwo.ca (C.L.F Temple).

0094-1298/05/$ – see front matter
doi:10.1016/j.cps.2005.02.002
plasticsurgery.theclinics.com

vault resections of brain neoplasms or cutaneous malignancies. Significant defects may also be produced by infection, radiation, burn (thermal or electrical) injury, penetrating injury, and degloving trauma, including avulsion [2].

Anatomy of the scalp and forehead

Understanding the surgical anatomy of the scalp and forehead is crucial for the reconstructive surgeon. Knowledge of the vascular anatomy will aid the surgeon in the use of regional flaps, in attempting microsurgical replantation, and in completing microsurgical reconstruction of complex defects. Knowledge of the specific aesthetic principles of reconstruction of the forehead and scalp will allow the surgeon to progress from "filling a hole" to creating a functionally and cosmetically sophisticated reconstruction.

Scalp

Medical students are taught the mnemonic SCALP (skin, subcutaneous, aponeurosis, loose areolar layer, pericranium) to remember the five layers of tissue that are present in the scalp. Anatomic nomenclature is occasionally confusing, particularly in the temporal region [3]. The most obvious important attribute of scalp skin is that it is hair bearing. Hair follicles are found in the layer of fat just deep to the dermis and laterally, just superficial to the temporoparietal fascia (also known as the superficial temporal fascia). The galea aponeurotica is a fibrous aponeurosis that extends between the occipital muscles posteriorly and the frontalis muscles anteriorly. The temporoparietal fascia is the lateral extension of the galea and is confluent with the superficial musculoaponeurotic system. The temporal branch of the facial nerve travels within the temporoparietal fascia, so the loose areolar layer deep to this forms a safe plane of dissection when raising a coronal flap [4]. The deep temporal fascia is a stout muscular fascia that envelops the temporalis muscle.

The blood supply to the scalp runs in the subcutaneous plane (superficial to the galea) and is derived from a number of vessels, including the occipital, superficial temporal, supratrochlear, supraorbital, and posterior auricular. This anatomy makes it possible for large flaps to be reliably designed when raised in the subgaleal plane [5].

Although there are no aesthetic subunits of the scalp per se, attention has been drawn to reconstructing the natural "whorl" at the vertex of the scalp and a natural anterior hairline [6]. Given the lack of hair-bearing autologous free-tissue transfers, the hairline may be maintained with a local transposition flap while one uses microsurgical transfer for most of the coverage.

Forehead

The forehead is bounded by the hairline superiorly and laterally and by the supraorbital ridge inferiorly. The muscular anatomy of the forehead has been extensively studied recently as the use of botulinum toxin for facial rhytids has increased [7] and the endoscopic brow lift has become more popular [8]. The frontalis muscles are paired muscles that arise as an extension of the galea aponeurotica and insert into the dermis at the level of the brow. Inferiorly, the frontalis blends with three muscles: the procerus medially, the corrugator centrally, and the orbicularis oculi laterally. Contraction of the frontalis causes elevation of the eyebrow and horizontally oriented lines in the forehead. Motor and sensory innervation of the forehead arise from separate sources. The frontalis and corrugator muscles receive motor innervation from the temporal branch of the facial nerve, whereas the procerus is innervated by the deep buccal branch of the facial nerve [9]. Sensation is supplied by the supraorbital and supratrochlear nerves, which derive from the ophthalmic division of the fifth cranial nerve. The blood supply of the forehead is provided by the superficial temporal, supraorbital, and supratrochlear vessels. Anastomoses among these three vascular systems allow for the design of many local and regional flaps with a robust blood supply.

Gonzalez-Ulloa [10,11] conceived of the idea of aesthetic units in the face. This concept has subsequently been refined, particularly in nasal reconstruction, with the development of the subunit priniciple [12]. As originally described by Gonzalez-Ulloa, the entire forehead from hairline to eyebrow was considered a single aesthetic unit. Subsequently, this was subdivided into paramedian, lateral, and lateral temporal regions, with the eyebrows forming separate aesthetic subunits [13]. Menick [14] has outlined nine principles to maximize the aesthetic outcome of facial reconstruction, including forehead reconstruction. Among the most important of these is that "contour is the primary determinant of normal" and should be striven for at each stage of reconstruction.

Defect analysis and treatment algorithm

Thoughtful analysis of the wound is paramount in flap selection. A number of factors are important when making this choice and are summarized in **Table 1**.

The wound also needs analysis in the context of the particular patient. A thorough knowledge