



Scalp reconstruction with supragaleal flap: a great option for large scalp avulsion

Reconstrução de couro cabeludo com retalho supragaleal: uma boa opção para grandes avulsões de escalpo

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■ ABSTRACT

The treatment of large scalp defects remains a big challenge, even though several therapeutic options are available. According to localization, size and depth of injury, and patient's characteristics, the plastic surgeon may use techniques such as skin graft, tissue expanders, local or free flaps. Microsurgery has revolutionized reconstructive plastic surgery and is the gold standard for more complex cases. However, it is available only in large centers. Using the simplest technique is a broadly accepted concept that should be applied to scalp wounds as well. In this paper, we report a case of trauma of a 4 year-old child who lost approximate one third of the scalp including pericranium areas, that it is possible to reconstruct the scalp by rotating a supragaleal flap followed by a skin graft over the galea. This is an easily reproducible technique with a short learning curve, and therefore is an interesting option for large scalp injuries.

Keywords: Surgical flaps; Reconstructive surgical procedures; Scalp.

■ RESUMO

O tratamento de grandes defeitos no couro cabeludo permanece um desafio, a despeito de muitas opções terapêuticas. De acordo com a localização, tamanho e profundidade da lesão, assim como características do paciente, o cirurgião plástico poderá optar dentre inúmeras técnicas com graus variados de complexidade, como enxertos de pele, expansores teciduais, retalhos locais ou livres, entre outras. A microcirurgia revolucionou a cirurgia plástica reparadora e se configura como padrão ouro de tratamento em casos complexos, no entanto, está disponível apenas nos grandes centros. Observando essa limitação, devemos nos ater ao preceito da escada reconstrutora, que prioriza uso da técnica mais simples possível e também deve ser aplicada em casos de ferimentos de escalpo. Nesse artigo demonstramos, em um caso de traumatismo numa menina de 4 anos de idade com perda de aproximadamente um terço do escalpo incluindo áreas de pericrânio, que é possível a reconstrução do couro cabeludo com a rotação de um retalho supragaleal seguida de enxertia de pele parcial sobre a gálea. Essa é uma técnica reprodutível e com curta curva de aprendizado, sendo uma opção bastante interessante para esses casos.

Descritores: Retalhos cirúrgicos; Procedimentos cirúrgicos reconstrutivos; Couro cabeludo.

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INTRODUCTION

Even though infrequent and despite the vast therapeutic options available, the treatment of large scalp defects remains a huge challenge^{1,2}. Such defects result from traumas, thermal and electrical burns, infections, radiotherapy sequelae, excision of benign and malignant tumors or congenital lesions³⁻⁵. Even if rare, the etiology of trauma is very relevant because of its psychological impacts and high potential of associated lesions.

Reconstructive surgery was developed in parallel to technical and scientific progress. Belloste, in 1696, described the perforation of the outer table of the skullcap, enabling the granulation and epithelization of the wound and only in 1871 did Netolitzky publish the first case of a partial granulation tissue skin graft. Robson successfully demonstrated, in 1908, a skin graft in intact pericranium. Soon after, different authors reported reconstruction techniques using local flaps.

Kazanjian demonstrated that incisions in the aponeurotic galea allow better tissue distensibility. Orticochea published his four-flap technique for large defects in 1967 and reviewed his technique to three-flap in 1971. In 1957, Neumann reported the first use of tissue expanders in a case of scalp expansion for the reconstruction of the ear, a technique that was popularized by Radovan in 1976. In 1976, Miller successfully reimplanted a case of total avulsion of the scalp⁵.

A detailed anatomic study of the scalp was essential for technical improvement and remains so for the planning of a successful reconstruction. It must be continuously studied by surgeons willing to treat this kind of lesions.

The scalp has five different anatomic layers: skin, subcutaneous tissue, galea, loose areolar tissue and pericranium as indicated by the acronym SCALP (Skin, subCutaneous tissue, galea Aponeurotica, Loose areolar tissue e Pericranium). The scalp is the thickest tegument of the human body, with a thickness ranging between three and eight millimeters.

Blood and lymphatic vessels are located in the subcutaneous tissue and the understanding of the anatomy is important in the planning of local flaps, once elevating a flap superficially to the galea may hinder its blood supply.

The galea aponeurotica provides strength to the skin coverage and communicates anteriorly with the frontal muscle fascia, posteriorly with the occipital muscle fascia and laterally with the temporoparietal fasciae. Below the galea there is a loose connective tissue layer, responsible for the scalp mobility. This layer is also known as subgaleal fascia, innominate fascia or subaponeurotic plane. Flaps are usually elevated in this place because it is easy to dissect and safe to maintain blood supply intact. The periosteum is firmly attached to the skullcap and plays an important role in the blood supply of skull bones.

The skull is made by the frontal, parietal, temporal, occipital and sphenoid bones. These bones have three layers, the outer table, the diploe space and the inner table, and the thickness of the inner and outer tables varies according to the area of the skull, age and genetic characteristics of an individual.^{1,3,5,6}

The scalp is well vascularized by arteries from the internal and external carotid system. These vessels are located in the subcutaneous layer, superficially to the galeal aponeurosis and form an extensive network of collaterals, so that a single pedicle can maintain the whole scalp in cases of total avulsion of the scalp. Among the most important pedicles, we highlight the superficial temporal, supraorbital, supratrochlear, posterior auricular and occipital vessels^{1,3,5-7}.

Anteriorly, the scalp is supplied by the supratrochlear and supraorbital arteries, branches of the ophthalmic artery of the internal carotid system; laterally, by the superficial temporal arteries, terminal branches of the external carotid artery; posteriorly, above the hair implantation line it is supplied by the occipital arteries and below this line, by perforating branches of the trapezius and semispinalis muscles; and finally, the small posterolateral area, by the posterior auricular artery, a branch of the external carotid artery. The understanding of the blood supply in this area is essential, since it enables axial branches to be incorporated to the flap, providing greater safety.

The innervation of the scalp is provided by the trigeminal, cervical spinal nerves and branches of the cervical plexus. The supratrochlear and supraorbital nerves innervate the skin of the forehead, anterior region of the hair line and frontoparietal region; the auriculotemporal nerve innervates the skin of the lateral region and the greater and lesser occipital nerves innervate the posterior region^{3,5,7}.

The scalp covers the skullcap and plays an important esthetic and protective role of intracranial structures. In the past, covering the skull was the only objective, however, currently, plastic surgeons must make an effort to obtain favorable esthetic results. Functionally speaking, the aim is to protect from desiccation and infections, providing coverage with vascularized tissue.

From an esthetic point of view, the aim is to maintain the contour and form of the head and preserve the characteristics of hair, with special care not to distort the hair line and to maintain the hair follicles. The closure of wounds under tension or unrestrained use of the electrocautery, especially the monopolar, may destroy the hair follicles and lead to alopecia^{3,5,8}.

Plastic surgeons may choose from different techniques with different levels of complexity, such as skin grafts, tissue expanders, area of free flaps, among others^{7,9-12}. Microsurgery is extremely valuable to

reconstructive surgery, however, its use is limited due to the long learning curve, high cost and limited availability to large centers^{4,10,13}.

Wound size, location and depth will guide the choice of surgical technique. The most accepted classification for scalp defects divides wounds into small, when smaller than 2 cm²; medium, between 2 and 50 cm²; and large, when greater than 50 cm²^{2,3}.

Surgeons must also consider the patient's global health, comorbidities, such as diabetes mellitus, smoking and chronic use of steroids, social status, ability and commitment with treatment, previous surgical incisions, radiation therapy or planning for future adjuvant radiation therapy, in addition to the expectations of outcomes.

The reconstruction pathway for the repair of scalp defects is similar to climbing stairs. At each step, the surgeon must evaluate the complexity of the lesion, determining what techniques are required to treat it. In other words, the simplest reconstruction modality must be used whenever possible to achieve the best functional and esthetic results with the least technical complexity. Putting it short, the order of a reconstructive scale should be: closure by second intention, primary closure, skin graft, use of dermal matrix and dermal replacements, tissue expansion, regional flaps and free flaps^{3,5,8}.

OBJECTIVE

Report a case of trauma in a four-year-old child who lost approximately one third of the scalp including areas of the pericranium, demonstrating it is possible to reconstruct the scalp by rotating a supragaleal flap followed by partial skin graft over the galea.

CASE REPORT

We report the case of a four-year-old child, who was run by a car and lost about one third of the scalp, including areas of the pericranium. Initially she was submitted to a surgery for the cleaning, hemostasis and detachment of the subgaleal plane to try to close the lesion. It resulted in a residual injury of approximately 7x5 cm in its longest axis and with involvement of the adjacent pericranium (Figure 1).

In the intraoperative, the superficial temporal artery and left occipital artery were mapped by Doppler ultrasound to design the preserved flap, preserving the main pedicles that vascularize this region, making the flap safer (Figure 2). A transposition flap was designed and dissected in the supragaleal plane, covering the full thickness defect (Figure 3). The donor area was closed with a partial skin graft, removed from the scalp, presenting excellent integration, since the galea is a good receptor area. Figure 4 illustrates the surgical procedure.



Figure 1. Residual defect after the first galea detachment surgery.

The procedure was totally successful and the proposal is of a staged resection of the area with alopecia with or without the use of a skin expanders (Figure 5).

DISCUSSION

The use of the simplest possible technique for the correction of a defect is a basic surgical principle and must be applied to scalp injuries^{3,11}. Factors such as wound size, depth, involved anatomic unit and clinical status of the patient must be taken into account⁴.

Small partial thickness defects may close by second intention, especially if there is intact pericranium, in concave areas and in patients with fair skin. The disadvantages include longer scarring period, thin coverage, pigmentation changes, alopecia and telangiectasia, but it is an interesting option in patients who do not tolerate prolonged anesthesia time or morbidity of the donor area^{3,8}.

Primary closure is the simplest and preferable alternative in most cases due to the excellent esthetic result and fast scarring. However, it is only indicated in defects smaller than three centimeters^{2,3,7}. Extensive detachment may be required to obtain closure without tension, in addition to relaxing incisions in the galea. These incisions must be performed carefully to avoid hematoma and damage to the blood supply of the flap; incisions must be parallel and made at every 15 to 20 mm^{1,8,10,12}.

Partial skin graft is considered a quick, simple and safe technique to reconstruct medium sized to large injuries when the cosmetic result is not a priority. Another indication for partial skin grafts is the closure of donor areas of large local flaps. To do so, the pericranium must

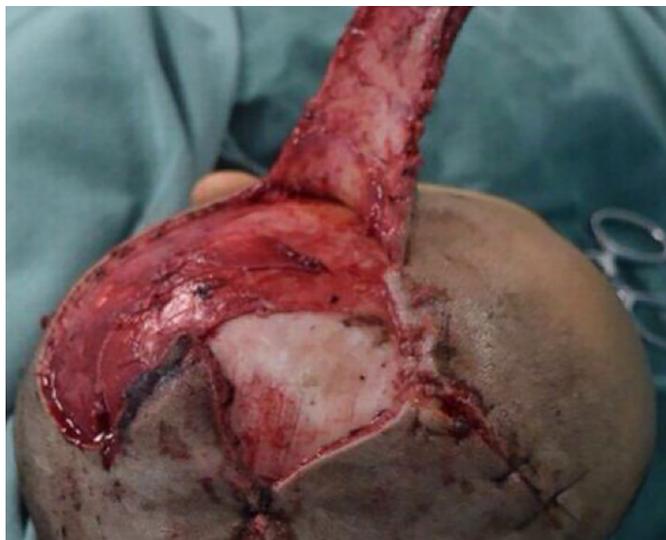


Figure 2. Supragaleal flap to cover the full thickness flap, including the area without perichondrium.



Figure 4. Supragaleal flap covering the full thickness defect and partial skin graft covering the galea.

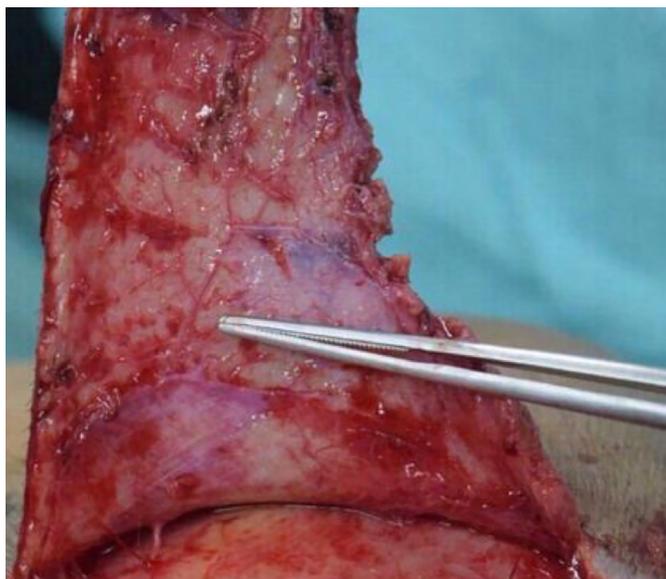


Figure 3. After mapping of the main scalp pedicles with the support of Doppler ultrasound. Detail of the donor area of the supragaleal flap.



Figure 5. Final aspect after 8 months.

be present and intact, thus guaranteeing adequate blood supply to the transplanted skin^{2,8}.

In cases where this layer is missing, a pericranium flap may be used, preferably a bipediculated flap, a subgaleal fascia flap including loose areolar tissue, or yet, perforating the outer table encouraging the growth of granulation tissue^{2,5}. These three situations are followed by skin grafts. The use of a total skin graft, even though reported in the literature, is not usually used. Later, serial excisions of the graft may be planned to decrease alopecia until primary closure is possible^{3,10,12}.

Vacuum dressings were introduced at the end of the 90's as a powerful tool in cases of wounds that are

difficult to treat, such as pressure ulcers, and may be considered and a complementary treatment in patients with complex wounds of the scalp. The objective is to obtain granulation tissue and decrease wound size by means of debridement, decreasing the colonization of bacteria, increasing blood supply and removing excess exudate, which may all inhibit scarring.

Different studies have reported their use in the treatment of scalp injuries in children and adults, and the contraindications for their use include gross contamination, malignant neoplasia, necrosis and osteomyelitis. Some authors use them temporarily in cases of complex wounds, until reconstruction is possible^{3,8}.

There are different local flaps that may be used in the reconstruction of the scalp, including advancement, rotation and transposition⁶. Local flaps enable reconstructions with similar tissues and therefore are the main choice for the reconstruction of defects that cannot be closed primarily^{3,7}. They are safe, have a low complication rate of about 3.4%.

When planning, it is essential that the design is greater than the defect to be reconstructed and with large bases, incorporating as much vascularization as possible. There should be no distortion of the hair line. Another relevant aspect is that flap detachment area must be extensive enough to enable distribution of tension in a larger surface. Finally, relaxing incisions must be performed carefully and small dog ear deformities are temporarily tolerated, since their immediate correction may damage the vascularization of the flap and they tend to evolve over time and may be corrected later in the clinic^{1,3,8,10,12}.

In general, advancement flaps have a limited role due to the inelastic nature of the tissue and are used mainly in small defect in the tempoparietal region. Rotation flaps have a broader application, since the natural convexity of the cranium is adequate for curved incisions.

There is a very large variety of scalp flaps and describing them is not part of the scope of this study, however, there are two extremely relevant flaps which will therefore be described. The Orticochea flap, initially described as the four-flaps, was modified to three-flaps and may be used for defects of up to 30% of the skull. In this technique, two flaps are made to cover the defect, each one based on the superficial temporal artery and a third large and posterior flap, based on the occipital artery is used to close the donor defect^{3,7}. The temporoparieto-occipital, flap, known as the Juri flap, was initially described for the treatment of alopecia, but it is widely used for reconstruction. It is used in defects of the anterior line of hair implant and is based on the parietal branch of the superficial temporal artery⁷.

Regional flaps have limited indications, especially in the era of microsurgical flaps. They may be used when a large amount of vascularized tissue is required, but the patient is not candidate for reconstruction using a free flap or in palliative cases. The best flap for these patients is the temporoparietal fascia flap, whose pedicle is a branch of the superficial temporal artery. There are also flaps in islands of the trapezius and latissimus dorsi, but they cannot go being the region of the vertex³.

More recently, the use of acellular dermal matrix and dermal replacements have been incorporated for the management of wounds, especially in patients who do not tolerate long and complex treatments. This new technology represents a technical improvement in cases of skin grafts and provides better outcomes, since the hair

line contour is preserved. Treatment is usually performed in two stages, with the inclusion of the dermal matrix and subsequent skin graft after granulation of the bed⁸.

The controlled expansion of tissues has been increasingly more used and has become an important tool in the reconstruction of medium sized and large defects of the scalp, where local flaps cannot provide enough coverage. The use of tissue expanders enables primary closure with less distortion of the hair line in injuries of up to 50% of the scalp^{2,3,8}. It must be placed on the subgaleal plane and expanded until the flap is 20% larger than the defect to be repaired. Prior radiation therapy and infection are contraindications and the complication rate ranges between 6 and 25%^{2,5,7}.

Currently, free flaps are the main reconstruction modality for medium-sized and large defects, especially in the presence of prior radiation, exposure of brain structures and chronic infection. They can provide a large amount of vascularized tissue and correct contour defects and are therefore the treatment of choice in cases of total avulsion of the scalp, where reimplants cannot be used. However, alopecia and skin color and texture changes are limitations of optimal outcomes. Another disadvantage is that only large centers have the required technology available³.

Finally, hair transplant is an alternative that may be used to hide small areas of alopecia and surgical incisions and scars or to restore a hair line that has been distorted by a local flap. Although it has been used for the treatment of large areas of alopecia caused by post-burn scars, it is considered a revisional technique and not treatment^{3,5}.

Some precautions should be taken: the electrocautery should be used carefully, thus avoiding alopecia secondary to thermal injury of the hair follicles; avoid closure tension, as tension causes alopecia due to a loss of follicles and because it interferes in hair growth and flap ischemia; closure in planes, with special care to the galea, which is the stronger layer of the scalp and delay the correction of eventual dog ear deformities to a second surgical time, thus avoiding to damage the vascular pedicle of the flap⁵.

Many protocols have already been proposed for scalp reconstruction and it is up to the plastic surgeon to evaluate case by case and then according to his/her own experience and methods available, choose the best technique. Although the main objective is the coverage of the lesion and functionality, maintaining body contour and preventing alopecia is also desirable.

Even after the acute phase, scalping causes physical and emotional sequelae, secondary to loss of self-esteem, identity, body perception, mood, sociability and affection.¹ It is within this context that the plastic surgeon will play an important role, decreasing suffering and rescuing quality of life.

CONCLUSION

Skull bone coverage after scalp avulsion, when it is not possible to reconstruct using regional flaps has always been a challenge to plastic surgeons.

This a relevant issue, keeping in mind that the gold standard treatment, the microsurgical reimplant, is not available in most Brazilian plastic surgery centers. In this paper, we present a treatment alternative that may be performed anywhere in our country. It is reproducible and has a short learning curve.

COLLABORATIONS

PAM	Analysis and/or interpretation of data; completion of surgeries and/or experiments; writing the manuscript or critical review of its contents.
CAWM	Conception and design of the study; completion of surgeries and/or experiments.
LPFS	Completion of surgeries and/or experiments.
BAPC	Analysis and/or interpretation of data; completion of surgeries and/or experiments.
DMFSM	Final approval of the manuscript.
DD	Writing the manuscript or critical review of its contents.

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