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Original Article

Moving from the O-Z flap to the O-S flap for scalp reconstruction: A new geometrical model

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ABSTRACT

The O-Z flap is the most commonly used local flap technique to repair round and oval scalp defects in clinical practice. Preoperative flap marking is one of the major technical issues of this reconstructive method and it is essential to achieve an optimal outcome. Nevertheless, the absence of a unified arc design scheme could significantly limit the use of this useful and reliable technique, and flap drawing is sometimes based more on the surgeon's experience than on a real geometrical model. Our aim was to describe an intuitive and standardizable method for O-Z flap marking, that we called "O-S flap," based on a simple and easily replicable geometrical pattern.

We reported our experience in this case series of eight patients with skin tumors of the scalp who underwent scalp reconstruction with the "O-S flap" technique at our university hospital. Most patients had defects located on the vertex or parieto-occipital regions of the scalp. The area of the defects ranged from 7 to 78.5 cm^2. There were no cases of flap necrosis, wound infection, or positive margins, and no patients required revision surgery.

We believe that our technical refinement represents a safe, easy, and reproducible method for O-Z flap marking. It follows a

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simple geometrical model which could be customized according to different clinical needs.

Introduction

Reconstruction of scalp defects can be challenging owing to relative scalp immobility. Functional preservation including protection of the calvarium and maintenance of the aesthetic relationships with the surrounding structures represent the main goals of scalp reconstruction. Neighboring tissues allow for a "like with like" reconstruction providing excellent thickness, texture, color match, and hair-bearing skin. Several local flaps can be used to distribute the tension of the closure over a wider area of the scalp, including advancement, rotation, and transposition flaps.[1,2]

The O-Z flap is a double-rotation flap that is typically used in the reconstruction of circular to oval defects on the scalp, forehead, and temple, even though it has been proposed for back reconstruction in challenging cases as well. As its design provides minimal distortion of nearby structures and conserves tissue, it is mechanically simple with predictable tension vectors.[3,4]

An accurate and reproducible preoperative flap marking represents one of the major technical issues of this reconstructive technique, and it is more essential than ever to obtain an optimal result.

Nevertheless, there is little published information on flap design specifics such as the optimal angle of incision or length of the opposed flaps, and sometimes the flap drawing could be too approximate as it is based more on the surgeon's experience than on a real geometrical model.

Buckingham et al. had proposed an ideal design of the flap by incising and undermining the flap to a distance of 4 radii from the center point of the defect to minimize closing tension.[5]

We describe an alternative method for O-Z flap marking, that we called "O-S flap," based on a simple and easily replicable geometrical pattern.

Materials and Methods

Patient selection and data collection

This case series included eight patients with skin tumors of the scalp who underwent scalp reconstruction with the O-S flap technique at our university hospital. Data collected included age, gender, defect site, diagnosis, defect area, dept of the defect, operating time, and postoperative complications at the 1-month follow-up.

Ethical consideration

This study was submitted to the ethics committee of our hospital (CETM-Comitato Etico Territoriale delle Marche- IRB# ID3843).

The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and it was conducted in accordance with the Good Clinical Practice requirements and 1975 Declaration of Helsinki principles. Written informed consent for surgery and use of pictures for academic and study purposes was obtained from all patients. Patient confidentiality was maintained throughout the study.

Flap marking and surgical technique

The marking of the O-S flap starts from the defect design in a circular fashion, which represents the mainstay of this surgical technique. Then, a square is drawn such that the circumference of the

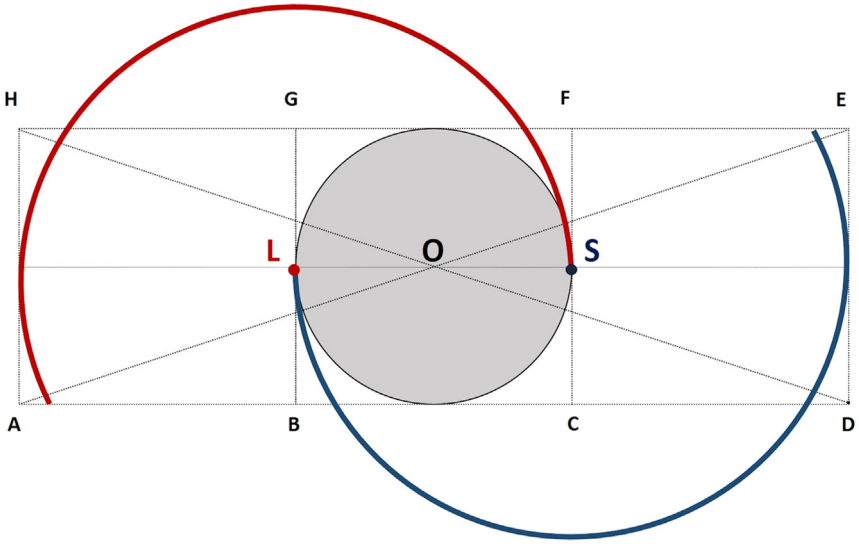

Figure 1. Design scheme of the O-S flap. Point *O* represents the center of the defect (gray circle) and it is the intersection of the diagonals of the rectangle *A, D, E,* and *H. L* and *S* are the points of tangency of the circle inscribed in the square *B, C, F,* and *G*. The distance *LS* represents the diameter of the defect and it represents the radius of the two opposing flaps (red and blue).

circle is inscribed in the square. When a circle is inscribed inside a square, the side equals the diameter. In this way, two more squares can be drawn on both sides of the central square with the same side. The intersection point between the two diagonals of the rectangle resulting from the union of the three previously drawn squares, therefore, coincides with the center of the circular defect. Simultaneously, the points of tangency of the circle inscribed in the square represent the pivot points from which the opposing flaps can be drawn. The radius of the flaps is equal to the diameter of the circular defect (Figure 1). Two different pairs of diametrically opposed points can be used as pivot points to draw the two opposing rotating flaps, depending on the location of the defect, nearby anatomical structures, tissue laxity, tension lines, and potential for hairline distortion. The maximum surface we can reconstruct with this method is essentially dependent on the proximity of the neighboring anatomical structures as the width of the base of the flap is equal to the diameter of the defect.

The flap tips could be trimmed at your convenience to allow comfortable stitching and avoid wound dehiscence.

Results

Eight patients underwent a single-stage scalp reconstruction using our design of O-S flap for small to large scalp defects. The mean age was 71.9 years (range 34-87 years), including seven men and one woman. Most patients had defects located on the vertex (three patients, 37.5%) or parieto-occipital (three patients, 37.5%) regions of the scalp. All patients were being treated for neoplastic skin lesions, including squamous cell carcinoma (four patients, 50%), basal cell carcinoma (three patients, 37.5%), and one case of actinic keratosis. The mean surface area of the defects was 25.9 cm^2 (range 7 to 78.5 cm^2). The mean operative time for our technique was approximately 60 minutes (range 40-100 minutes). All patients had defects that extended down to the calvarium (four patients) or periosteum (four patients).

There were no cases of flap necrosis, wound infection, or positive margins, and no patients required revision surgery. Only one patient experienced a minor wound dehiscence due to an unsuitable local wound care which healed after secondary suturing in an outpatient setting (Figure 2-6). Table 1 presents the patient demographics.

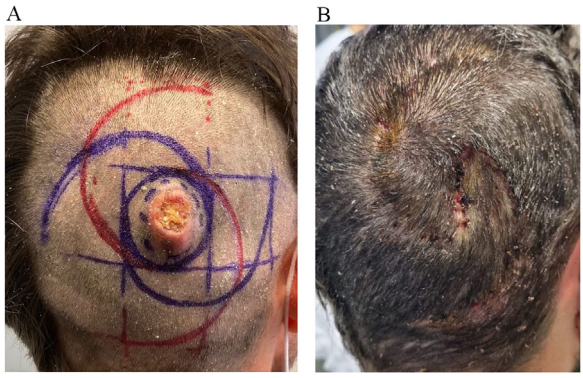

Figure 2. Preoperative picture of a 36-year-old male with a squamous cell carcinoma of the scalp measuring 5 cm. Two different pairs of opposing O-S flaps are drawn in red and blue (A). One-month follow-up picture showing satisfactory anatomical contour and aesthetic results, and no areas of alopecia (B).

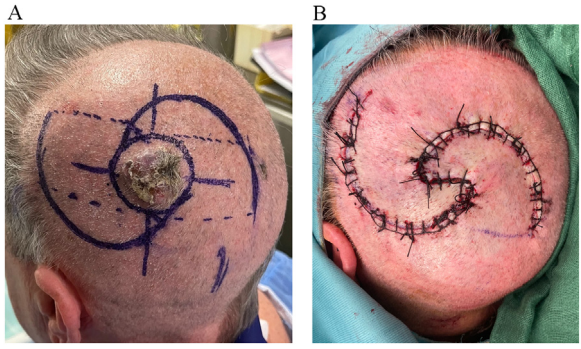

Figure 3. Flap markings in a 75-year-old female with basal cell carcinoma of the parieto-occipital region of the scalp with a diameter of 5 cm (A). Immediate postoperative picture showing a tensionless closure of the defect and a good flap vascularization (B).

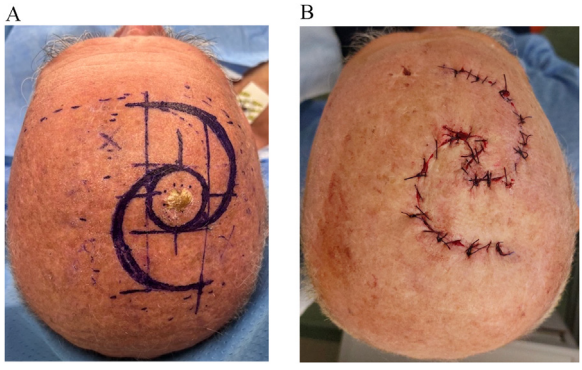

Figure 4. Preoperative picture of a 79-year-old male with an actinic keratosis of the vertex (A). One-week follow-up picture showing good flap viability (B).

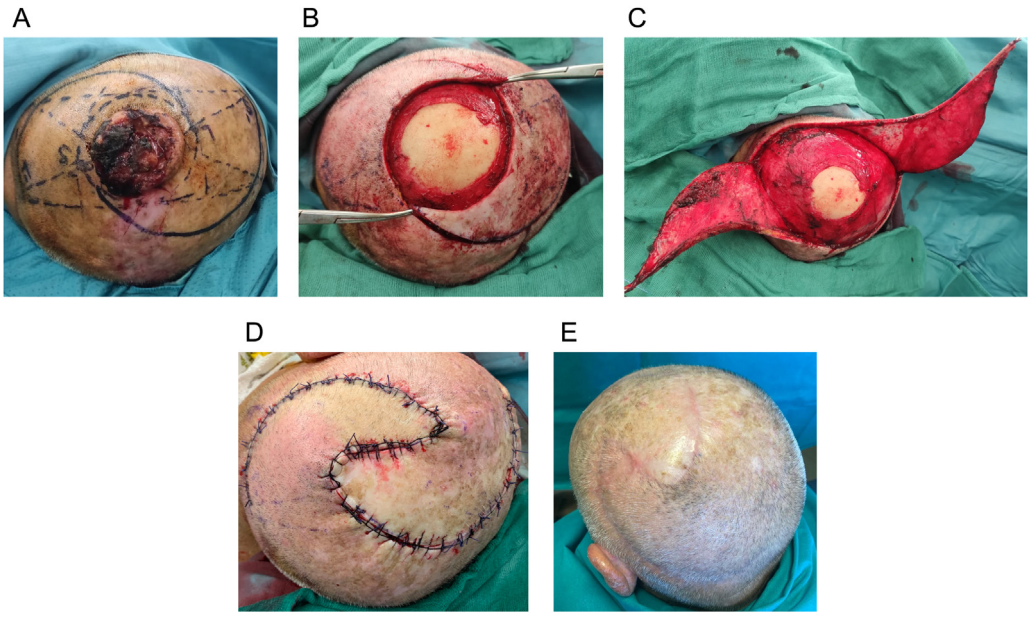

Figure 5. Preoperative picture of an 87-year-old male with squamous cell carcinoma of the vertex. The diameter of the defect was 8.5 cm (A). Intraoperative pictures showing the defect depth (down to the calvarium), and the two flaps raised (B-C). Immediate postoperative picture showing wound closure (D). Three-month follow-up picture showing excellent cosmetic outcome (E).

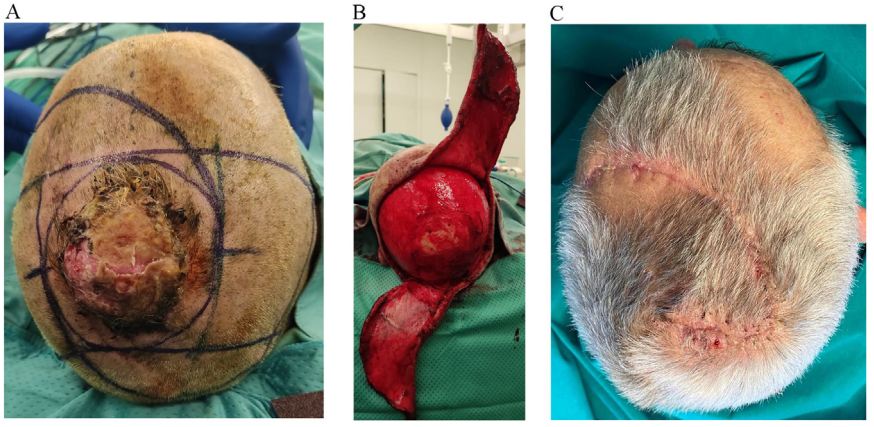

Figure 6. Preoperative picture of an 80-year-old male with squamous cell carcinoma of the vertex. The diameter of the defect was 10 cm (A). Intraoperative pictures showing the defect depth (down to the calvarium), and the two flaps raised (B). One-month follow-up picture showing excellent cosmetic outcome (C).

Discussion

An armamentarium of surgical procedures for scalp reconstruction after oncologic resection ranging from skin grafts over dermal substitutes to local or free flaps has been described. The choice of the most appropriate technique should be tailored to the individual patient and it usually depends on defect location, wound size and depth, presence of neighbor scars, patient comorbidities, and surgeon preferences.[6,7]

Table 1
Patient demographics and tumor characteristics.

Patient	Age (years)	Sex	Defect site	Diagnosis	Defect area (cm^2)	Dept of defect	Operating time (min)	Complications
1	87	Male	Vertex	Squamous cell carcinoma	56.7	Down to the calvarium	75	No
2	79	Male	Vertex	Actinic keratosis	11.3	Down to the periosteum	50	No
3	34	Male	Parieto-occipital	Squamous cell carcinoma	12.6	Down to the calvarium	65	No
4	75	Female	Parieto-occipital	Basal cell carcinoma	15.9	Down to the calvarium	40	No
5	71	Male	Temporo-parietal	Basal cell carcinoma	13.8	Down to the periosteum	55	No
6	80	Male	Vertex	Squamous cell carcinoma	78.5	Down to the calvarium	100	Minor wound dehiscence (healed after secondary suturing)
7	79	Male	Parieto-occipital	Squamous cell carcinoma	11.4	Down to the periosteum	50	no
8	70	Male	Parietal	Basal cell carcinoma	7	Down to the periosteum	45	no

Reconstruction of superficial scalp defect with the remaining periosteum may be achieved by skin grafting, which represents a simple and feasible option for large defects.[8] Nevertheless, alopecic areas remain a significant drawback of this reconstructive method, often requiring secondary serial excisions or tissue expansion.[7] Dermal substitutes have been advocated as a reliable method for scalp reconstruction as well, even for the coverage of soft tissue defects that are not amenable to direct skin grafting, and they appear to be less expensive than the treatment with free or pedicle flaps.[9,10] Nevertheless, the use of dermal substitutes may be limited by the poor cosmetic appearance and radiation therapy.

The inelastic nature of the scalp probably represents the most important feature which may limit the use of local flaps for scalp reconstruction. Often, multiple separate rotational or rotation-advancement flaps are necessary to better distribute the tension of the suture over a wider area of the scalp. Common examples include bilateral opposing rotational flaps (O-Z flaps), the “pinwheel” flaps, and 3- or 4-flaps Orticochea technique. [1]

The pinwheel flaps were first described by Vecchione and Griffith in 1978 for defects >3 cm in diameter, and their markings required that the diameters of the flaps be twice that of the defect.[11] Simsek et al. subsequently proposed another mathematical proportion of the pinwheel flaps with the base length of the flap equal to the radius of the defect, which is sufficient for tensionless closure of the defect.[12] Nevertheless, according to an algorithmic approach proposed by Leedy et al., the pinwheel flaps are less useful for the resurfacing of medium-sized defects (up to 25 cm^2) of the vertex.

The Orticochea technique represents a useful alternative in case of a large defect (>50 cm^2), although it is classically described for the reconstruction of the occipital scalp.[6]

The O-Z flap is one of the most used local flaps for surgical repair of round and oval scalp defects as it offers a flexible design, good blood circulation, uniform tension, and good hair growth after operation. It has been proposed as a reliable alternative to free tissue transfer even for the closure of extremely large-sized scalp defects (up to 63 cm^2).[13]

Nevertheless, the current absence of a unified arc design scheme could significantly limit the use of this technique. Presently, only Buckingham et al. has proposed a flap design to achieve lower incision tension; however, whether this technique is the best design remains to be elucidated.[5,14]

In their study, the authors designed the flap by selecting an origin on the defect and creating a curve-linear flap with points 45° from each other at 2, 3, and 5 radii. The use of these coordinates for the flap design with incision and undermining of one flap side to 4 radii provided the minimum closing tensions. Our design appears to show some differences with the one described by Buckingham

et al. We mark the flaps in a perfect semicircular fashion, with the radius of the circular incision being twice the radius of the defect. Conversely, in the study of Buckingham et al., the outer border of the flap is typically an elliptical line which is four times the radius of the defect. In our technique, we use a narrower flap base without concerns about flap-tip vascular compromise. In our series, although limited, we did not have any vascular complications or flap necrosis.

Furthermore, we avoided excessive flap lengthening and undermining which could otherwise be performed to counteract the excessive tension and firmness of the scalp, thus avoiding longer scars and risks of alopecia. The overall amount of recruited tissues is therefore significantly reduced. This allows the flap to be used even in locations where the presence of nearby anatomical structures would preclude its use. In our case series, we used this technique for the reconstruction of all regions of the scalp, thus making the O-S flap an extremely versatile method.

In this scenario, the location of the defect on the scalp is essential to design the flaps to recruit the looser skin areas. In fact, the anatomical layers of the scalp differ greatly depending on the anatomical region of the scalp. Typically, the parietal scalp is the tight region of the scalp as the galeal layer is considerably dense with no underlying muscle. Conversely, the forehead and occipital areas are considered loose regions of the scalp, as the galea is represented by a thin fascial layer overlying the muscle. Therefore, the orientation of the two opposing flaps must necessarily consider these anatomical features.

A further concern exists about the reliability of the cadaveric model used in the study by Buckingham et al. In fact, the scalp is far stiffer than cadaver buttock skin, which makes the results less applicable to clinical practice. Our model could be easily reproduced in other anatomical areas as needed.

Conclusions

We believe that our O-S design represents a safe, easy, intuitive, standardizable, and reproducible method for a modified marking of the O-Z flap. It does not require a learning curve as required for other techniques and it follows a simple geometrical model that could be customized according to different clinical needs.

Compliance with Ethical Standards

Ethical approval

This study was submitted to the ethics committee of our hospital (CETM-Comitato Etico Territoriale delle Marche- IRB# ID3843).

This study was conducted in accordance with the Good Clinical Practice requirements and 1975 Declaration of Helsinki principles.

Informed consent

Written informed consent for surgery and use of pictures for academic and study purposes was obtained from all patients.

Conflict of interests

The authors declare that there is no conflict of interest.

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