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EAR DEFECT RECONSTRUCTION WITH THE REVOLVING DOOR FLAP: A MODERN LOOK AT AN OLD CLASSIC

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Abstract
Despite being extensively elucidated in the literature, the employment of the revolving door flap is not prevalent within the broader scope of general plastic surgery. This flap method has primarily found application in addressing anterior auricular and conchal defects, lauded for its distinctive design and the intricacies of its harvest approach. Nonetheless, its limited application for highly specific cases and the intricacy of its harvest technique, which might be challenging to apprehend, contribute to its relatively low popularity within the realm of reconstructive procedures. In this research an attempt has been made to assess and comprehend progression associated with RD flap by evaluating studies performed and procedures optimized previously. The study aims to underscore the flap's effectiveness and refined nature in addressing ear defects, reiterating its value in the field of reconstruction.

Keywords: revolving door flap, postauricular, tissue reconstruction, flap harvest

Introduction

"Revolving door" flap surgery, also known as a "flap surgery," is a medical procedure employed to treat various medical conditions, particularly those requiring tissue reconstruction. The revolving door (RD) flap, also referred to as the subcutaneous pedicle postauricular island flap, is a surgical procedure that, despite its infrequent application in the broader field of "general plastic surgery," has garnered significant coverage within medical literature. This flap was initially introduced by Masson [1] and has found application in addressing various defects of the “conchal and anterior auricular” regions depicting from the surgical removal of tumours. The effectiveness of the flap has been established previously by authors inscribing reduced incidents of complete flap loss [2]. The flap is notable for its distinctive design and the specialized approach required for harvesting. Despite its proven reliability and intricate harvesting method, this technique remains relatively obscure, primarily due to insufficient awareness.

Theory of Revolving Door

The flap harvesting technique was explained by previous authors utilizing the revolving door (RD), trap door, pull-through, buttonhole, or flip-flop concept is well documented. According to the concept of the revolving door (RD), the flap undergoes a rotational movement, shifting from the "postauricular to the preauricular" surface along a "vertical axis" formed by a neurovascular subcutaneous pedicle, resembling motion that of "wings" on a door's "shaft" [3]. After the ant and post wings of the flap are undermined, they are suspended around the soft central tissue shaft connected to the retroauricular groove.

The raised flap's anterior and posterior wings operate similarly to the separate panels of a revolving door. They pivot around a central unraised shaft that connects to the retroauricular groove located behind the ear [4]. This cylindrical structure serves as a foundational soft tissue linkage for the flap. Blood supply is provided to the flap through an arterial network formed by branches originating from the superficial temporal and post auricular arteries within the retroauricular groove [5]. The groove contains subcutaneous tissue that enables extensive wing mobility.

Following its rotation around the central shaft, the flap's anterior and posterior wings transition from the region behind the ear to the frontal side by traversing a gap formed in the cartilage beneath the frontal imperfection. This motion can be likened to threading a button through a buttonhole [6]. Once these wings have been effectively shifted to the front side, the mastoid wings and back-of-the-ear are placed inside of the front and back edges of the imperfection. The flap stays connected to the groove behind the ear through the subcutaneous pedicle shaft [7].
After the transfer and positioning of the flap, a new donor defect emerges on the postauricular surface, resembling the standard defect left by a postaur full-thickness skin graft (FTSG), followed by its closure in a similar manner.

Aim and Objectives:

Comprehending the intricacies of flap design, harvesting, and transplantation are pivotal for achieving a successful reconstruction. Once grasped, the revolving door (RD) flap becomes notably straightforward and secure to elevate, attributed to its gentle learning curve.
In this research an attempt has been made to assess and comprehend progression associated with RD flap by evaluating studies performed and procedures optimized previously. The study aims to underscore the flap's effectiveness and refined nature in addressing ear defects, reiterating its value in the field of reconstruction.

Methodology

This study comprised twenty-seven individuals who visited the plastic surgery outpatient department due to potential malignant lesion growths on the front part of their ear (pinna). This study was conducted from February 2023 to August 2023. A wedge biopsy was executed to validate the presence of malignancy. In three subjects, flap procedure was conducted to cover the cartilage that became exposed after the elimination of a pigmented nevus. The line of action for all patients were carried out under daycare, the patients were locally anaesthetised. Each surgery was preceded by the collection of written informed consent from the patients, in accordance with established ethical protocols.

Surgical aspects

Resection of Lesion

The cancerous growths were removed, leaving a healthy 5-mm margin around them. Verification was done through a frozen section biopsy [8]. This removal resulted in a defect that involved the combined loss of both the front part of the ear's skin and its underlying cartilage. In a specific instance where only cartilage was exposed, a 3-mm segment of cartilage was additionally excised to create space for the flap to be inserted in the region of defect.

Harvesting Flap

A template was used to mark the imperfection on the rear section of the ear's pinna. This template was positioned to align the front two-thirds of the flap with the area behind the ear (forming the front wing), while the one-third remaining part extended over the mastoid region (creating the back wing) [9]. The flap's dimensions were planned to be 12 to 27% larger than the actual defect size, aiding in its transfer and proper positioning. A piece of subcutaneous tissue within the groove between the ear and mastoid was preserved, and an incision was made only in the skin to complete the flap's boundaries overall.

Transfer of Inset and Flap

The flap's wings underwent a rotation around its vertical axis, similar to the motion of a revolving door. Guided towards the anterior auricular area, these wings advanced to the ear's front surface by passing through a cartilage opening. During this process, the ear was gently drawn backward [9].
Subsequently, the ear-connected wing "auricular wing" was dislodged to overlay the frontal segment of the imperfection, extending towards the concha, and aligned with its leading edge. In parallel, the mastoid wing, linked to the mastoid region, was aligned with the posterior edge of the imperfection, directed towards the helix. Intermediate segment of the subcutaneous tissue remained attached to the "auriculomastoid groove". The edges of the skin surrounding it were brought together to meet the central parts of the upper and lower defect boundaries, thus finalizing the flap insertion.

Closure of Donor Site

After the proper positioning of flap was completed, donor site was primarily closed by bringing together edges of flap's donor defect located at the auricular and mastoid region [10]. This closure also ensured coverage of the subcutaneous pedicle in the retroauricular area.
To evaluate the ease of the flap procedure, the surgery was segmented in distinct stages: flap harvesting, transfer, insertion, and donor site closure [11]. Comprehension and implimentation of each stage were subjectively evaluated and categorized into simple sections, moderately difficult, or difficult. The complete duration of the operation was noted.

Evaluation and assessment

On the same day of procedure patients were discharged and provided with oral antibiotics and analgesics (pain killers). The patients underwent follow-up examinations on days after the procedure was conducted 1, 4, and 8, during which on the day eighthexcision of stitches were performed. Subsequently, examination of patients was conducted for potential occurrences of local recurrence and overall outcomes.
During the observation period, patients were monitored for possible complications such as flap congestion, pain, scarring, and ear fixation, among others. Significant ear fixation was recognized if the projection of the ear (space between scalp and helical rim), above the auricle's upper section, the measurement surpassed 5.02 mm, while at the midpoint, it exceeded 1.01 cm. The evaluation of data collected took place at the 6-month and 1-year marks, with measurements including the ear's ratio of height: breadth, structure and three- dimensional shape, symmetry, sensory perceptions, texture congruence and color.

Results and Analysis

The study involved 27 outpatients and surgeries were performed to treat Basal Cell Carcinoma (BCC) and 3 cases of pigmented nevus. Factors considered assessing surgery and its effects includes age, sex and site of surgery, surgery time and pinning of ear.
All cases involved the primary closure of the donor site. During a follow-up period lasting at least one year or until observation of patients, no instances of recurrence were detected. In the postoperative phase, six cases exhibited flap congestion; nonetheless, this concern autonomously and fully resolved within the initial two weeks without necessitating any intervention. Notably, there were no cases of complete or partial flap loss.

Twelve cases exhibited significant pinning of the ear, primarily observed with larger flaps. In nine instances, this condition showed symptomatic improvement, with minor residual pinning still present after one year. In three cases, major pinning persisted even at the one-year mark. Fifteen cases showed minor pinning occurrences, with twelve of them demonstrating subsequent improvement. However, minor complications in relation to scars at the donor site were reported in a single case.

Table 1: General operative details and complications studied in the follow up of 27 patients

Factors	**Frequency**
Age	
>60	18
≤60	09
Sex	
Males	18
Females	09
Site of surgery	
Conchal bowl	15
Scapha	06
Concha and helical root	06
Surgery time	
30- 50 min	12
50- 90 min	15
Pinning of ear (postoperative results of follow-ups)	
Resolved (minor)	12
Persisting (minor)	3
Residual minor (major)	9
Residual major (major)	3

Discussion

Tissue defects arising from oncological resection and trauma in the antihelix and concha regions can be effectively rectified using a subcutaneously anchored postauricular island flap. Other techniques for regional restoration often involve a two-step process or, in certain cases, necessitate the use of grafts. The method of harvesting this flap is distinct and might pose a challenge in its execution [9, 11]. This particular flap is referred to in the literature by several names, including alternating Flap, Back-and-Forth Flap, reversible Flap, backside island flap, behind-the-ear island flap, pedicle graft of sub-skin island, Cartilage-Bridge Island Pedicle Flap, or Passage Flap [12].

The classic indication for the RD flap involves repairing defects in the conchal bowl's anterior surface. In these cases, when the flap is moved, it results in minimal "pinning" effect. However, this approach has been adapted and expanded to effectively tackle concerns within the antihelix, helix, scapha, auditory meatus (external), and more extensive auricular imperfections [4]. While alternatives such as closure primarily, secondary is considered to be healing, skin grafting, and local flaps are available in addressing ant auricular defects, suboptimal in nature when dealing with situations involving exposed cartilage or combined defects affecting both the anterior skin and cartilage [2].

In contrast, the RD flap presents a flexible remedy by providing extensive coverage for exposed cartilage. It skillfully manages complex auricular imperfections, safeguarding the ear's three-dimensional form and outline. Furthermore, the initiation of primary closure at the donor site ensures any resultant scar remains hidden [13]. Notably, a significant benefit of the RD flap lies in its ability to be executed in a single procedure, necessitating solely local anesthesia and a concise surgical duration.

The RD flap receives its blood supply from the “auricular branch” of the “postauricular artery” located within the ‘retroauricular groove’. The subcutaneous pedicle’s abundant vascularization enables a broad range of movements to the flap. Nevertheless, notable limitations of the RD flap include the occurrence of "pinning," which refers to the attachment of the auricle to the scalp, and potential issues related to venous congestion [10]. Pinning becomes particularly problematic in

scenarios involving larger flaps or when the flap is harvested more peripherally on the auricle. However, these concerns might alleviate over time with the use of intralesional triamcinolone or through the implementation of physiotherapy.

The vital aspect of the surgery was the preservation of an ample subcutaneous pedicle within the auriculomastoid groove, positioned along the flap's axis. By gently drawing the flap forward and concurrently retracting the pinna backwards, the flap was adeptly maneuvered through the cartilage defect of the ear, analogous to threading through a "buttonhole." This method facilitated the eventual rotation of the flap, akin to the motion of a revolving door, pivoting on the axis provided by the subcutaneous pedicle [5, 8].

A fundamental strategy employed was ensuring alignment of the flap's anterior border with the anterior edge of the defect. This approach played a significant role in streamlining both the design and the transfer of the flap. In the study conducted, significant pinning was observed in twelve out of twenty-seven cases, with nine of these cases involving flap dimensions of 3 cm or more. It's noteworthy that, in almost all cases except one, major pinning was successfully managed through conservative methods, resulting in resolution in duration of follow-up.

Conclusion

The study revealed significance of the “Revolving door flap” as a recognized, convenient and safe surgical method for the treatment of BCC malignancy. It has a significant role in reconstructive surgeries, harvest technique and flap movement. Complete or partial flap loss is exceedingly uncommon with this technique. Moreover, the flap offers sensory perception, ensures favorable color congruence, preserves the natural contour of the ear, and allows for successful primary closure at the donor site, which is concealed adeptly.

While the occurrence of ear pinning is a notable issue and is observed frequently, it typically ameliorates with the passage of time. A crucial aspect lies in grasping the intricacies of flap design and transfer, a knowledge base that is fundamental for this distinctive and refined flap procedure.

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