Partial ear reconstruction

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Introduction

The ear is a sensory organ that receives and transduces extraordinarily sensitive frequency sounds between 16 and 20,000 Hz into nerve impulses subsequently interpreted in the auditory centers of the cerebral cortex; it consists of anatomical structures contained in the bone thickness of the temporal skull. The function of these structures is essentially to ensure the perception of two types of stimuli: sounds stimulation and statokinetic stimulation. For this reason we find two different type of receptors: receptors for the hearing sensation and statokinetic receptors for gravitational and acceleration perception.

The auditory system is topographically divided into three parts that follow one another in the lateral-to-medial direction: outer ear, middle ear, inner ear (See Picture).
The outer ear receives sound waves; through the chain of three small auditory bones, the middle ear transforms sound waves into mechanical vibrations; in the inner ear mechanical vibrations are transmitted to the fluid contained therein. The movements of the fluid are detected by specialized epithelial cells to stimulate axonal terminations of the acoustic nerve fibers. In addition, the inner ear also contains the vestibular organs, able to feel the rotational and linear accelerations of the head and generate nerve impulses necessary to maintain the body's balance. Therefore, the outer ear and the middle ear have the exclusive property of auditory sensation, while the inner ear has acoustic and statokinetic functions. Auditory sensation is picked up by the cochlear nerve, the statokinetic sensitivity is conducted by the vestibular nerve. These two nerves enter the cranial cavity through the internal acoustic meatus, heading to the axial centers of the pons and midbrain.

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Historical background

The auricle has always been related to aesthetic factors; infact its proportions to the cranial structures make it balanced and pleasant, with consequent positive influences on self esteem and better integration into society. For this reason the reconstruction of partial deficiency of the auricle has always represented a surgical challenge. Over the years, different authors have tried various surgical techniques: their application nowadays makes it possible to obtain satisfactory cosmetic results.

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External ear anatomy

The external ear includes the auricle and external auditory canal.

The auricle

The auricle is constituted by a skeleton of fibrocartilage covered by skin and is located in the lateral part of the head, anterior to the mastoid region; it is in relationship with the temporal region, with the temporomandibular joint and the parotid region.
Its shape is roughly oval with the major axis vertical, oriented slightly inferiorly and anteriorly.
The size of the auricle varies based on race, gender and age. Our group have studied the average size (length and width) expressed in mm, of the auricle. This study was conducted in a voluntary population divided into groups by age and height. The technique used for measuring the size of the ear was based on evaluation of four points, two for the length (above-and below-ear headset), two points for the width (pre-auricular and retro-auricular) and the measurement of the distance between the points mentioned above. Moreover, it was possible to evaluate the variation of size relative to the cartilaginous and soft tissue components. It was shown that increases in size, length and width of the ear, both in the cartilaginous and in the soft tissue component were directly correlated to age [2] [3].

Topographic anatomy of the auricle

In the auricle we consider two surfaces, lateral and cranial.

The lateral surface has characteristic eminences and numerous depressions, the largest of these is the concha and is located approximately in the center of the auricle itself; it continues directly into the external ear canal. The helix is the peripheral rim of the auricle and with its root divides the concha into two parts, an upper part or cymba conchae and a lower part, the cavum conchae; forward, upward and backward the helix constitutes the contour of the upper half of the auricle and extends down, with its tail, until reaching the lobule (or lobe)(See Picture).

In its posterosuperior portion the helix may present, a protrusion that takes the name of Darwin tubercle. The antihelix is a second ridge located between the concha and the helix from which it is separated by the groove of the helix (or scapha). The antihelix origins at the junction of two branches which delimit the triangular fossa. In front of the concha and below the helix root there is the tragus, a pointed eminence of triangular shape which partially hides the entrance of the external auditory canal. The antitragus is the tubercle which delimits the rear of the concha; it is located posterior to the tragus and is separated from it by the intertragal fold. The lobule (or lobe) of the auricle is a skin fold, devoid of cartilaginous skeleton, which is located in the lower part of the auricle, below the tragus, antitragus and the tail of the helix.
The cranial side of the auricle is free in his posterior aspect, while the anterior part adheres to the surface of the head. The auricolocephalic groove divides the lateral surface of the head from the free part of the auricle, which, in turn, presents elevations and depressions which correspond, on the opposite side, to the surface irregularities already described.

Vascularization of the auricle

The arteries that supply the auricle come from the superficial temporal artery and the posterior auricular artery (branches of the external carotid artery) (See Picture). The posterior auricular artery supplies the lateral face of the ear, through small perforating vessels that pierce the cartilage at the level of the triangular fossa, of the cymba conchae, of the helical root and the concha.

The superficial temporal artery provides blood supply through three ear branches. A branch ensures blood supply to the lobule (lower branch), a second one ensures blood supply to the tragus (middle branch), a third one ensures blood supply to the ascending helix (upper branch). The venous system of the auricle is made, at the lateral side, of the superficial temporal vein and at the medial side of the posterior auricular veins, all tributaries of the external jugular vein.
The lymphatic system of the auricle is organized in a rich network which belongs to three lymphnodal groups: the lymphatic vessels of the anterosuperior region of the lateral face merge to the pretragal lymphonodes and to parotidal subfascial lymphnodes; lymphatic vessels of the lower region of the lateral side are tributaries of the lower parotid lymphnodes; lymphatic vessels of the posterior part of the lateral side and of the medial side are tributaries of the mastoidal lymphnodes and inferior parotidal lymphnodes.

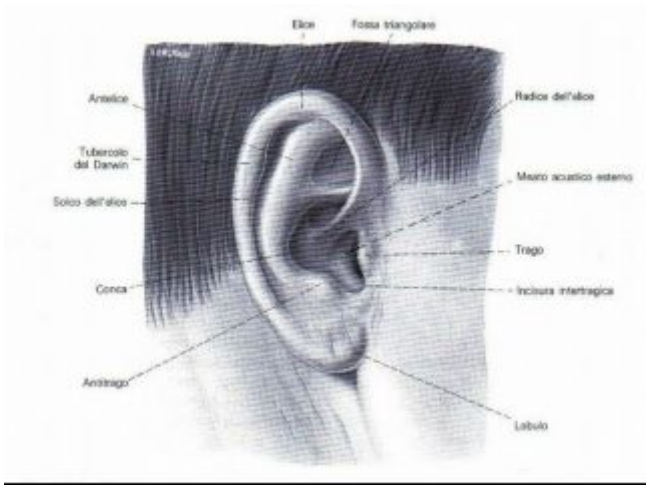
Innervation of the auricle

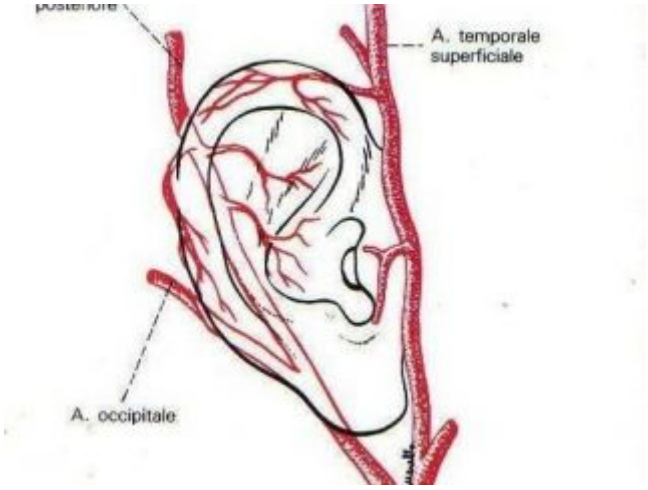
Auricular innervation can be divided into sensory and motor. Motor nerves are branches of the facial nerve and are directed to auricular extrinsic and intrinsic muscles. Sensory innervation is provided primarily by the trigeminal nerve and the cervical plexus. The trigeminal nerve, through the auriculotemporal nerve (mandibular), provides to the innervation of the tragus and of the ascending part of the helix. The cervical plexus, using the great auricular nerve, innervates the entire medial face, and most of the lateral face of the auricle. The skin of the concha receives sensory nerve fibers that come mostly from the headset branch of the vagus nerve.

External auditory canal

The external ear canal is structured with a fibrocartilaginous skeleton in his third side and a bony skeleton in its medial two thirds, which extends from the concha to the middle ear, ending at the level of the tympanic membrane. It is about 4 cm. in length if measured from the tragus; from the bottom of the concha its length is about 2.5 cm. It forms an S-shaped curve, and is directed at first inward, forward, and slightly upward (pars externa); it then passes inward and backward (pars media), and lastly is carried inward, forward, and slightly downward (pars interna). It is an oval cylindrical canal, the greatest diameter being directed downward and backward at the external orifice, but nearly horizontally at the inner end. It presents two constrictions, one near the inner end of the cartilaginous portion, and another, the isthmus, in the osseous portion, about 2 cm. from the bottom of the concha. The tympanic membrane, which closes the inner end of the meatus, is obliquely directed; in consequence of this the floor and anterior wall of the meatus are longer than the roof and posterior wall. The external acoustic meatus is formed partly by cartilage and membrane, and partly by bone, and is lined by skin. The cartilaginous portion is about 8 mm. in length; it is continuous with the auricular cartilage and firmly attached to the circumference of the auditory process of the temporal bone. The cartilage is deficient at the upper and back part of the meatus, its place being supplied by fibrous membrane; two or three deep fissures are present in the anterior part of the cartilage. The osseous portion is about 16 mm. in length, and is narrower than the cartilaginous portion. It is directed inward and a little forward, forming in its course a slight curve the convexity of which is upward and backward. Its inner end

is smaller than the outer, and sloped, the anterior wall projecting beyond the posterior for about 4 mm.; it is marked, except at its upper part, by a narrow groove, the tympanic sulcus, in which the circumference of the tympanic membrane is attached. Its outer end is dilated and rough in the greater part of its circumference, for the attachment of the cartilage of the auricula. The front and lower parts of the osseous portion are formed by a curved plate of bone, the tympanic part of the temporal.





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Clinics

Malignancies and precancerous lesions

More than 5% of malignant tumors of the skin interests the ear. Most of them are epithelial tumours: basal cell carcinoma and squamous cell carcinoma. In a lower percentage malignant melanoma can occur. Among the most frequently detected precancerosis, Bowen's disease and actinic keratosis should be included.

Basal cell carcinoma

Basal cell carcinoma (BCC) is a malignant epithelial tumour composed of cells similar to those of the basal layer of the epidermis and adnexal epithelial structures, closely related to a dermal stroma. It rarely metastasizes. Etiologically, basal cell carcinoma skin cancer is the most common and widespread lesion in white race. It affects with a slight predominance males, having the highest incidence between the sixth and the eighth decade. In addition to many predisposing factors (white skin, male gender, old age, family history, chronical sun exposure, local trauma), basal cell carcinoma may occur in patients receiving immunosuppressive therapy, or may occur on dystrophic chronic ulcers, or even on old scars. Basal cell carcinoma is most frequently localized at the antihelix, at the concha and at the posterior skin of the pinna. The possible clinical forms are: nodular, superficial and ulcerative.

The nodular basal cell carcinoma usually begins as a nodule, of colorful red-brownish or frankly erythematous, translucent, with thin teleangiectasias and with a not always evident pearly margin, constituted by a series of irregular whitish small nodules of the size of a pin tip that grow at the edges of the main lesion. This form can also present as pigmented BCC. The clinical course is slow and progressive with irregular growth superficially and deeply, down to the subcutaneous tissues (See Figure).

The ulcerative form may often show a rapid infiltration. It presents as an easily bleeding ulcer with sharp edges that tends to spread more towards the deep than to the skin surface.

The superficial basal cell carcinoma looks like an erythematous, slightly detected, sharp margins patch, with an appearance of rosary beads due to the presence of whitish and translucent nodules; it mostly appears in this eroded form, covered by a brownish crust. The course is particularly slow with a mostly superficial proliferation.

The superficial spreading type shows an infiltrated plaque, rather hard, whitish, with irregular margins, with fine teleangiectasia and erythematous, crusted or ulcerated areas distributed at the periphery of the lesion. This form has a very slow course and develops mainly superficially. Histologically, basal cell carcinoma is characterized by polymorphism. The lesion originates from undifferentiated multipotent epithelial cells and can differentiate into keratinizing basal cell. BCC can be divided into keratotic type (structures pilari), solid-infiltrating type (epidermis and dermis below), adenoideous type (glandular structures), sebaceous type (sebaceous structures), cystic type and dedifferentiate type. Other forms can present pigmented melanocytes and melanophages. The nodular clinical form must be considered in the differential diagnosis especially with squamous cell carcinoma, whereas the pigmented clinical form needs to be differentiated by malignant melanoma. Treatment is surgical. Different studies agree that the excision of basal cell carcinoma must be accompanied with at least 3/5 mm margin of skin around the lesion apparently clear from tumor. The lesion should always be sent to histological examination. You then need to run a close monitoring for early detection of local recurrence or similar lesions in the same area or in adjacent areas.

Squamous cell carcinoma

The squamous cell carcinoma (SCC) is a malignant epithelial tumor that can occur on any epithelium; it is made of cells that tend to keratinization. It is able to metastasize. Etiologically, squamous cell carcinoma is, after basal cell carcinoma, the most common malignant epithelial tumor. It affects with notable prevalence males with high incidence between the fifth and the seventh decade of life. There are certain predisposing factors: environmental (sun, ionizing radiation, artificial UV), individual (age, sex, skin type, tobacco use, immunosuppressive therapy) and skin (chronic ulcers, chronic radiodermitis, scars, SLE). The lesion is most frequently localized in areas of major sun exposure (helical margin, scapha, antihelix) and may be preceded by actinic keratosis. There are various clinical forms: nodular, infiltrative, ulcerative and vegetating.

The nodular form of SCC manifests a reddish nodule, often itchy that rapidly undergoes erosion and bleeding, crusting with close fitting. The nodule, surrounded by an erythematous area, tends to a quick growth in an irregular way, gaining an hard consistency and a characteristic fixity on the subcutaneous planes (See Figure). The erosion is progressive. The lesion is often painful.

The infiltrating SCC starts as small plate with blurred margins, normal coloured or hyperemic, smooth surface, often hollowed, consisting of hard, tightly adherent to the surrounding planes. The evolution is towards the ulcerative SCC (See Figure); infiltration progresses on the surface but also at depth. Last type occurs typically as an erosive scar that has no tendency to heal but rather to expansion and deepening.

The SCC vegetating form has an exophytic development but adheres to the surrounding planes and in depth. The surface can be eroded and bleeding.

Histologically, squamous cell carcinoma is a proliferation of neoplastic epithelial cells, which are worn by the epidermis in depth, with cytological aspects and architectural variables according to their degree of differentiation. There are three histological types: well-differentiated, moderately differentiated and poorly differentiated. The well differentiated histotype consists of cords of cells, which, considering their irregular shape and size, retain the ability to keratinization and express the formation of lamellar and rounded clusters of keratin (pearls corneas). The stroma does not undergo any significant change. The moderately differentiated histology differs from the previous one for greater anaplasia, that full maturation of cells and for their lack of keratinization. The poorly differentiated histology is an expression of a state of cellular anaplasia with a modest trend to maturation and keratinization. There are numerous multinucleated cells and a high mitotic index. The differential diagnosis is commonly made with keratoacanthoma and basal cell carcinoma. Actinic keratosis and others precancerous lesions can be safely evaluated only from the histological point of

view. The treatment of choice is surgical excision including a wide margin of healthy tissue around the lesion: 5 mm is considered appropriate. If lymphnodal involvement is suspected, an ultrasound examination of the affected lymphatic stations is indicated; in presence of sonographic positivity, biopsy of the suspicious lymphnodes is appropriate. In case of positivity, it is indicated to procede to radical lymphadenectomy. A close monitoring is useful for early detection of a local recurrence or similar lesions in the same or adjacent areas.

Malignant melanoma

Malignant melanoma is a malignant tumor that originates from melanocytes of the skin and mucous membranes, more rarely, from melanocytes located in extra-cutaneous sites such as the eye, the inner ear, or meninges. Malignant melanoma accounts for 3% of all malignancies and is responsible for 1% of deaths from malignant tumors. During the last years its incidence has increased dramatically. Etiologically malignant melanoma is rare before puberty, mainly affects people of both sexes, aged between 30 and 60 years, with a peak around 45 years. The main risk factors are family predisposition, a high number of naevi, the presence of congenital naevi and skin type. There is a risk factor related to the environment: intermittent exposure to sunlight, especially at a young age and of such intensity as to cause burns. The localization of malignant melanoma to the ear is rare, it interest most frequently anatomical subunits most exposed to degenerative solar radiations. Clinically, the tumor began as an asymmetric lesion then, it turns into patch, plaque or nodule with a tendency to ulceration. The edges are often indented: the color has uneven distribution, colour blackish-brown; the size varies from a few mm to several cm. Different forms are superficial spreading melanoma, nodular melanoma, lentigo maligna and acral melanoma. Amelanotic forms are possible, or localization to the subungual area. Melanoma can regress partially or totally and this phenomenon usually has a negative prognostic significance. Metastases may occur through lymphatic channels or through the blood and are distinguished in satellite, in-transit, regional and at distance. An early clinical diagnosis can be made through a careful and precise evaluation of some morphological characteristics summarized in the mnemonic ABCDE: asymmetry of the lesion, irregularly indented edges, color unevenly distributed, size greater than that of a common melanocytic nevus (> 6mm), age predominantly > 15, elevation of the lesion that shows the start of the invasive phase of the tumor, evolution with change in morphology. When the clinician suspects a melanoma, a complete removal of the lesion (excisional biopsy) is indicated for histopathology. Malignant melanoma is commonly in the differential diagnosis of melanocytic lesions and other benign or malignant lesions sometimes pigmented. The prognosis of malignant melanoma is variable according to the clinical parameters (gender, age, diameter of the lesion, presence of secondary lesions) and histological parameters such as Breslow thickness, Clark level of invasion, index of cellular mitosis, degree of ulceration, lymph node metastasis and distant metastasis. The treatment of choice is surgery. Any suspicious pigmented lesion should be removed for diagnostic purposes with a narrow margin, around 3 mm. The result of the histopathological examination will guide the treatment scheme. On the basis of the thickness of the tumor according to the Breslow classification, a wide local excision should be performed together with sentinel lymphnode biopsy, for cutaneous melanomas thicker than 1 mm. This is a diagnostic test that identifies the first lymph node that drains the skin area affected by melanoma. The identification of the node to be removed is done by a preoperative lymphoscintigraphy with isotope radiotracers specific for lymph node drainage. In malignant melanoma of the ear the most frequently involved lymph node basin is the in the lower parotid area.

Bowen's disease

Bowen's disease is an intraepidermal squamous cell carcinoma. More often affects the sun-exposed areas or areas involved in repeated traumas. In the auricle it is localized mainly to the marginal anatomical subunits. Clinically, it presents as a reddish patch, slightly detected, sharp margins, covered with scaly formations with underneath a grainy surface, moderately secreting but not bleeding. The lesion progressively increases in size and, usually over a decade, can transform into an invasive squamous cell carcinoma. The transformation is characterized by the appearance of nodules or ulcers, sometimes bleeding in the context of a squamous erythematous patch. Histologically, there is evidence of anaplastic squamous cells that proliferate in the thickness of the epithelial layers without exceeding the basal membrane. The anaplasia with presence of multinucleated giant cells, numerous mitoses and widespread structural disorder, demonstrates the neoplastic nature of this lesion. Bowen's disease must be differentiated from basal cell carcinoma. The first choice treatment is surgical excision with adequate clear margins (3-5 mm).

Actinic Keratosis

The actinic or solar keratosis is a circumscribed lesion characterized by hyperkeratosis of sun exposed skin. It is the most common of precancerous skin lesions, with the potential to evolve in a skin cancer. Etiologically prolonged exposure to solar radiation is the main cause. It is typically seen in people with light skin type, elderly or young people who lead a long life outdoors. In ear actinic keratosis is most frequently localized to

helix and antihelix. Clinically, actinic keratosis appears as a patch or macula slightly detected, a clear-cut limits, whose surface is dry, hyperkeratotic, brownish-yellow in color, sometimes warty or exophytic. Hyperkeratotic layer can be removed with difficulty proving to be an erosion surface, tending to bleed. Histologically, actinic keratosis is characterized by hyper- and parakeratosis with thickening of the epidermis. The course is slow with increase in the size of the lesion; malignant transformation is usually toward squamous cell carcinoma and occurs after a latency of years, with the appearance of infiltration at the base of the keratotic plaque and increase of its consistency. The lesion must be differentiated by superficial basal cell carcinoma, LES and seborrheic keratosis in the early stages. Surgical excision of the lesion and histopathology should be considered.

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Indications

The therapeutic approach for premalignant conditions and skin cancer affecting the auricle, consists in the surgical resection of the pathological tissue, ensuring tumor-free margins. Surgical treatment determines an acquired anatomical deficit that needs reconstruction. It is always better to estimate the real defect preoperatively: the extension of the defect is directly related to the size of the lesion and its histology linked skin margins. By the reconstructive point of view, partial and total defects can be identified and distinguished.

ACQUIRED PARTIAL DEFECTS

Acquired partial defects that result from excision of precancerous and skin cancer lesions can be:

1. marginal defects or in other words defects that affect topographical " peripheral" zones of the pinna itself;
2. non marginal defects or defects affecting the central areas of the ear.

Both marginal and non marginal defects should be further divided into full-thickness and partial-thickness, depending on the actual involvement of anatomical layers. Generally, marginal deficits mostly involve the helix and can affect the upper third, the middle third or the lower third of the ear. Classical and modified wedge excisions in addition to reconstructive technique of Antia and Buch and its modifications can be used for the reconstruction of full-thickness marginal defects. When the deficit is full thickness and is wide enough to affect the whole central portion of the ear, the flap described by Dieffenbach [postauricular advancement flap] can be helpful. In the reconstruction of non marginal defects, the chondrocutaneous rotation flap described by Ramirez is indicated. In other cases, the postauricular "revolving door" island flap may be used. The postauricular flap, and its variations, can be widely used in the reconstruction of marginal and non-marginal partial thickness defects.

ACQUIRED TOTAL DEFECTS

Acquired total defects of the ear can be caused by burns, trauma (primary or secondary amputation) or can be the result of surgical removal of a tumor of significant size.

Total ear reconstruction requires expertise and different techniques can be used.

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Contraindications

There are no significant contraindications to the surgical treatment of ear tumors. The early diagnosis of skin cancer and their effective treatment can lead to optimal results for both oncological radicality and aesthetic outcome. Patients have to be cooperative during the first part of the procedure because anesthesia is performed by local injection.

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Principles of surgical therapy

Reconstruction of full thickness marginal defects

Wedge excision technique

Wedge excision is a simple and effective method in the reconstruction of full-thickness marginal defects; it can be used to reconstruct small defects sized less than 1.5 cm, located in the middle third of the ear, on the helix and on the antihelix. In certain cases, small triangles of Burow can be excised at the two sides of the wedge to allow closure without evident alterations of the curvatures of the auricle itself. [6] This technique is based on the conversion of a skin defect in a full-thickness wedge (anterior skin, cartilage and posterior skin) of triangular shape (See Figure). Ideally, the internal angle of the wedge is 30°, to minimize the risk of consequent deformity [7].

The advantages of this technique are the simplicity and speed of execution; the operation is performed in a single stage. The limit of this technique is that in presence of defects larger than 1.5 cm, the result can be unsatisfactory because of resulting deformities [6].

With regard to this technique different deformities of the auricle such as "cupping" deformity (see Figure), (See

Figure) or "webbing" deformity (See Figure) (See Figure) [8], secondary to this operation, have been reported in literature.

Star excision technique

The star technique can be considered a modification of the wedge excision technique, to which two triangles opposite and symmetrical are added. It is indicated in the reconstruction of marginal defects affecting the helix, the antihelix and the scapha. In each case the size of the defect should not be more than 1/4 of the total size of the auricle. This technique is based on the presence of a full-thickness marginal defect with rectangular shape. From the inner margin of the defect, are performed full-thickness incisions, after an appropriate preoperative planning, of the skin (anterior and posterior) and cartilage according to the design of a star that extends in a centripetal direction to scapha and/or to the antihelix (See Figure), (See Figure), (See Figure), (See Figure).

Star technique provides good results in terms of maintaining the normal shape of the auricle even if with the consequent reduction of total dimensions.

Staggered wedge excision technique

This technique is similar to the previous one. It is mainly used for the reconstruction of helical defects (See Figure), (See Figure). Lesion is removed with margins in a full-thickness excision. Above the lesion, a full-thickness wedge is removed (See Figure). It possible to close the defect with an upward advancement of the antihelix associated to an inferior advancement of the helical flap (see Figure). [4] In this way it is possible to reduce the risk of deformities related to the intervention.

Chondrocutaneous advancement flaps (Antia and Buch)

The success of this technique depends on the possibility of releasing the helix from scapha, with an anterior incision at the helical groove that should be performed including the cartilage, but without involving the posterior skin (See Figure), (See Figure), (See Figure). Dissection down to the anterior perichondrium provides mobilization of the helix, prepared as a chondrocutaneous flap based on the posterior skin. Extra amount of tissue can be obtained with a V-Y advancement flap at the level of the helical radix: this is necessary in the correction of the constricted ear or in the reconstruction of large defects (up to 2,5 cm). To prevent excessive tension at the suture line, it is possible to remove part of the external cartilage of the scapha [5].

Antia has designed this technique for the reconstruction of defects of a size not larger than 2.5 cm, affecting the helix. Although Antia has originally described for the reconstruction of defects of the upper third, this method is also valid for the reconstruction of middle third defects, as well as those located at the junction between the middle and lower third [5].

The advantages of the Antia technique are safety, simplicity and speed of execution of the flap; it is important to note that the scars of this operation are well hidden in the natural shadows of the ear. The drawback consists in a reduction of the size of the auricle, compared with the controlateral auricle. In this case Antia has proposed a wedge excision on the healthy auricle, where this should appear more prominent, so as to reduce the asymmetry [5].

Chondrocutaneous composite flaps (Fata)

Fata proposed this technique for the reconstruction of large full-thickness marginal defects involving helix, antihelix and scapha (See Figure), (See Figure). The technique is based on two chondrocutaneous advancement flaps following the principle previously highlighted by Antia and Buch. The skin of the medial surface is left intact, but dissected by the chondrocutaneous flaps. Anterior wedge-shaped excisions, that include anterior skin and cartilage, should be performed at the upper and lower pole of the concha (See Figure). For larger defects, the concha can be reduced by excision of skin and cartilage on its outer margin until there is no tension on skin margins (See Figure). [10]

This technique differs in part from that of Antia and Buch, because skin and cartilage are incised including the antihelix rather than the helix alone. Flap movement is by rotation advancement. The tendency to ear cupping is minimized [10].

The advantages of this one stage technique are a good vascularization of the flaps, safety and speed of execution. The disadvantage is that this technique significantly reduces the vertical dimensions of the auricle, especially if used for reconstructing large defects.

Modified chondrocutaneous advancement flaps (Butler)

Butler described a technique that is another modification of Antia and Buch technique based on the use of chondrocutaneous advancement flaps. Butler proposed a modification that can be used for reconstruction of

full-thickness defects that also affect the scapha, the antihelix and the triangular fossa, based on the combination of a reduction procedure of the ear with advancement flaps of the helical margins (See Figure).
Skin and cartilage of the ear are incised along the helical groove, from the root down to the lobule. Anterolateral skin and cartilage of the scapha, including parts of the triangular fossa and antihelix, are excised. An anterolateral skin Burow's triangle of the lobule is excised. A complete posteromedial dissection of the skin from the cartilage surface down to the auricolocephalic sulcus is performed. The flaps of the helical margin are advanced, avoiding the tension of the tissues with the meticulous apposition of cartilage using vertical mattress sutures. If further advancement is needed, three options, excision of a larger Burow's triangle, V-Y advancement of the helical root, further reduction of scapha, could be performed. Excision of posterior skin excess is made, having care to preserve blood supply [11].
One stage operation, simplicity, a slight reduction of the vertical height are the main advantages of this technique. Cupping deformities or variations of the treated ear projection are not generally detected. The disadvantages of this technique are: contour alteration of the lobule and more or less evident scars [11].

Modified advancement chondro-cutaneous flap (Low)

This is a modification of the design of the chondrocutaneous advancement flap proposed by Antia and Buch for reconstruction of larger defects that do not affect just the helical margin. The modification described is based on an extension of Antia skin flaps (See Figure). [9] According to this technique, helical chondrocutaneous flaps are first designed with an additional cutaneous component made of two triangular skin flaps; these two triangular flaps come from the anterior skin and are based on the helical margin. Skin flaps are incised and dissected from the underlying perichondrium of scapha and antihelix. Then the cartilage extremities of the two flaps are approximated and the skin sutured. By doing so, Low provides an adequate profile of the ear, without deformity of size and shape, with complete coverage of the deficit [9].

Dieffenbach flap

In presence of full-thickness lesions affecting various subunits of the middle third, surgical excision is usually extremely aggressive. Reconstruction is challenging.
Dieffenbach flap is a valid solution. It is a postauricular pedicle advancement skin flap, drawn on the skin of the mastoid region. After excision margins of the lesion are marked on the auricle (See Figure), flap is designed according to the expected defect dimensions. Flap is harvested and advanced to the defect. Dieffenbach flap is moved anteriorly, exploiting the elasticity of the skin. Its effectiveness is greater in elderly patients, in which skin tension is minimal. Flap is sutured to the remaining pinna, clear from tumour. A drain can be applied, which can be removed within 24-48 hours (See Figure). The execution of the Dieffenbach flap is not complex, but requires a second operative stage to divide the pedicle and redefine the helix (See Figure). Aesthetic results are not exciting, but must be evaluated relative to defect's size.

Reconstruction of partial thickness marginal defects

Postauricular pedicled flap (Peninsular)

The reconstruction of an acquired partial defect of the ear, where localized at marginal anatomical subunits, can be obtained by the use of postauricular peninsular flap; flap is drawn at the postauricular region, based on a cutaneous pedicle, that can be superior or inferior.
The peninsular flaps are designed as a long "V"; the open end of the "V" indicates the whole thickness base of the flap that can be both, superior and inferior.
The lesions are excised according to oncological principles and the deficit that emerges is prepared to receive the flap.
The design of the flap is performed preoperatively: it highlights the skin island. No special care is taken to include the posterior auricular artery. The width of the pedicle is equal to the maximum width of the ellipse. At the end of the pedicle, the skin on both margins of the ellipse is dissected to allow the pedicle to be more mobile to retain its width. The flap is raised with all the subcutaneous tissue from the auricolocephalic groove and transferred to the deficit. The donor site is closed by primary intention.
Peninsular flaps can be superiorly pedicled (See Figure), (See Figure), (See Figure), (See Figure) for defects of the superior pole and inferiorly pedicled (See Figure), (See Figure), (See Figure) (See Figure) for lower pole defects.
Reconstruction of the lobule [12] can be obtained by a peninsular inferiorly pedicled flap (See Figure), (See Figure), (See Figure), (See Figure).

Postauricular propeller island flap

The postauricular propeller island flap is a pedicled flap, with a subcutaneous pedicle, mainly used in the reconstruction of partial thickness marginal defects. A subcutaneous pedicle propeller flap is preferred in the reconstruction of localized defects in all anatomical subunits on the lateral auricle surface: the root and the anterior part of the helix, the scapha, the upper crura, the lower portion of the antihelix and the tragus. Different to the revolving door flap, the subcutaneous pedicle of propeller flap is eccentric (positioned at one end of the ellipse), while the skin island is along the ellipse (See Figure), (See Figure). The flap is transferred to the deficit with a 180° rotation of the skin island, without any opening of the cartilage (See Figure), (See Figure), (See Figure). The donor site is directly closed.

Reconstruction of non-marginal defects

Chondrocutaneous rotation flap for not marginal defects: Ramirez technique

Ramirez offered an effective surgical technique in the reconstruction of large defects of all non-marginal subunits of the auricle (See Figure) such as antihelix, scapha, triangular fossa and concha. Based on the principle of the separation of various ear anatomical subunits, it uses their redistribution for closing defects in not marginal areas without minimal sacrifice of tissue, size and shape. It is a reliable technique, relatively simple that can be performed in a single stage.

After resection of the tumor with adequate margins, including the underlying cartilage, an incision along the scapha (depression between helix and antihelix) can be extended, down to the lobule. The vascularization of the helical chondrocutaneous flap is based on the postauricular skin and the vascularization of the chondrocutaneous flap of antihelix and concha is based on the preauricular skin. The internal flap is advanced superiorly and the external flap is advanced inferiorly (see Figure), (See Figure), (See Figure). A small cartilage wedge can be excised where the two flaps meet, to favour their rotation. Main donor site is at the level of the lobule. To be able to get closure, V-Y fashion or rotation flaps can be used (See Figure). [13]

Revolving Door flap

The postauricular revolving door flap is an island flap with subcutaneous pedicle. The revolving door flap is performed according to the original description of Masson [14]; it is used in the reconstruction of acquired partial defects mainly affecting the concha [15] (See Figure), (See Figure), (See Figure), (See Figure) (See Figure), (See Figure).

Postauricular flap

Postauricular flap can be considered, due to its versatility and effectiveness, one of the best options in the surgical reconstruction of this anatomical area. Different locations of the defects require different types of design of postauricular flap. There is no single design of this flap to be used as universal in the reconstruction of auricular defects, but it is always necessary to choose and plan the most suitable design of the flap.

Postauricular flap classification

Postauricular flaps are classified in two groups:

- island
- peninsular

Postauricular **island** flaps are divided into dermal pedicle flaps and subcutaneous pedicle flaps.

Dermal pedicle island flaps are further classified according to the direction of their pedicle and based on the transfer method. There are: island superior pedicle folded flaps, island superior pedicle twisted flaps, island inferior pedicle folded flaps and island inferior pedicle twisted flaps.

The subcutaneous pedicle island flaps are the Revolving Door flap and the Propeller flap.

Peninsular postauricular flaps are standard trasposition flaps that can be grouped into superior pedicle and inferior pedicle flaps.

Surgical technique

The design of the flap begins with the design of the skin island in a way that this has the same characteristics of form and size of the defect to reconstruct. The skin island is just drawn on the skin of the postauricular area, centered on the auricolo-cephalic groove [16]. The remaining drawings and procedural steps are different

depending on the type of pedicle.
The postauricular donor site is closed by primary intention.

Postauricular dermal pedicle island flap

Marking involves an ellipse drawn with the main axis along the auriculocephalic groove. The ellipse includes the skin paddle and the pedicle area. The pedicle of the flap can be superiorly or inferiorly based according to the position of the defect. [17]. The pedicle area is de-epithelialized and the skin edges on both sides of the pedicle are freed laterally to enhance its mobility. An adequate window in the auricular cartilage is made to transfer the flap to the defect anteriorly. The flap and its pedicle are gently passed through the cartilage window. Transfer is either by folding or twisting the pedicle on its longitudinal axis to bring the skin paddle into position without any tension or distortion. The skin paddle is then tailored to match the exact shape of the defect. This involves trimming the distal tip of the ellipse and the edges of the flap as necessary. The donor site is directly closed.

Postauricular subcutaneous pedicle island flap

Postauricular subcutaneous pedicle island flaps are the postauricular revolving door flap already described in the reconstruction of partial non-marginal deficit and the postauricular propeller flap described in the reconstruction of partial thickness marginal defects.

Postauricular peninsular flaps

Postauricular peninsular flaps, drawn with either superior or inferior pedicle have already been described in the reconstruction of partial thickness marginal defects.

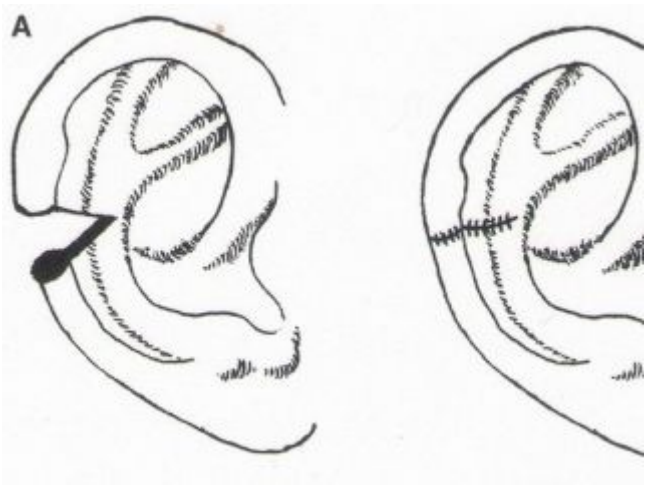
Surgical indications of the postauricular flap

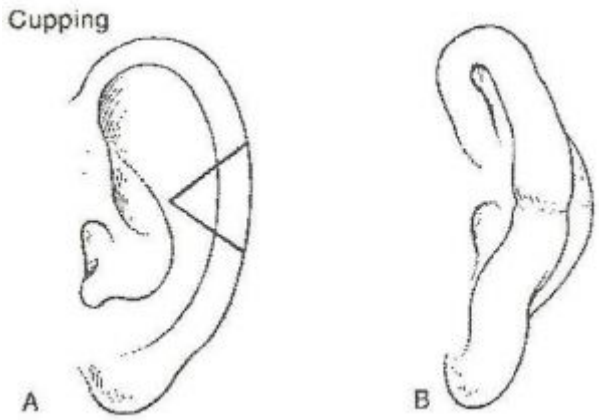
The auricle can be divided into several areas that can be central and peripheral.
The central area of the auricle is the concha: the postauricular flap type most suitable for the reconstruction of conchal defects is the previously described subcutaneous pedicle revolving door island flap.
The peripheral area of the auricle is divided into lateral and medial.
The lateral face includes the root and the anterior part of the helix, the scapha, the upper and lower crura of the antihelix and the tragus: the postauricular flap type most suitable for the reconstruction of a deficit of this area is the already described subcutaneous pedicle propeller island flap.
The auricular lateral face is divided into upper third, middle third, lower third and lobule.
The upper third can be reconstructed with a superior folded dermal pedicle island flap (See Figure).
The middle third can be reconstructed with a superior dermal twisted pedicle island flap (See Figure), or with an inferior dermal twisted pedicle island flap (See Figure).
The lower third can be reconstructed with an inferior dermal folded pedicle island flap (See Figure).
If the defect of the helix margin extends to the medial face of the auricle, it is possible to use peninsular flaps, as previously described, which can be superiorly pedicled for deficits of the upper pole and inferiorly pedicled for deficits of the lower pole.
The reconstruction of the lobule [12] can be obtained by peninsular inferior pedicle flaps or by subcutaneous pedicle propeller island flaps.
Therefore, according to different localizations of the defect, different designs of postauricular flap are allocated. The topographical zones of the ear and their corresponding postauricular flaps are represented as follows (See Figure). [18]

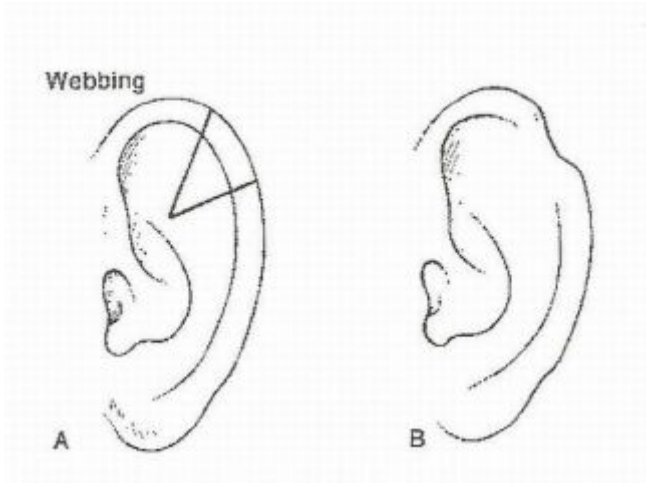
The postauricular flap is highly regarded for its rapid availability, for its rich vascularization and the easyness of donor site closure. This flap is used in the form of different designs. In practice, none of the described postauricular flap designs can be used as universal choice in the closure of deficit localized in different areas of the auricle.
Some authors stressed the importance of the vascular anatomy of the postauricular region in planning postauricular flaps. Postauricular flaps have been considered axial flaps, based on one of the major divisions of the posterior auricular artery [19]. The clinical and surgical experience has shown us that the postauricular flap is suitable to close almost all partial ear defects with a simplified and standardized approach.
The idea of using the skin area localized behind the ear is relatively recent: it was first described by Brown and Cannon in 1946 as a donor site for skin grafts.
The posterior auricular skin area became the donor site of choice for full-thickness skin grafts, for local flaps, for regional flaps and even for free flaps in facial reconstruction. The popularity of this area as a donor site is mainly due to its minimal morbidity, with little or no distortion of local anatomy, the ability to hide the scars, to

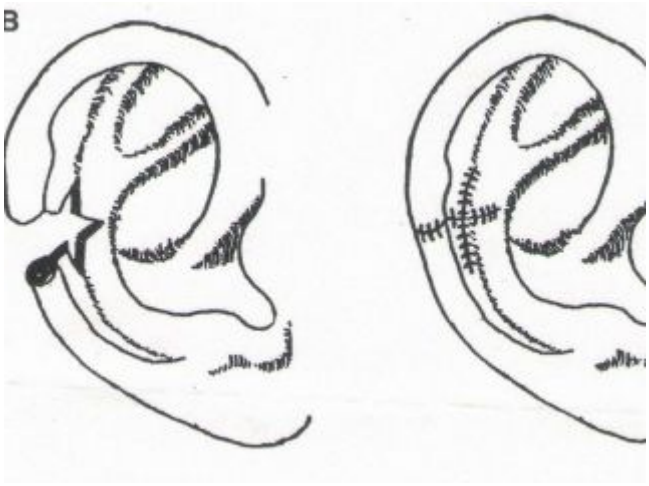
the possibility of direct closure, the excellent match to the ear skin, excellent match to the other districts facial skin and, finally, to the richness of its dermal and subcutaneous vascular plexus [20].

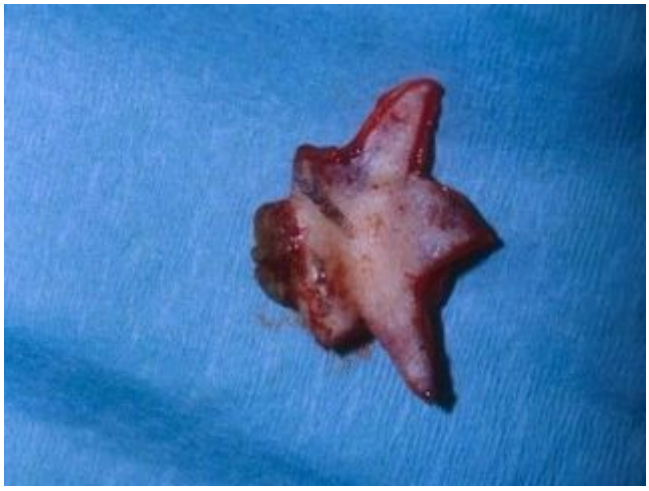
In conclusion, postauricular flap is the natural surgical option in the reconstruction of partial defects of the auricle. The key to get good aesthetic and reconstructive results is the choice of the most suitable design from those available.

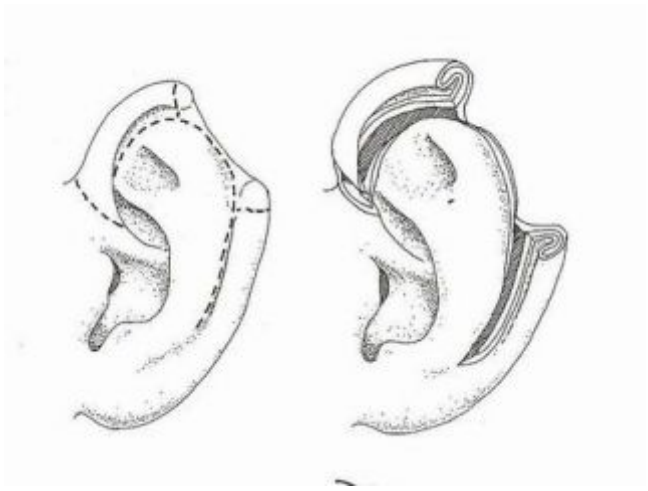


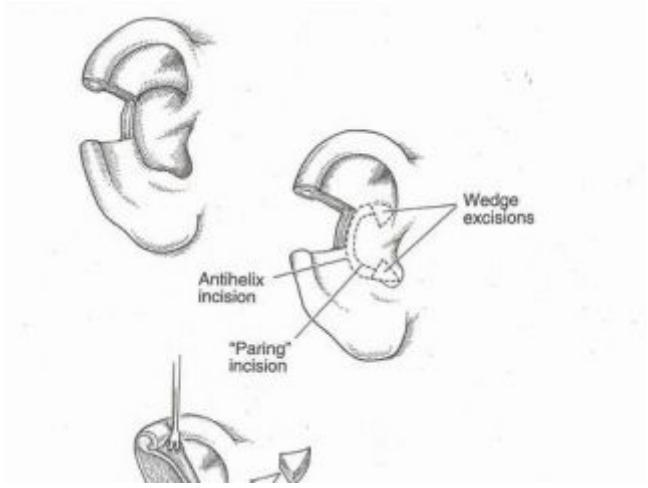


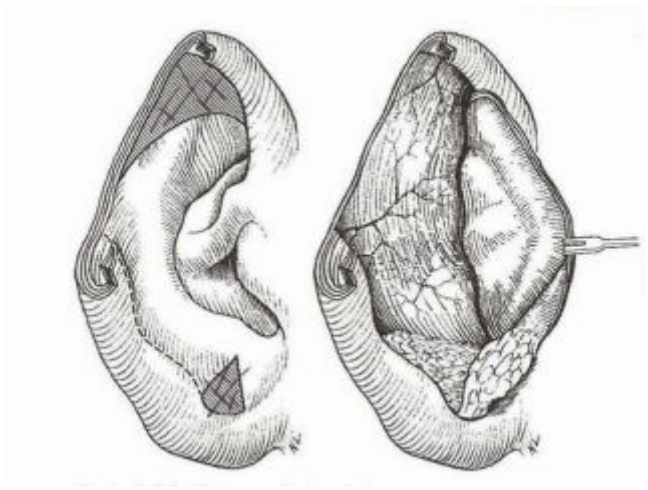

Webbing
A
B

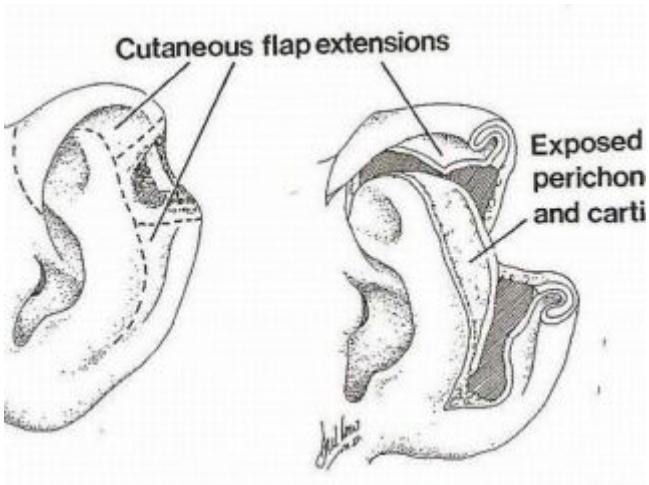

B

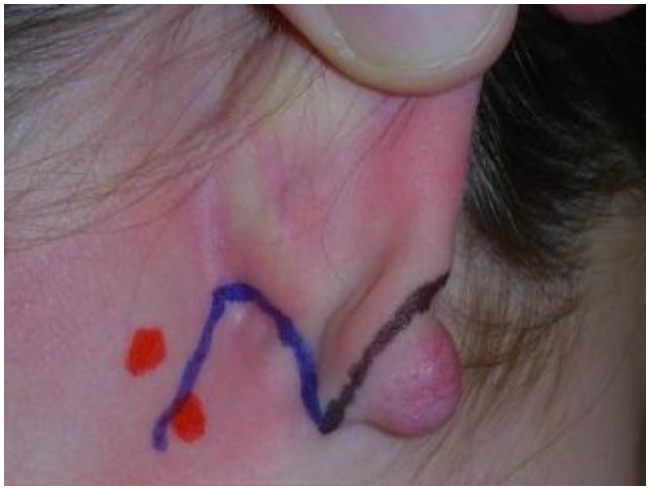


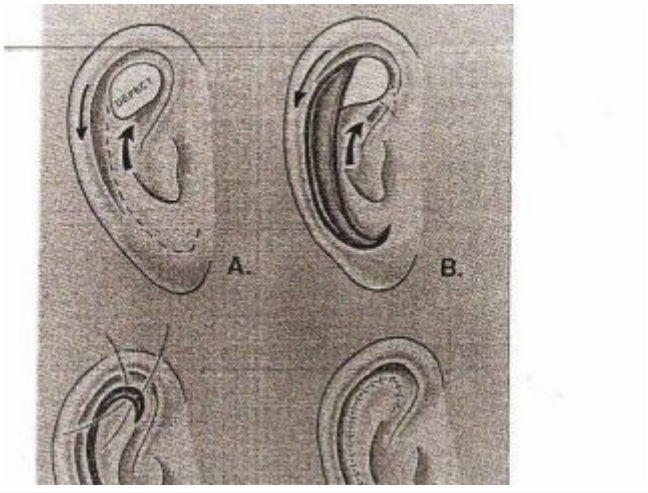


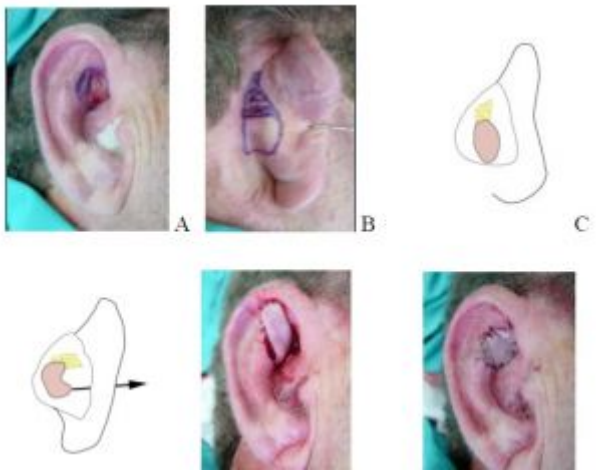

Wedge excisions
Antihelix incision
"Paring" incision

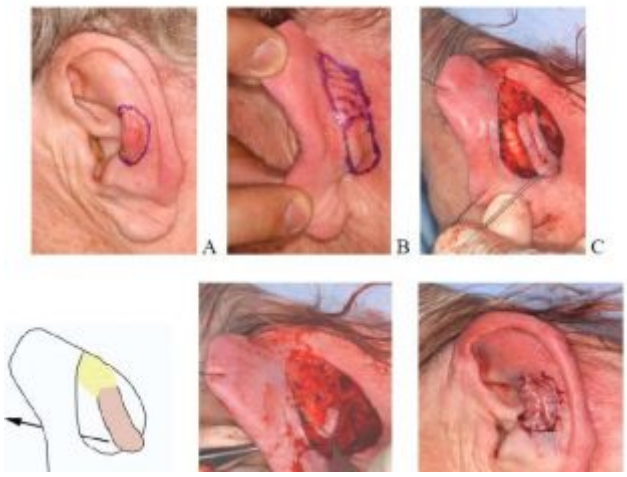


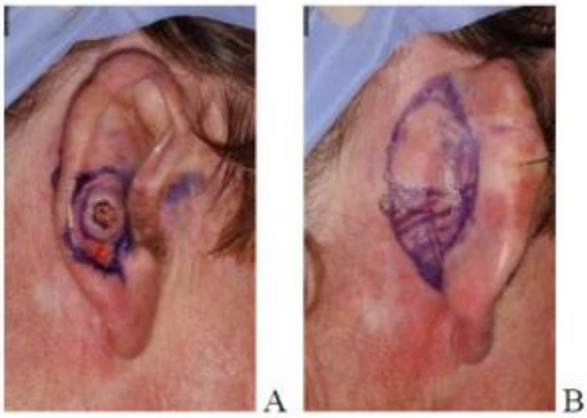

Cutaneous flap extensions
Exposed
perichon
and carti




DEFECT
A.
B.


A
B
C


A
B
C


A
B

	Region
1	Anterior upper half of helix
2	Scapha
3	Upper antihelix
4	Middle antihelix
5	Lower antihelix, antitragus
6	Lobule and lower helix
7	Concha
8	Helical root

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Postoperative treatment

Antibiotic therapy is prescribed to patients who undergo surgery for the reconstruction of partial ear defects. The antibiotic is chosen taking into account any specific allergy; the oral administration of Cefuroxime for 5 days is preferred, starting the day of surgery. An anti-inflammatory and pain medications should be added for the first couple of days.

The first check is made about on the 5th postoperative day: it's necessary to assess local conditions, an eventual onset of complications; the vitality of the flap used for reconstruction is assessed and a new wound dressing is applied.

The second check is to be carried about on the 7th - 10th postoperative day: local conditions are evaluated and stitches can be generally removed.

The result of histology is a key moment in the management of these patients: this result indicates the type of the lesion excised and evaluates the adequacy of the margins.

The subsequent follow-up appointments are programmed at 1, 3 and 6 months from the date of surgery; the correct timing and the possible integration with other diagnostic procedures are to be evaluated according to the type of the lesion excised.

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Complications

INFECTION

In patients who undergo reconstruction following oncological resection of the pinna, a surgical site infection may arise in the immediate postoperative days (36-48 hours) and may be caused by different types of microorganisms (eg. Staphylococcus aureus, Staphylococcus epidermidis, etc.). Infection may affect the skin and the underlying cartilage and can be characterized by local signs of inflammation (swelling, heat and tenderness around the wound), discharge of purulent material, the presence of contaminated fluids. Patients may present temperature. In this condition a specific antibiotic therapy is required.

HEMATOMA

This complication is related to the presence of bleeding at the surgical site. It may require an external drainage.

PARTIAL OR TOTAL FLAP NECROSIS

Tissue necrosis is a complication that generally affects the skin and subcutaneous tissue of different flaps used to close ear defects. Flap necrosis can be partial or total and is due to insufficient blood supply or venous stasis. The onset of infection and hematoma may also cause tissue necrosis.

CHONDRITIS

It is the inflammatory involvement of the cartilaginous structures of the ear. In patients who undergo surgery for reconstruction of the ear, chondritis is due to infective processes supported by bacteria such as Staphylococcus, Streptococcus and Pseudomonas. The cartilaginous localization of the infection may cause degenerative modifications with subsequent permanent cosmetic deformities relative to the irreversible erosion of the cartilage.

PATHOLOGICAL SCARS

Hypertrophic scars and keloids are the result of an altered response of the skin to trauma. Keloids, in particular, are most likely to appear on the ear and therefore represent a serious complication of any surgical procedure involving this anatomical region.

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