

RECONSTRUCTION OF THE EXTERNAL EAR* †

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NEW YORK, N. Y.

RECONSTRUCTION OF THE EXTERNAL EAR to correct for substance lost by reason of congenital, post-infectious, or posttraumatic defects, or following excision of malignant tumor, represents one of the most difficult problems in plastic surgery. An abnormal ear is conspicuous and an absent one is a major cephalic deformity. Criteria for successful reconstruction have been set down by Suraci who lists seven points as essentials if the reconstruction is to be acceptable to patient and to surgeon. These are: correct size, similarity of outline, similarity of height, correct cephalo-auricular angle, permanency of size and shape, rigidity of the ear and matching color. The earliest attempts at reconstruction of the ear fell far short of this goal.

Survey of the literature reveals that Tagliacozzi,² in the 16th century, referred to the repair of partial losses of the ear by the use of flaps of skin from the scalp or neck. Also, Dieffenbach,³ in 1830, outlined the reconstruction of partial defects by the use of local flaps. In 1870, Szymanowski⁴ reported his technic for subtotal reconstruction of the external ear. The method utilized the principle of the local flap, outlined in butterfly shape on the scalp, then elevated and folded on itself. In 1907, Nelaton and Ombredanne⁵ proposed a local flap for partial loss of the ear, providing rigidity by the insertion of a free graft of cartilage. Gillies⁶ (1920) embedded free grafts of cartilage in the auricular area, elevating the constructed pinna into position at a second operation. Van Dijk⁷ (1926) reported one case of total loss of the ear following a burn by electricity. He used a compound cervico-thoracic flap incorporating costal cartilage. De River⁸ (1927) utilized the Szymanowski "butterfly" flap combined with a tubed pedicle. Graham⁹ (1927) used septal cartilage as a buried transplant, reflecting a flap of skin from behind the ear at the second stage of the procedure. Graham also reported a case of Pierce¹⁰ in which buried costal cartilage had been elevated and backed with a stent graft of skin after which a thoracic tubed pedicle was transplanted to simulate the helix of the ear. Pierce¹⁰ (1930) reported four cases in which he used free cartilage as an inlay graft combined with a cervical tubed pedicle to construct the helix. Lockwood¹¹ (1930) reported two cases constructed by the use of pedicled flaps of soft tissue. The results were not comparable to those of Pierce. New¹² (1931) published photographs of one case of partial traumatic loss repaired by a tubed flap from the thoracic area. Easer¹³ (1935) used foreign material, hard rubber, to supply rigidity to the reconstructed ear. Padgett¹⁴ (1938) reported four cases in which he had used Pierce's technic modified

* Read before the Surgical Section of the New York Academy of Medicine, January 2, 1948.

† Submitted for publication, May 1948.

by the use of a split flap of soft tissue. Newman¹⁵ (1941) reported two cases in which Pierce's technic had been used with gratifying results. Gillies¹⁶ (1937) reported on his failure in one case to make use successfully of a pedicled flap supported by carved grafts of iliac bone. He also listed cases in which

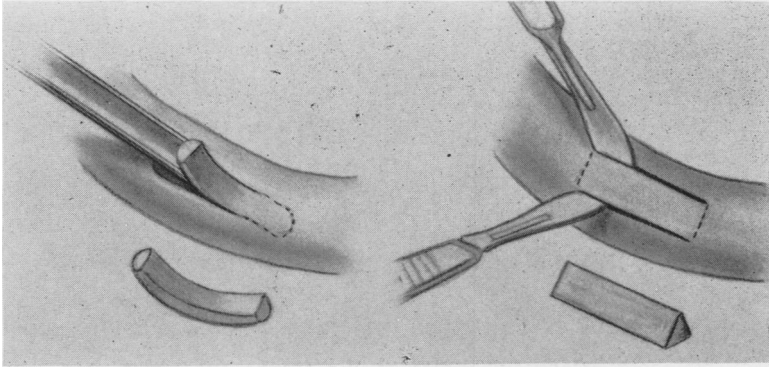


FIG. 1.—The technic of cutting free cartilage grafts by gouge as shown at the left causes compression of the cartilage so that some degree of distortion or curling of the graft is unavoidable. The use of two scalpels as shown at the right prevents abnormal compression of the cells and minimizes the tendency to curling.

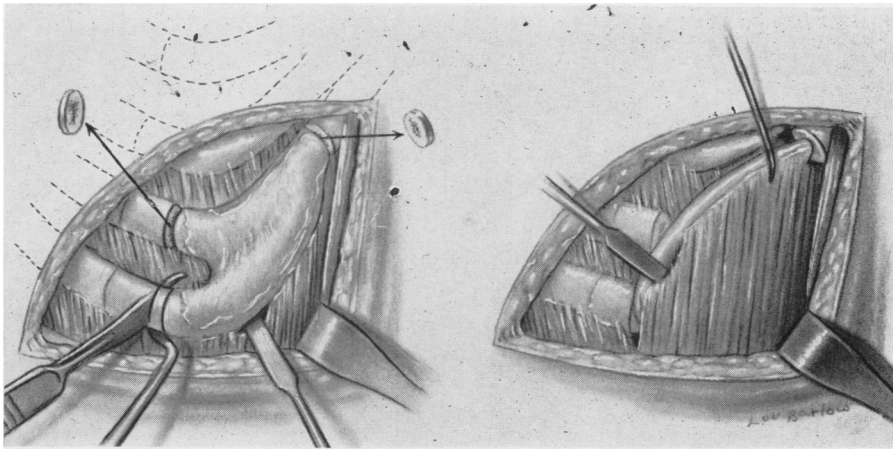


FIG 2.—Sketch showing the technic of cutting the costo-chondral cartilages so that a large free graft may be obtained from the site of fusion of two cartilages. The excision of a disc, 2 to 3 mm. in thickness, at the level of each transection facilitates the removal of a large block of cartilage.

cartilage from the maternal ear was substituted as a homoplastic graft for the absent auricle. This type of transplant was successful in five of seven cases. Nattinger¹⁷ (1937) also reported two cases in which maternal ear cartilage had been used successfully. Pierce and O'Connor¹⁸ (1938) used preserved cartilage from cadavers or living cartilage from the ear of the mother. Kirk-

ham¹⁹ (1940) also reported on the use of cadaver cartilage for reconstruction of the ear. In his technic the dead cartilage was perforated freely and soaked in solution of formalin to establish rigidity of the graft. A further report by Gillies²⁰ (1941) listed 16 cases in which cartilage from the mother's ear had

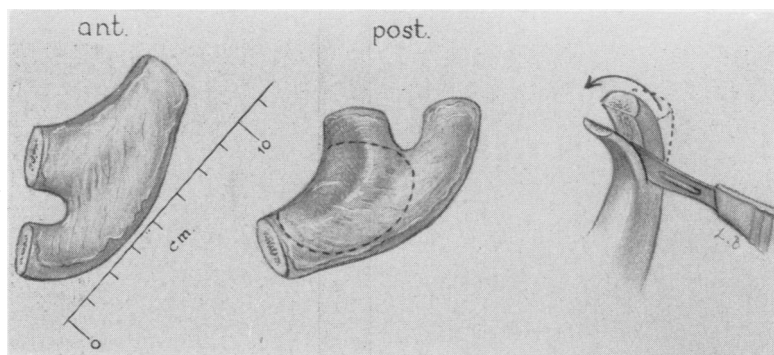


FIG. 3.—Sketch showing the anterior and posterior aspects of a specimen of costochondral plate at the level of fusion of the cartilages of the 8th and 9th ribs. The posterior aspect of such a specimen is concave. As the costal cartilage is thinned by carving, advantage is taken of the tendency of such cartilage to curl, in order to exaggerate this concavity. The transplant is embedded under the skin of the auricular region in such a way that the concavity of the graft assumes the position of the concha of the normal ear.

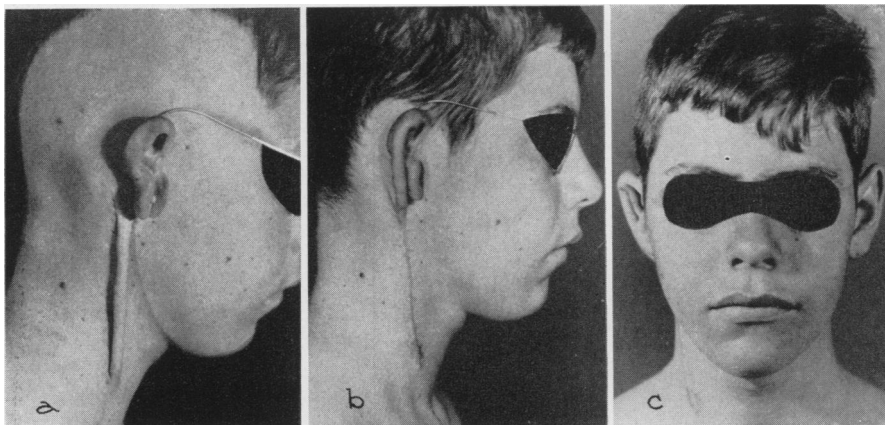


FIG. 4.—Case 1 (a) congenital microtia corrected by use of a cervical tubed pedicle. (b) pedicle detached at its lower end and sutured to upper portion of pinna. (c) appearance after suture of the tubed pedicle to the ear.

been transplanted to the child; 11 of these were considered successes. In two cases there was aseptic absorption of the cartilage and in three the grafts were lost due to sepsis. Greeley²¹ (1941) used this method but later reported that there was absorption of the maternal cartilage. Young²² (1940), in animal experimentation, observed that strips of costal cartilage healed by cartilaginous union when transplanted to articular surfaces. Then, in 1941, Young²³ pre-

sented a new idea. In animal experiments he determined that autogenous costal cartilage, finely chopped and seeded over the fascia of the rectus muscle, stayed viable and fused into a solid sheet of opaque "cartilage-like" tissue. The fused areas were found to consist of fibrous tissue. Grossly this tissue had some of the properties of fibro-elastic cartilage. Peer²⁴ (1943) reported on the

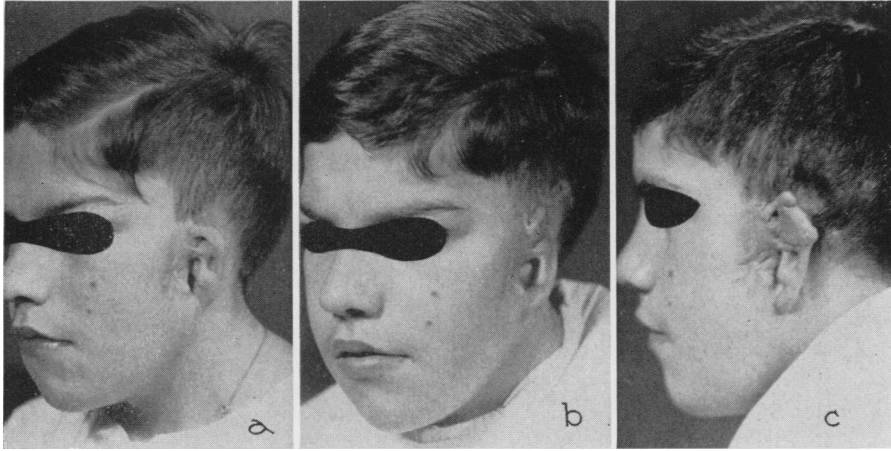


FIG. 5.—Case 2 (a) Congenital microtia. (b) Appearance after implantation of carved costal cartilage. (c) After elevation of cartilage graft and backing with a split graft of skin. Further revision of the tissue of the helix is necessary in this case.

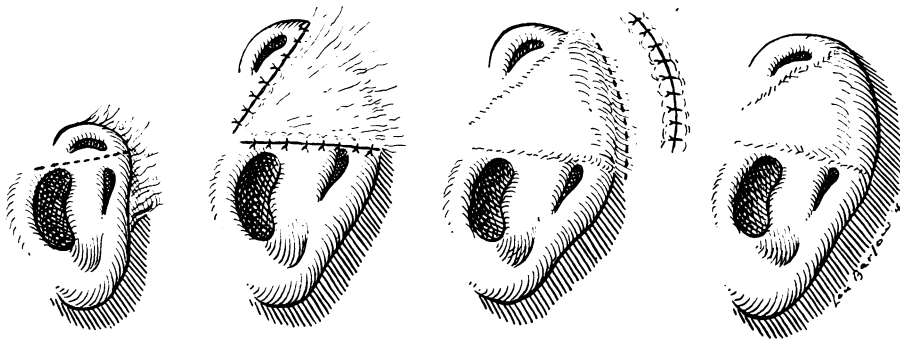


FIG. 5.—(d) Sketch of operative steps involving the transverse section of the rudimentary ear, rotation of the superior and inferior portions and their suture to the skin of the post-auricular area, the implantation of a carved graft of costal cartilage and the elevation of the graft from the head and its backing with split skin graft.

use of finely chopped pieces of cartilage as grafts in the reconstruction of the external ear in humans. He referred to such finely chopped costal cartilages as "diced cartilage grafts." In 1943 he²⁵ reported on the accurate formation of such fibro- cartilage into the shape of auricular cartilage by the use of a perforated bi-valved mold of vitallium which had been filled with "diced" cartilage and buried in the abdominal wall for three months. This fibro-cartilaginous

framework was then successfully transplanted beneath the skin of the aural area. Young²⁶ (1944), using a perforated mold of ticonium, cast fibro-cartilaginous grafts in the shape of the auricular cartilage. He reported one case

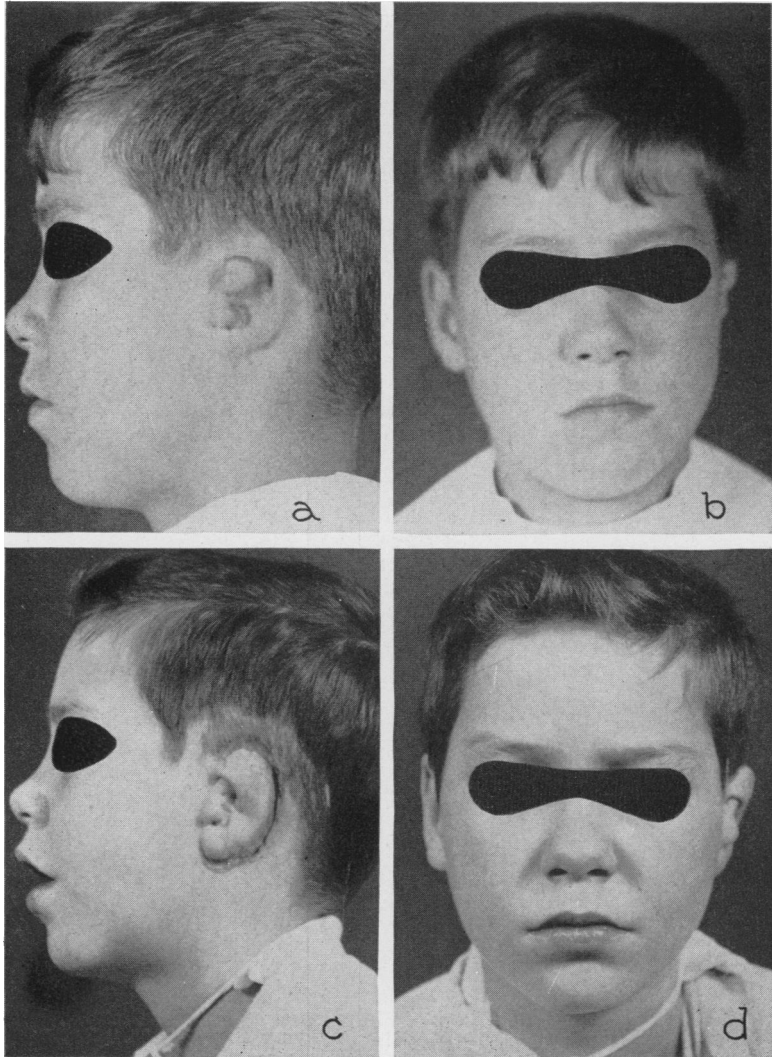


FIG. 6.—Case 3 (a and b), Congenital absence of the ear. (c and d), Appearance after reconstruction by use of a carved graft of cartilage and its elevation and backing with a split skin graft.

in which the principle was applied to the construction of the external ear. Aufricht²⁷ (1947) reported on the pre-casting of auricular cartilage by the use of a perforated acrylic mold, filled with flat chips and thin platelets of cartilage and buried in the abdominal wall. He emphasized the necessity for the use of a generous flap from the scalp in the creation of the concha, recognizing that

the pressure of a tight cutaneous flap tends to obliterate the contours of auricular cartilage which have been constructed by this method. This experience of Brown et al²⁸ (1947) in reconstruction of the ear indicated that suitable reconstruction of the external ear can be accomplished by the use of carved costal cartilages. They emphasized that reconstructive surgery of this magnitude need not be prolonged but can be accomplished in cases of loss of helix or pinna in only two stages and that total reconstruction of the ear can be completed in three operative stages.

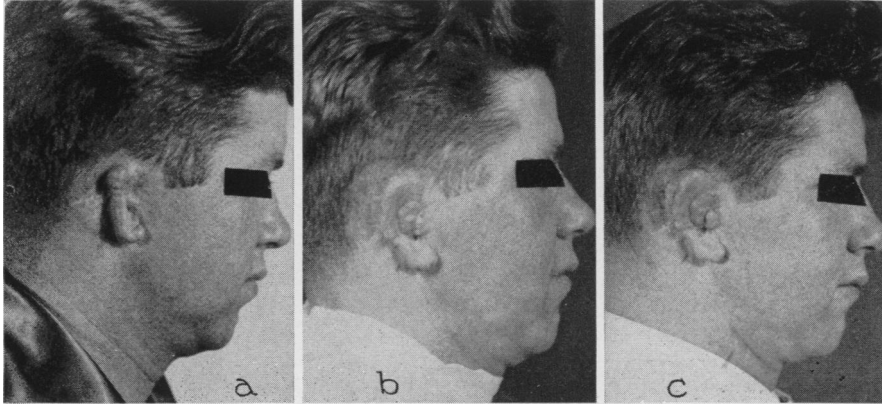


FIG. 7.—Case 4 (a). Congenital absence of the ear. (b) Appearance after implantation of large, carved graft of costal cartilage. (c) Appearance after elevation of cartilage and application of split graft of skin behind the ear. Reconstruction in two stages.

During the past two years the authors have had experience with ten cases of reconstruction of the external ear. These were managed on the Surgical Service of The New York Hospital and on the Plastic Surgery Service of the U. S. Veterans' Hospital,* Bronx, New York. The general principles of the technic of Pierce have been followed with agreement in execution with the advancements of Brown et al. In several cases subtotal reconstruction of the ear has been carried out in two stages. The authors have had no experience with molded cartilage grafts. The management of cases included in this report has led to the opinion that suitable reconstruction of the external ear can be accomplished if sufficient attention is given to the cutting and the carving of costal cartilage, to the importance of the establishment of a lateral concavity to represent a concha, and to the many minor details which enter into the execution of this type of reconstructive surgery.

CARVING OF COSTAL CARTILAGE

Experience in the handling of fresh costal cartilage has led to observations which have contributed to success in obtaining a suitable restoration of the

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external ear. A common objection to the use of straight grafts of cartilage in reconstructive surgery is that, after transplantation, the graft may undergo distortion of shape, curling. Figure 1 shows the technic of cutting grafts from

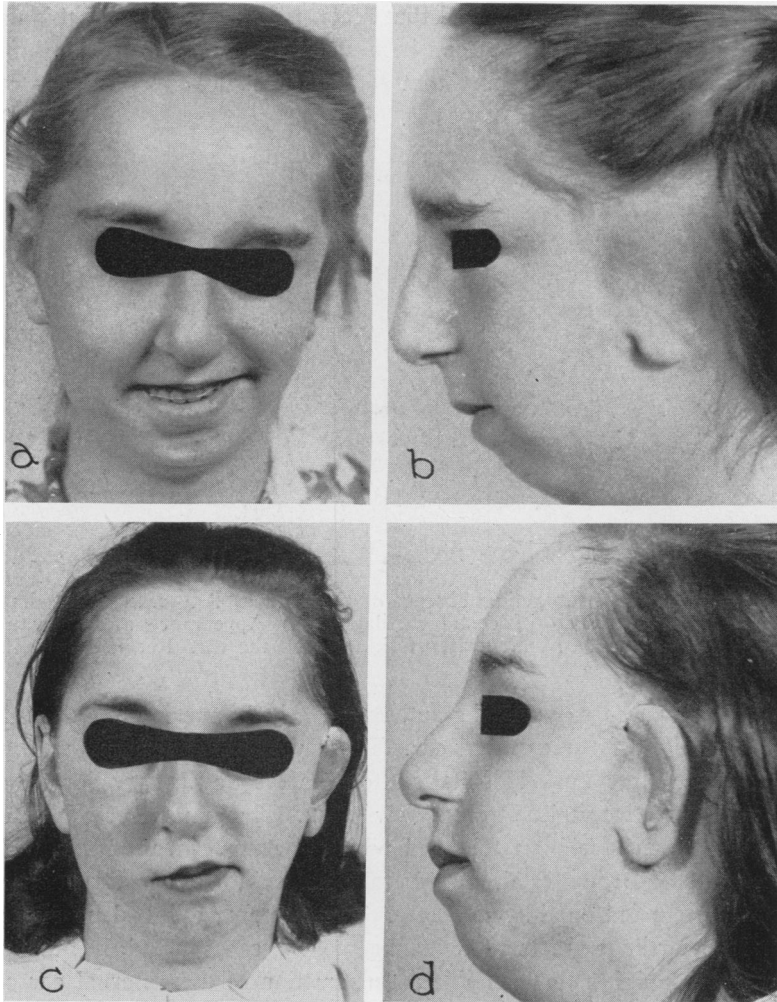


FIG. 8.—Case 5 (a and b) Congenital absence of the ear in association with facial asymmetry. (c and d) Appearance after reconstruction by implantation of carved costal cartilage, elevation of the cartilage and backing with a split skin graft and use of a tubed pedicle to simulate the appearance of the helix.

costal cartilage by gouge and by scalpel. The use of a gouge causes compression of medullary and cortical cells of the costal cartilage in such a way that, even after carving, the graft tends to warp or curl. The use of two scalpels as shown prevents abnormal compression of cells and minimizes this tendency. On microscopic examination of the transversely cut edge of costal cartilage it

is apparent that the center of the cartilage is yellow and the periphery is grey. The gross structure of the costal cartilage is somewhat similar to that of bone. It is stated in Gray's²⁹ "Anatomy" that "in the thickest parts of the costal cartilages a few large vascular channels may be detected. This appears, at first sight only, to be an exception to the statement that cartilage is a non-vascular tissue; actually the vessels give no branches to the cartilage substance itself, and the channels may rather be looked upon as involutions of the perichondrium." This gross structure apparently causes a variation in tissue tension when the costochondral cartilage is cut or carved. Figure 2 shows the approach to the costochondral plate commonly used in securing a graft. In order to obtain a large graft two adjacent rib cartilages are resected en bloc. The

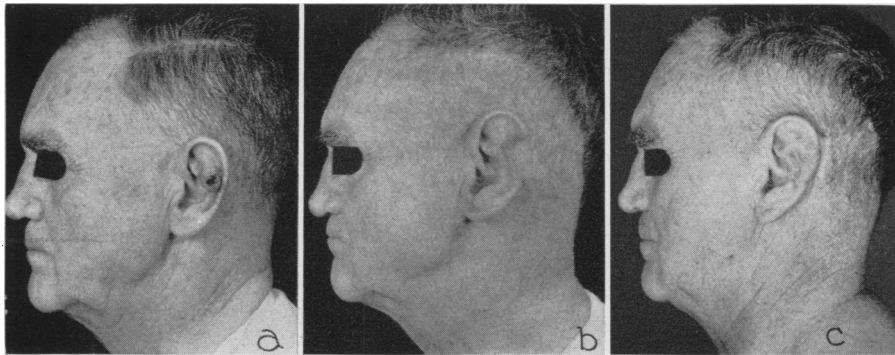


FIG. 9.—Case 6 (a) Squamous cell carcinoma of the ear. (b) Appearance after primary excision of tumor and suture of ear to the post-auricular skin. Following this step a patterned framework of tantalum mesh was inserted under the skin in the region of the aural defect. (c) After elevation of post-auricular skin and tantalum mesh and application of a skin graft to the post-auricular wound.

excision of a disc, 2 to 3 mm. in thickness, at the level of each transection makes easier the removal of such a block of cartilage. Inspection of such a graft from its posterior aspect shows (Fig. 3) that there is a concavity in the cartilaginous portion of the thoracic cage. This can be used effectively in the carving of cartilage for reconstruction of the ear. As the rib cartilage is split longitudinally, advantage is taken of the curling effect to exaggerate this concavity. Cartilaginous or fibro-muscular fusion of two adjacent cartilages is made use of in obtaining the desired width of graft. With attention to these details, it is possible to cut and carve, from costochondral cartilage, a free graft which has size, shape and rigidity, suitable for reconstruction of the external ear.

CASE REPORTS

Case 1. *Partial congenital absence of the external ear.* In this case as shown in Figure 4a, b, c, the microtia was corrected by the use of a cervical tubed pedicle. Reconstruction was carried out in three stages: the construction of the tubed pedicle of skin in the neck, the transfer of its distal end to the upper, anterior margin of the pinna, and the final division of the tubed pedicle with suture to the outer margin of the ear.

Case 2. *Partial congenital absence of the external ear.* In this case the operative steps were carried out as shown in Figure 5d. Transverse section of the rudimentary ear at the junction of its middle and upper thirds with rotation of the upper third anteriorly and suture of both segments to the skin of the mastoid area was done at the first operation. A free graft of carved cartilage was inserted as a wedge at the second operation. Elevation

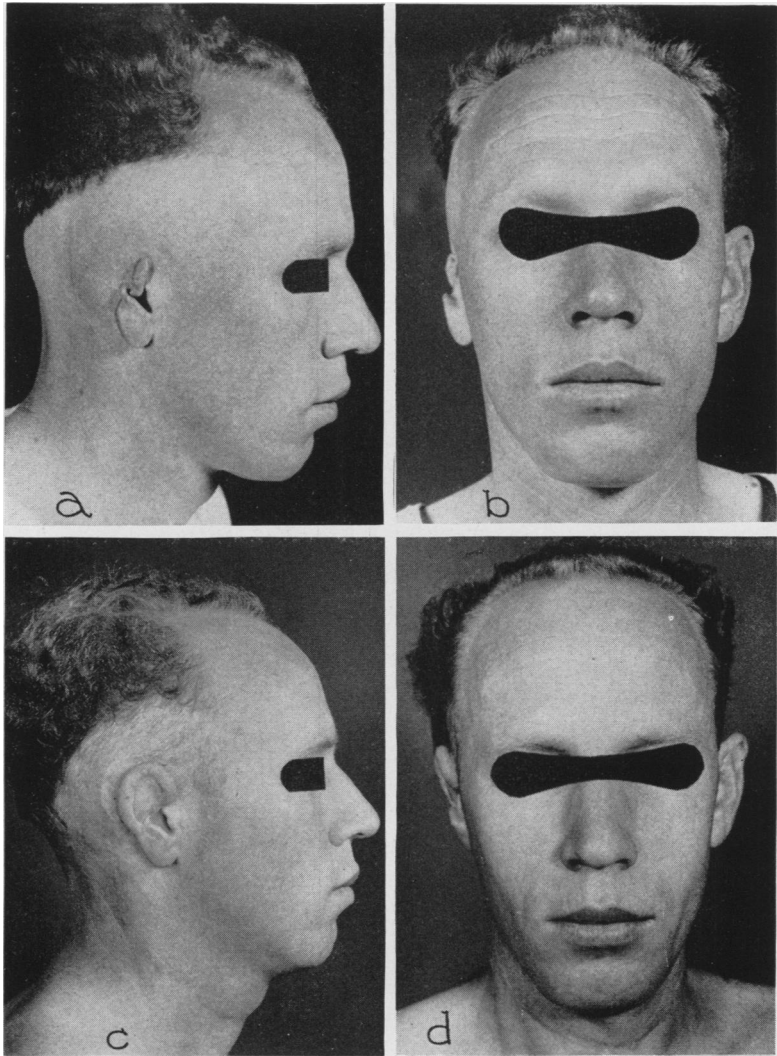


FIG. 10.—Case 7 (a and b) Traumatic loss of upper two-thirds of ear. (c and d) Appearance after reconstruction by use of carved cartilage and tubed pedicle from neck.

of the graft and backing with a split skin graft was done at the third operation. Minor revision of the tissue in the region of the helix is required before this reconstruction can be looked upon as completed. Photographs are shown in Figure 5 a, b, c.

Case 3. *Congenital absence of the external ear.* In this case (Fig. 6) the position of the rudiment of the ear was such that it was necessary to carve a graft from costal

cartilage in the shape of the letter "C." This was embedded at the first operation. At the second step the cartilage was elevated from the head and a split skin graft was applied behind it. At a third operation the congenital remnant of ear cartilage was displaced behind the graft. This increased the lateral concavity to simulate a concha, provided rigidity to the constructed auricle and established the proper cephalo-auricular angle.

Case 4. *Congenital absence of the external ear.* In this case (Fig. 7) the small rudimentary ear was used only as a foundation for the reconstruction. Carved costal cartilage

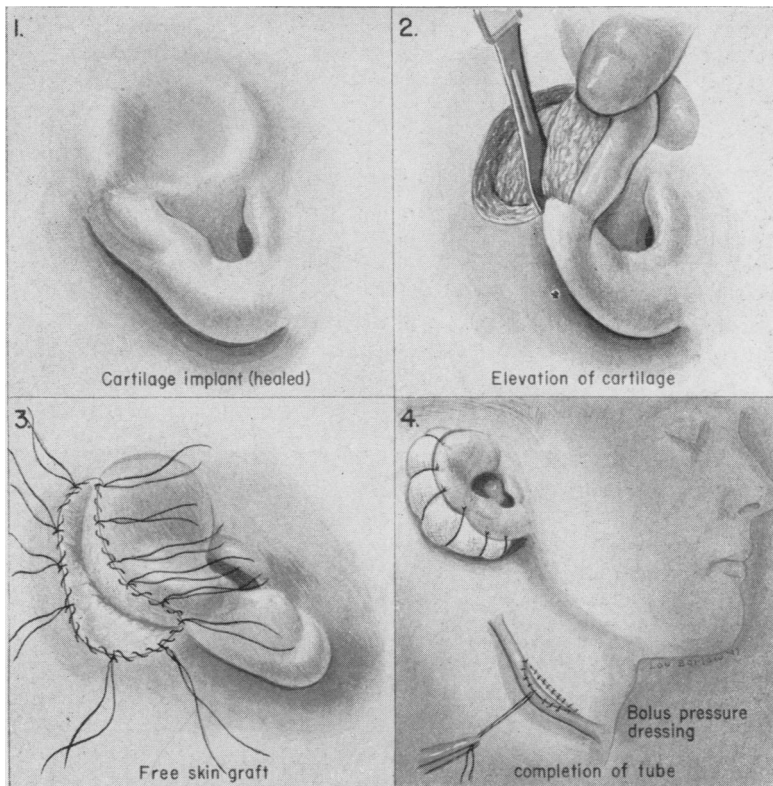


FIG. 10.—(e) Steps in elevation of implanted cartilage, backing with split skin graft and construction of tubed pedicle.

was buried in the auricular area at the first operation. At the second operation the cartilage was elevated from the head and a split skin graft was applied to the posterior aspect of the graft and to the defect of the aural and mastoid regions. Reconstruction was completed in two stages.

Case 5. *Congenital absence of the external ear.* Operative steps one and two in this case were the same as in Cases 3 and 4. The curling of the cartilage in this case was used to maximum effect in the simulation of the concha. (Fig. 8.) The associated facial asymmetry made the estimation of the required size of graft difficult to determine. Rather than disfigure the skin of the cervical region in this young girl, a tubed pedicle was constructed on the arm and transplanted to the ear in the reconstruction of the helix. This construction required three additional operative steps, five operations in all.

Case 6. *Loss of substance of the middle third of the ear by the surgical excision of malignant tumor.* This patient had a squamous cell carcinoma of the skin of the ear which

nad invaded the auricular cartilage. At the time of excision the remainder of the ear was sutured to the post-auricular skin as shown in Figure 9. At the second operation a supporting framework of tantalum mesh was inserted under the post-auricular skin now in the middle third of the ear. At the third operation the constructed ear was elevated from the head and a split skin graft applied behind it.

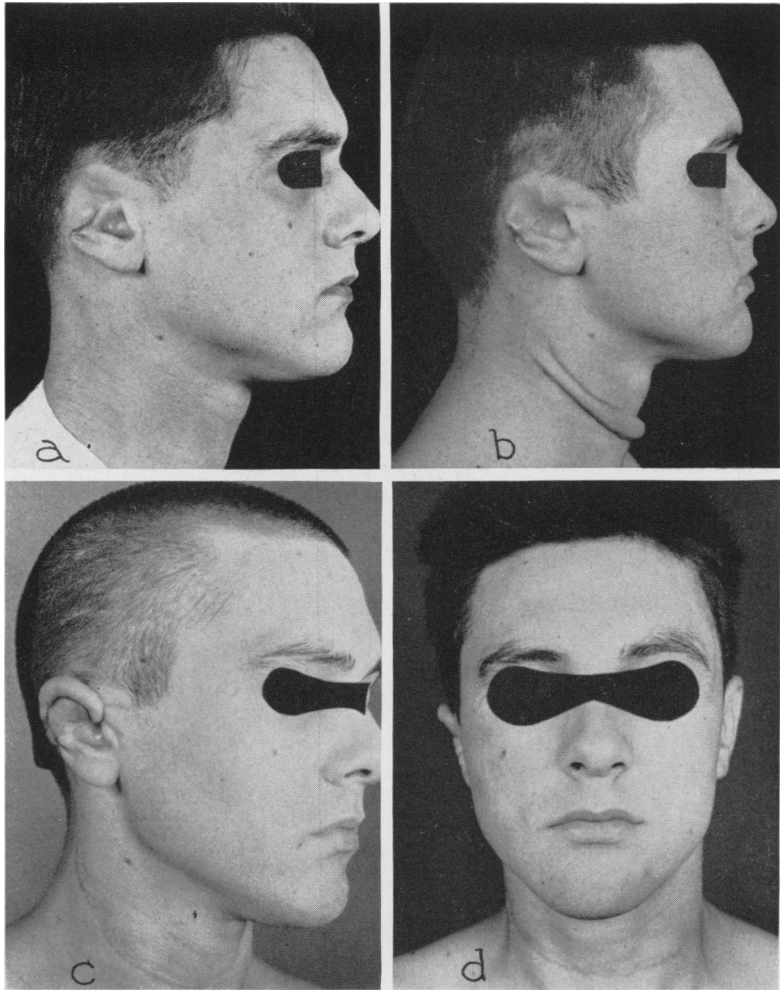


FIG. 11.—Case 8 (a) Traumatic loss of upper half of ear. (b) Appearance after implantation of carved cartilage. (c) Appearance after elevation of cartilage graft and application of a tubed pedicle to simulate the helix. (d) Front view after reconstruction.

Case 7. *Traumatic loss of upper two-thirds of external ear.* The patient lost the upper two-thirds of his ear in an injury in which he was thrown from a jeep. The ear was amputated by flying glass. Photographs are shown in Figure 10. Reconstruction was by the insertion of carved cartilage, its elevation and application of a skin graft posteriorly and the use of a cervical tubed pedicle to construct the helix. Visible defect

of the scalp in the region of the cephalic portion of the skin graft was camouflaged by tattooing.

Case 8. *Traumatic loss of upper half of external ear.* This patient lost the upper half of his ear in an automobile accident. Photographs are shown in Figure 11. Reconstruction was carried out five years after the primary injury. Operative steps were the same as in Case 7.

Case 9. *Traumatic loss of upper half of external ear; reconstruction by recovery and implantation of autogenous auricular cartilage.* In an accident in which this patient was thrown from an automobile the upper half of the ear was amputated. The astute interest of a resident surgeon sent the relatives to another hospital where first aid treatment had

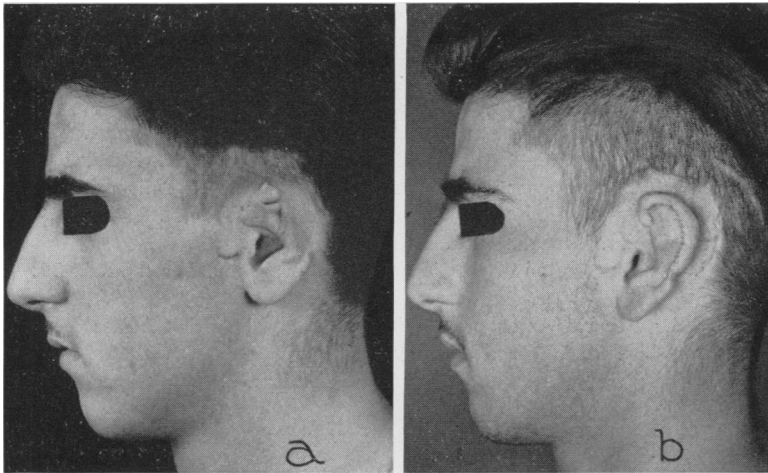


FIG. 12.—Case 9 (a) Traumatic loss of upper half of ear. (b) Appearance after reconstruction by use of autogenous auricular cartilage (see case report) and reproduction of appearance of helix by revision of soft tissue over the cartilage graft.

been given. The amputated ear was recovered from a basin of discarded dressings. It was washed with soap and water, sterilized with merthiolate solution. The skin was then removed and the auricular cartilage was buried in the abdominal wall. The lacerated ear was sutured to the skin of the mastoid area. Six weeks later the cartilage was removed and implanted behind the post-auricular skin. It was disappointing to note the excessive fibrosis around the cartilage. At subsequent operations the cartilage has been elevated from the head. Photographs are shown in Figure 12.

Case 10. *Congenital absence of the external ear.* In this case particular difficulty was encountered because the anomalously left only skin of the scalp in the aural region. After implantation of a large carved graft of cartilage there was excessive growth of scalp hair over the skin of the new ear. A tubed pedicle was used to construct the helix. Displaced hair of the scalp was removed by electrolysis.

SUMMARY

Ten cases are reported in which partial or complete reconstruction of the external ear has been carried out. Reconstructions have been effected by the use of buried free grafts of cartilage, their elevation from the head and their backing by free grafts of skin at a second operation. A small tubed pedicle

has been used to effect the appearance of the helix in some cases. Technical details in the cutting and carving of costal cartilages have been set down. The opinion is advanced that reconstruction of the external ear, acceptable to patient and to surgeon, can be effected if attention is given to these details.

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