

## THE USE OF PRESERVED CARTILAGE IN EAR RECONSTRUCTION\*

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THE RECONSTRUCTION of ears, either partial or total, has long been one of the most disappointing and unsatisfactory branches of plastic surgery. This is due in large measure to the complicated form of the ear cartilage or scaffold, making it extremely difficult to carve and pattern rib cartilage so that it will be thin enough and light enough to preserve the normal position and appearance of the new ear. Rib cartilage has been employed because of the unavailability of elastic cartilage in large enough amounts and shapes. It is obvious from this premise that the chief difficulty in ear reconstruction has been to obtain a suitable scaffold or mold upon which to reconstruct an ear. If any thin, light reproduction of ear cartilage could be formed, even though a foreign body, and used as a foundation, the reconstruction would be simplified and the ultimate result should have a more pleasing cosmetic appearance. What better mold could one use than ear cartilage itself, if, when transplanted, it would remain as cartilage and remain *in situ*.

Some years ago the author became interested in the fate and behavior of transplanted rib cartilage, which occupies an unique position as regards its life and existence. For many years the excess costal cartilage removed in the course of a plastic reconstruction has been stored by burying it in a subcutaneous pocket in the abdominal wall, and here it remained indefinitely, and intact, for such future use as might be necessary. Despite the opinion of some authorities that much transplanted cartilage, in time, becomes absorbed or fibrosed and converted into fibrous tissue, studies of this transplanted cartilage, as shown in Figures 1 and 2, have definitely convinced the author that this is not true, but that cartilage remains permanently as cartilage.

The behavior of transplanted cartilage in remaining as such led to the belief that cartilage might be transplanted after death, and still retain its character, which, if true, would solve some of the difficulties of ear reconstruction. It was necessary to determine: (1) Is the behavior of elastic cartilage identical with the behavior of rib cartilage? (2) Could elastic cartilage be employed as a heterogenous graft? (3) If it could be employed as a heterogenous graft after death—how long after death would this be possible? Accordingly, a series of experiments were performed upon rabbits to answer these questions.

Rabbit A was killed, and one hour after death five pieces of ear cartilage were removed. Two of these were placed on ice dry, and two on ice moist in Ringer's solution. The fifth piece was planted in the abdominal wall of Rabbit B. Each hour thereafter another piece of ear cartilage was removed

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from Rabbit A and planted in the abdominal wall of Rabbits C, D, E, F and G, respectively. At the end of 24 hours a piece of wet and dry ice-box cartilage was planted in Rabbit H, and at the end of 48 hours this was repeated in Rabbit I. These rabbits were watched for a period of six months, one however, dying in the interim; namely, the three-hour rabbit. After six months

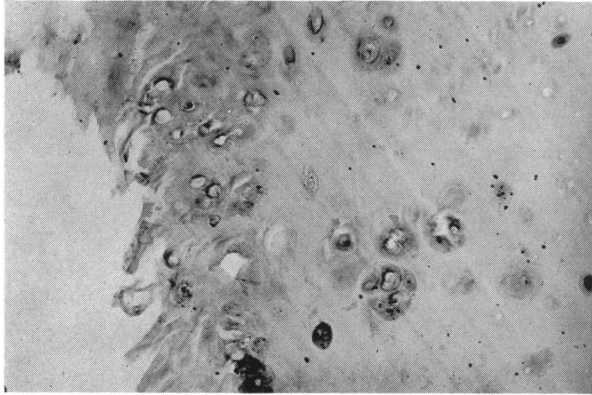


FIG. 1.—Rib cartilage after autogenous transplantation for ten years.

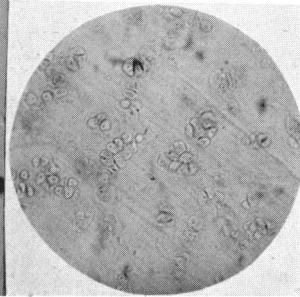


FIG. 2.—Rib cartilage after autogenous transplantation for eight years.

the wounds were opened, the cartilage removed and sectioned (Fig. 3), and with the exception of the dry, iced cartilage all were intact, and showed the characteristics of cartilage, though the cell spaces were vacuolated, the nuclei having disappeared, and the cartilage dead. This answered the three ques-

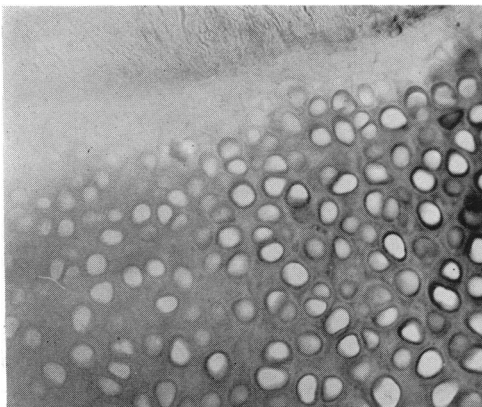


FIG. 3.—Experimental rabbit ear cartilage after six months' heterogenous transplantation.



FIG. 4.—Preserved rib cartilage after two years' transplantation.

tions to be determined in the affirmative, establishing the fact that heterogenous cartilage grafts remain as cartilage, the cartilage retaining its form even though cellular death has occurred.

Shortly after this an ear cartilage was removed from a person soon after death and transplanted into the abdominal wall of another individual, with the

idea of employing it later to reconstruct an ear. One year later this cartilage was distinctly palpable under the skin, but unfortunately the patient drifted away and it was never possible to obtain microscopic sections of it or to complete the reconstruction.\* About this time the author became acquainted with the splendid work being done by O'Connor and Pierce<sup>1</sup> on preserving excess

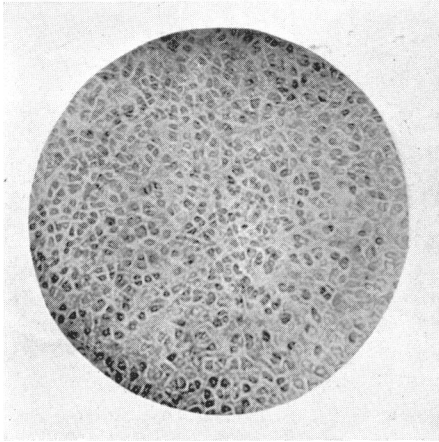


FIG. 5.—Preserved ear cartilage after two years' transplantation.

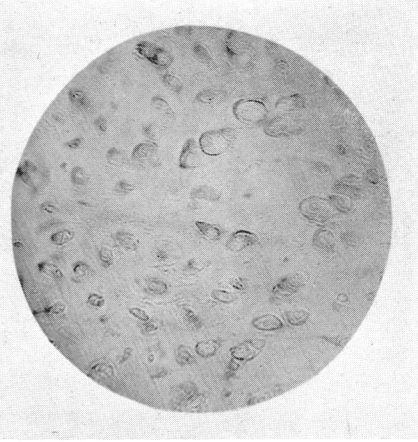


FIG. 6.—Preserved ear cartilage after four years' transplantation.

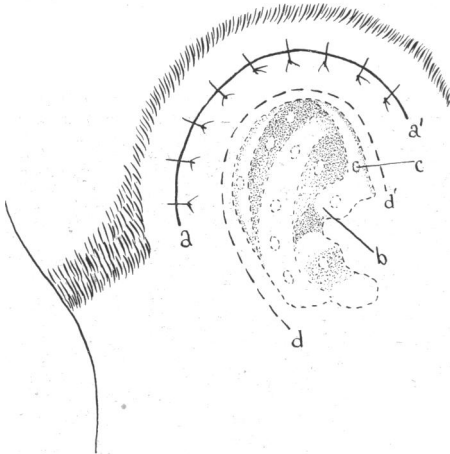


FIG. 7.—Shows implantation of preserved cartilage. (a a') Represents incision in the hair line. (b) Shows ear cartilage placed under skin flap. (c) Represents puncture holes through the cartilage for anchorage. (d d') Shows line of incision for the second-stage operation.

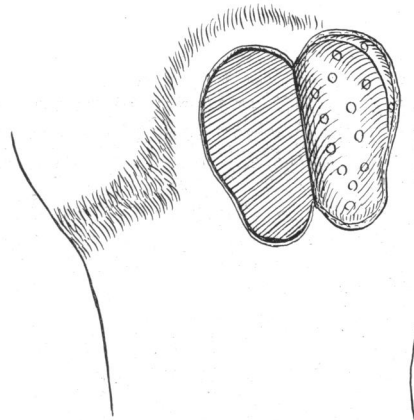


FIG. 8.—Shows the implanted cartilage with its skin covering raised and brought forward, leaving a raw surface behind the new ear, and over the mastoid region. This is covered with a free stent skin graft.

rib cartilage indefinitely, and its satisfactory employment in various reconstructive procedures, and all credit should be given them for the valuable adjunct to plastic surgery this procedure has advanced. Since their work, not only experimentally but clinically, has shown that the employment of preserved rib cartilage is practicable, why should not the same hold true of

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ear cartilage? Clinical experience has shown that ear cartilage behaves in the same manner, and thus it can be collected, preserved and stored for future use, and employed as a scaffold upon which to build a new ear. Pierce and O'Connor have found the most satisfactory preservative to be a solution of

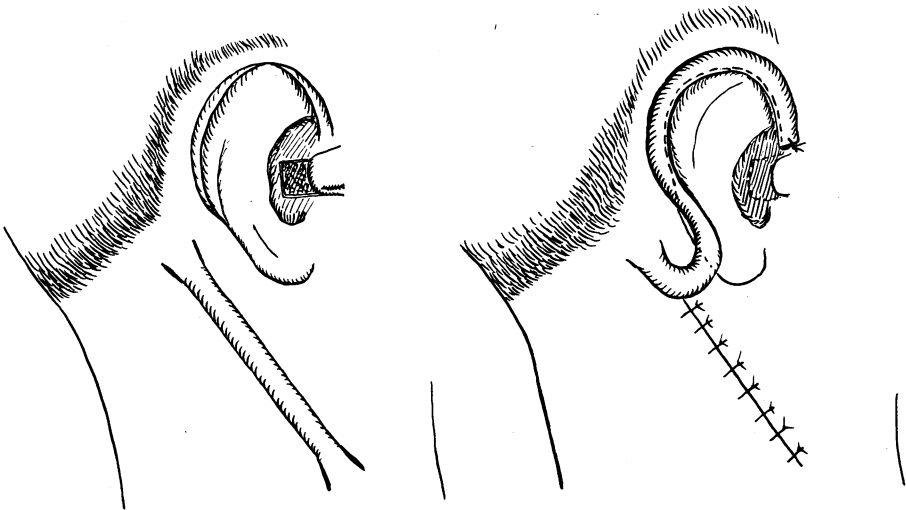


FIG. 9.—Double pedicle-tube flap of the neck. At the same time a flap of skin is turned on itself to form the new tragus, which procedure deepens the davum and concha. The resulting raw area is covered with a free skin graft.

FIG. 10.—Lower end of tubed pedicle raised, and attached to crus of helix. Tube opened and draped over the ear to form the helix.



FIG. 11.—Subtotal loss of ear due to automobile injury.

FIG. 12.—Preserved ear cartilage transplanted in the mastoid region.

aqueous merthiolate in normal saline, 1 : 4, and kept on ice. The solution, however, should be changed about every week or ten days.

In the employment of ear cartilages from cadavers, it is found that they are often too soft and pliable, but this can be overcome by soaking for two or three days in a solution of formalin before being placed in the merthiolate.

This method is also applicable in the case of automobile or other injuries where part of the ear is completely severed and the piece can be found. In these instances the skin is removed and the cartilage stored in the usual manner until such time as the ear reconstruction is deemed advisable. Since

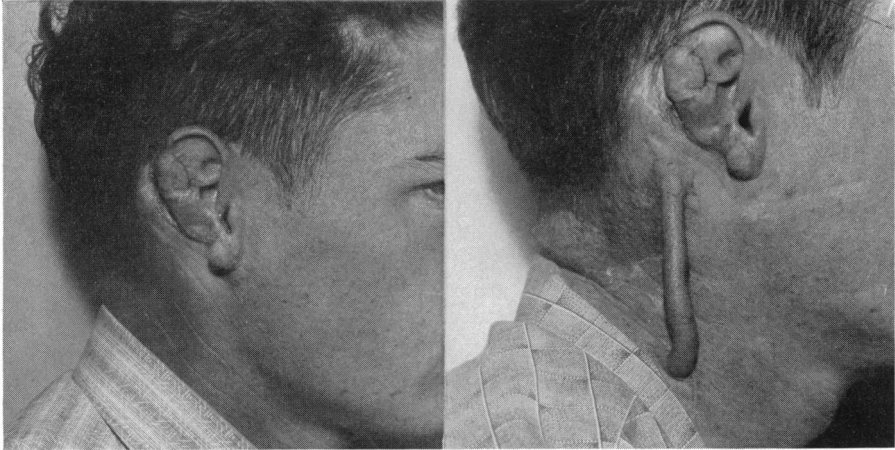


FIG. 13.—The ear brought forward, and the back of the ear and mastoid covered with a free graft.

FIG. 14.—Double pedicle tube-flap raised from the neck.

these cartilages are essentially foreign bodies, and consequently may become loose from the surrounding tissue, it has been found that perforating the cartilage with small holes before it is planted allows granulation tissue from

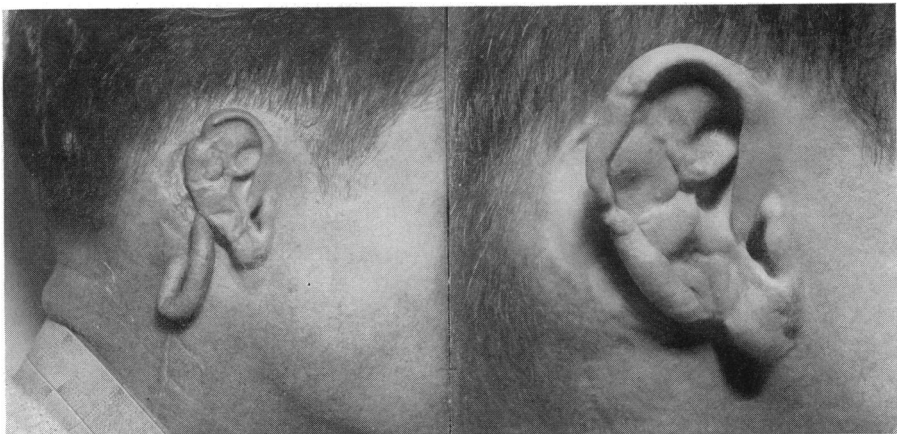


FIG. 15.—Tube-flap transferred to the edge of the new ear.

FIG. 16.—Tube-flap molded to form the new helix.

both sides to pass through the perforations, and in this way acting as rivets to hold the cartilage in place.

The reconstruction of the ear is accomplished in about five stages. At the first stage the cartilage, which has been previously perforated, is planted

under the skin of the mastoid area through a curved incision high up in the hair line. In about two months the cartilage, with the skin of the mastoid region, is raised, thus bringing the new ear forward, leaving a raw surface over the mastoid and back of the new ear. This area is covered with a thin split-graft placed on a molded stent. At a later date a double pedicle tube-flap is made on the neck, about the size of a lead pencil, and long enough to be carried over the ear. In about three weeks the lower end of the flap is transferred to the edge of the new ear, and in three more weeks the draping of the flap around the new ear to form the helix is completed, and the excess removed or returned to its bed. If no tragus exists this can be constructed by infolding a flap of skin on itself and the resulting raw area covered by a free graft, and this procedure at the same time deepens the concha.

Having employed this method in ear reconstruction during the past few years, in only one has there been a loss of the cartilage, and this resulted from an infection in the graft bed which might have occurred by the use of an autogenous graft. It is believed that ears so reconstructed, with a normal ear scaffold, are more sightly and satisfactory to the patient and surgeon alike.

#### REFERENCE

- <sup>1</sup> O'Connor, G. B., and Pierce, G. W.: Refrigerated Cartilage Isografts. *Surg., Gynec., and Obstet.*, 67, 796-798, December, 1938.

DISCUSSION.—DR. VILRAY P. BLAIR (St. Louis, Mo.): No one who has never tried to make an ear can appreciate the value of this contribution. We have attempted many of them in some other way, and our results recommend this method most strongly. In using a shell of cartilage of somewhat the size and shape desired, cut from the surface of the anterior costal junctions, you can make something that will stand out, give it the general outline of an ear, and in this way get by, because nobody looks at an ear, but will note its absence four blocks away. Another thing that makes this timely is that, until recently, we were never called upon to restore a girl's ears, but they are now exposing these last of hidden things. I think one point is worthy of discussion. Possibly the outstanding contribution of the paper is the removal of a piece of live cartilage from a dead body before changes have occurred, and then burying it in the abdominal wall of the patient who is going to be the recipient. That would give you time to study the recipient's tissue reactions. A suggestion along this line has been made by Gillies—that is, to dissect out the mother's cartilage and use it as the form upon which to build the child's ear. I was more impressed with this suggestion after seeing some patients of Dr. Paul K. Greeley's, in Chicago, upon whom he was carrying out this plan. There is probably no advantage in using the mother's cartilage other than that it is available. One thing I noted in the mother was that there was little deformity after removing the cartilage, merely a little lopping over of the ear, and that can be taken care of by slipping in a little bit of her costal cartilage. One tremendous advantage in using human ear cartilage is that it permits early restoration. A great deal of psychic damage can be done by having a child teased about the deformity. No matter what cartilage is used, if you can put it over, I should say it probably should be done before the age of five, and that is a tremendous advantage.

Doctor Pierce and Doctor O'Connor did a good deal of work with preserved costal cartilage.

DR. JOHN STAIGE DAVIS (Baltimore, Md.): I have been much interested in Doctor Kirkham's report. I have been using cartilage transplants for a great many years, and recently have gone back to trying isocartilage again. My feeling is that if it is possible to obtain autogenous cartilage I think it ought to be used. The difficulty with isocartilage, which has been preserved, is that you never know when the reconstruction, which you have built with the preserved cartilage, will begin to absorb. Some of the transplants last over long periods of time, and others absorb quite quickly. I seldom use large pieces of preserved cartilage, but have found it useful for filling out small areas. I prefer, in reconstructive work, autogenous cartilage which is fresh, or has been stored under the skin for as long as it is convenient.

DR. H. L. D. KIRKHAM (Houston, Texas), closing: I want to thank Doctor Blair and Doctor Davis for this discussion. Undoubtedly the use of fresh cartilage is very much superior, where it can be obtained, to the use of any preserved cartilage. Also, if you get fresh cartilage from a body that has just died, as we did in our first experimental work and in the first case with the child, that would be preferable, but the objection is that whenever you have an ear to reconstruct such cartilage is seldom available. Another objection to fresh cartilage is that when you put the fresh cartilage under the skin, and it is later taken out, it has become attached to the surrounding tissue and you have a piece of thick fibrous tissue—scar tissue which has thickened up—and I do not think you get such a thin ear in the final result.