The Journal of Laryngology and Otology
May 1984, Vol. **98.** pp. 445–448

Ossicular reconstruction—a new prosthesis

by

M. V. KIRTANE, K. S. PARSRAM, A. K. SHAH and P. P. KARNIK
(Bombay, India)

Abstract

We have used human teeth for ossicular reconstruction in 20 tympanoplasties, the longest follow-up being over 2 years. The take of the graft and the hearing improvement have been very satisfactory and long-lasting. This preliminary report discusses the merits of the tooth as a prosthetic material for ossicular reconstruction. Our experience to-date indicates that the material satisfies all the criteria of an ideal prosthesis.

Introduction

The variety of materials used for reconstructing or replacing the ossicular chain in tympanoplasty is proof enough that no single material has been found to be completely satisfactory in all situations. Various criteria must be satisfied before accepting a graft or prosthesis for use in ossiculoplasty: the prosthesis should be inert, non-toxic, easily moulded into any shape and size, stable, non-reactive, easily sterilized and preserved and, last but not least, inexpensive.

The two most popular ossicular prostheses used today are the homologous incus, and TORP's and PORP's made from synthetic material like plastipore.

We have been using the homologous incus for about fifteen years and have been fairly satisfied with it for ossiculoplasty. However, only a small percentage of our colleagues have access to autopsy material and hence the search goes on for a material which can match the homologous incus in results or even improve upon it, and also be freely available. In India the TORP's and PORP's have to be imported and they are rather expensive. We have used the human tooth as an ossicular prosthesis and our experience is presented in this preliminary report.

Material & Methods

Before using the tooth for ossiculoplasty in patients, we had to determine the inertness of the material and to compare the tissue reaction evoked by it to the reaction evoked by an accepted graft material, e.g. homologous incus.

Healthy bicuspids and tricuspids obtained from the orthodontic department or from cadavers were stored in 70 per cent alcohol. The roots of the teeth were cut with a dental saw and were shaped by a drill to match approximately the body of an incus in size, shape and weight. After a thorough wash in normal saline, this prepared tooth root was implanted into a subcutaneous pouch on the thigh of a white mouse, and a similarly treated incus was implanted in the opposite thigh. This was done in six animals. The homologous incus was chosen as a control as it is an accepted graft material.

Next, we had to determine the change of structure in the tooth on storage and sterilization. Six tooth roots were taken from

https://doi.org/10.1017/S0022215100146882 Published online by Cambridge University Press

two healthy tricuspids of the same cadaver. The root canals were cleaned with a reamer. Each root was stored separately for six weeks in different containers as follows:

(1) Normal Saline
(2) 0.5 per cent Formaldehyde
(3) Chloromycetin solution
(4) 70 per cent alcohol
(5) Non-autoclaved dry tooth
(6) Autoclaved dry tooth

When examined macroscopically six weeks later, the specimens were identical and were processed into paraffin blocks after decalcification. The sections were stained with Haematoxylin and Eosin and examined microscopically for changes in histological structure. There was no alteration in the structure of any of the specimens thus indicating that, whatever the mode of storage of the teeth, their structure remains unaffected.

Preparation of tooth prosthesis

The tooth roots were cut with a dental saw, as shown in Fig. 1a. They were then reduced to the desired size with the help of a diamond paste drill, the tooth root being fixed by passing a pick through its root canal (Fig. 1b). They were stored in 70 per cent alcohol. Fig. 1c shows such a prepared tooth root (on the extreme right) in comparison with the incus and a ceramic prosthesis. Prior to use in a patient, the tooth root was thoroughly washed in saline and chloromycetin solution. The final shaping to the exact measurement required was done during the surgery. The root canal may also be enlarged to fit snugly on to the head of the stapes, as shown in Fig. 1d.

Such a prosthesis has now been used in 20 cases. The types of reconstruction done are shown in Fig. 2.

12 cases had central perforation and 8 had cholesteatoma.

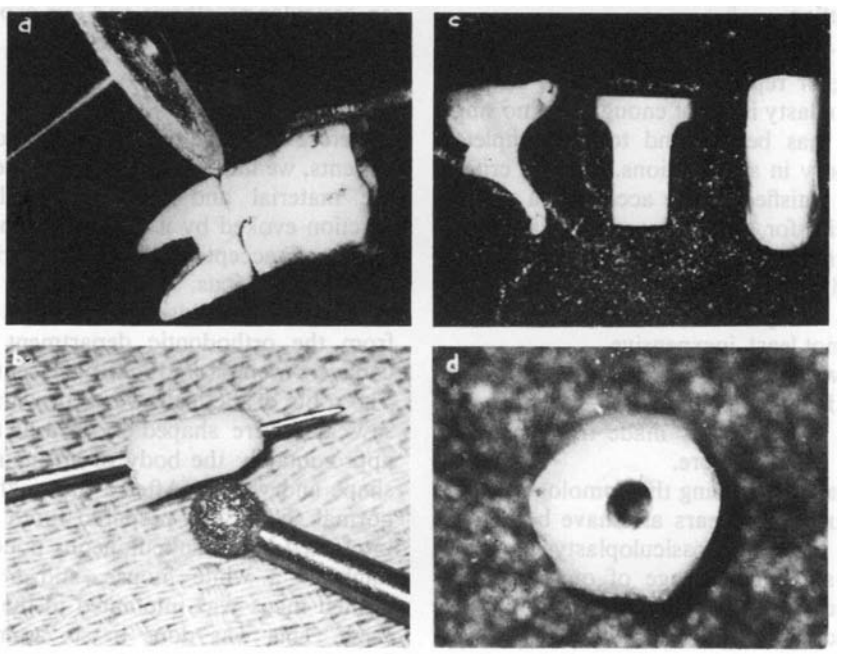


FIG. 1

(a) Cutting of the tooth with a dental saw.
(b) Shaping of the prosthesis with a diamond paste burr.
(c) Prosthesis in comparison with a homograft incus and a ceramic prosthesis.
(d) Enlarged root canal to fit onto the head of stapes.

https://doi.org/10.1017/S0022215100146882 Published online by Cambridge University Press

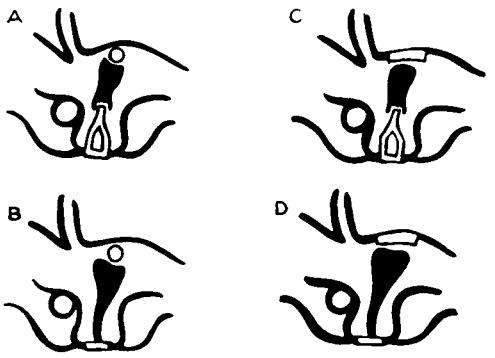


FIG. 2

Types of reconstitution (Prosthesis shown as solid black)

A—Malleus to head of stapes.

B—Malleus to footplate.

C—Tympanic membrane to head of stapes.

D—Tympanic membrane to footplate.

In C and D a piece of autograft tragal cartilage is interposed between the prosthesis and the tympanic membrane.

For the former an intact canal wall technique was used while in all the cholesteatoma cases a small mastoid cavity was exteriorized for drainage while the middle ear was reconstructed as required.

The tooth roots were reduced to the required size and the final shaping was done on the operation table, depending on the type of defect encountered. When the stapes superstructure was available the tooth root was used like a PORP. The root canal of the tooth provides a ready socket to receive the head of the stapes. However, it has to be enlarged to the necessary size for a proper fit (Fig. 1d). When this prosthesis had to be placed against the tympanic membrane directly, a piece of autograft tragal cartilage was interposed between the tooth prosthesis and the tympanic membrane, to avoid extrusion. Temporalis fascia as an inlay graft was used in all cases to close the tympanic membrane perforation.

Discussion

It has been found that the middle ear is a 'privileged site', like the anterior chamber of the eye and the meninges, in which foreign antigenic tissues can be grafted without being rejected (Gagnon *et al.*, 1979). This privileged site confines the antigen within its cavity, shields it from the host and makes tolerance of an ossicular graft possible.

This is the reason why such a large variety of graft materials have been used by otolaryngologists with reasonable success. However, there is no material in middle-ear reconstructive surgery which satisfies all the requirements of an ideal ossicular prosthesis. Homologous incudes and porous plastic prostheses (like TORP's and PORP's) have been commonly used with satisfactory results, but various problems (such as availability, fixation, extrusion, partial resorption and rejection) have maintained the search for a better prosthesis.

Prior to accepting any prosthesis one must be convinced of its compatibility. It should be relatively inert so that the tissue reaction evoked is not harmful to the host. We chose the tooth as ossicular reconstruction material because of its easy availability, durability and correct consistency. Our animal experiments indicated that the tooth is less bio-active than the homologous incus and is thus suitable for ossicular reconstruction. It can be easily moulded to the desired size and shape with a drill. The root canal offers two additional advantages: first, a pick can be passed through it, to fix it during shaping; and secondly, the canal can be enlarged to form a close fitting socket to receive the head of stapes, thus giving a very stable ossicular assembly.

Revision surgery has shown that the implanted tooth becomes covered by a layer of mucosa with negligible tissue reaction and therefore no adhesions are formed. The structure of the tooth also remains unaltered. Thus a tooth prosthesis which is easily and freely available will give a stable, durable and mobile ossicular assembly and good long-term results in tympanoplasty.

There has not been a single case in which the tooth prosthesis has been rejected although in one case there was a residual central perforation. The hearing improvement has been satisfactory in 15 cases, i.e. with reduction of the air-bone gap to within

https://doi.org/10.1017/S0022215100146882 Published online by Cambridge University Press

15 db. One of the cases, with a well-healed tympanic membrane but a residual air-bone gap of 35 dB., was re-explored after 3 months. The tooth prosthesis placed on the foot plate was found to be large, producing a tenting of the tympanic membrane. It was interesting to note that the tympanic membrane could be lifted off it very easily. The interposed cartilage was adhering firmly to the tympanic membrane. Macroscopically the prosthesis retained its size and shape and, on histology, its structure was maintained and there was almost no foreign body reaction in the mucosal covering. A fresh reconstruction with a smaller prosthesis restored the hearing, reducing the air-bone gap to less than 10 db. In no case did we observe a deterioration of hearing or a sensorineural hearing loss.

Conclusion

A tooth root satisfies all the criteria required of an ideal prosthesis for ossicular reconstruction. It is accepted well by the middle ear, with no evidence of rejection even when used with open mastoid cavities. The hearing gain is comparable to that with the homograft incus. As the prosthesis is found to be stable and remains without adhesions, the hearing gain is maintained. A larger series with a longer follow-up is needed to confirm the above experience.

Acknowledgement

We are grateful to Dr. C. K. Deshpande, Dean, Seth G. S. Medical College and K. E. M. Hospital, Parel, Bombay, for allowing us to use the Hospital records in this paper.

Reference

GAGNON, N. B., PICHE, J., LAROCHELLE, D. and WILLIAMS, M. L. (1979) Homografts of the Middle Ear. *Archives of Otolaryngology*, **105:** 35–38.

https://doi.org/10.1017/S0022215100146882 Published online by Cambridge University Press