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Bony meatus homografts

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Introduction

MEATAL stenosis following reconstructive surgery for congenital meatal atresia remains a problem despite many different operative techniques (Livingstone, 1958; Shambaugh, 1967; Gill, 1969; Crabtree, 1970), and as yet there appears to be no universally satisfactory operation. Stenosis is a serious complication as it may prejudice the hearing result of an otherwise successful surgical procedure. It may also lead to infection and cholesteatoma formation in the deep recess of the skin-lined meatus and obviate the satisfactory fitting of a hearing aid mould.

In 181 ears operated upon at the Radcliffe Infirmary during the last twelve years for congenital meatal atresia there was an overall stenosis rate of 20 per cent (Table I). For these operations a conventional skin bag technique was used.

TABLE I.

INCIDENCE OF STENOSIS.

Operation	Number of		Stenosis		Incidence %	
	Patients	Ears	Patients	Ears	Patients	Ears
Unilateral ..	95	95	31	31	32·6	32·6
Bilateral ..	43	86	9	12*	20·9	14·0
Total	138	181	40	43†	29·0	23·8

* 6 unilateral and 3 bilateral.

† In addition—10 wet without stenosis — overall complication rate $= \frac{53}{181} = 29{\cdot}3\%$.

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Stenosis occurs in the soft tissue lateral to the bone and is due to lack of either a cartilaginous meatus, or an anterior meatal wall adjacent to the temporo-mandibular joint. As part of a long-term programme to provide a more stable bony meatus, a histological study has been made of the fate of homograft bony meatuses in dogs, to determine the applicability of this grafting procedure to human patients. The graft reaction alone has been studied and no claims are made in this paper concerning the meatus as a functioning unit.

Grafts

The grafts consisted of bony meatus only (Fig. 1) and were taken from cadaver heads which had been refrigerated at 2 °C. for 48 hours following

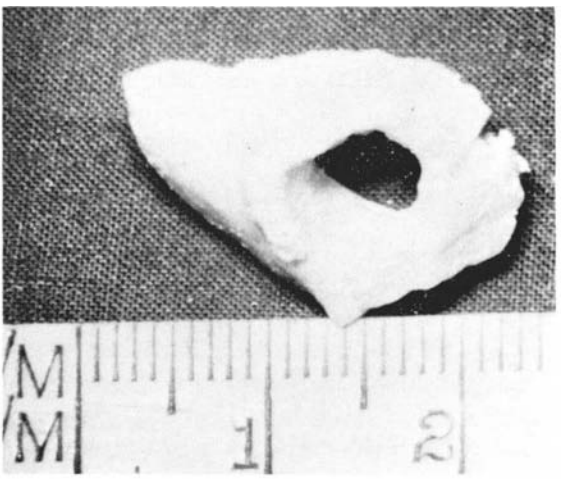


FIG. 1.
Untrimmed bony meatus.

sacrifice. They were taken under clean but not sterile conditions, as these conditions pertain in the post-mortem room when human material is taken.

The pinna and cartilaginous meatus were excised exposing the bony meatus. The meatal skin was then removed as a complete cuff with the squamous outer layer of the tympanic membrane. The bulla was cut inferiorly with a circular burr and a number of holes drilled around the meatus which were subsequently joined to free it. The malleus and tympanic membrane were removed with the meatus, but not used in this experiment.

Sterilization and freeze drying

The meatuses were sterilized by immersion in 2 per cent Ethylene Oxide for twelve hours. They were then snap frozen to −79 °C. using a dry ice and ethanol mixture and freeze dried in a standard freeze drying apparatus.

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The freeze dried grafts were then stored under vacuum in 'Pyrex' glass containers. Under these conditions grafts have a shelf life of several years and are readily available for use. They were reconstituted with normal saline before implantation.

Hosts

The hosts were healthy male dogs of varied breed, their ages ranged from six months to two years. Ten dogs were used as hosts. Littermates were not used as graft and host simultaneously.

The surgical approach to the host meatus was similar to that employed for taking grafts. Under general anaesthesia a circumferential incision was made around the pinna conserving an elliptical flap of skin from the dorsal surface. The incision was deepened to expose the cartilaginous meatus which was excised with the pinna. A cuff of canal skin and the tympanic membrane were then removed and the bony meatus enlarged to receive the inner portion of the graft. After reconstitution and suitable trimming with a cutting burr the graft was wedged into position in the enlarged meatus. Gelfoam was placed in the graft lumen during earlier operations and later a small polythene tube was used.

Histological methods

The graft reaction was studied at three weeks, six weeks, three months, six months and one year. The meatuses and surrounding bone were decalcified in 5 per cent Nitric Acid, paraffin embedded and sections cut in the sagittal plane. Pre-auricular and upper deep cervical lymph nodes from both sides of the neck were also examined for evidence of an immune response.

Results

At three weeks the graft osteocyte lacunae had become empty and the graft was easily recognizable as a piece of dead bone. Apart from small, pressure points the surfaces of graft and host were separated by a layer of granulation tissue and activity was observed at each surface. There was new woven or non-lamellar bone growing from the surface of the host into the granulation tissue (Fig. 2); the graft showed evidence of early attack by multinuclear osteoclasts (Fig. 3).

At six weeks there was continuing production of abundant fibre bone. Straight cement lines were on the surface of the host and there was intense osteoblastic activity (Fig. 4). The osteoclastic attack had ceased and there was little activity at the graft surface. Lymph nodes examined at this stage showed reactive hyperplasia only.

The three month, six month and one year sections showed a continuous process of graft fusion with host bone, and new bone formation

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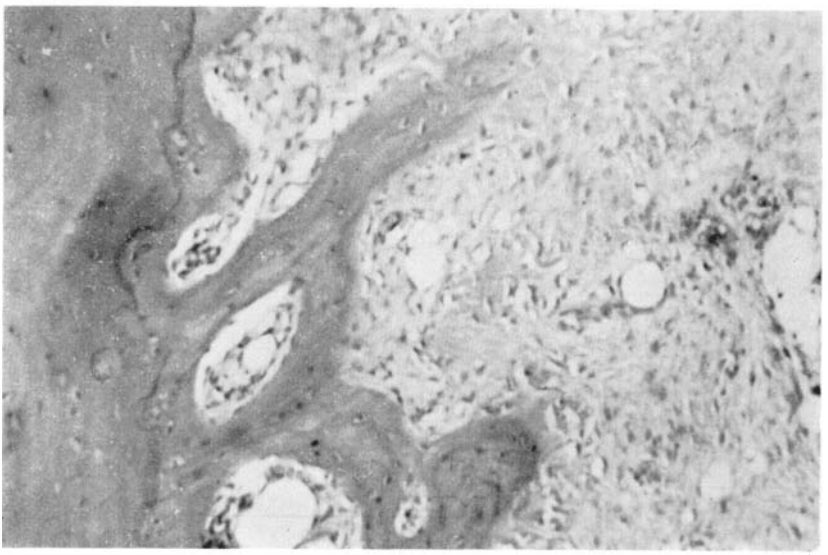


FIG. 2.
Woven bone formation on surface of host.

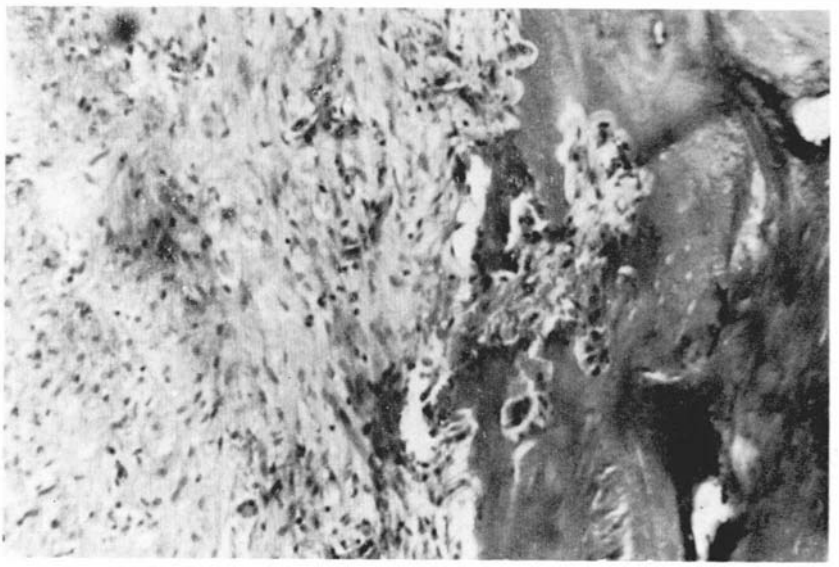


FIG. 3.
Early osteoclastic attack which does not persist. Graft recognizable by empty osteocyte lacunae.

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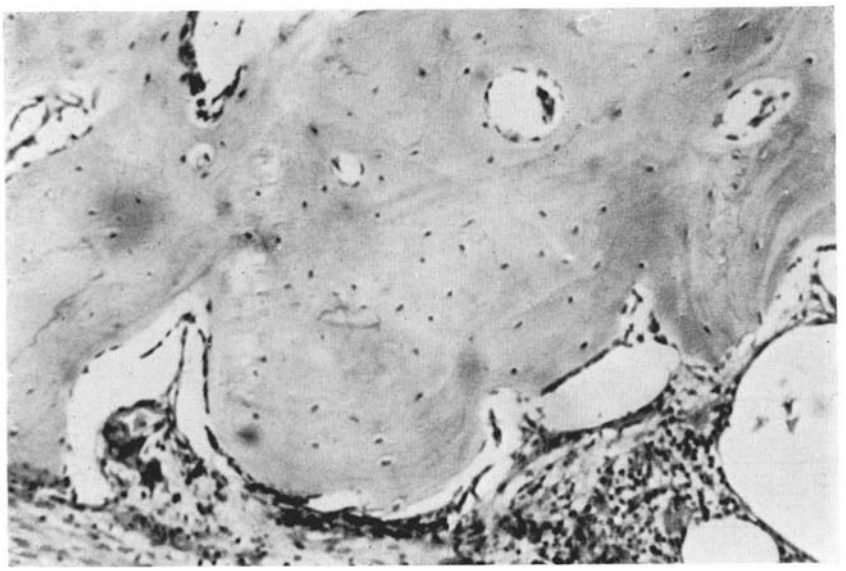


FIG. 4.
Osteoblasts lining host surface.

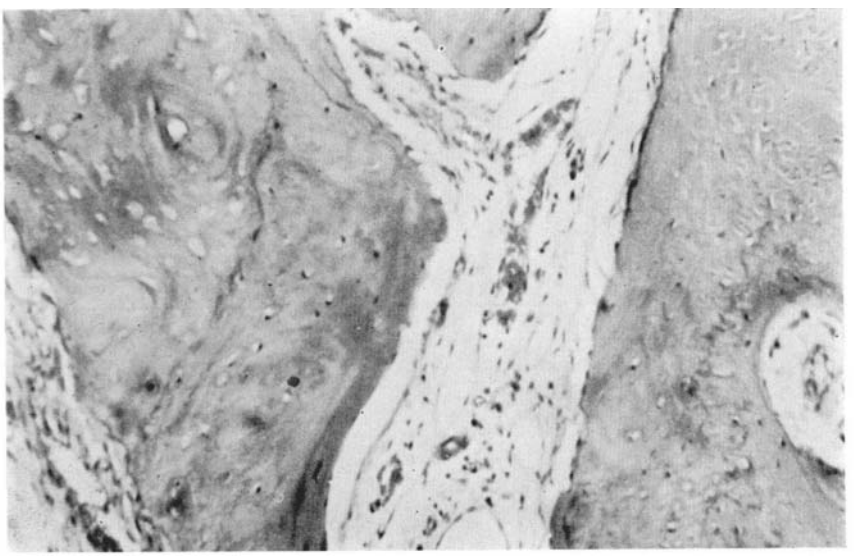


FIG. 5.
6 months. Section through graft showing revascularization of Haversian canals with new bone formation.

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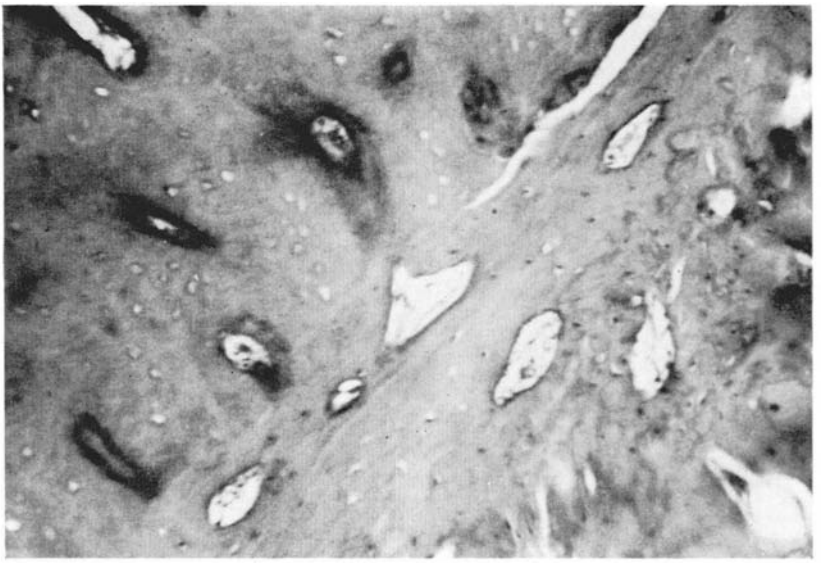


FIG. 6.
1 year. Fusion of graft and host surfaces.

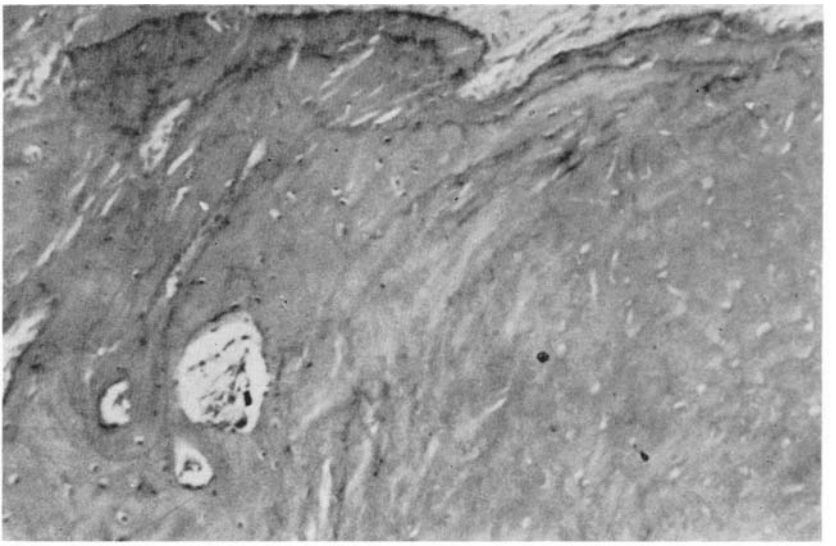


FIG. 7.
6 months. New bone formation on free portion of graft.

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occurred both on the surface and in the Haversian canals of the graft (Fig. 5). The abundant fibre bone seen earlier had securely fused the graft and host surface (Fig. 6). New bone formation occurred throughout the graft including the external portion surrounded by fibrous tissue (Fig. 7).

Gelfoam was abandoned as an insert for the meatal lumen in view of the intense giant cell foreign body reaction. The polythene tube stimulated an early well-differentiated fibrous bed thus reducing the number of

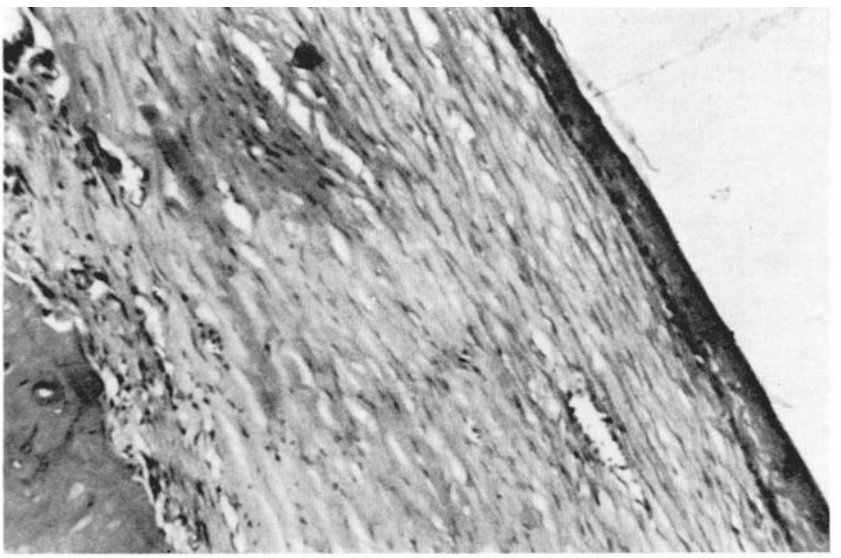


FIG. 8.

6 months. Thickened middle ear epithelium with good fibrous bed lining grafted meatus.

undifferentiated mesenchymal cells available to attack the graft. It was noted that when a polythene obturator was used the middle ear epithelium grew out to line the meatus (Fig. 8). This could possibly be utilized during a second stage reconstruction.

Summary

1. The graft does not provoke an inflammatory reaction and is not rejected.

2. The graft is not resorbed during the period of study and acts as a scaffold for a new bone.

3. When a polythene obturator is used middle ear epithelium grows out to line the meatus.

4. In view of the histological study the functional aspect of bony meatuses in human patients is under investigation.

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