MASTOID OSTEOPLASTY USING AUTOGENOUS CANCELLOUS BONE: A NEW PROCEDURE

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The exenteration of the mastoid bone to form a cavity communicating with the external auditory canal is an integral step in all modified and radical mastoid operations and in fenestration and tympanoplasties, types 2 - 5. It is unfortunate that this procedure, which is an essential feature of these operations, is also responsible for most of the post-operative complications, involving the following undesirable features:

1. *Prolonged after-care.* After operation the patient often has to attend repeatedly for a long time, to allow the cavity to become completely epithelized, or lined by a healthy layer of fibrous tissue, and yet retain its saucerized shape. These attendances are sometimes distressing, especially for children.

2. *Aural discharge.* Many of the cavities fail to heal completely, despite the most diligent and prolonged after-care, and a discharging ear remains. Patients with a discharging ear after fenestration or tympanoplasty are invariably dissatisfied, especially if there has been no improvement in their hearing.

3. *Hearing-aid problems*, as follows:

(*a*) The acoustic qualities of the external auditory canal are altered when a large mastoid cavity is constructed, so that if a hearing aid is required, the patients find that although the sound is amplified it is distorted.

(*b*) It is seldom satisfactory to mould a hearing-aid insert into an ear with a large mastoid cavity and an enlarged meatal opening. When the ear mould fits loosely, a disconcerting whistling noise is emitted from the hearing aid.

(*c*) Stenosis of the meatus is a complication not often seen, but when it does occur it makes it difficult to carry out aural toilet and often impossible to fit a hearing-aid insert, should that be required.

(*d*) In the presence of a discharging cavity, it is undesirable to fit a hearing-aid insert.

Hitherto surgeons have directed their attention towards obtaining a dry, trouble-free cavity, which can at all times be readily inspected, though despite the use of skin grafts many cavities still remain wet and troublesome. The functional relationship of the mastoid cavity to the hearing properties of the affected ear has been completely neglected. This would be unimportant if the operation performed restored serviceable, unaided hearing, but where a hearing aid is required this relationship assumes great significance.

A NEW CONCEPT TO OBVIATE THE DISADVANTAGES OF THE MASTOID CAVITY

It was felt that if the mastoid cavity could be completely obliterated it should be possible to obviate these difficulties and snags. The cavity must perforce be created, but it seemed feasible to fill in the defect with suitable bone grafts and skin flaps. These would serve to reconstruct the petromastoid, the posterior bony canal wall and the outer attic wall and provide a complete, healthy lining to the re-formed external auditory canal.

A one-stage procedure was devised to incorporate these principles. In the planning of this procedure, the following factors required consideration: (*a*) Type of bone graft, (*b*) nutrition of the graft, (*c*) the effect of infection on the graft, and (*d*) provision of skin cover for the portion of the external auditory canal re-formed by the graft.

It was decided that the most suitable graft for this purpose would probably be strips of autogenous cancellous bone obtained from the iliac crest. The cancellous strips are nourished by tissue fluids for 72 hours before they are revascularized; moreover, it is known from bone-grafting procedures on the mandible and elsewhere that cancellous strip grafts will survive even in the presence of mild infection.

Previous attempts have been made to introduce grafts into the cavity—not to obliterate the entire cavity, but to fill in large cells exposed during exenteration of the bone. Mastoid bone chips or diced cartilage have been used,[1] but these are unsatisfactory tissues for grafting because *inter alia* they cannot safely be used if infection is present.

It is important to provide cancellous grafts with a vascular bed. This can to some extent be ensured by the judicious use of pedicle flaps constructed from the soft tissue which covers the auricle and the postauricular area, and from the lining of the membranous and bony auditory meatus. These flaps help to furnish a blood supply for the grafts and provide the newly-constructed external auditory canal with an epithelial lining which should survive because each flap has a good blood supply. The nature of the operation determines the type of flap to be used. The following types have been found useful:

1. *Postauricular flap* (Figs. 1 and 2). This flap was constructed by Beales and Hynes[2] to line the mastoid cavity. In reconstructing old mastoid cavities, this flap provides the

necessary nutrition and skin covering for the bone grafts forming the reconstructed lateral surface of the mastoid and the posterior wall of the external auditory canal.

2. *Auricular flap.* This constitutes the usual flap of soft tissues, which includes the postauricular skin, the entire auricle and the postero-superior portion of the membranous meatus. It is used in all modified and radical mastoid operations and tympanoplasties, if the approach is by the postauricular route, and nourishes the bone grafts forming the lateral surface of the mastoid and upper part of the bony external auditory canal.

3. *Fenestration flap.* This is constructed from the skin lining the posterior, the superior, and part of the anterior meatal wall, and is hinged on the tympanic membrane.

The auricular flap and the fenestration flap may be used for modified radical mastoids and tympanoplasties if *no* attic perforation or subtotal perforation of the drum is present.

4. *Double hinge flaps*, which act like swinging-gates (Figs. 3 and 4). To construct these, the skin lining the posterior, the superior and a portion of the anterior bony meatal walls is freed as far as the region of the tympanic sulcus. At this level, it is severed circumferentially from 12 o'clock to 6 o'clock. The hinge flaps are formed by bisecting this elevated sheet of skin. As shown diagrammatically, the anterior flap hinges at the junction of the anterior and inferior walls, and the posterior flap on the inferior wall of the external auditory canal. When replaced these cover the bone grafts forming the superior and posterior bony walls of the external auditory canal. These flaps may be used in conjunction with postauricular or auricular flaps in all modified and radical mastoidectomies and all tympanoplasties.

PROCEDURE

Pre-operative Preparation

1. *Radiographs of mastoids.* Radiographs indicate the extent of sclerosis. If there is dense sclerosis, bone grafting may not be indicated, because then the cavity is usually small and not troublesome.

2. *Bacteriological study and antibiotics.* Where the middle ear or external auditory canal is infected, aural swabs are required for culture and sensitivity tests. The appropriate antibiotic is administered orally or intramuscularly and also instilled locally for 48 hours before the operation. Where no infection is present, a broad spectrum antibiotic such as tetrex is used 48 hours pre-operatively.

3. *Skin preparation.* The mastoid area and the ipsilateral or contralateral hip and thigh are prepared in the ordinary manner.

Technique of Operation

Stage 1: *Approach.* It is better to use the postauricular approach than the endaural, because it is essential to preserve all the skin and soft tissues of the meatal opening and external auditory canal, which are necessary for the formation of the skin flaps.

Stage 2: *Formation of skin flaps.*

Stage 3: *Exenteration of bone.* The methods of exenteration of the mastoid bone have been well described by many authors. The only variation in this procedure is to avoid exposing the dural plate and the thin bone covering the lateral sinus. This bone, being compact, has a poor blood supply and therefore inadequate regenerative powers.

Stage 4: *Cancellous strip grafts.* The ipsilateral or contralateral iliac crest is approached *via* a 3-inch incision extending posteriorly and slightly laterally from the anterior superior iliac spine. The iliac crest is then denuded of periosteum for 2 - 2½ inches. Within this limit, 1 horizontal cut and 2 vertical cuts (½ inch long) are made with an osteotome through the outer cortical layer of cancellous bone and a 'lid' of the crest is swung medially (Fig. 5). Now 2 further vertical cuts (2½ - 3 inches) are made with an osteotome within this limit through the outer cortical layer only, and this flap of cortical bone, which is hinged below, is pushed laterally, exposing the middle cancellous layer (Fig. 6). Then 2 or more strips of cancellous bone, measuring 1½ inches by 1/8th of an inch, are removed with a sharp osteotome and are later cut and shaped into further strips as required for the cavity (Fig. 7). This is easily done with a small, sharp, slightly angled pair of bone-cutters. These strips are placed in a bowl containing penicillin solution, until required. The 'lid' and the lateral cortical flap are replaced and the wound is carefully closed in layers after all bleeding has been controlled.

Stage 5: *Utilization of the cancellous bone strips.* Two methods of inserting the strips of cancellous bone have been found suitable. Method A (depicted diagrammatically in Fig. 8) is used for reconstruction of the petromastoid and the posterior wall of the bony canal. Method B (Fig. 9) is used for reconstruction of the petromastoid, the posterior wall of the bony canal, and the outer attic wall. When introducing the bone grafts, it is desirable (1) to avoid crushing or pulping the strips, which destroys the osteogenic cells and the excellent natural scaffolding for invasion of new bone-forming elements from the host bone; (2) to place the strips so that the largest possible surface comes into contact with the host bone; (3) to avoid inserting too many strips of bone, because if an excess is used (*a*) too narrow an external auditory canal is created and (*b*) the skin flaps do not entirely cover the exposed surfaces of the grafts; and (4) to place the fenestration flap or the tympanic free skin graft in position before inserting the bone strips.

Stage 6: *Replacing the skin flaps.* The flaps are carefully replaced to cover all the exposed surfaces of the graft. Free skin grafts used to cover any of the bone strips do not survive. The external auditory canal is then loosely packed with sterospon and paraffin gauze strips.

Finally, the postauricular incision is sutured. The denuded areas on the postauricular surface can be covered with free split-thickness grafts taken from the thigh or inner aspect of the arm.

Post-operative Treatment

Antibiotic therapy is continued until the sutures are removed on the 7th post-operative day. The meatal gauze pack is removed, and the liquefied or semi-liquefied sterospon is evacuated by gentle sucking and/or mopping. A general anaesthetic is not required for this. Afterwards 1·5% neocortef-acetate drops are instilled into the meatus twice a day. On the 12th post-operative day (with children), or the 14th (with adults), sutures at the iliac crest are removed and the patient can then commence walking. Radiological examinations are made at monthly intervals until it is evident that the graft has become an integral part of the mastoid bone.

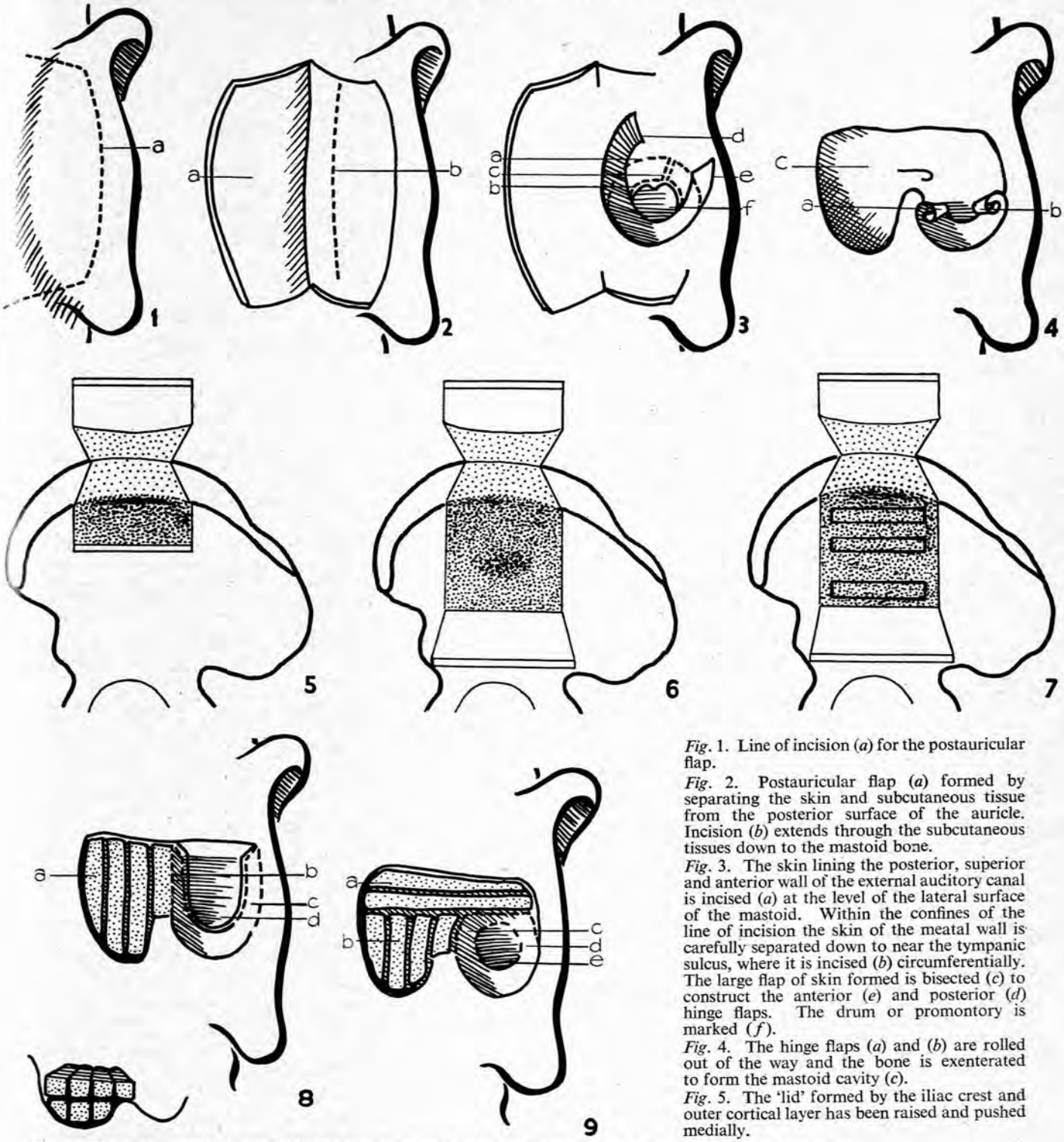

Fig. 1. Line of incision (*a*) for the postauricular flap.

Fig. 2. Postauricular flap (*a*) formed by separating the skin and subcutaneous tissue from the posterior surface of the auricle. Incision (*b*) extends through the subcutaneous tissues down to the mastoid bone.

Fig. 3. The skin lining the posterior, superior and anterior wall of the external auditory canal is incised (*a*) at the level of the lateral surface of the mastoid. Within the confines of the line of incision the skin of the meatal wall is carefully separated down to near the tympanic sulcus, where it is incised (*b*) circumferentially. The large flap of skin formed is bisected (*c*) to construct the anterior (*e*) and posterior (*d*) hinge flaps. The drum or promontory is marked (*f*).

Fig. 4. The hinge flaps (*a*) and (*b*) are rolled out of the way and the bone is exenterated to form the mastoid cavity (*c*).

Fig. 5. The 'lid' formed by the iliac crest and outer cortical layer has been raised and pushed medially.

Fig. 6. The outer cortical layer is hinged inferiorly and pushed laterally, exposing the middle cancellous layer.

Fig. 7. Cancellous strips removed from the middle layer.

Fig. 8. Strips of cancellous bone (*a*) are inserted lengthwise between the tegmen and the lower margin of the mastoid cavity. This reconstructs the petromastoid and the posterior bony wall of the canal, which becomes lengthened by the width of the attic. The strips are not squeezed into apposition and the gaps between the strips are not filled in with bone chips. The posterior hinge flap (*b*) covers the reconstituted posterior bony canal wall, and the anterior hinge flap (*c*) covers the anterior attic wall. The full-thickness skin graft (*d*) forms the drum and extends onto the medial and superior attic walls.

Fig. 9. Strips of cancellous bone (*a*) are introduced lengthwise, extending from the sinodural angle to the anterior attic wall. This reconstitutes the outer attic wall and portion of the mastoid cavity. Strips (*b*) are then inserted lengthwise at right angles to (*a*) to reconstruct the remainder of the mastoid cavity and the posterior bony canal wall. The hinge flaps (*c* and *d*) are unfurled to cover the exposed surfaces of the strips forming the posterior and superior walls of the canal. The full-thickness skin grafts used for the tympanoplasty are shown as (*e*).

TABLE I. POST-OPERATIVE RESULTS

	Case 1	*Case 2*	*Case 3*	*Case 4*	*Case 5*	*Case 6*	*Case 7*
Operation	Tympano-plasty. Mastoid and reconstruction. Method B.	Fenestration. Recon-struction. Method A.	Tympano-plasty. Recon-struction. Method A.	Recon-struction of old mastoid cavity	Tympano-plasty. Recon-struction. Method B.	Tympano-plasty. Recon-struction. Method A.	Tympano-plasty. Recon-struction. Method B.
Time of dry and complete epithelization of external auditory canal and attic area	17 days	21 days	27 days	21 days	21 days	21 days	21 days
Post-operative contour of external auditory canal	Normal	Normal in its outer 2/3rds. Inner 1/3rd widened by the inclusion of the attic and part of antrum	Elongated by the inclusion of the attic area	Irregular	Normal	Elongated by the inclusion of the attic area	Normal
Post-operative radiological appearances	Complete integration of bone grafts with the host bone.			Less than 3½ months. Incorporation is proceeding but not complete.			

Contra-indications

In the following conditions the grafting of the mastoid cavity with cancellous bone should not be undertaken:

1. Middle ear infection, associated with complications.
2. Dense, sclerotic mastoid bone. In these cases the eventual mastoid cavity is usually small and not troublesome. Moreover, the avascular sclerotic bone is a poor, unsuitable bed for the cancellous bone strips.

CASE RECORDS

The following are notes on the first 7 cases in which this grafting procedure has been applied. The cases comprise 5 tympanoplasties, 1 fenestration, and 1 old infected cavity following a radical mastoid operation. The post-operative results are shown in the concluding section under the heading 'summary and results' and in Table I. One of us (A.S.) performed the ear operation, including the bone grafting of the cavity, and the other (M.S.) took the grafts from the iliac crest.

Case 1

D.G., Coloured female aged 11 years.

History. Persistent, foul-smelling aural discharge for 4 years.

Examination. Left ear normal. Right ear Malodorous, purulent discharge; pars tensa absent and medial tympanic wall covered with cholesteatomatous debris; conversational voice heard at maximum distance of 1 foot; fistula sign negative.

Diagnosis and conclusion. Cholesteatoma formation in right tympanic cavity resulting in otorrhoea and deafness. Right tympanoplastic operation to be performed and the exenterated mastoid bone reconstructed with autogenous cancellous bone strips taken from iliac crest.

Pre-operative preparation. Although scheduled to arrive 3 days before the operation, the child was only admitted the night before; therefore no preliminary X-ray or bacteriological investigations were possible. A broad-spectrum antibiotic (tetrex, 250 mg. 12 hourly) was prescribed and skin prepared for the mastoid area and contralateral hip.

Operation, 21 October 1959. Pentothal and scoline induction; intubation; gas, oxygen and ether. Small sandbag placed under right buttock to render the iliac crest prominent; head positioned as for mastoidectomy. Towels first placed around hip and then towels for mastoidectomy positioned. External auditory canal and promontory area cleansed and inspected. The skin flaps employed were (*a*) a conventional auricular flap and (*b*) 2 swinging-gate flaps constructed from the skin lining the posterior superior, and portion of the anterior walls of the canal (Fig. 3).

A postauricular incision was made down to bone, avoiding injury to the temporalis muscle. The soft tissues were pushed forwards to expose the lateral surface of the mastoid and the outer attic wall. The external auditory canal was entered by a transverse incision through the skin of the posterior meatal wall. The incision extended circumferentially from 12 o'clock to 6 o'clock, thereby allowing the auricle and soft tissues to be reflected forwards, and the auricle was held there by a retractor without exerting any tension on the skin lining the bony canal down to the tympanic sulcus. By carefully separating the skin lining down to the tympanic sulcus and incising it (Fig. 3) adequate posterior and anterior hinge flaps were constructed.

With gouges, the bone was exenterated as for a radical mastoidectomy. The bone was of the small cellular variety. Extensive infected cholesteatoma was found in the antrum and attic area. This was removed. With a Zeiss microscope (×10 magnification) the middle ear mucosa was inspected and found grossly diseased. Every visible shred of cholesteatoma and diseased mucosa was meticulously removed from the mastoid cavity and tympanum. The stapes and the round windows were isolated and found to be mobile. The eustachian orifice was cleared of a collection of cholesteatomatous debris.

A full-thickness skin graft was taken from the postauricular surface, prepared, and placed in position to complete a type-3 tympanoplasty.

The cancellous bone, synchronously taken from the iliac crest and cut into strips measuring about 1½ inches by 1/8th of an inch, were then removed from the penicillin solution and trimmed to the necessary requirements.

The outer attic wall was first reconstructed by inserting strips lengthwise, extending from the sino-dural angle to the anterior wall. The innermost of these strips rested on the bone of the medial attic wall. The mastoid and posterior bony wall was then rebuilt by inserting strips lengthwise at right angles to the others. The space previously occupied by the antrum and attic was obliterated (Fig. 9).

After inserting the bone strips, the mastoid retractor was released and the auricle replaced in its normal position. Through a speculum inserted into the meatal opening, the positioning of the bone grafts was inspected and size of the external auditory canal noted.

As it appeared satisfactory, the auricle was again reflected and held forwards. The anterior and posterior hinge flaps were unfurled and found to cover the grafts forming the posterior and superior canal walls, except for the small innermost area where the superior wall extended onto the medial wall of the attic. This area was covered by the uppermost portion of the free tympanic graft which had been placed in position before the bone grafts were inserted. The canal was filled with sterospon pledgets soaked in penicillin.

When the auricle was released the soft tissues were observed to cover the grafts forming the lateral surface of the mastoid.

Finally, after the postauricular incision was sutured a small paraffin gauze plug was inserted through the meatal opening for about ½ inch and the usual external mastoid dressing was applied.

Case 2

B.S., Coloured male aged 24 years.

History. Bilateral otosclerosis. Three months previously, right stapes mobilization done; result unsuccessful, and fenestration with reconstruction of the exenterated mastoid and posterior bony canal wall with autogenous cancellous bone strips from iliac crest now advised.

Pre-operative preparation. (1) Radiographs of mastoid showed mastoid structure to be cellular. (2) Audiogram showed 50 decibel loss over all frequencies in both ears. (3) Tetrex, 500 mg. 12 hourly, prescribed and skin prepared for mastoid and contralateral hip area.

Operation, 13 November 1959. Pentothal and scoline induction; intubation; gas, oxygen and ether. A routine fenestration operation was done *via* the postauricular approach. After the tympano-meatal flap had been placed in position over the fenestra, strips of autogenous cancellous bone, synchronously exsected from the iliac crest and soaked in penicillin solution, were trimmed and placed in position to build up the mastoid cavity and posterior bony meatal wall (method A, Fig. 8). No attempt was made to reconstitute the outer attic wall by inserting bone strips. The area was inspected through the meatal opening after the auricle had been repositioned. It was noted that the external auditory canal had a normal-looking contour and that the attic area was easily visible. The reconstitution of the mastoid and posterior bony canal wall appeared satisfactory.

The auricle was again reflected and held forwards by inserting the mastoid retractor. The portion of the fenestration flap lying immediately posterior to the lateral semicircular canal was gently elevated and placed over the surface of the adjacent bone grafts. It only provided skin cover for the grafts forming the upper half of the reconstituted posterior bony canal wall, and to provide skin covering for the lower half, which remained exposed, a rotation sliding flap was constructed from the skin covering the remaining normal part of the posterior canal wall and from the skin of the inferior wall.

Sterospon pledgets and a paraffin gauze plug were placed in contact with the skin flaps to exert gentle pressure. The auricle was replaced in its normal position and the postauricular wound sutured.

Case 3

M.F., Coloured female aged 14 years.

History. Left otorrhoea for 5 years. Hearing poor. Seven years previously a modified radical mastoidectomy had been done on right ear, which still discharged.

Examination. Left ear: Foetid, purulent discharge; tympanic membrane destroyed; skin lining of bony meatal wall soggy and unhealthy; loud voice heard at maximum distance of 6 inches; fistula sign negative. Right ear: Malodorous purulent discharge from a large modified radical cavity, which was filled with cholesteatomatous material. Heard conversational voice up to 2 feet.

Diagnosis and conclusion. Left ear: Cholesteatoma formation, causing destruction of drum and ossicles, and otorrhoea and deafness. Right ear: Non-epithelized mastoid cavity with cholesteatoma formation. Tympanoplasty operation to be performed and mastoid cavity reconstructed with autogenous cancellous iliac strips. The operation was first performed on the left ear (case 3) and, after an interval of 2 weeks, the right ear was operated on (case 4).

Pre-operative preparation. (1) Radiographs of mastoids: 'Left ear—mastoid bone structure small, cellular variety; large, translucent area in antral and attic region suggestive of cholesteatoma formation.' (2) Skin prepared for mastoid and hip areas. (3) Tetrex, 500 mg. 12 hourly, commenced 48 hours pre-operatively.

Operation. As the skin lining the canal was unhealthy, it was decided to prepare a postauricular flap (Figs. 1 and 2) and also, if possible, posterior and anterior hinge flaps (Fig. 3). The post-auricular flap was constructed, but during the preparation of the hinge flap the skin lining the antero-superior portion of the canal wall disintegrated. This resulted in the formation of a long posterior flap and very short anterior flap.

The exenterated bone was cellular. An extensive infected cholesteatomatous cast was removed from the antrum and the attic area and a large mastoid cavity resulted. After careful removal of cholesteatoma-bearing areas under ×10 magnification, a tympanoplasty type 4 was completed.

Autogenous cancellous bone strips soaked in penicillin solution were trimmed and inserted into the mastoid cavity and attic area (method B, Fig. 9). When the hinge flaps were replaced they did not adequately cover the exposed surface of the grafts forming the superior wall of the bony canal.

The bone strips were then removed and repositioned to reconstruct the mastoid cavity and posterior bony canal wall only (method A, Fig. 8), and the attic area was left in its exenterated state. It was then found that the posterior flap completely covered the strips forming the elongated posterior canal wall. The small anterior flap covered the anterior attic wall. This left the exposed bone of the medial and superior walls of the attic without an epithelial covering and, to provide this covering, a portion of the postauricular flap was excised, making it long enough not only to form the tympanic membrane, but also to extend onto and cover the medial and superior attic walls (Fig. 8).

The reconstituted canal was well formed but elongated, and completely lined with an epithelial covering.

The canal was filled with sterospon pledgets soaked in penicillin. The auricle was sutured into position and a short paraffin gauze plug was inserted through the meatal opening.

Finally, a split-thickness graft was sutured to the raw post-auricular surface.

Case 4

M.F., Coloured female aged 14 years (same child as case 3).

History, etc. See case 3.

Pre-operative preparation. Same as in cases 1 and 3.

Operation. As there was no skin present to form anterior and posterior hinge flaps, the approach was by the postauricular route with the construction of a postauricular flap (Figs. 1 and 2).

The old mastoid cavity was carefully cleansed of all diseased tissue and the medial wall of the tympanic cavity prepared for tympanoplasty type 4.

Autogenous cancellous bone strips synchronously removed by one of us (M.S.) from the iliac crest, were trimmed and inserted into the cavity to reconstruct the mastoid bone and the posterior bony wall of the external auditory canal (method A, Fig. 8). The outer attic was not reconstructed.

The postauricular flap was positioned to cover the exposed surfaces of the bone grafts. A redundant portion of this flap was used as a free graft to complete the tympanoplasty.

Sterospon and paraffin gauze were placed in contact with the free skin graft and skin flap to exert gentle pressure.

The postauricular opening was closed by carefully suturing the subcutaneous soft tissues of the auricle, at its free margin, to an area on the transposed skin which had been denuded of its surface layer of dermis along the site corresponding to the original area of attachment of the auricle (Beales and Hynes[2]).

The large raw area on the posterior surface of the auricle was covered with a split-thickness graft, which was sutured into position.

Case 5

M.R., Coloured female aged 12 years.

History. Right chronic suppurative otitis media for 3½ years. *B. pyocyaneus*, sensitive to polymixin, was the organism responsible. The ear continued to discharge despite antibiotic treatment.

Examination. Right ear: Purulent discharge; pars tensa completely destroyed, and promontory covered with oedematous red granulation tissue. Conversational voice heard up to 2 feet.

Conclusion. Right tympanoplasty to be performed and the petromastoid, the posterior bony canal wall, and the outer attic wall reconstituted by inserting autogenous cancellous bone strips taken from iliac crest (method B, Fig. 9).

Pre-operative treatment. (1) Radiographs of mastoids: 'Left ear—large radical mastoid cavity; right ear—the mastoid bone structure is of the small cellular variety; no evidence of bone destruction noted.' (2) Bacteriological report on aural swab: '*B. pyocyaneus*, sensitive to polymixin only.' (3) Oral tetrex, 500 mg. 12 hourly, and local instillation of polymixin solution, commenced 48 hours before the operation.

Operation. A postauricular approach was used and a post-auricular flap and 2 swinging-gate hinge flaps were constructed.

The exenterated mastoid bone was found to be of the small cellular variety and the antrum and attic were completely filled with oedematous fibrous tissue. All diseased tissue was carefully removed under ×10 magnification from the antrum, attic and tympanic cavity. As a mobile stapes was isolated, tympanoplasty type 3 was completed in the conventional manner.

The prepared strips of autogenous cancellous bone synchronously taken from the iliac crest were trimmed and inserted into the mastoid cavity to reconstruct the outer attic wall, the petromastoid, and the posterior bony canal wall (method B, Fig. 9).

After inspecting the contour of the reconstructed external auditory canal, the hinge flaps were unfurled and positioned. Sterospon pledgets were packed into the canal and a short length of paraffin gauze introduced through the meatal opening, and the operation was completed by suturing the postauricular incision.

Case 6

G.V., Coloured female aged 14 years.

History. Chronic right suppurative otitis media for 7 years.

Examination. Thick, purulent discharge. Drum completely absent and medial tympanic wall covered with granulations. Conversational voice heard up to 6 inches.

Conclusion. Tympanoplasty type 3 to be performed and the petromastoid and the posterior bony canal wall reconstructed by inserting autogenous cancellous bone strips taken from the iliac crest.

Pre-operative treatment. (1) Mastoid radiographs: 'Right—bone sclerotic; left—cellular'. (2) Tetrex, 500 mg. 12 hourly, commencing 48 hours pre-operatively.

Operation. By the postauricular approach, an auricular flap and 2 swinging-gate hinge flaps were constructed. The posterior hinge-flap was made longer than the anterior so that it would adequately cover the reconstructed elongated posterior bony canal wall.

The mastoid bone, which was sclerotic, was exenterated. A small antrum and attic contained cholesteatoma. This was carefully removed under ×10 magnification. A free, full-thickness skin graft was prepared to form the drum and to cover the medial and superior attic walls. A type 3 tympanoplasty was completed.

The autogenous cancellous bone strips taken from the iliac crest were prepared and inserted into the mastoid cavity to reconstruct the petromastoid and posterior bony canal wall (method A, Fig. 8). After inspection of the contour of the reconstructed external auditory canal, the hinge flaps were unfurled and positioned.

Sterospon and paraffin gauze packing was inserted to exert gentle pressure and, finally, the postauricular incision was sutured.

Case 7

O.P., Coloured male aged 27 years.

History. Persistent malodorous discharge from the left ear for 7 years. Slow deterioration of hearing.

Examination. Large attic perforation was present and pars tensa was seen to be adherent to medial tympanic wall. Conversational voice heard up to a distance of 3 feet.

Conclusion. Tympanoplasty operation to be performed, and the exenterated mastoid bone reconstructed by introducing autogenous cancellous bone strips from the contralateral iliac crest.

Pre-operative treatment. (1) Mastoid radiographs: 'Left ear—the bone shows evidence of sclerosis; right ear—extensive pneumatization of the mastoid bone.' (2) Tetrex, 500 mg. 12 hourly, commenced 48 hours before operation.

Operation. After cleansing and inspection of the external auditory canal, it was decided to create a conventional auricular flap and two swinging-gate hinge flaps.

The exenterated bone was of the small cellular variety. A large mastoid antrum and wide attic were found filled with cholesteatoma and oedematous infected granulations. The diseased tissue was carefully removed and a tympanoplasty type 3 was completed.

Strips of autogenous cancellous bone soaked in penicillin, synchronously taken from the contralateral iliac crest, were trimmed and introduced into the exenterated area to reconstruct the outer wall, the petromastoid, and the posterior bony canal wall (method B, Fig. 9).

After positioning of the hinge flaps, the canal was packed with sterospon and the postauricular wound was sutured.

SUMMARY AND RESULTS

1. A new osteoplastic reconstructive procedure performed on the ear has been described. Seven cases are presented—5 tympanoplasties, a fenestration and an old, infected radical mastoid cavity.

2. In each case, autogenous cancellous bone strips taken from the iliac crest were inserted into the mastoid cavity to reconstruct the exenterated petromastoid and the bony walls of the external auditory canal. Skin flaps were fashioned to provide the epithelial covering.

3. Thus far, in every instance, the mastoid bone has been completely reformed, with obliteration of the mastoid cavity. The normal contour of the external auditory canal has also been restored (Table I).

4. The post-operative course and end-results in this series of cases showed several striking advantages:

(*a*) The sutures and plugs were removed painlessly without a general anaesthetic.

(*b*) Healing took place at a rapid rate with a minimum amount of local treatment. Gentle mopping of the canal was only performed at weekly intervals and the canal was completely dry and epithelized 3½ weeks after operation in all cases. The multiple visits and painful local toilet to the mastoid cavity, often over a prolonged period, were completely obviated.

(*c*) The final result is a dry, relatively normal-shaped, and completely epithelized external auditory canal. In 4 cases the canal was a little elongated by the inclusion of the attic area.

(*d*) In the first 3 cases, radiographic evidence of successful integration of the bone grafts with the host bone was present 3 months after operation (Table I). In the remaining cases, too short a period has elapsed for the final radiographic assessment to be made. There has been no evidence of sequestration of the bone grafts.

5. Post-operative pain was experienced in the iliac crest wound but this disappeared when the stitches were removed. No undesirable sequelae resulted from this wound.

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ADDENDUM

Since the completion of this paper a further 5 patients have undergone the operation of mastoid osteoplasty. The post-operative course thus far has been the same as in the 7 cases recorded above.

REFERENCES

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