Surgical management of the discharging mastoid cavity

R. P. MILLS, M.PHIL., FRCS* (LONDON)

Abstract

A survey of 67 patients with 74 mastoid cavities has been carried out. During the study period they made a total of 126 cavity/outpatient visits. Thirty-five patients (56 per cent) had discharge from at least one cavity on at least one outpatient visit. At only 5 per cent of visits was the discharge classified as profuse. A retrospective study of 54 mastoid revision operations on 51 patients has been made. Overall 59 per cent of operations resulted in a dry ear. The best results were achieved by carrying out cavity revision combined with a meatoplasty (83 per cent dry ears). Cavity revision alone produced a dry ear in only 57 per cent of cases. The worst results were produced by soft tissue obliteration (33 per cent dry ears). This supplement also presents the early results of a prospective investigation of bone paté obliteration of mastoid cavities. Of the eight cases studied so far, five (63 per cent) have dry ears following surgery. Three of the patients in this group had undergone previous unsuccessful revision surgery using other techniques. Cavity revision with meatoplasty is the technique of choice for most patients, but mastoid obliteration offers potential advantages for younger patients, particularly those wishing to swim.

1: INTRODUCTION

Twenty per cent of mastoid cavities remain unhealed six months after surgery and of those which heal initially, a proportion begin to discharge again subsequently (Beales and Hynes, 1958). This means that a significant proportion of patients undergoing mastoid surgery experience intermittent or chronic discharge following the operation. According to Beales (1959) this proportion can be as high as 60 per cent. Palva (1982) has reported a series of 123 cases treated by radical mastoidectomy. Ten per cent of cavities discharged continuously while 20 per cent were occasionally moist. In some cases discharge can be eliminated by medical treatment, but in others it persists despite the most meticulous aural toilet and judicious instillation of suitable medication.

A number of surgical techniques have been devised to promote satisfactory healing of existing mastoid cavities. In some cases revision of the cavity, involving smoothing its contours and lowering the facial ridge, may be successful. This approach is often combined with a meatoplasty. Recently Osborne *et al.* (1985) have reported excellent results following the use of a large meatoplasty technique alone.

Some surgeons have sought to reduce the volume of the cavity by obliterating the mastoid bowl, either at time of primary surgery, or during revision of existing cavities. In 1911, Mosher described the use of a postaural skin flap to obliterate cortical mastoid cavities. Beales and Hynes (1958) have used a similar flap to facilitate healing of radical mastoid cavities. In 1928, Kisch described a technique using a pedicled temporalis muscle flap. This technique was further elaborated by Rambo (1958) and this approach has also been used by Guilford (1960, 1961) and Thorburn (1961). Popper (1935) used periosteum to line mastoid cavities, but not to obliterate the mastoid bowl. Palva (1962) described the use of a flap composed of periosteum and overlying soft tissues, including muscle. This approach has also been advocated by Guilford (1960) and Janzen (1981). Soft tissue flaps tend to lack bulk and muscle in particular tends to atrophy.

Alternatively bone may be used in the form of strips taken from iliac crest (Schiller, 1961) or chips from femoral heads (Shea and Gardiner, 1970). Bone chips, however, tend to be reabsorbed (Plester and Steinbach, 1977). Palva (1973) has now added the use of a mixture of bone dust and water ('bone paté') to his obliterative technique. Others have used a powder composed of a ceramic material in a similar manner (Leonard *et al.*, 1973). Meuser (1984) has described an alternative obliterative technique using an artificial material, methacrylate. Guilford (1960) has used diced cartilage to partially obliterate fenestration cavities. Other surgeons have reconstructed the posterior meatal wall, leaving an aerated cortical cavity. Techniques using cartilage (Wehrs, 1972), bone (Wigand *et al.*, 1974) and 'Proplast' (Shea and Hornsby, 1974) have been described. More recently the ceramic materials 'Ceravital' (Reck, 1984) and hydroxyapatite (Grote and Kuijpers, 1983; Grote and Van Blitterswijk, 1986) have been used in a similar manner.

The purpose of the present study was to investigate the incidence and severity of discharge from established mastoid cavities and to evaluate the effectiveness of different surgical techniques for revision of persistently

* ENT Department, King's College Hospital, London. (Based on the winning entry for the 1987 Xomed Prize.)

https://doi.org/10.1017/S0022215100600361 Published online by Cambridge University Press

TABLE I
DISCHARGE SCORES FROM 74 MASTOID CAVITIES

	Discharge			Dry	Total
	Profuse	Moderate	Slight		
Cavity/visits	6	30	35	55	126

discharging ears. Cavity revision, with and without meatoplasty, and soft tissue obliteration techniques have been studied retrospectively. The early results of a prospective investigation of obliteration of mastoid cavities using bone paté are also presented.

2: SURVEY OF ESTABLISHED MASTOID CAVITIES

Materials and methods

Patients with established open mastoid cavities attending ENT outpatient clinics at King's College Hospital were examined by the author and the condition of their cavities assessed. The state of the cavity was recorded as either 'dry' or 'discharging'. Discharge was graded as 'slight', 'moderate' or 'profuse'. 'Slight' discharge included moist cavities and those with small amounts of discharge in them. 'Moderate' discharge described cavities with a moderate amount of discharge in them and 'Profuse' discharge those which were full or nearly full of discharge and debris. Cavities were classified as 'dry' if they were empty or contained only cerumen. The date of the original operation and the type of surgery performed (radical or modified radical) were also recorded.

Results

During the course of the survey 67 patients with 74 mastoid cavities made a total of 126 cavity/outpatient visits (34 females, 33 males). They had undergone mastoid operations between 1 and 75 years before the period of the survey (mean = 26 years). The majority of the patients had their original operations at King's College Hospital, but a significant minority had undergone surgery elsewhere. There were 36 radical cavities and 32 modified radical cavities (6 no data). Thirty-five patients (56 per cent) had discharge from at least one cavity on at least one occasion. The grading of discharge is summarized in Table I.

TABLE II
RESULTS OF MASTOID REVISION SURGERY: RETROSPECTIVE STUDY

	Discharge	Dry	Total
Cavity revision	9	12	21
Cavity revision + meatoplasty	3	15	18
Total	12	27	39
Palva flap	7	2	9
Muscle flap	3	2	5
Other	0	1	1
Total	10	5	15
Overall total	22	32	54

3: RETROSPECTIVE STUDY OF REVISION MASTOID SURGERY

Materials and methods

The records of patients who had undergone operations to revise existing mastoid cavities at King's College hospital between the years 1966 and 1986 were examined. Details of the surgical technique used, the duration of follow-up after the revision surgery and the state of the cavity at the most recent outpatient visit were all noted. The condition of the cavity was recorded as either 'dry' or 'discharging'. Some of the patients whose cavities continued to discharge following surgery may well have been significantly improved. However, in the context of a retrospective study, it is not possible to make such relative judgements in a meaningful way.

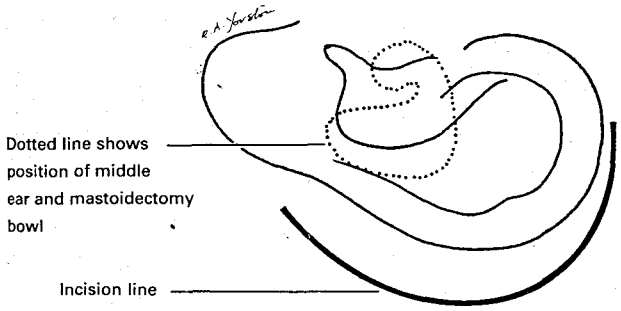
Results

The records of 54 patients who had undergone revision mastoid surgery during the study period were available for examination. Three of the patients had been followed for less than one year following revision surgery and these were excluded. The remaining 51 patients had undergone a total of 54 revision operations. They had been carried out by a number of different surgeons, of differing experience. The age of the patients ranged from 8 to 66 years at the time of surgery (mean = 35 years), 31 were male and 20 female. They had been followed for between 1 and 19 years following revision surgery (mean = 5.8 years). Overall 59 per cent of operations resulted in a dry ear. The most successful technique was cavity revision with meatoplasty (83 per cent dry ears) and the least successful was soft tissue obliteration (33 per cent dry ears). Cavity revision alone resulted in a dry ear in 57 per cent of ears. The detailed breakdown of the results in relation to the surgical technique used is shown in Table II.

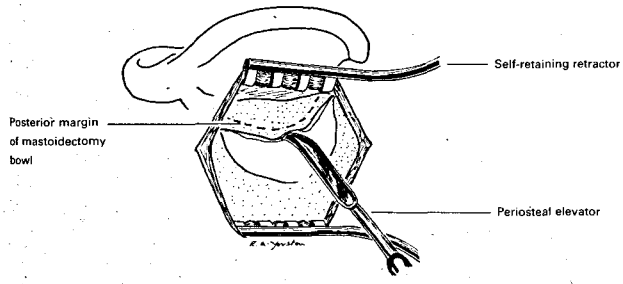
4: PROSPECTIVE STUDY OF MASTOID OBLITERATION USING BONE PATÉ

Materials and methods

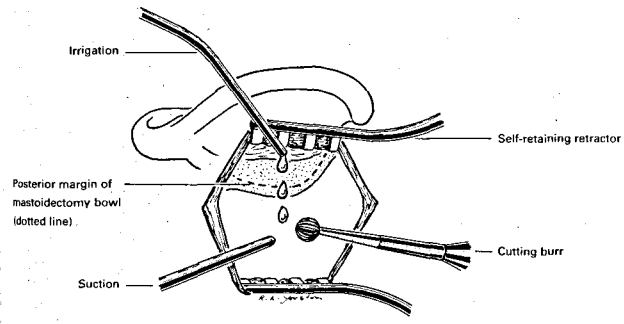
All patients entering this study had intermittent or chronic discharge from their mastoid cavities unresponsive to a period of medical treatment carried out personally by the author. They were questioned about the frequency and duration of their discharge and the occurrence of other ear symptoms. When possible details of previous operations were recorded. All the operations in this group were carried out by the author. Patients



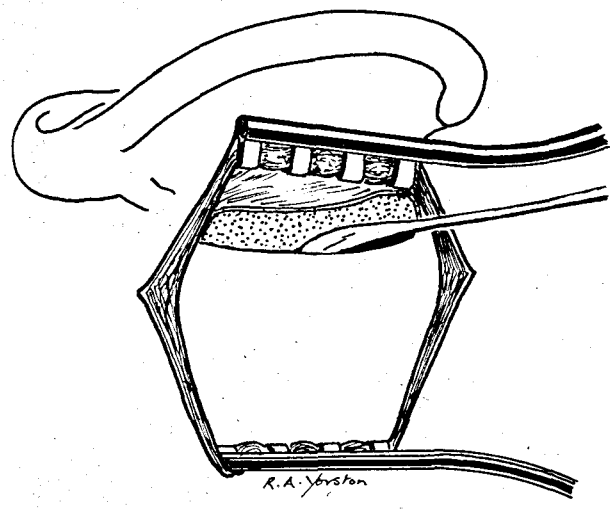
(a) The skin incision. This is made well posterior to the cavity which is shown in outline by the broken line.



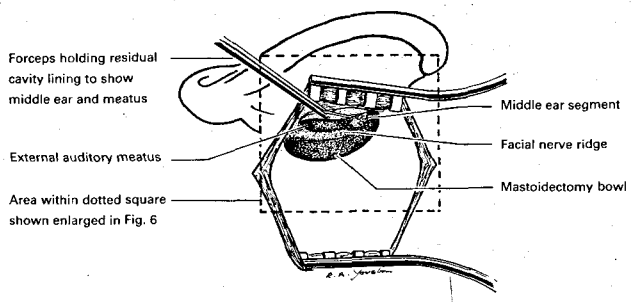
(b) The exposure of the skull posterior to the cavity and collection of bone paté. Care is taken not to enter the mastoid bowl (posterior margin shown by broken line).



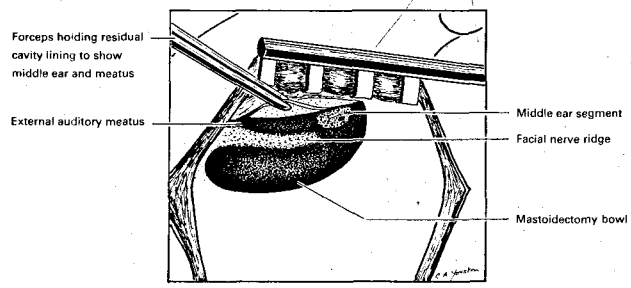
(c) Collection of bone paté.



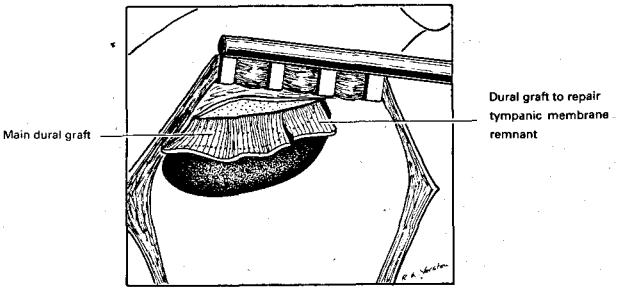
(d) Elevation of soft tissue from mastoid bowl.



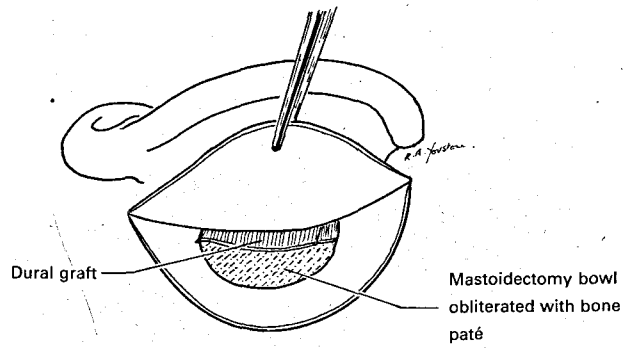
(e) The mastoid bowl and middle-ear segment following soft tissue dissection.



(f) Close-up view to show facial ridge and tympanic remnant.



(g) Grafting of tympanic remnant and posterior meatal wall.



(h) Cavity filled with bone paté.

FIG. 1
Surgical technique for mastoid obliteration.

https://doi.org/10.1017/S0022215100600361 Published online by Cambridge University Press

were warned of the risk of failure to eliminate discharge, worsening of hearing and facial weakness.

Surgical technique: Surgery was carried out via a post-aural incision placed well posterior to the pinna (Fig. 1a). It should be continued anteriorly to the top of the pinna superiorly to facilitate access to the cavity. The skull posterior to the cavity was exposed, taking care not to enter the cavity itself (Fig. 1b). The outer table of the skull was then drilled away with a large cutting burr, using liberal irrigation (Fig. 1c). The resulting mixture of bone dust and water (bone paté) was collected using a modified sputum trap. Care was taken to prevent its contamination by infected discharge or squamous epithelium. The cavity was then entered by dissection of the soft tissues, and removal of its posterior edge using a cutting burr (Fig. 1d). Its lining was then elevated from the bone of the bowl and subsequently from the facial ridge. Unhealthy cavity lining was discarded. The bowl was then smoothed with cutting and diamond burrs to allow meticulous removal of any remaining pockets of soft tissue, in order to prevent the inclusion of squamous epithelium beneath the obliterating bone paté (Figs. 1e and f). If appropriate, the middle-ear segment was then opened so that an underlay graft of homograft dura could be introduced to repair the tympanic remnant. A second piece of dura was used to supplement the residual soft tissue from the mastoid bowl, forming the lining of the new posterior meatal wall (Fig. 1g). In some cases a piece of homograft septal cartilage was used to reinforce the posterior meatal wall superiorly. The cavity was then filled with bone paté (Fig. 1h and Fig. 2). The incision was then closed in layers and a Yates drain was inserted. The external auditory meatus was packed with half-inch (1.25 cm.) ribbon gauze impregnated with bismuth and iodoform paste. A pressure bandage was applied for 24 hours and the patient was given a broad spectrum antibiotic for 5 days. The dressing was removed from the external auditory meatus after 14 days. Following this the patients were reviewed weekly until the condition of the ear had stabilized.

Results

Eight patients have undergone revision surgery using this technique. Three of them had undergone previous revision surgery using other techniques. Five patients (63 per cent) have dry ears so far following a mean follow-up period of 12 months. Of the remaining three patients, two can be considered to be improved and only one remains unchanged. A detailed analysis of the results is shown in Table III. The appearance of the external auditory meatus and tympanic membrane 12 months after successful obliteration of a mastoid cavity is shown in Figure 3. An X-ray of the same patient's obliterated mastoid process taken at the same interval following surgery are shown in Figure 4.

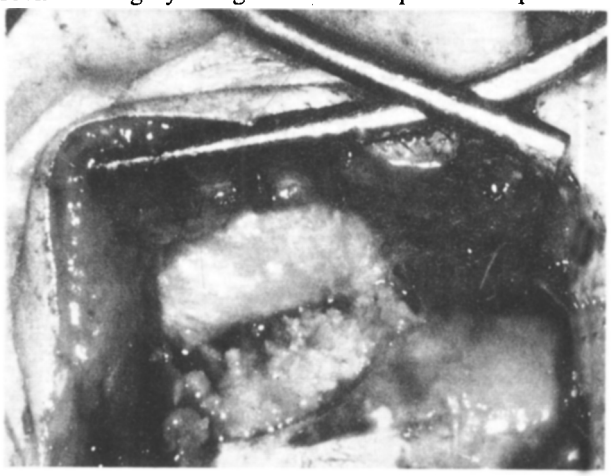


FIG. 2
Mastoid bowl filled with bone paté.

5: DISCUSSION

The incidence of discharge from established mastoid cavities (56 per cent) is disappointingly high. Some of these cavities are only moist and probably cause little distress to the patients. Profuse discharge was noted on only 5 per cent of cavity/visits. Patients with discharging cavities visit outpatients more frequently than those which are dry and this means that the use of cavity/visits as a means of assessing the frequency of discharge tends to produce an artificially high figure. However, it does expose cases with intermittent discharge which would otherwise have gone undetected during the survey. There is no room for complacency about the incidence of discharge from cavities revealed by this study. Some of the patients in this survey were too elderly to be considered for revision surgery and in other cases medical contraindications to surgery existed. Other individuals would not accept an operation if it was offered to them, either because they are unconcerned about the discharge, or because they could not face another ear operation. There remains, however, a significant number of patients who could benefit from revision of their cavities by one method or another.

Sadé *et al.* (1982) have demonstrated that mastoid cavities are more likely to be dry if they are not excessively large, have a low facial ridge, an adequate meatal opening and a closed middle-ear space. On this basis it is not surprising that good results have been obtained using cavity revision with a meatoplasty as the surgical technique. The results illustrate that the addition of a meatoplasty to simple cavity revision produces improved results. The results of soft tissue obliteration are disappointing. However, the number of cases operated on in this way in the present study was small and in some cases these techniques were used as the second revision procedure, so it can be argued that this group contained some particularly difficult cases. Palva (1982) has used his musculo-periosteal flap alone in 750 cases, principally as part of primary mastoid operations, and has reported that only 3 per cent of ears were still discharging 8 years after surgery. Nonetheless, he has now added the use of bone paté and bone chips to his obliterative technique. Bone paté obliteration appears to be more a successful operation, especially when it is taken into account that the results presented here are early ones. It does appear that the success of the operation depends to some extent on the degree of obliteration of the cavity which is achieved. It is usually possible to achieve a greater degree of cavity obliteration using bone paté than is possible with a soft tissue flap. This view is supported by the experience of Palva (1982).

Opponents of mastoid obliteration argue that there is

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TABLE III
RESULTS OF REVISION MASTOID SURGERY: PROSPECTIVE STUDY

Patient	Age	Sex	Side	Duration of f/u	Degree of obliteration	Cavity condition	Comments
1	51	F	Rt	24 m	Partial	Dry	Discharge to 20 m. Bone paté extruded via post-aural incision
2	28	M	Rt	24 m	Subtotal	Discharge	Post-aural haematoma post-op
3	43	M	Rt	18 m	Subtotal	Dry	
4	52	F	Lt	14 m	Complete	Dry	
5	27	M	Lt	6 m	Partial	Dry	
6	39	F	Lt	7 m	Partial	Moist	Irregular recurrent cavity
7	41	F	Rt	3 m	Complete	Dry	
8	35	F	Lt	2 m	Subtotal	Moist	

a risk of recurrence of cholesteatoma deep to the obliteration tissue, out of sight. The importance of meticulous removal of soft tissue from the mastoid bowl has already been stressed in the description of the surgical technique given above. Beales (1962) has described a case of cerebral abscess following the use of a muscle flap for obliteration of a mastoid cavity during primary surgery for cholesteatoma. Subsequently he sent questionnaires to other British ENT surgeons asking about their experience of the complication of muscle flap obliteration (Beales, 1969). Replies were received from 162 surgeons, reporting a total of 880 operations. One case of cerebral abscess was reported. Other complications, including recurrence of cholesteatoma, were also reported. In the same paper, Beales also reported the experience of Thorburn, who had a series of 198 cases. He too had had one case of meningitis following muscle flap obliteration and he also reported 11 cases of recurrent cholesteatoma. He also quoted the experience of Schiller who had performed 136 obliterative operations using bone strips. Schiller had had no cases of intracranial sepsis. In view of the fact that techniques of this sort have been widely used over a number of years, it appears that the risk of serious complications is low. Ojala and Palva (1982) have reported the long-term results of using the musculo-periosteal flap in 463 cases. Cholesteatoma was found in 22 ears (4.8 per cent) during the follow-up period, sometimes as long as ten years after the initial surgery. It was considered to be residual in eight and recurrent in 14 cases. In no case was it arising from the mastoid bowl. In a study of three temporal bones from two patients who had undergone mastoid obliteration, Palva *et al.* (1975) reported finding a cholesteatomatous pearl in one temporal bone. However, it was situated in the middle ear and not deep to the flap.

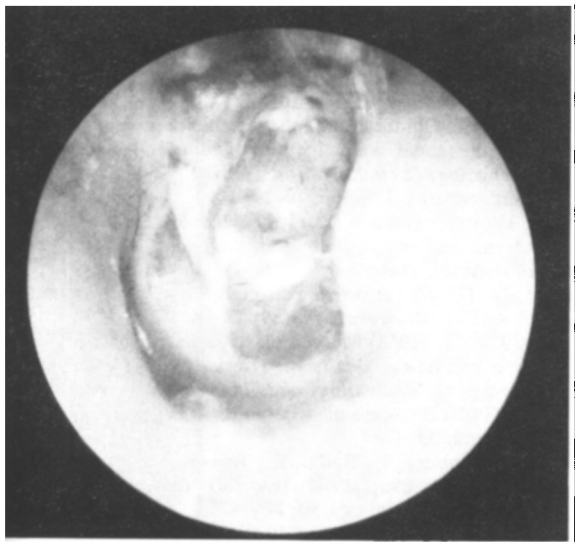

FIG. 3
Photograph of the external auditory meatus and tympanic membrane one year after bone paté obliteration of a chronically discharging mastoid cavity (Case 4).

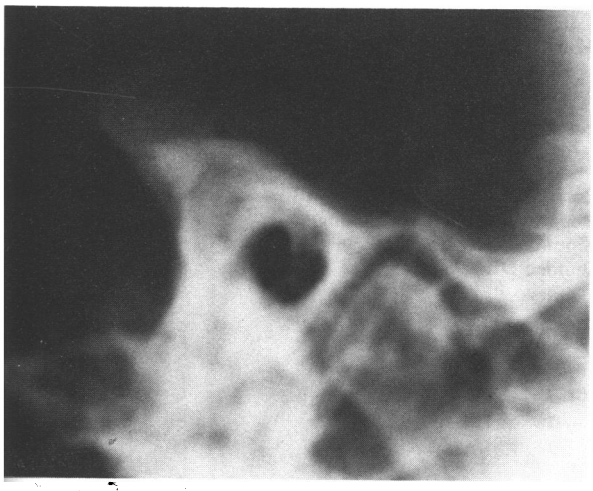

FIG. 4
Mastoid X-ray of Case 4, taken one year after successful bone paté obliteration of a chronically discharging mastoid cavity.

Reconstruction of the posterior wall with preservation of the mastoid bowl as an air-containing space has two potential advantages. The mastoid reservoir helps to maintain an aerated middle-ear space, and the presence of a rigid posterior wall facilitates middle-ear reconstruction with the tympanic membrane in a near-physiological position in contrast to the shallow middle-ear space in mastoid cavities and in ears which have undergone mastoid obliteration (Grote and Van Blitterswijk, 1986). It can, however, be argued that the 'cortical cavity' created by these techniques allows recurrent cholesteatoma to expand undetected, as in cases treated primarily by combined approach tympanoplasty. Posterior wall reconstruction is a better technique when the main aim is hearing improvement, but is likely to fail in the chronically infected cavities for which the author has been performing mastoid obliteration. Even those open cavities which are dry usually require regular removal of wax due to inadequate migratory function. Obliterative

and reconstructive techniques offer the chance to create a self-cleansing ear.

Many ENT specialists discourage patients with mastoid cavities from swimming and this may be viewed as an additional handicap by some patients. In a recent study El Silimy *et al.* (1986) have demonstrated an equal incidence of discharge from the mastoid cavities of swimmers and non-swimmers. The most disabling consequence of swimming was vertigo which was reported by 5 per cent of swimmers. Techniques involving reconstruction of the posterior meatal wall or obliteration of the mastoid bowl in conjunction with closure of the middle-ear space offer the best prospect of avoiding this problem, because they offer protection for the lateral semicircular canal. On this basis it seems reasonable to offer reconstructive or obliterative revision surgery to younger patients, especially those wishing to swim, while performing cavity revision with meatoplasty for the remainder. However, continuing evaluation of results will be required to confirm the appropriateness of this policy.

Acknowledgements

I would like to thank the ENT consultants at King's College Hospital for allowing me to include their patients in the studies. I am also much indebted to Dr. Robert Yorston for preparing the diagrams comprising Figure 1. I am very grateful to the following companies who have contributed towards the cost of publishing this Supplement: Xamed, Richards Medical Company (U.K.) Ltd, Carl Zeiss Ltd and Exmoor Plastics.

References

Beales, P. H. and Hynes, W. (1958) Rapid healing after mastoid surgery by the use of the post-auricular flap. *Journal of Laryngology and Otology,* **72:** 888–901.

Beales, P. H. (1959) The problem of the mastoid segment after tympanoplasty. *Journal of Laryngology and Otology,* **73:** 527–531.

Beales, P. H. (1962) Cerebral abcess after obliterative mastoid operation. *Archives of Otolaryngology,* **76:** 123–125.

Beales, P. H. (1969) Complications following obliterative mastoid operations. *Archives of Otolaryngology,* **89:** 196–198.

El Silimy, O., Smelt, G. J. C. and Bradley, P. J. (1986) Swimming with a mastoid cavity: What are the risks? *Clinical Otolaryngology,* **11:** 209–212.

Grote, J. J. and Kuijpers, W. (1983) The use of biomaterials in reconstructive middle-ear surgery. In: *Biomaterials in reconstructive surgery*, Ed. Ruben, L. R. C. V. Mosby, St Louis, 987–995.

Grote, J. J. and Van Blitterswijk, C. A. (1986) Reconstruction of the posterior auditory canal wall with a hydroxyapatite prosthesis. *Annals of Otology, Rhinology and Laryngology,* **Suppl. 123:** 6–9.

Guilford, F. R. (1960) Controlled cavity healing after mastoid and fenestration operations. *Archives of Otolaryngology,* **71:** 165–171.

Guilford, F. R. (1961) Obliteration of the cavity and reconstruction of the auditory canal wall in temporal bone surgery. *Transactions of the American Academy of Ophthalmology and Otolaryngology,* **65:** 114–122.

Janzen, V. D. (1981) Mastoid obliteration with primary ossicular reconstruction. *Journal of Otolaryngology,* **10:** 321–324.

Kisch, H. (1928) Temporalis muscle grafts in the radical mastoid operation. *Journal of Laryngology and Otology,* **43:** 735–736.

Leonard, R. B., Sauer, B. W. and Hulbert, S. F. (1973) The use of porous ceramic to obliterate mastoid cavities. *Journal of Biomedical Materials Research (Symp.),* **4:** 85–95.

Meuser, W. (1984) Permanent obliteration of old radical cavities combined with tympanoplasty. *Journal of Laryngology and Otology,* **98:** 31–35.

Mosher, H. P. (1911) A method of filling the excavated mastoid with a flap from the back of the auricle. *Laryngoscope,* **21:** 1158–1163.

Ojala, K. and Palva, A. (1982) Late results of obliterative cholesteatoma surgery. *Archives of Otolaryngology,* **108:** 1–3.

Osborne, J. E., Terry, R. M. and Gandhi, A. G. (1985) Large meatoplasty technique for mastoid cavities. *Clinical Otolaryngology,* **10:** 357–360.

Palva, T. (1962) Reconstruction of the ear canal in surgery for chronic ear. *Archives of Otolaryngology,* **75:** 329–334.

Palva, T. (1973) Operative technique in mastoid obliteration. *Acta Otolaryngologica,* **75:** 289–290.

Palva, T., Karma, P., Karja, J. and Palva, A. (1975) Mastoid obliteration: Histopathological study of 3 temporal bones. *Archives of Otolaryngology,* **101:** 271–275.

Palva, T. (1982) Obliteration of the mastoid cavity and reconstruction of the canal wall. In: *International Medical Reviews; Otolaryngology I: Otology.* Eds. Gibb, A. G. and Smith, M. F. M., Butterworths, London, 19–29.

Plester, D. and Steinbach, E. (1977) Histologic fate of tympanic membrane and ossicle homografts. *Otolaryngology Clinics of North America,* **10:** 487–499.

Popper, O. (1935) Periosteal flap grafts in mastoid operations. *South African Medical Journal,* **9:** 77–78.

Rambo, J. H. T. (1958) Musculoplasty, a new operation for suppurative middle-ear deafness. *Transactions of the American Academy of Ophthalmology and Otolaryngology,* **62:** 166–177.

Reck, R. (1984) Bioactive glass ceramics in ear surgery. *Laryngoscope,* **Suppl. 33:** 1–54.

Sadé, J., Weinburg, J., Berco, E., Brown, M. and Halvey, A. (1982) The marsupialised (radical) mastoid. *Journal of Laryngology and Otology,* **96:** 869–875.

Shea, M. C. and Gardiner, G. (1970) Mastoid obliteration using homograft bone. *Archives of Otolaryngology,* **92:** 358–365.

Shea, J. and Hornsby, C. A. (1974) The use of Proplast (TM) in otologic surgery. *Laryngoscope,* **84:** 1835–1845.

Shiller, A. (1961) 'Mastoid osteoplasty' using autogenous cancellous bone. *Journal of Laryngology and Otology,* **75:** 647–668.

Thorburn, I. B. (1961) Experience with pedicled temporalis muscle flaps in radical mastoid and tympanoplasty operations. *Journal of Laryngology and Otology,* **75:** 885–896.

Wehrs, R. (1972) Reconstruction mastoidectomy with homograft knee cartilage. *Laryngoscope,* **82:** 1177–1188.

Wigand, M. E., Weidenbecher, M., Bumin, P. and Mollenhawer, H. W. (1974) Tympanoplastik nach radikaloperation: Mit konchen oder knorpel? *Archiv fur Otolaryngologie,* **207:** 542–544.

Correspondence to: Mr. R. P. Mills,
Department of Otolaryngology,
Ninewells Hospital,
Dundee DD1 9SY.