Mastoid Obliteration Versus Open Cavity: A Comparative Study

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Abstract A chronic discharging ear has been a perpetual problem and a source of worry to the otologists for centuries because of its high rate of morbidity. Active squamous chronic otitis media is a commonly encountered disease entity which requires prompt surgical management. The surgical procedure most commonly employed is modified radical mastoidectomy. This results in an ‘open’ cavity with its attendant problems of recurrent breakdown and discharge. Mastoid obliteration technique would appear to be the best solution for these cavity problems. Forty cases of active squamous chronic otitis media were studied. The patients were randomly divided into two groups of 20 each. The group of 20 controls had an open mastoid cavity. Out of the 20 cases, patients were divided in four groups of 5 each. For each group the mastoid cavity was obliterated with cartilage, bone dust, hydroxyapatite and Singapore swing. Healing of the cavity and the associated cavity problems in terms of pain, discharge, giddiness and wax formation, were assessed. The incidence of pain, discharge, giddiness and wax formation was markedly reduced in obliterated cavities as compared to open cavities. Healing of the cavity as evidenced by epithelialisation, at the end of 6 months, was better in those ears where cavity was obliterated (90%) as compared to those with open cavity (70%). Cases obliterated with bone dust and Singapore swing had better and early epithelialisation (100%) as compared to cartilage and hydroxyapatite (80%).

Keywords Mastoid obliteration · Cartilage · Bone dust · Hydroxyapatite · Singapore swing

Introduction

The surgical treatment for chronic active squamous otitis media often entails creation of an ‘open’ mastoid cavity after total excision of the cholesteatoma. The skin lining the cavity is often subject to breakdown and recurrent infection. Otolologists all over the world are familiar with these cavity problems. The ‘open’ or modified radical mastoidectomy technique has a long and distinguished history. It has been the mainstay of surgical management of active squamous otitis media or cholesteatoma for the last one and half centuries. However the creation of a large cavity in the mastoid is beset with problems, which include:

1. Chronic discharge from open cavity.
2. Collection of debris in the cavity.
3. Dizziness due to exposure of semicircular canals to direct caloric stimulation by cold air/water entering the cavity.
4. Dependence on the surgeon for regular cleaning of the cavity.
5. Unsightly appearance due to large meatoplasty.

Within 40 years of introduction of mastoidectomy technique, significant modifications were introduced to try to improve the long term stability of the cavity. Since then, countless otologists have exercised their ingenuity on surgical techniques and modifications aimed at improving the status of the cavity or of avoiding or eliminating a cavity altogether.

Surgical options for the large mastoid cavity are:

1. Autologous cultured epithelial graft
2. Large meatoplasty

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3. Revision mastoidectomy with/without meatoplasty
4. Reconstruction with an aerated cavity
5. Mastoid cavity obliteration
6. Mastoid and middle ear obliteration

Mastoid obliteration techniques make up by far the largest group of the many surgical methods recorded in the literature and the most satisfying solution of the discharging cavity.

In our study, a set of 40 cases of active squamous chronic otitis media were studied. The patients were randomly divided into two groups of 20 each. The group of 20 controls had an open mastoid cavity. Out of the 20 cases, patients were divided in four groups of 5 each. For each group the mastoid cavity was obliterated with cartilage (Fig. 2), bone dust (Fig. 3), hydroxyapatite (Fig. 4) and Singapore swing (Fig. 6).

Aims and Objectives

1. To study the surgical result of mastoid obliteration
2. To study the efficacy of different methods of mastoid obliteration.
3. To study the need for cavity care
4. To study cavity problems.

Materials and Methods

Patients of either sex, less than 60 years of age, having good general physical condition, having evidence of attic-antral disease and cholesteatomatous disease in the middle ear cleft, not having any evidence of active infection in nose, throat or paranasal sinuses were selected. Patients with otogenic intra-cranial complications in the past were excluded from the study. Forty patients, thus selected were subjected to otological examination, examination under microscope, pure tone audiogram with proper masking, X-ray mastoids, general examination and a pre anaesthetic checkup. A written, informed, valid consent of the patient was taken for mastoidectomy. General anesthesia with endotracheal intubation was used for children or uncooperative adult patients. Local anesthesia was used for cooperative adult patients. 1:2,00,000 adrenaline solution of 2% lignocaine was injected. The advantages of local anesthesia are decreased bleeding, on table assessment of hearing, and avoidance of general anesthesia.

After induction of anesthesia, the auricle and the surrounding area was painted and draped. A post auricular incision was taken and the mastoid cortex was exposed. Middle ear was evaluated for cholesteatoma and ossicular chain status. Cholesteatoma sac was removed surgically,

using the drill, from the mastoid and middle ear. All diseased air cells till dural plate superiorly, sinus plate posteriorly, sinodural angle posterosuperiorly and tip cells inferiorly were removed. Exteriorization of cavity was done by lowering the facial bridge till the ridge (Fig. 1). Complete removal of disease was done from middle ear cleft including sinus tympani and facial recess.

Fig. 1 Operative photo showing left mastoid cavity with low facial ridge

Fig. 2 Operative photo showing left mastoid cavity obliterated by cartilage

Fig. 3 Operative photo showing left mastoid cavity obliterated by bonedust

Fig. 4 Operative photo showing left mastoid cavity obliterated by hydroxyapatite granules

Fig. 5 Operative photo showing elevation of periosteal—temporo-fascial flap (Singapore swing)

Fig. 6 Operative photo showing left mastoid cavity obliterated by Singapore swing

After complete removal of disease, the size of the cavity was assessed by filling it with a physiological saline solution.

Small: <1 ml
Medium: 1–2 ml
Large: >2 ml

Till this step the procedure adopted was same in all the patients.

Patients in paediatric age group with invasive cholesteatoma and those with extensive disease were not subjected to mastoid cavity obliteration and the cavity was kept open. In the patients assigned to the control group, temporalis fascia graft was used to cover the middle ear. The mastoid cavity was left open. Adequate meatoplasty was done by excising a large piece of conchal cartilage. Haemostasis was achieved. The postaural incision was closed in layer.

Out of the 20 cases, patients were divided in four group of 5 each. For each group the mastoid cavity was obliterated with cartilage (Fig. 2), bone dust (Fig. 3), hydroxyapatite (Fig. 4) and Singapore swing (Fig. 6). Bone dust was collected before entering the middle ear by a large cutting burr with minimum irrigation. Care was taken to prevent its contamination by infected discharge or squamous epithelium. For obliterating the cavity with cartilage, conchal cartilage was harvested and small pieces were made from the whole big piece while obliterating the cavity. Hydroxyapatite (ceramic made of calcium phosphate) is readily available in block and granule form. The granules were mixed with saline to form a paste and the cavity was obliterated. Singapore swing is a composite flap comprising temporalis fascia superiorly and the periosteum of outer mastoid cortex inferiorly. The pedicle is sited inferiorly near the mastoid tip and is based on a branch of the postauricular artery (Fig. 5). The periosteal segment of the flap should be kept as broad as possible as it is required to line much of the mastoid cavity.

Adequate meatoplasty was done. Finally the external auditory canal was packed with gelfoam. The post auricular incision was closed in layers after haemostasis was achieved. A pressure dressing was applied. All patients were put on oral antibiotics, analgesics, and antihistaminics in the post-operative period. All patients were instructed to take adequate precautions to prevent entry of water into the ear canal. Antibiotics were continued for 10 days and antihistaminics for 3 weeks. Skin stitches were removed after 7 days. All patients were followed in the OPD on 7th, 15th, 21st, 30th, 45th, 60th, 90th day and 6 months. Healing of the cavity and the associated cavity problems in terms of pain, discharge, giddiness and wax formation, were assessed.

Results

Forty cases of squamous active chronic otitis media were studied. The patients were randomly divided into two groups of 20 each. One group underwent mastoid obliteration with various materials and other group had no obliteration done i.e. had a open mastoid cavity.

In our study 37.5% patients presenting with squamous chronic active otitis media were in the age group

11–20 years, 27.5% were between 20 and 30 years, 10% were less than 10 years and 25% were above 30 years of age.

There was equal sex predilection.

In our study, 95% of patients presented with complaints of ear discharge. 87.5% of patients presented with history of decreased hearing and only 15 and 5% had complaints of tinnitus and vertigo respectively. Eighty percent of patients had cholesteatoma, 12.5% had granulations and only 7.5% had polyp (Table 1).

On post operative day 15, 12 (60%) patients of control group had pain, while only 8 (40%) patients of case group experienced pain. On post operative day 45, only 1 (40%) patient of case group had pain, while 2 (10%) of control group experienced pain.

Of the 20 cases, 15 (75%) patients had a dry cavity at the end of 2 months whereas 5 (25%) patients still had ear discharge. Of the 20 control cases, 12 (60%) had a dry cavity and 8 (40%) still had ear discharge. In addition to this 1 (5%) patient of control group had giddiness at the end of same period. Amongst the group of patients were cartilage, bone dust or Singapore swing was used for obliteration of cavity, complete epithelialisation had occurred in 12 (80%) cases during this period, while in those patients where hydroxyapatite was used, epithelialisation had occurred in 3 (60%) cases.

Three months after surgery, of the 20 cases, 16 (80%) patients had a dry cavity (Fig. 7) whereas 4 (20%) patients still had ear discharge. Of the 20 control cases, 12 (60%) had a dry cavity and 6 (30%) still had ear discharge. In addition to this 1 (5%) patient of control group had giddiness and 2 (10%) presented with wax. Amongst the group

of patients were cartilage, or Singapore swing was used for obliteration of cavity, complete epithelialisation had occurred in 12 (80%) cases, cavities obliterated by bone dust were epithelialised by 100% while in those patients where hydroxyapatite was used, epithelialisation had occurred in 3 (60%) cases.

Six months after surgery, of the 20 cases, 18 (90%) patients had a dry cavity whereas 1 (5%) patient still had ear discharge and 1 (5%) presented with wax. Of the 20 control cases, 14 (70%) had a dry cavity and 2 (10%) still had ear discharge. In addition to this 1 (5%) patient of control group had giddiness and 4 (20%) presented with wax (Table 2). Amongst the group of patients were bone dust, or Singapore swing was used for obliteration of cavity, complete epithelialisation had occurred in 100%, cavities obliterated by cartilage and hydroxyapatite were epithelialised by 80%. Only 1 (5%) case of cartilage obliteration presented with wax (Table 3).

The relation of healing of cavity with size of the cavity was studied. It was found that healing rate was 100, 90.90, and 66.66% for small, medium and large cavity respectively in obliteration group, as compared to 100%, 63.63, and 40% respectively in the non obliteration group (Table 4).

In our study of 20 cases, 2 patients underwent revision mastoidectomy, the primary surgery was done outside our institute. First patient presented with chronic ear discharge and a post auricular fistula. Patient had a high facial ridge, incompletely exenterated mastoid air cells and a large mastoid cavity was found to be the cause of discharge. After ensuring complete removal of disease, cavity was saucerised, facial ridge lowered and cavity was obliterated with cartilage. The cavity epithelialised completely in

Table 1 Intraoperative observations

	Cholesteatoma	Granulation	Polyp
Cases	14	3	3
Controls	18	2	0
Total	32 (80%)	5 (12.5%)	3 (7.5%)

Fig. 7 Photo showing a well epithelialised left mastoid cavity, 3 months after surgery

Table 2 Postoperative observations

	Post op day 30	Pain	Discharge	Giddiness	Epithelialisation	Wax
Cases	2 (10%)	10 (50%)	0	8 (40%)	0	
Controls	4 (20%)	14 (70%)	2 (10%)	1 (5%)	0	
<i>Post op day 45</i>						
Cases	1 (5%)	4 (20%)	0	14 (70%)	0	
Controls	2 (10%)	8 (40%)	2 (10%)	10 (50%)	0	
<i>Post op day 60</i>						
Cases	0	5 (25%)	0	15 (75%)	0	
Controls	0	8 (40%)	1 (5%)	12 (60%)	0	
<i>Post op day 90</i>						
Cases	0	4 (20%)	0	16 (80%)	0	
Controls	0	6 (30%)	1 (5%)	12 (60%)	2 (10%)	
<i>Post op 6 month</i>						
Cases	0	1 (5%)	0	18 (90%)	1 (5%)	
Controls	0	2 (10%)	1 (5%)	14 (70%)	4 (20%)	

Table 3 Comparison of result of various obliteration methods

	Pain	Discharge	Epithelisation	Wax
<i>Post op day 90</i>				
Cartilage	0	1 (20%)	4 (80%)	0
Bone dust	0	0	5 (100%)	0
Hydroxyapatite	0	2 (40%)	3 (60%)	0
Singapore swing	0	1 (20%)	4 (80%)	0
<i>Post op 6 month</i>				
Cartilage	0	0	4 (80%)	1 (20%)
Bone dust	0	0	5 (100%)	0
Hydroxyapatite	0	1 (20%)	4 (80%)	0
Singapore swing	0	0	5 (100%)	0

Table 4 Comparison of cavity size and healing of cavity

Cavity size	Technique	No of cases	No. of healed cavities	%
Small	Obliteration	3	3	100
	No obliteration	4	3	75
Medium	Obliteration	11	10	90.90
	No obliteration	11	7	63.63
Large	Obliteration	6	4	66.66
	No obliteration	5	2	40

Table 5 Comparison of cavity size and its healing rate by various authors

Cavity size	Sade [5] n = 119 (%)	Wadhwa [6] n = 50 (%)	Our study (2004) n = 20 (%)
Small	88	66.67	75
Medium	87	64.28	63.63
Large	61	50	40

6 months. Second of these two patients presented with complain of giddiness only. The mastoid cavity was dry with a high facial ridge and small meatoplasty. High resolution computer tomography of temporal bone showed a labyrinthine fistula. Intra operatively, the diagnosis was confirmed, facial ridge was lowered, the fistula was covered by soft tissue and bone dust and the large cavity was obliterated by hydroxyapatite. Post surgery patient never had giddiness and cavity was completely dry in 6 months.

Of the 20 cases operated during our study, only one case had post operative complication. This was a 10 years old girl who presented with unsafe chronic suppurative otitis media. After complete removal of disease, hydroxyapatite was used to obliterate the resultant small cavity. Post operatively patient had continuous ear discharge with minimal perichondritis for 2 months. Culture and sensitivity of the pus revealed pseudomonas as the offending

agent, which was sensitive to amoxycillin plus clauvullinic acid combination. Patient was treated with appropriate antibiotics. Though there was no residual infection after 3 weeks of antibiotic therapy, she developed canal stenosis. Patient was taken up for canalplasty after 6 months. The intra operative findings revealed hydroxyapatite was well taken up in the cavity. The bony canal was normal but the meatal skin was stenosed. Appropriate reparative surgery for the same was performed. The patient had no complaints since then.

Discussion

Obliteration of the mastoid cavity leaves a smaller surface which epithelialises easily and rapidly, with a reduced likelihood of developing cavity granulations. The cavity, being smaller, is also more likely to retain its epithelial migratory potential and be self-cleaning. Exposed bone following mastoidectomy secretes tissue fluid, which is a rich medium for bacterial proliferation. When the bony walls are covered with obliteration material, this process of secretion is reduced, with a resultant reduction in the risk of infection.

Patients with an open cavity and an exposed lateral semicircular canal describe vertiginous episodes while swimming and this is one of the reasons why swimming is to be avoided by patients with an open cavity. In the patient with a successfully obliterated cavity, the smaller surface area and the protection of the lateral canal by obliteration material allow most patients to swim free of complications.

Hearing aids, if required, are better tolerated in an obliterated cavity than an open cavity. It is undesirable to fit a hearing aid in a discharging cavity and constructing a mould for either an enlarged or stenotic meatus is seldom satisfactory.

The open mastoid cavity is physiologically and anatomically unsatisfactory. Skin does not readily grow on the bare bone and the naturally moist environment tends to favour the growth of mucosa and granulation tissue. Meatoplasty of an appropriate size helps to ventilate the additional volume of the cavity, but large meatoplasties are unsightly and on the other hand stenosis not infrequently results in an unstable ear. It is noticeable how closed cavity operations, whatever other problems may ensue, become dry postoperatively much more rapidly than open cavity surgery and remain so. It seems therefore, that the cavity itself is a major cause of the recurrent or persistent discharge, that these patients suffer and it would seem reasonable to offer such patients the possibility of relief by obliterating the cavity.

Obliteration of the open cavity gives ultimately a smaller cavity, although some enlargement of the cavity

occurs with time. Providing the new cavity develops a healthy lining and any previous infection has been eradicated, then the cavity remains stable despite the possibility of some resorption. In cases where a cavity has reformed, the mastoid tip usually remains obliterated. The elimination of this sump is probably one of the most important advantages of this technique.

The major argument against cavity obliteration is the risk of trapping microscopic islands of cholesteatoma deep to the obliteration material. A meticulous surgical approach with removal of the entire cavity lining in continuity will reduce this risk and, if there is any doubt, e.g. when there is uncertainty about clearance of disease from the attic, then this should not be obliterated but left exteriorized.

Bone dust should be collected before entering the middle ear disease by a large cutting burr with minimum irrigation. Care should be taken to prevent its contamination by infected discharge or squamous epithelium. It was observed that there was some amount of shrinkage of cavities which were obliterated by cartilage or bone dust [1].

The greatest advantage of cartilage is its low metabolic rate [2]. The nourishment of cartilage is by diffusion with the help of perichondrium. Hence, for the viability of the cartilage, perichondrium on at least one side should be intact. There is alteration in shape and structure of the cartilage with time. It was seen that though the cartilage becomes non viable, it remains functional. There is gradual replacement of cartilage with fibrous tissue and deeper proliferation of blood vessels leading to lamellar bone around blood vessels. Because of inherent elasticity, the position of the cartilage at the time of operation may not remain the same during healing. However small pieces made from the whole big piece while obliterating the cavity reduces the chances of the same. The other advantages of cartilage are:

1. Readily available
2. Easily shaped
3. No extra cost
4. Same surgical field.

Hydroxyapatite is a ceramic made of calcium phosphate, which is similar to the mineral matrix of bone. It generates controlled resorption and remodeling, leading to living bone tissue within a year [3]. This remodeling is also controlled in infected surroundings. The advantages of hydroxyapatite ceramic as an implant for bony reconstruction in the middle ear are

1. Biologically inert
2. Readily available
3. Because of standard manufacturing procedures the resorption and remodeling are controlled.
4. No possibility of transmission of disease.

Singapore swing is a composite flap compromising temporalis fascia superiorly and the periosteum of outer mastoid cortex inferiorly. The pedicle is sited inferiorly near the mastoid tip and is based on a branch of the postauricular artery (Fig. 5). The periosteal segment of the flap should be kept as broad as possible as it is required to line much of the mastoid cavity [4]. Hence the incision has to be planned properly. The advantages of Singapore swing (Periosteal-temporofascial flap) are as follows:

1. It could be easily used to seal perforation of the tympanic membrane by its fascial component and obliteration of the cavity by the periosteum component.
2. The pliability of the flap enables the flap to adjust in all corners of the mastoid cavity,
3. good vascular supply leading to better healing of the cavity,
4. See through character of the flap which would enable detection of recurrence.

The results of our study was compared with other authors (Table 5). The social implications of a wet and foul-smelling ear are frequently underestimated by a complacent surgeon, and patient's lives can be profoundly restricted by their symptoms. In addition, a dry ear is less of a drain on hospital resources, requiring infrequent attendance, fewer courses of medical treatment, and less outpatient time. Moreover these patients describe better quality of life following successful surgery, and therefore all appropriate cases should thus be offered obliteration treatment.

On the basis of all the above observations we infer that, cavity obliteration is a useful method of reducing post operative morbidity of the patients. It reduces the post operative cavity problems thereby decreasing the patient's dependence on the doctor, thus improving their quality of life. It would be prudent however, to invite further research on the subject so that the best material for the obliteration of the mastoid cavity may be evolved.

Conclusion

1. The incidence of pain, discharge, giddiness and wax formation was markedly reduced in obliterated cavities as compared to open cavities.
2. Healing of the cavity as evidenced by epithelialisation, at the end of 6 months, was better in those ears where cavity was obliterated as compared to those where cavity was kept open.
3. Cases obliterated with bone dust and Singapore swing had better and early epithelialisation as compared to cartilage and hydroxyapatite.

4. Patients with obliterated mastoid cavity required less cavity care, thus decreasing doctor dependence, frequent OPD visits and fewer courses of medical treatment and fewer burdens on hospital resources.

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