Canal-Down Mastoidectomy: Experience in 81 Cases

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Objectives: To identify the common presentation(s) and the clinical and operative finding(s) in patients with cholesteatomatous and long-term noncholesteatomatous chronic suppurative otitis media and to adapt a surgical management best suited to ensure long-term safety in these Papua New Guinean patients for whom postoperative follow-up is minimal.

Design: Retrospective case series.

Setting: Port Moresby General Hospital, the tertiary referral center for otolaryngologic services.

Patients: Eighty-one patients in all age groups who received a clinical diagnosis of chronic suppurative otitis media, with or without cholesteatoma, with or without its associated complications.

Intervention: Canal-down (modified radical) mastoidectomy with wide meatoplasty.

Main Outcome Measure and Results: Adults were more commonly affected than adolescent or pediatric cases, and there was a male preponderance. The median age was 24 years (range, 13 months to 73 years). Otorrhea remained the most common presentation in all age groups. Postauricular abscesses and fistulae were seen frequently. Cholesteatoma and granulation with polypoidal mucosa were frequent operative findings; a high incidence involved both the attic space and the antrum. Five (6%) patients had preoperative facial paralysis; in addition, postoperative facial paralysis developed in three (4%) patients. The incidence of postoperative “wet ear” was high in all age groups. Meningitis was the most common intracranial complication, followed by lateral sinus thrombosis. There were seven (9%) deaths altogether, and all the deaths occurred as a direct result of otogenic intracranial complication.

Conclusion: Lack of health consciousness, poor socioeconomic status, and lack of health care delivery system resulted in late presentations and poor postoperative follow-up. Hence, the canal-wall-down technique with wide meatoplasty is recommended to ensure a best possible one-time treatment in Papua New Guinean patients with cholesteatomatous or long-term “dangerous” chronic suppurative otitis media with or without complications.


Chronic suppurative otitis media (CSOM) is still quite common in any otolaryngology clinic in developing countries (1–6). Despite an overall decline in the incidence of otitis media, severe complications still exist, with considerable morbidity and high mortality (1–6).

This article reviews our experience in 81 cases of canal-down mastoidectomies over 6 years and analyzes all the clinical, audiologic, radiologic, and operative findings and the postoperative follow-up data.

MATERIALS AND METHODS

Port Moresby General Hospital is the tertiary referral center of Papua New Guinea and has established ear, nose and throat specialist services. Located in the southern region in the capital city of the country, this hospital caters to the local population of 400,000 and, indeed, to the entire 4.5 million people of the country. It receives both formal referrals and self-referrals from all the provinces of the country. This hospital is also the undergraduate and postgraduate teaching and training center of the Medical Faculty of the University of Papua New Guinea.

During the 6 years from 1992 to 1997, 93 patients underwent canal-down mastoidectomy with wide meatoplasty. All these patients had cholesteatoma or noncholesteatomatous but dangerous CSOM and underwent this procedure exclusively by the postauricular approach. Additional procedures, namely, exploration of the facial nerve, lateral sinus, and internal jugular vein, and drainage of intracranial abcesses, were also done in the same sitting when there were complications. Thrombi from the lateral sinus and internal jugular vein were removed by arterial embolectomy catheter. Patients with infective complications were treated with full dosages of the latest generation of cephalosporin or gentamycin and metronidazole along with penicillin or chloramphenicol intravenously, depending on availability, and emergency operations were done as soon as full evaluations of the patients’ conditions had been made. The complete records of 12 (13%) patients were not available, and they were therefore excluded, leaving 81 patients in this study. The patients’ records and the following information were gathered: age, sex, presenting symptom, clinical feature, radiologic finding, audiologic status, operative finding, and postoperative follow-up.

RESULTS AND OBSERVATION

Of the 81 patients, 17 (21%) were children: 11 (65%) boys and 6 (35%) girls. There were 15 (19%) adolescent
patients: 4 (27%) boys and 11 (73%) girls. The majority of the patients (49, or 60%) were adults: 41 (84%) men and 8 (16%) women. The ages ranged from 13 months to 73 years (median, 24 years). Otorrhea, hearing loss, and postauricular swellings or tenderness were common in all age groups. In addition, facial weakness and features of intracranial and inner ear complications were not uncommon.

Most of the affected children were brought for treatment in the first year (35%) and years 6 through 7 of otorrhea. It was different, however, for the adolescent (45%) and adult (60%) patients because a significant number of them sought treatment in their 10th year of experiencing discharge from their ears. It was observed that aural polyp was common in all age groups (pediatric group, 29%; adolescent group, 33%; adult group, 20%).

Osteolytic changes were the most common radiologic findings and represented 8 (47%) cases in the pediatric group, 5 (33%) cases in the adolescent group, and 22 (45%) cases in the adult group. Pure-tone audiometry was rarely done in the pediatric group, not only for otorrhea and tender mastoids, but also lack of cooperation and poor understanding of the procedure by the children. Similarly, pure-tone audiometry was not done in 4 (27%) adolescent patients and 19 (40%) adults. There were more cases of conductive hearing loss than of sensorineural deafness. Posterior marginal perforation was commonly seen in the children (8, or 47%). Attic perforation was commoner in both the adolescent (6, or 40%) and the adult (15, or 31%) groups. Subtotal perforation was observed in all age groups.

Table 1 shows the type and extent of the disease in the middle ear cleft as encountered during operation. Cholesteatoma as well as cholesteatoma combined with granulation was common. Involvement of both the attic space and the mastoid antrum was seen in more than half of all the cases in all age groups. The intraoperative findings in the mastoid bony landmarks, i.e., facial nerve canal, lateral semicircular canal, sinus plate, and dural plate, are described in Table 2. The pediatric and adult patients showed a high incidence of dehiscence of one or more of the bony landmarks. By contrast, the adolescents showed a high incidence of intact bony landmarks. This finding seemed to be directly related to the complications in these age groups. Table 3 shows the operative finding of ossicular chain condition. The malleus was noted to be intact in the majority of all the age groups: pediatric group, 11 (65%) cases; adolescent group, 7 (47%) cases;
and adult group, 29 (59%) cases. The incus, however, was noted to be absent in most of the cases in all age groups: pediatric group, 13 (76%) cases; adolescent group, 9 (60%) cases; and adult group, 30 (61%) cases. Absence of the stapes superstructure was seen in two (13%) adolescents and five (10%) adults.

Table 4 shows the otogenic intracranial and extracranial complications. Three (18%) pediatric and four (8%) adult patients died of otogenic complications. There were no recorded deaths in the adolescent group, possibly because of our small sample size, despite poor access to health care and lack of early detection and diagnosis. The postoperative situation of the mastoidectomy cases, i.e., status of the cavity, revision metaplasty or mastoidectomy, facial nerve paralysis, and death, are shown in Table 5. Moist discharging cavity commonly affected the patients in all age groups. Facial nerve paralysis and death occurred only in the pediatric and adult groups. Five patients had preoperative facial palsy. In addition, facial palsy developed postoperatively in three patients.

**DISCUSSION**

A study similar to ours by Schuring et al. (7) turned up 354 cases over a 10-year (1978 to 1988) study period (twice the duration and four times the number of cases in our study but with an age classification similar to ours). They used three age categories: children, 0 to 9 years old (n = 38, 2%); adolescents, 10 to 15 years old (n = 50, 14%); and adults, 16 years old or older (n = 266, 84%). The sex distributions of these patients were not mentioned. In our series, the age categories were slightly different: pediatric, 0 to 12 years old (n = 17, 21%); adolescent, 13 to 18 years old (n = 15, 19%); and adults, over 18 years old (n = 49, 60%). A conspicuous difference was the incidence of cases in children, which was high in our study. It is reasonable to comment that personal hygiene, health awareness, and socioeconomic status of the individual and the community as a whole contributed significantly to the pathophysiology of the disease process.

A 12-year retrospective study by Harley et al. (8) included 57 children aged 3 months to 15 years (our pediatric patients were of ages up to 12 years old). Their study included 33 (58%) male patients and 24 (42%) female patients, whereas ours included 11 (65%) male and 6 (35%) female patients. It is clear that male patients were dominant in these two studies. A study by Rigner et al. (9), however, discovered an almost equal number in

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**TABLE 3. Operative findings of ossicular chain condition (n = 81)**

<table>
<thead>
<tr>
<th>Operative findings</th>
<th>Children (≤ 12 years, n = 17)</th>
<th>Adolescent (13–18 years, n = 15)</th>
<th>Adult (&gt; 18 years, n = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Malleus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact</td>
<td>11 (65)</td>
<td>7 (47)</td>
<td>29 (59)</td>
</tr>
<tr>
<td>Eroded</td>
<td>6 (35)</td>
<td>5 (33)</td>
<td>14 (29)</td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>0</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Not specified</td>
<td>0</td>
<td>3 (20)</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Incus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact</td>
<td>0</td>
<td>2 (13)</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Eroded</td>
<td>4 (24)</td>
<td>3 (20)</td>
<td>13 (27)</td>
</tr>
<tr>
<td>Absent</td>
<td>13 (76)</td>
<td>9 (60)</td>
<td>30 (61)</td>
</tr>
<tr>
<td>Not specified</td>
<td>0</td>
<td>1 (7)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Stapes superstructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact</td>
<td>10 (59)</td>
<td>5 (33)</td>
<td>25 (51)</td>
</tr>
<tr>
<td>Eroded</td>
<td>7 (41)</td>
<td>7 (47)</td>
<td>18 (37)</td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>2 (13)</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Not specified</td>
<td>0</td>
<td>1 (7)</td>
<td>1 (2)</td>
</tr>
</tbody>
</table>

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**TABLE 4. Otogenic intracranial and extracranial complications**

<table>
<thead>
<tr>
<th>Type of complication(s)</th>
<th>Children (≤ 12 years, n = 17)</th>
<th>Adolescent (13–18 years, n = 15)</th>
<th>Adult (&gt; 18 years, n = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Cerebellar abscess</td>
<td>1 (6)</td>
<td>1 (7)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Temporal abscess</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Extradural abscess</td>
<td>1 (6)</td>
<td>0 (0)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Subdural abscess</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Meningitis</td>
<td>5 (29)</td>
<td>2 (13)</td>
<td>6 (12)</td>
</tr>
<tr>
<td>Lateral sinus thrombosis</td>
<td>3 (18)</td>
<td>1 (7)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Internal jugular vein thrombosis</td>
<td>1 (6)</td>
<td>0 (0)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Epileptic seizure</td>
<td>1 (6)</td>
<td>0 (0)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Facial paralysis (preoperative)</td>
<td>1 (6)</td>
<td>0 (0)</td>
<td>4 (8)</td>
</tr>
</tbody>
</table>
both genders (male: n = 9, 47%; females: n = 10, 53%). In another study, the male to female ratio strongly favored the male gender (10).

It is a common finding that there is a high incidence of otitis media (otorrhea) in children. Hence, it is envisaged that complications such as cholesteatoma and mastoiditis may be developing, if not already present. Wetmore et al. (11) studied such cases in 161 children and found that otorrhea or draining ear (and hearing loss) was the most common presenting symptom by far. Other studies with similar findings include those by Harley et al. (8), Rosenfield et al. (10), and Edelstein et al. (12). Their findings of common symptoms such as otorrhea, hearing loss, and pain compare closely with our findings. Children with postauricular swelling/pain (inflammation) were in high incidence (90%) in a retrospective study of mastoiditis (8). We have a similar situation (65%), primarily because of the highly pneumatized state of the pediatric mastoid, and hence its susceptibility to the easier and earlier development of mastoiditis and the spread of cholesteatoma than in the older person (8).

Facial paralysis caused by CSOM with or without cholesteatoma, even in countries with a high level of health care, is not uncommon. Over 5 years (1983 to 1987), Cvetnic (13) recorded eight individual adult cases of facial weakness. Sheehy (14), who studied 181 cases of cholesteatoma in children, reported 1 case of facial paresis before surgery. In our adult patients, there were four such cases over the similar study duration. Furthermore, Cvetnic (13) reported that four of his patients with facial paralysis recovered spontaneously postoperatively. In our cases, facial nerve paralysis developed in three adult patients after surgery. Follow-up in Port Moresby General Hospital—and in other hospitals in this country, for that matter—is very difficult. Hence, it was difficult to detect postoperative improvement of facial weakness. Chronic suppurative otitis media associated with cholesteatoma can cause facial nerve paralysis, which may not be reversible even after surgery. One reason may be recurrence of the condition or residual cholesteatoma (13). Various studies in children reveal similar findings and incidences with particular reference to the bony facial canal (15,16).

Perforation of the tympanic membrane commonly accompanies otorrhea (8–11). Bunne and Raivio (17) described 147 mastoidectomies in patients 16 years old or younger (that is, children and adolescents) with discharging ears during 1981 to 1986. Of these total numbers, only 26 (18%) patients had cholesteatoma. Our combined pediatric and adolescent cases of 15 (47%) cholesteatomas found intraoperatively is alarmingly too and a half times more common than in that study. This is without doubt a significantly high incidence, particularly with nearly half the number of this combined group who are basically young people. This means that a much higher incidence of cholesteatoma is expected in older person because of chronicity and the longer duration of infection.

Kurien et al. (3) observed that posterosuperior or attic involvement of the drum was common in cases with otogenic intracranial extension in both children and adults. The results of our series are similar. Kurien et al. also found that the malleus was least affected (67%) and the incus the most affected (100%) in both age groups, whereas there was significant involvement of the stapes (95%) in the children compared with the adults (67%) (3). Our series showed involvement of the malleus in 32%, of the incus in 89%, and of the stapes (in the children) in 41%. Hence, the incus was commonly affected. A 5-year study from 1982 to 1986 by Brackmann assessed 108 cases of ossicular involvement in children (n = 35, 32%) under 15 years of age and adults (n = 73, 68%) over 16 years of age (18). He found that there was a tendency for a greater degree of ossicular destruction in children than in adults. In our series, such cases in children (that is, pediatric and adolescent cases) numbered 32 (40%), whereas in adults they numbered 49 (60%). The age divisions between these two (above) studies compared very well. Brackmann’s pediatric cases of intact ossicles, intact malleus and stapes (diseased incus), and intact stapes accounted for only 9%, 11%, and 46%, respectively (18). It is clear that our patients had chronic ear disease with subsequently high incidences of ossicular involvement. In addition, the duration of symptoms as mentioned by the patients seemed to be underestimated. Similarly, Brackmann’s adult cases regarding the ossicles, as mentioned above, were 5%, 3%, and 73%, respectively. Here, again, the above reasons may well explain the high incidence of diseased ossicles and low rates of intact ossicles in our study. The ossicular chain findings of Palva et al. (19) describe a picture of more ossicular chain involvement in adults than in children.
The main reason is that the length of time (duration) of ear and/or mastoid infection is longer in adults than in children.

The extension of cholesteatoma can be great and therefore life-threatening. Our pediatric case study had 1 (6%) case of attic involvement, 4 (24%) cases of antral involvement, and 10 (58%) cases of involvement of both the attic space and the antrum. Palva et al. (19) found attic involvement in 5 (8%) of their 65 patients and antral involvement in 5 (8%) patients. Mastoid involvement accounted for seven (11%) of their cases (19). In the adolescent group we found two (13%) cases of attic involvement and five (33%) cases involving the antrum. Involvement of both the antrum and the attic space was seen in eight (54%) of patients. In comparison, Palva et al. (19) had 16 (25%) adolescents with attic involvement and 13 (20%) with antral involvement. The extent of cholesteatoma findings in the adult patients in our study revealed five (10%) with attic involvement and nine (18%) with antral involvement. Cholesteatomatous involvement of both the attic and antrum developed in 31 (64%) patients. Palva et al. (19) had 17 (26%) cases of attic involvement and 37 (57%) of antrum involvement. In general, there are more cases of attic involvement in children than in adolescents or adults.

Balyan et al. (20) questioned the necessity to do mastoidectomy in noncholesteatomatous CSOM. Long-standing untreated otorrhea can lead to osteitis and polypoid mucosal lining in the middle ear cleft, even without cholesteatoma. Osteitis and infective granulation tissue can itself prolong otorrhea, thereby creating a vicious circle. Moreover, osteitis itself can be the focus when infection spreads beyond the mastoid boundary, as noticed during surgery in our series. We called this category noncholesteatomatous but dangerous CSOM. Hence, all our patients with cholesteatoma and noncholesteatomatous but dangerous CSOM underwent canal-down mastoidectomy. This was done to ensure free drainage and easier toileting of the ears, thus, rendering the patient “safe” in the long term because follow-up and accessibility to health care are poor in our area.

Pure-tone audiometry was mainly done preoperatively. Postoperative pure-tone audiometry was very limited because of poor follow-up. Schuring et al. (7), Wetmore et al. (11), and Glasscock et al. (21) have detailed information of both preoperative and postoperative audiologic assessment in their cases.

Otogenic intracranial and extracranial complications are well documented (3–6,22–24) and have a high prevalence in the lower socioeconomic communities (5,6). Intracranial complications arising from otitis media caused 25 of 1000 deaths (22) in the preantibiotic era. Lateral sinus thrombosis was the next most common otogenic complication resulting in high mortality (5,22), whereas meningitis was the most common intracranial complication observed by Samuel et al. (6), Singh et al. (5), and Kangsanarak et al. (4). All cases of internal jugular vein thrombosis in our series were caused by the downward extension of thrombus from the lateral sinus. Extreme tenderness was elicited by pressing over the vein medial to the sternomastoid muscle in the neck. This clinical sign is very reliable despite altered sensorium of the patient when there are additional complications. In our series, lateral sinus thrombosis and intracranial and extracranial complications were comparatively infrequent because our sample size was smaller. Nonetheless, in our experience, such complications are associated with high mortality. This is supported by other studies (3–6,22–24). Otogenic brain abscess, whether temporal lobe abscess, cerebellar abscess, or subdural and extradural abscess, is not uncommon (3–6,22–24) and still occurs despite advances in antibiotics (4,6,23). However, significant reduction in the incidence of otogenic intracranial complications resulting in a diminished death rate is noted (3–6,22–24). It is, however, prevalent in many parts of the world, particularly in the lower socioeconomic group (5,6).

The appropriate management of otogenic complications involves early detection and diagnosis based on clinical signs and symptoms and supportive investigations such as culture and prompt radiologic assessment while appropriate antibiotics are administered intravenously, followed by otologic with or without neurosurgical intervention (3–5).

Routine postoperative assessment was encouraged for all patients. Our study of 10 (59%) children with postoperative discharging ear contrasts significantly with 8% cases reported by Palva et al. (19) and 1.7% of 200 cases by Robinson (25). However, the study by Palva et al. (19) had three (5%) patients who underwent repeat exploration (revision mastoidectomy). This compares with our study of three (18%) cases with revision mastoidectomy. Schmid et al. (26) found that residual cholesteatoma in children was twice as frequent in those treated by intact canal wall procedures than in those treated by canal-down procedures. This finding was supported by Sheehy (16). The high incidence of postoperative otorrhea in our study reflects a direct relationship to the level of health awareness, personal hygiene, and socioeconomic status of the affected persons and in the community at large. Moreover, despite standard routine treatment, persistent chronic otorrhea can also be a sign of an underlying medical problem (27). The medical problems are immune deficiency syndromes, fungal infections, tuberculosis, syphilis, and granulomatous and connective tissue diseases (27). We had one (2%) HIV-positive woman with persistent otorrhea and fever with intracranial complications. Despite emergency surgery, the entire wound gaped on the 3rd postoperative day, and the patient expired on the 7th postoperative day.

CONCLUSION

This article is a reminder of the problem of CSOM and its associated complications, prevalent in many parts of the developing world. Lack of health awareness, poor personal hygiene and socioeconomic status, and deficient health care delivery systems not only aggravate the natu-
ral history of the disease process but also make management difficult, with considerable morbidity and mortality and poor postoperative follow-up. Hence, we believe that one-stage canal-down mastoidectomy in this group of patients is justified to make their ears safe throughout their lifetimes.

REFERENCES