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Case Report

Case study of a hydrostatic pressure-induced traumatic chronic tympanic membrane perforation with purulent otorrhea and spontaneous closure

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ABSTRACT

Tympanic membrane (TM) perforations are ruptures of the membrane separating the middle and outer ear which heal spontaneously in 78.7-94% of cases. However, with large perforations and infection, the spontaneous closure rate diminishes. Chronic TM perforations are thought to rarely close spontaneously and are often treated with a myringoplasty which has a variable success rate, potential risks, and a significant recovery period during which patient activity is notably limited. Significant controversy exists over the indication for surgical intervention in the case of grade 3, chronic TM perforation with a history of infection. The aim of this case study is to provide insight into the typical progression and potential spontaneous resolution of such cases. Moreover, there is a lack of publicly available reference images outlining the progress of TM perforation healing, so detailed time-stamped photos are included. The investigators imaged, at regular intervals, a 23-year-old male's mid-anterior chronic grade 3 TM perforation who presented with an outer and middle ear infection with purulent otorrhea. The result indicates that chronic grade 3 TM perforations with a history of infection still have potential to spontaneously close. Given the risks and inconvenience of a myringoplasty, further consideration should be taken before recommending this procedure in these cases.

Keywords: Tympanic membrane perforation, Otorrhea, Grade 3, Spontaneous closure, Traumatic, Myringoplasty

INTRODUCTION

Tympanic membrane (TM) perforations are ruptures of the membrane separating the middle and outer ear, which is mostly comprised of cartilaginous connective tissue. It primarily serves to aid in the transaction of external oscillatory fluid pressure gradients to the cochlea by transferring the vibrations through a chain of three auditory ossicles.

The most common cause of TM perforations is acute trauma, followed by acute otitis media.[1] It is estimated that the lifetime incidence of traumatic TM perforation is 6.8/1000. TM perforations are more common in males and younger individuals, with children comprising approximately 25% of patients.[2]

It is estimated that 78.7-94% of TM perforations will heal spontaneously; however, larger perforations and perforations with infection are significantly less likely to do so.[3,4] There are several classification systems describing the size of TM perforations, one of which is a grading system from 1-5, indicating the percentage of the TM that is occupied by the perforation, ranging from 1-100% (grade 1=pinhole, grade 2≤25%, grade 3=25-50%, grade 4=50-75%, and grade 5≥75%). Studies have found

that nearly all grade 1 and grade 2 perforations heal spontaneously with few exceptions, and grade 3 perforations and above sometimes lead to chronic TM perforations. The overall closure rate is relatively high, at about 97% for grade 1, 40% grade 2, and 20% grade 3 perforations. Median closure time for small perforations is between three and four weeks, but larger perforations might not heal, and early surgical repair may be needed.[5] Examining early healing response through imaging over time may aid the clinician with respect to a decision to postpone surgery or repair early.

TM perforations that do not close spontaneously under 90 days are considered chronic. These usually require surgical intervention via myringoplasty or tympanoplasty, especially if the perforation has a history of infection.[5] A patient with a chronic, grade 3 TM perforation with a history of infection would likely be considered a candidate for myringoplasty. However, data on patients in this category is limited and there is controversy regarding surgical indication.[4]

A myringoplasty or type 1 tympanoplasty involves using a patch to surgically close the TM perforation to improve hearing and prevent recurrent infection. However, success rates are variable, with estimates ranging from 60-99% in adults[6] and there are several risks associated with the procedure, including, but not limited to, those associated with general anesthesia, wound infection, further hearing loss, vertigo, tinnitus, altered taste, and facial weakness. Even when the procedure is successful, patients must refrain from activities that limit fluctuations in external pressure such as flying on a plane and swimming for approximately 3 months.

CASE REPORT

The patient is a 23-year-old male with a left mid-anterior chronic grade 3 TM perforation who presented with an outer and middle ear infection with purulent otorrhea and minimal hearing loss. The patient provided both verbal and written informed consent.

He described the 16 June 2020, incident that provoked the perforation as quickly descending in depth while swimming in a local lake. Presumably, the rapid increase in external pressure without time for the eustachian tube to reach a pressure equilibrium resulted in a pressure differential across the TM exceeding the rupture threshold. This allowed the external fluid from the lake to enter the middle ear which ultimately resulted in a middle ear infection, despite the patient reporting use of ethanol to mitigate infection.

On 20 June 2020, the patient was prescribed SANDOZ neomycin (3.5 mg/ml), polymyxin B sulfates (10,000 units/mg), and hydrocortisone (10 mg/ml) otic solution, administered through four drops, twice per day, to treat the middle and external ear infection with purulent otorrhea, which the patient adhered to until the infection completely resolved.

Given the uncertainty over the indication for surgical intervention in the case of grade 3, chronic TM perforation with a history of infection, the aim of this case study is to provide insight into typical progression and the potential for spontaneous resolution of such cases.

From 23 June 2020, to 04 January 2021, the left tympanic membrane was imaged with a DEPSTECH 3.9 mm endoscopic otoscope at relatively regular intervals to assess the progress of the TM rupture and infection. Also, the perforation site was imaged on 17 October 2021, approximately 10 months following its spontaneous closure as well.

The images taken of the patient's TM at various timepoints are shown in Figure 1 discussed in Table 1. The inflammation subsided after 30 days of otic solution application and the TM perforation permanently closed after an additional 165 days.

Table 1: Description of healing progress of a 23-year-old male's left grade 3 TM perforation as shown in Figure 1 otoscope images.

Figure	Timepoint	Description
Figure 1A	23 June 2020	The initial image is taken; significant external otitis and otorrhea is present.
Figure 1B	01 July 2020	After eight days on antibiotic and anti-inflammatory otic solution, reduction in swelling with noted increase in purulent otorrhea.
Figure 1C	07 July 2020	Inflammation has subsided and otorrhea has stopped.
Figure 1D	18 July 2020	Further reduction in swelling is evident and a partial initial closure of TM perforation with a significant amount of surrounding scar tissue is observed.
Figure 1E	23 July 2020	Only minor inflammation is present; thus, the otic solution is stopped after 30 days of use; an increase in cerumen near TM perforation site is noted.
Figure 1F	27 July 2020	Further increase in cerumen near the TM perforation site is observed.
Figure 1G	31 July 2020	No notable change is observed.
Figure 1H	09 August 2020	Partial closure of the perforation occurs while the surrounding scar tissue begins to abruptly thin and appears weaker than previous timepoints.

Continued.

Figure	Timepoint	Description
Figure 1I	15 August 2020	A near full perforation closure 53 days post initial imaging with significant thinning of scar tissue is evident. The scar tissue has thinned to the extent that it is relatively translucent. Minor erythema on the malleus is also evident.
Figure 1J	22 August 2020	Further thinning of scar tissue near perforation site and exacerbation of malleus erythema are evident, possibly indicating a minor case of external otitis.
Figure 1K	30 August 2020	A small secondary rupture due to thinning of scar tissue has occurred, while the malleus erythema absolves.
Figure 1L	26 September 2020	The secondary rupture begins to open.
Figure 1M	14 September 2020	Further opening of the secondary rupture is evident.
Figure 1N	04 October 2020	Opening of the secondary rupture continues.
Figure 1O	25 October 2020	Additional opening of the secondary rupture is evident. The peak size of TM perforation occurs here, 124 days post initial imaging.
Figure 1P	09 November 2020	Slight closure of the TM rupture is evident.
Figure 1Q	30 November 2020	Further closure of the TM rupture is evident.
Figure 1R	21 December 2020	Closure of the TM rupture continues.
Figure 1S	04 January 2021	The TM rupture has completely and permanently closed, 195 days post initial imaging.
Figure 1T	17 October 2021	At the 10 month follow up post-closure, a significant amount of scar tissue is present with no self-reported hearing detriment.

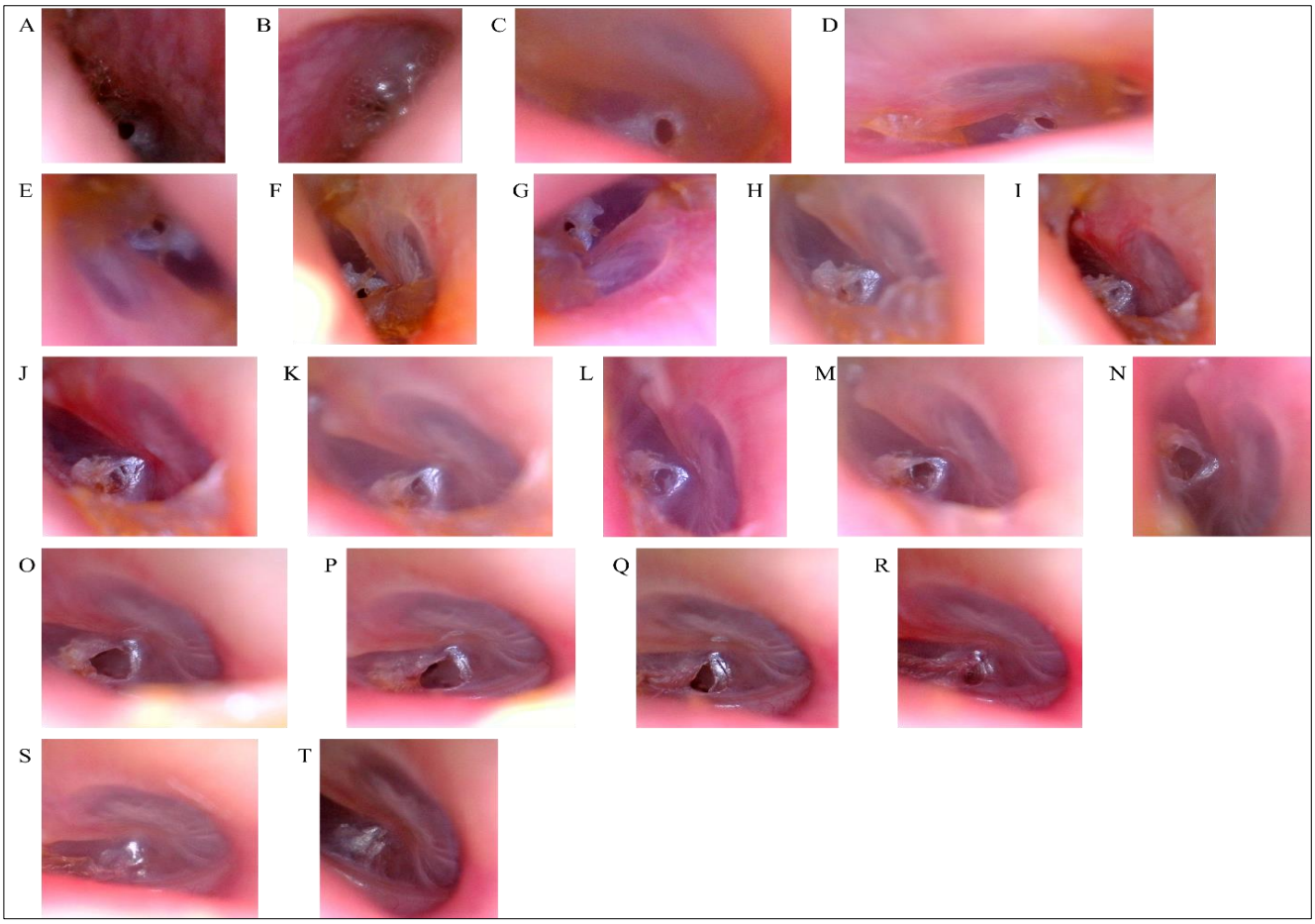

Figure 1: Regular interval otoscope images showing healing of a 23-year-old male's left grade 3 TM perforation.

DISCUSSION

Due to the logistical difficulty of regular interval imaging no current study exists depicting the progression of large, chronic TM perforations presenting with a history of infection healing in human models, although some exist in animal models.[7-9]

Despite possessing characteristics which would typically indicate that this TM perforation would not exhibit

spontaneous closure, it closed more than 6 months after the acute trauma causing the perforation. It is evident that one major contributing factor to this is this initial 30-day infection with purulent otorrhea. Moreover, after complete initial closure, it appears that a minor case of external otitis with malleus erythema provoked the degradation of existing scar tissue and a secondary perforation. The secondary perforation appears to have opened to a much larger maximum size than the initial perforation as well, which clearly extended the time to permanent closure.

Given the progression of this patient, it is evident that chronic grade 3 tympanic membrane perforations with a history of infection still have potential to spontaneously close. Moreover, considering the risks and inconvenience of a myringoplasty procedure, careful consideration should be taken before a procedure is performed in such cases.

CONCLUSION

The history of the perforation should be taken into consideration before concluding that spontaneous closure is unlikely. Imaging the tympanic membrane at regular intervals allows improved consideration of perforation history and should help understand prognosis. Frequent monitoring though physician appointment is, however, not convenient or economical and thus, the investigators suggest that patients would benefit from safe and affordable, at home, otoscopic equipment which could image the tympanic membrane, and allow the patient to share the information with his or her physician. However, given that frequent monitoring is often not feasible, the results from this case study indicate that similar patients without a known perforation history should not undergo a myringoplasty procedure until at least 6 months have passed since the onset of the perforation.

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