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Extraction of Aural Foreign Bodies in a Rural Setting: 10-Year Review and a Novel Method to Remove Magnetic Stones

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Abstract

Background: The external auditory canal's unique anatomical characteristics made the presence of foreign bodies (FBs) a clinical challenge, particularly in rural settings without ready access to tertiary care and specialist intervention. **Aims:** Our study surveys the experience in aural FBs surgical management in a rural Australian tertiary center. It proposes a safe, easy, and affordable technique to remove stones from the ear canal. **Methods:** We have completed a 10-year retrospective surgical chart review, including 474 patients (52 adults and 428 children) requiring surgical management to remove aural FBs at the Royal Darwin Hospital, Northern Territory, Australia. We surveyed for patient demographics, foreign-body description, complications, location, and removal attempts. We identified what factors determine the need for surgical management and propose a technique for a safe, uncomplicated, and affordable removal of stones from the ear canal after applying this method in a small subgroup. **Results:** The most common FBs requiring surgery in children were stones. A predominance in the Aboriginal population from remote communities was found, leading to a nasal bridle magnet technique to remove stones in rural settings. This method reduces the number of extraction attempts of the most frequent FB found in children's ears, aiming to minimize complications, negative experiences, and health cost. **Conclusion:** Contrary to international literature, stones were found to be the most common FB in remote aboriginal populations. The proposed technique reduces the number of extraction attempts of the most frequent FB found in children's ears, aiming to minimize complications, negative experiences, and health cost.

Keywords

aural foreign body, surgical management, rural setting, stones, nasal bridle magnet

Introduction

The external auditory canal (EAC) has a sigmoid shape with the cartilaginous portion angling posteriorly and superiorly with 2 natural narrowings, first at the bony–cartilaginous junction and then just lateral to the tympanic membrane. These unique characteristics made ear foreign bodies (FBs) challenging to be removed.[1]

The presence of FB in the ears represent a clinical challenge for general practitioners and emergency departments, particularly in rural settings without ready access to tertiary centers equipped with microscopy, direct vision, microsuction, and specialist intervention.[2]

A study done in 689 pediatric ear FBs in a tertiary care center during 6 years showed that FB in the inner third of the ear canal, spherical objects, and objects in the ear canal for more than 24 hours had less removal success and higher complication rates.[3]

The Royal Victorian Eye and Ear Hospital and The Bendigo Hospital between 1996 and 2004 reported 333 ear FB, of which 33% required general anesthesia (GA) and otolaryngologist management.[4]

Literature shows that the most commonly removed FBs in acute care settings include beads, paper/tissue paper, and seeds[1]; however, our clinical experience at the only Regional tertiary center in the Northern Territory (NT), Australia, is that stones are prevalent.

The Northern Territory is a vast, sparsely populated area of 1 349 129 km^2, more than 6 times the UK size. Three-quarters of the population reside in 5 regional centers, while the

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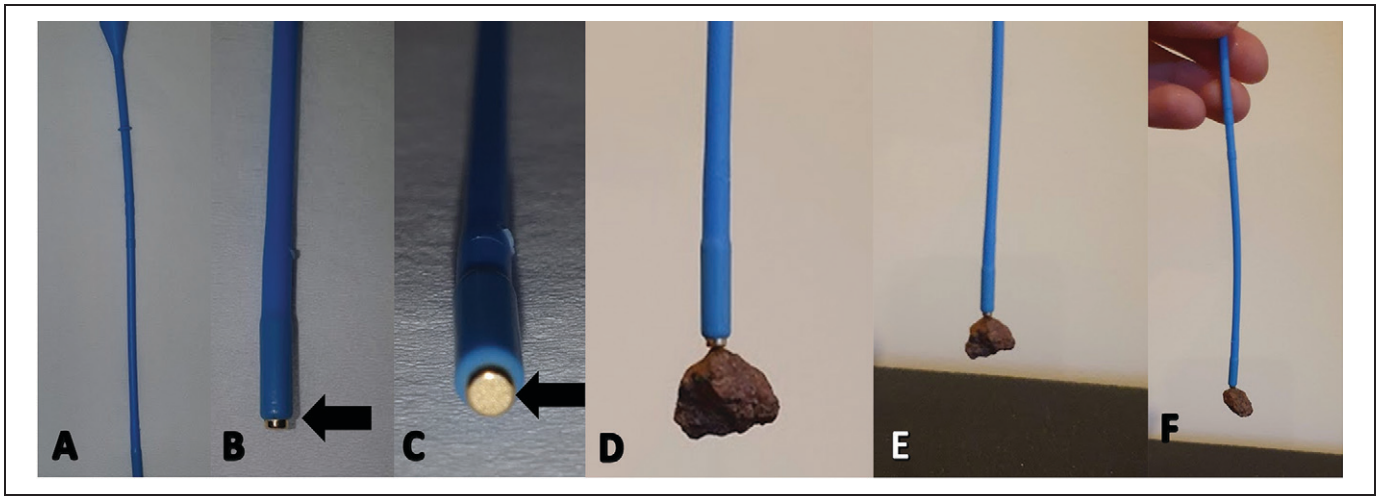

Figure 1. (A-C) Nasal bridle system (arrow showing the magnet). (D-F) Randomly picked stones and magnetic field.

remainder of the population lives in hundreds of small remote communities and outstations through the Territory.

Due to the communities' remoteness and the lack of specialist instrumentation, most of the patients had several attempts to remove the FB, complicating the extraction, requiring transferring the patient by care flight, and leading to negative experiences elevation in health costs.

This study shows our clinical experience in managing aural FBs at the Royal Darwin Hospital and a proposal technique to remove stones from the external ear canal in a rural Australian setting.

Methods

This study is a 10-year retrospective chart review from January 1, 2010, to January 1, 2020, of patients who required GA and microscopic instrumentation for removal of aural FB in the Royal Darwin Hospital. As a result, we propose a technique for a safe, uncomplicated, and affordable removal of stones from the ear canal after applying this method in a small subgroup. Ethics approval granted from the human research ethics committee of the Northern Territory Department of Health and Menzies School of Health (research no. EFILE2020/29820).

Patient charts were used to collect age, gender, location, type of FB found, and presenting symptoms.

The number of days of the FB lodge in the ear, the number of removal attempts, removal methods, and medical personnel involved before GA and specialist intervention were recorded.

Complications following removal of FB were categorized as canal abrasion, bleeding, tympanic membrane perforation, and infection/discharge.

The data generated were entered into a password-protected spreadsheet (Excel version 16), which was then imported for the statistical analysis into STATA version 16.

Most variables were categorical and therefore reported as numbers. These were tested using Fisher exact test. Confidence limits were set at 95% and χ^2 and t test with $P < .05$ were considered statistically significant.

Technique Proposal

The stones identified as aural FBs were red, consistent with the NT characteristics and most of Australia's soil. Australian soil's brown and red coloration is due to a strong iron (Fe) content that oxides giving Australian soil its characteristic red appearance.[5]

This background is essential for our innovative proposal. We suggest the use of a nasal bridle system magnet to remove stones from ear canals. As Viscarra et al[5] describe that the Australian soil is coupled with iron, we decided to try the magnetism of randomly collected stones from several communities. Interestingly, a magnetic field between Australian soil stones and the magnet was demonstrated (Figure 1).

The nasal bridle system is a securement method used to discourage patients from pulling on their nasoenteric feeding tube. It consists of 2 magnetic rods to secure nasogastric tubes to the nasal septum and prevent them from being dislodged.[6] Since the stones commonly found in the Australian soil are magnetic, the rods can remove these FBs with enough strength to safely dislodge without trauma.

Results

Demographic Statistics

Four hundred seventy-four patients required microscopic instrumentation under GA to remove aural FB, including 428 children and 50 adults. Patient genre, indigenous status indicator, and side of the FB are provided in Table 1. Distributions were comparable between genres; however, there was distribution predominance in the indigenous population.

The most common FBs found in children were stones, followed by plastic beads and toilet paper. Fourteen metallic FBs were identified and 1 battery.

Location was determined by postal code category. Of the 474 FBs that required microscopic extraction with GA, 255 came from remote communities and 219 from an urban location.

Table 1. Demographics of Patients Requiring GA for Removal of FB and FBs Description.

	Frequency	Percent
Genre		
Female	234	49
Male	240	51
Procedure side		
Bilateral	115	24
Left	148	31
Right	211	46
Indigenous status		
Indigenous	319	67
Non-Indigenous	155	33
Overall FB description		

	Age								
	Bead	Foam	Hot metal	Insect	Metal bead	Metal earing back	Stones	Toilet paper	Battery
Total number	127	10	2	42	5	9	211	67	1
Mean	10.849	5.330	5.975	11.857	4.984	10.099	9.634	7.198	3.460
SEM	1.154	0.495	2.555	2.128	1.082	2.488	0.679	0.748	NA

Abbreviations: FB, foreign body; GA, general anesthesia; NA, nonapplicable.

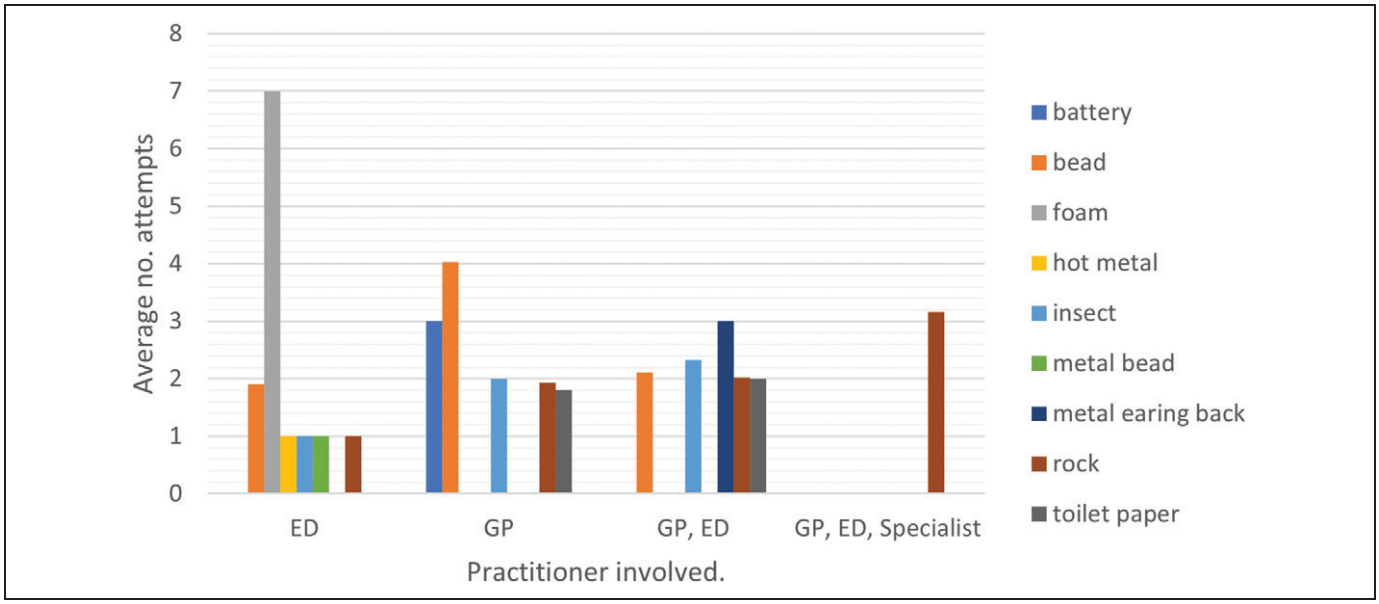

Figure 2. Average number of attempts by practitioner and type of foreign body.

Removal of FB

The presentation time varied based on the type of FB and the location with a mean of 7.9 (± 0.61) days with insects and 22 (± 1.3) days with stones. Remote location showed an overall delay in presentation. Dangerous items, including 1 battery and 2 hot metal FBs, were removed on the same day, which required urgent transportation via care flight from the community to the tertiary center.

On presentation, most patients were asymptomatic (n = 240; 51%), followed by discharge (n = 155; 33%), pain (n = 72; 15%), and mild hearing loss (n = 7; 1%). At least 1 attempt of removal was made before surgery (Figure 2).

Complications

During this study, the complications noted preceding surgical management were abrasion of the external ear canal, bleeding, polyp formation, granulation tissue formed around the FB, and tympanic membrane perforation. Complications were determined by the type of FB and the number of days of FB lodge in the ear (Figure 3).

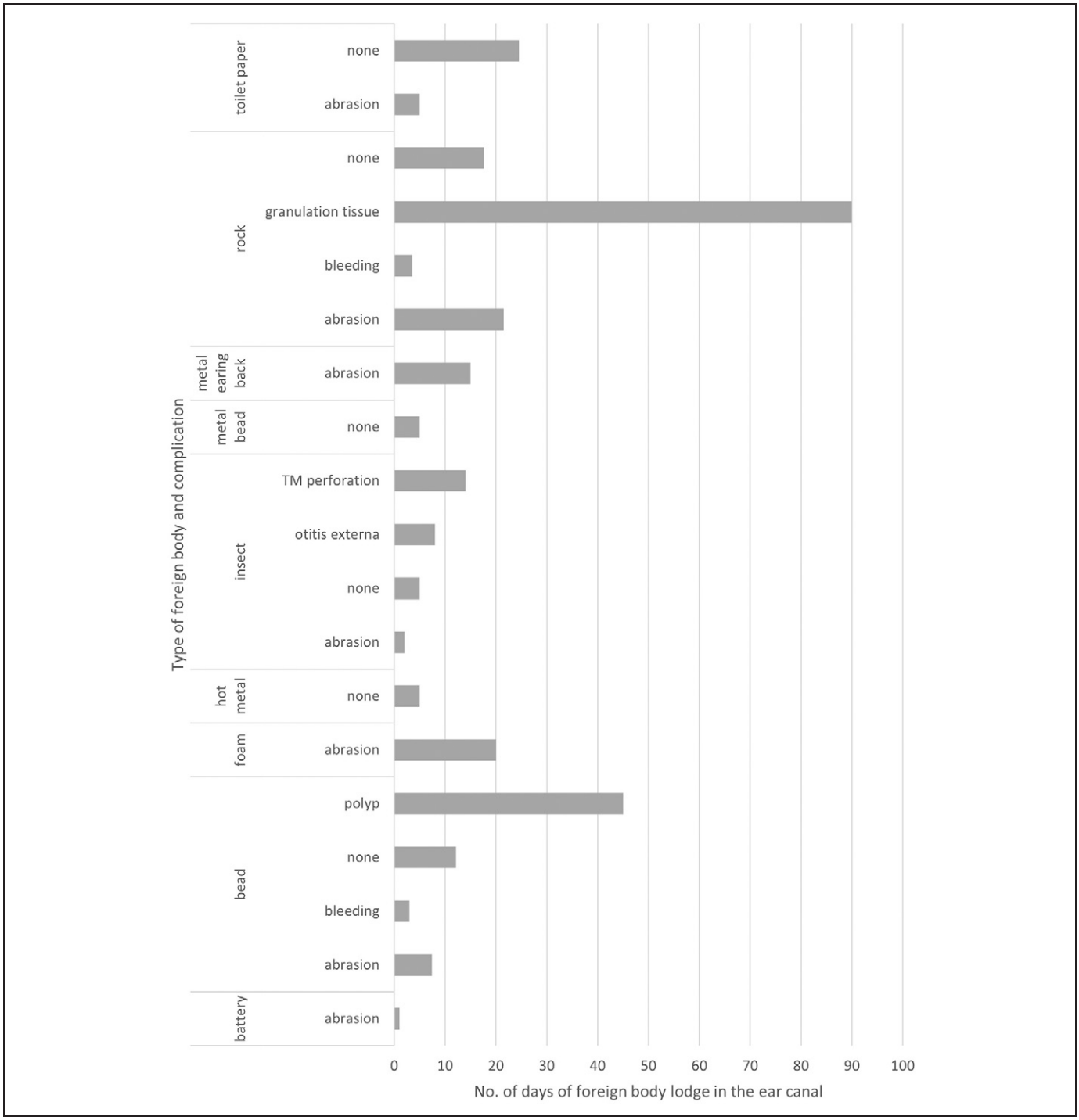

Figure 3. Complications found before surgical management.

Formation of granulation tissue around the FB was significantly more prevalent in the patients with stones, while tympanic membrane perforation was more prevalent with insects.

Increasing the number of aural FB removal attempts predicted complications and need for surgical management, with 3 attempts having OR 3.3 (95% CI, 1.1648-1.8199, $P = .025$), 4 attempts having an OR of 4.9 (95% CI, 1.05-3.63, $P = .034$), and 7 attempts having an OR of 21.6 9 (95% CI, 2.98-4.563, $P = .045$). A proportional relationship between the presence of complications with the number of days of FB retention was found (>10 days: OR 3.4; 95% CI, 1.05-5.16; $P = .044$).

Table 2. Nasal Bridal System Used to Remove Stones Lodge in the Ear Canal.

Successful removal with nasal bridal system	Age on presentation	Locality (all remote)	Type of foreign body	Number Of days of foreign body lodge in the ear	Number of attempts	Complications	Audiometry	Tympanometry
Yes	7	Wadeye	Stone	18	2	None	Bilateral satisfactory hearing	Bilateral type A
Yes	4	Wadeye	Stone	5	3	None	Bilateral satisfactory hearing	Bilateral type A
No	2	Gunbalanya	Stone	10	3	None	Bilateral satisfactory hearing	Bilateral type A
Yes	8	Maningrida	Stone	8	1	None	Bilateral satisfactory hearing	Bilateral type A
No	5	Maningrida	Stone	15	3	None	Bilateral satisfactory hearing	Bilateral type A
Yes	3	Wadeye	Stone	7	1	None	Bilateral satisfactory hearing	Bilateral type A
Yes	2	Wadeye	Stone	5	1	None	Bilateral satisfactory hearing	Bilateral type A
Yes	2	Milikapiti	Stone	2	1	None	Bilateral satisfactory hearing	Bilateral type A
Yes	3	Katherine	Stone	3	2	None	Bilateral satisfactory hearing	Bilateral type A
Yes	3	Nhulunbuy	Stone	1	1	None	Bilateral satisfactory hearing	Bilateral type A
Yes	4	Nhulunbuy	Stone	2	1	None	Bilateral satisfactory hearing	Bilateral type A
No	2	Nhulunbuy	Stone	5	3	None	Bilateral satisfactory hearing	Bilateral type A
Yes	2	Angurugu	Stone	3	1	None	Bilateral satisfactory hearing	Bilateral type A
Yes	4	Angurugu	Stone	8	2	None	Bilateral satisfactory hearing	Bilateral type A
Yes	3	Angurugu	Stone	3	1	None	Bilateral satisfactory hearing	Bilateral type A

Magnetic Technique Assessed in a Small Subgroup

We have tested the technique on 15 occasions during outreach trips to remote communities where lodged stones in the ear canal had been. Twelve (80%) stones were removed successfully with the nasal bridle system magnet, and 2 required extraction under GA (Table 2). Pure tone audiometry assessments done after removal of stone using the magnetic field technique were within normal ranges. Considering our population was located remotely and the lack of Hospital equipment, no otoacoustic emission tests was performed. No complications, hearing loss, dizziness, or any discomfort were reported.

Discussion

Aural FBs are common presentations to primary care and emergency departments. Most articles describing patients presenting with aural FBs usually mention the surgical instrumentation as a complementary part of the result section.

The type of FBs commonly found in the ear canal varies worldwide (Table 3). Previous studies in Australia describe aural FBs[4,7]; however, they have an urban setting. In contrast, this study describes the only tertiary hospital findings as a referral center to the entire Top End of the NT. The most common FB needing surgical management identified were stones, predominant among Aboriginals living in remote communities.

Das[8] reported irritation, otitis externa, chronic suppurative otitis media, or wax in the meatus as a factor leading to FBs insertion in the pediatric population. Indeed, this finding is consistent in our study where deliberate insertion of stones in children's ears was seen most frequently; underlying trigger factors are not identified.

Ethnicity and socioeconomic background have been poorly explored in association with aural FBs. Ijaduola and Okeowo[19] describe that up to 50% of FBs were found in children with low socioeconomic status. Marin and Trainor[10] explain that 31% of the cases with aural FBs in Chicago were identified as Hispanic, usually associated with a lower socioeconomic status. Regarding ethnicity, our study shows that 67% (n = 319) were Aboriginal or Torres-Strait islanders, and 54% (n = 255) were care flighted from a remote community. Socioeconomic status was not assessed in the current study.

International literature shows a time of presentation usually less than 24 hours (Table 3) with the exemption of Nigerian experience.[9] Foreign bodies were usually lodged in the ear canal for up to 10 days. Our study has identified that some FBs, in particular stones, had been present in the ear canal up to 45 days.

Table 3. International Literature of Aural Foreign Bodies.

Study	Follow-up in time	Location	Study included adults	Most common FB	Total number of patients	Time of FB lodge in the ear	Patients requiring surgical management (n)
Ng and Lim[6]	5 years	Frankston Hospital, Peninsula. Victoria, Australia	Yes	Insects	495	<24 hours	51 (13.4%)
Marin and Trainor[12]	5 years	Children's Memorial Hospital. Chicago, USA	No	Plastic beads	273	<24 hours	15 (6%)
Schulze et al[3]	6 years	Children's Hospital of Wisconsin, USA	No	Plastic beads	698	24-48 hours	48 (21%)
Ryan et al[4]		Royal Victorian Eye and Ear Hospital and The Bendigo Hospital. Victoria, Australia	Yes	Plastic beads (in children) Cotton tip (in adults)	330	<24 hours	23 (31%)
Ijaduola and Okeowo[9]	1 year	Lagos University Hospital, Nigeria	No	Seeds	400	Up to 10 days	Not described
Shih et al[13]	1 year	Baylor University Hospital, Texas, USA	No	Plastic toys/beads	366	<24 hours	10 (2.7%)
Karimnejad et al[14]	5 years	Cardinal Glennon Children's Hospital. St Louis, MO, USA	No	Plastic beads,	1197	<24 hours	85 (7.1%)
Current study	Ten years	**Royal Darwin Hospital**, Darwin Northern Territory, Australia	Yes	Stones (in children) Insects (in adults)	474	Up to 45 days	474 (100%) Patients included if they required surgical management

The multiple removal attempts and the need to transfer the patient from the community to the tertiary hospital have many clinical risks, financial implications, and emotional distress with negative experiences related to the health system, affecting the compliance of an already vulnerable population in future health procedures.

Regarding financial implications, the Patient Assistance Travel Scheme review[11] calculated that the average cost per patient to be transported to Darwin (including charter flight, accommodation, and return via commercial flight), ranges from AUD 220 per person from nearby communities to AUD 820 per person from a remote community. This cost duplicates as many of our patients are less than 18 years old; therefore, they require an escort. The financial cost of the surgical procedure needs to be added to those figures.

An advantage noted with using a nasal bridal magnet technique was a noncomplicated approach, not needing any specialized instrument but a headlight and introducing the magnet through the ear canal. The nasal bridal system can be sterilized and reused. Ear exposure to magnetic field forces at different intensities and frequencies had been documented with cochlear outer hair cells degeneration. Tuhanioglu et al[12] reported the effect of low-dose pulsed magnetic waves on laboratory rats cochleas exposed to 40 Hz pulsed magnetic field for 1 hr/d for 30 days. Our technique difference is that the exposure to the electromagnetic field was one single episode without pulses or continuity of the magnetic field. No evidence of hearing damage was noted in any of our study participants.

This technique might simplify removing the most common FBs found in remote communities, reducing the clinical risks, the negative experience while attempting removal, and the cost implied in transport and surgical intervention.

Conclusion

This study has shown valuable data that contradict the reported literature trends of aural FBs where the most common FBs requiring surgical management were plastic beads. In contrast, in remote Australian populations, the most common FBs identified were stones. We have demonstrated that factors such as remoteness, time of lodgment, and multiple extraction attempts are related to an increasing number of complications and the need for surgical management. As a result, we have described an innovative, uncomplicated, and inexpensive technique using a nasal bridle system magnet to pull out magnetized iron-charged stones common in the Australian landscape.

Our study's main limitation was its limited number of cases available for analysis. A proposal for future research is the trail of the magnet system and assessment with otoacoustic emission assessment at 4 and 12 weeks from the procedure.

Authors' Note

Dr N Reyes-Chicuellar takes responsibility for the integrity of the content of the article. Dr Nayellin Reyes-Chicuellar is the main author And contributed to data collection and writing. Dr Graeme Crossland Is a supervisor.

Ethics approval granted from the human research ethics committee of the Northern Territory Department of Health and Menzies School of Health (research no. EFILE2020/29820).

Declaration of Conflicting Interests

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