

Factors Influencing Hearing Outcomes in Pediatric Patients Undergoing Ossicular Chain Reconstruction

Abstract

Objective: Ossicular chain disruption in children leads to conductive hearing loss. Few studies have focused on factors influencing successful results in pediatric ossicular chain reconstruction (OCR). We aim to determine whether demographic or surgical factors affect hearing outcomes in pediatric OCR.

Methods: Electronic medical records between 2003 and 2014 were examined. Demographic information, surgical details, and pre- and post-operative pure-tone averages (PTA), speech reception thresholds (SRT), and air-bone gaps (ABG) were recorded.

Results: A total of 129 patients (133 ears) were included. 35% of cases required revision, most commonly due to displaced prostheses. 42% of patients had normal hearing post-operatively. Patients who underwent OCR due to temporal bone trauma had greater changes in PTA, SRT, and ABG than those of other etiologies ($p=0.037$, 0.034 , 0.027 , respectively). Post-operative PTA, SRT, and ABG were significantly better in patients with partial ossicular replacement prosthesis (PORP) compared with those with total ossicular replacement prosthesis (TORP) ($p=0.016$, 0.003 , 0.003). Patients receiving titanium prosthesis had better post-operative PTA and larger changes in PTA and ABG ($p=0.031$, 0.025 , and 0.019). Patients with titanium prostheses had decreased odds of requiring revision (OR=0.162, $p=0.001$), while patients with hydroxyapatite (HA) prostheses and TORP had increased odds of revision (OR=4.25, $p=0.001$, OR=3.23, $p=0.006$).

Conclusions: In our experience, children undergoing OCR due to trauma had an excellent hearing prognosis. Children with titanium prostheses and PORP had better hearing outcomes. Patients with titanium prostheses were also less likely to require revision surgery.

Introduction

Ossicular chain (OC) disruption occurs in children due to several etiologies including genetic disorders, eustachian tube dysfunction, cholesteatoma, and trauma¹. Discontinuity leads to conductive hearing loss, which can negatively impact the social and educational development of children. Surgical ossicular chain reconstruction (OCR) re-establishes the vibratory forces needed to properly conduct sound from the tympanic membrane to the cochlea. Although there is a need for expeditious and safe OCR in children, there is a paucity of studies examining which surgical technique leads to consistently positive hearing results¹⁻³.

Due to the lack of large evidence-based studies focusing on OCR in the pediatric population, pre-operative counseling is limited. Often, surgeons utilize statistics from studies looking at outcomes in both adults and children. Most of the studies in children have focused on the results of tympanoplasty⁴ or looked exclusively at the results of OCR in children after cholesteatoma surgery^{5,6}. Therefore, counseling a patient with a different pathology, such as a traumatic OC disruption, is challenging. Additionally, intra-operative decision-making about type of prosthesis, material of prosthesis, and surgical technique are often based on anecdotal or learned experience. Finally, there is sparse literature on what factors influence revision rates and prosthesis extrusion, and how to improve long-term outcomes for children.

In this study, we assess the influence of demographic factors, etiology of OC disruption, type and material of prosthesis, and surgical technique on hearing outcomes in children undergoing OCR in a tertiary care hospital setting.

Table 1. Surgical Information

	Total	Requiring Revision
Number of OCR (n)	133	47
Age, median (range), years	10.4 (3.4–22.5)	9.3 (3.4–21.9)
Ear, n (%)		
Left	74 (56%)	35 (74%)
Right	59 (44%)	12 (26%)
Etiology, n (%)		
Acquired ETD	94 (71%)	33 (70%)
Syndromic ETD	12 (9%)	5 (11%)
Congenital Cholesteatoma	15 (11%)	7 (15%)
Congenital Malformation	5 (4%)	1 (2%)
Temporal Bone Fracture	7 (5%)	1 (2%)
Mastoidectomy, n (%)		
Not Performed	62 (47%)	16 (34%)
Canal Wall Up	60 (45%)	26 (55%)
Canal Wall Down	11 (8%)	5 (11%)
Prosthesis, n (%)		
None	24 (18%)	7 (15%)
PORP	49 (37%)	11 (23%)
TORP	60 (45%)	29 (62%)
Cartilage Graft with Prosthesis	96/109 (88%)	36/40 (90%)
Material, n (%)		
Autologous	21 (16%)	7 (18%)
Titanium	37 (28%)	4 (10%)
Hydroxyapatite	60 (45%)	29 (72%)
Bone Cement	3 (2%)	0 (0%)
Unknown	12 (9%)	7 (18%)

Results

There were a total of 129 patients included in this study. 4 patients underwent bilateral OCR, for a total of 133 ears. Surgical details are shown in **Table 1**.

Hearing Outcomes: Overall, OCR significantly improved PTA, SRT, and ABG. Median PTA was reduced from 43.3 dB to 31.7 dB ($p<0.0001$). Median SRT was reduced from 40.0 dB to 25.0 dB ($p<0.0001$). Median ABG was reduced from 36.7 dB to 23.3 dB ($p<0.0001$). Patients who required revision surgery had more refractory hearing loss, even after OCR surgery.

Etiology: Patients with temporal bone fracture had significantly better post-operative ABG ($p=0.009$) and larger changes in PTA ($p=0.037$), SRT ($p=0.034$), and ABG ($p=0.027$) compared with other etiologies.

PORP vs. TORP: Post-operative PTA ($p=0.016$), SRT ($p=0.003$), and ABG ($p=0.003$) were significantly better in patients with PORP compared with those with TORP.

Material: Patients receiving titanium prostheses had significantly better post-operative PTA ($p=0.031$) and larger changes in PTA ($p=0.025$) and ABG ($p=0.019$) than patients with all other materials.

Revisions: Median length of follow-up for cases in this study was 2.2 years. During this time, 47/133 (35%) cases required revision. The total prosthesis extrusion rate was 31/130 (24%). Reasons for revision included displaced or extruded prosthesis (31/47, 66%). Needing a revision was associated with a negative family history of otitis media ($p=0.048$), left ear surgery ($p=0.001$), and CWU mastoidectomy compared with no mastoidectomy ($p=0.042$). **Figure 1** shows the percentage of cases requiring revisions based on a several factors. Patients with titanium prostheses had decreased odds of requiring revision (OR: 0.162, CI: 0.053–0.497, $p=0.001$), while patients with HA prostheses had increased odds of requiring revision (OR: 4.25, CI: 1.86–9.71, $p=0.001$) compared with all other materials. Use of TORP increased the odds of revision compared with PORP (OR: 3.23, CI 1.39–7.49, $p=0.006$).

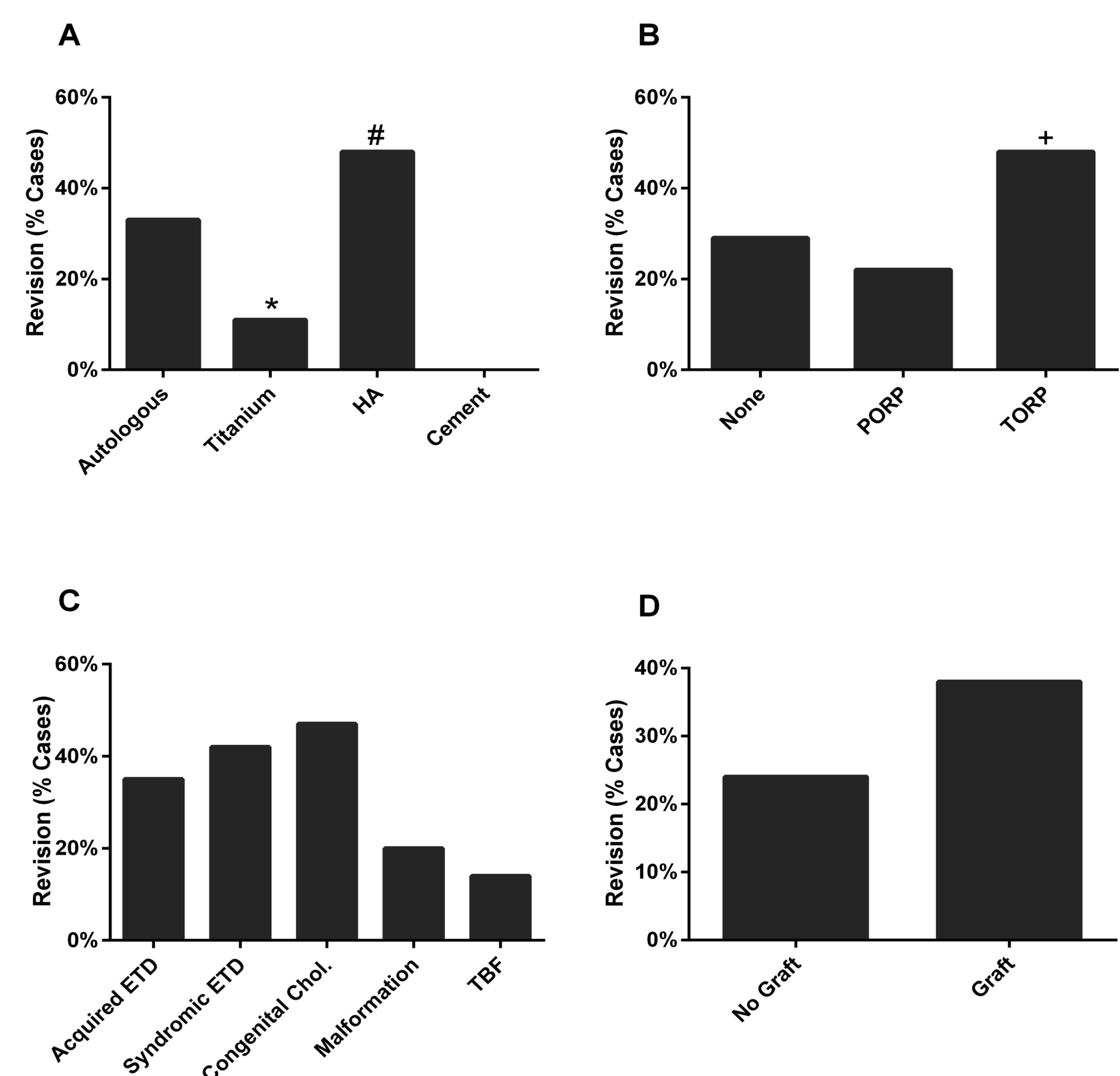


Figure 1. Factors affecting OCR revision rates: material (panel A, HA= hydroxyapatite), type of prosthesis (panel B), etiology (panel C, TBF= temporal bone fracture), inclusion of cartilage graft with prosthesis (panel D). *PORP vs. TORP, *Titanium vs. All Others, #HA vs. All Others, Logistic Regression, $p<0.01$

Discussion

Counseling pediatric patients undergoing OCR is challenging, as studies often do not separate out pediatric patients from adults or distinguish between surgical techniques. In this study, we found overall favorable hearing outcomes in all patients undergoing OCR ($p<0.0001$ for post-operative PTA, SRT and ABG). Children who required OCR due to temporal bone trauma and children receiving PORP and titanium prostheses had better hearing outcomes compared with other patients. Revision cases, which were required in 35% of children, most commonly due to prosthesis displacement, had more recalcitrant hearing. Patients with titanium prostheses had decreased odds of requiring revisions, whereas patients with HA prostheses and TORP had increased odds of requiring revision. In general, our study found that titanium PORP prostheses had the most favorable hearing outcomes with fewer revisions.

Contact

Nandini Govil, MD, MPH
University of Pittsburgh Department of Otolaryngology
Email: goviln2@upmc.edu

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