Literature review of the impact of MRIs on Cochlear implant Magnets

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INTRODUCTION

The utilization of cochlear implants (CI) as well as the use of magnetic resonance imaging for diagnostic purposes are simultaneously increasing (1, 2). This calls into question the safety and compatibility of cochlear implants while undergoing MRI scans. Currently, all cochlear implants are approved with the FDA as "MR conditional" with varying requirements based on the model type including "MRI kits" to be worn during the scan (3). While manufacturers have created guidelines for safe MRI use with CI, MRI related complications are well reported in the literature despite compliance with guideline (5). Axial magnets were previously utilized and exhibited outward torque away from the skull. In contrast, the diametric magnet poles will rotate in the direction of the magnetic field (6) (See Figure 1). The purpose of this project is to review the magnetic properties of the most current cochlear implants with freely rotatable magnets and the effects this has on patient safety and MRI artifacts. Specifically, we will investigate the Med-El Synchrony, Advanced Bionics HiRes Ultra 3D and Cochlear Nucleus Profile Plus.

METHODS

The study was IRB-exempted by the BSMH IRB. The literature review of all available studies was performed using PubMed, Cochrane, and Web of Science databases using the MESH term "magnetic resonance imaging" and phrases of "Med-el Synchrony", "Cochlear Nucleus Profiled Plus", "Advanced Bionics HiRes Ultra 3D", "rotatable magnet cochlear", "rotatable magnet" "diametric magnet", "diametric magnet cochlear implant", and "MRI-safe cochlear implant". Additional studies were identified from "Cited By" and reference lists. Non-English, non-human, cadaveric studies were excluded. Studies with non-implanted CI were also excluded.

RESULTS

18 studies were included for review, with 17 studies reporting on Med-el Synchrony, 5 studies on AB HiRes Ultra 3D, and 2 on Cochlear Nucleus Profile Plus. There were 58 specific patients identified with demographic information of 52.2% male and an age range of 16 months - 77 years. 320 MRI scans were performed for Med-el implants, 25 for Advanced Bionics implants, and 33 for Cochlear Nucleus, with more scans performed at 1.5T. Headwrap utilization was reported in 7 studies, while 13 studies mentioned no headwrap usage. 15 studies assessed pain as a complication, with 2 reporting its occurrence: two cases for Synchrony and one for Ultra 3D. Demagnetization did not occur in the 12 studies that reported on it. Only one implant displacement was noted with the Ultra 3D implant out of the 16 reporting studies. No significant post-imaging sequelae were reported. One study examined the need for sedation during MRI in 7 pediatric patients with an average age of 8 years. The study concluded that the presence of a diametric magnet (Med-el Synchrony) reduced the need for general anesthesia and sedation for all age groups. Artifacts were assessed in 11 studies, with all reporting the presence of artifacts and one describing a maximum radius of 5.6 cm for spin echo T1 and T2 and 6.9 cm for gradient echo-based images. The remaining studies reported that the impact on image quality depended on the location of lesions of interest and the scanning protocols applied.

CONCLUSION

Of the models reviewed with diametric magnets, Med-el Synchrony may enable MRI usage with fewer safety concerns when following the manufacturer's recommendations. However, clinical reports of freely rotatable CI safety during MRI scans are sparse and contain incomplete data. MRI artifacts from CI still pose concerns for image quality but can be minimized with appropriate implant location and scanning protocols.

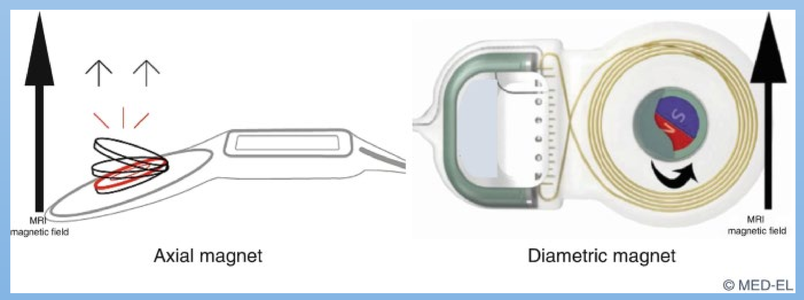

Figure 1. Diametric "Freely Rotateable" cochlear implant
Axial magnets were previously utilized and exhibited outward torque away from the skull. In contrast, the diametric magnet poles will rotate in the direction of the magnetic field (6)

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Abstract:
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