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Case Report

Cranial MRI in a young child with cochlear implants after bilateral magnet removal

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ABSTRACT

A young bilateral cochlear implant (CI) user required magnetic resonance imaging (MRI) to determine the cause of hydrocephalus. The images obtained with the CIs in place were not diagnostically useful due to large artefacts generated by the CI magnets. We obtained useful images by bilaterally explanting the CI-magnets and replacing them with non-magnetic placeholder dummies then conducted the imaging. The artefact in the new images was greatly reduced and the images were diagnostically useful. Lastly, we explanted the dummies and reimplanted the CI-magnets. This procedure should be useful to obtain useful images in CI users.

1. Introduction

Cochlear implant (CI) therapy in children with profound sensorineural hearing loss has become increasingly common over the last two decades [1]. Early identification and treatment of hearing loss, especially of severe-to-profound sensorineural hearing loss, is especially important in young children because a lack of hearing negatively impacts their language and speech skills, and furthermore affects academic and social-emotional development [2]. Therefore providing an appropriate, adequate, and timely hearing treatment should be an important goal of physicians, audiologists, and parents. For children who meet CI candidacy criteria, bilateral—not unilateral—treatment should be considered because children with bilateral CIs have better speech perception and verbal cognition skills, especially in complex listening situations, than do their peers with a unilateral CI [3]. Also, it can be assumed that children with bilaterally CIs have better sound localization skills than do their unilaterally implanted peers, since hearing with two ears helps localizing sounds in environment [4].

Magnetic Resonance Imaging (MRI) is a common noninvasive medical diagnostic tool to evaluate the causes of various diseases, e.g. tumors, infections, vascular problems. For CI users, however, having an MRI of their head could be problematic because not all CIs are Magnetic Resonance (MR) conditional: magnets can dislocate or generate large artefacts which may result in images which cannot be evaluated. The first issue will be solved with more MR conditional CIs from various CI manufacturers. The importance of the second issue will be reduced by CIs with removable magnets. Magnet removal before MRI can avoid artefacts in the appropriate head areas, magnet dislocations, or other adverse impacts, such as reversal of internal magnet polarity or other magnet-related device failures [5,6].

Although cases of unilateral CI magnet removal prior to MRI have been reported [7,8], the present paper is the first, to the best of our knowledge, to report on CI magnet removal before MRI 1) bilaterally on a young child and 2) on CIs of this magnet design, which is different than that of the CIs in previous papers, and therefore necessitates a different approach. Additionally, it compares for the first time the imaging effect of bilateral magnet removal on MRI in vivo.

2. Case report

The subject was a 23-month-old male bilateral CI user (MED-EL SYNCHRONY with removable magnets) who was presented at our clinic with spontaneous hydrocephalus.

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Hearing loss was detected at newborn-screening. The etiology is assumed to be hereditary because his older sister is also bilaterally deaf. After an unsuccessful hearing aid trial, he was sequentially bilaterally implanted (MED-EL SYNCHRONY FLEX28, right side at the age of 8 months, left side at the age of 11 months) without perioperative complications. The first fitting of the CIs after implantation was successfully performed and the subject showed obvious acoustically evoked reactions. More than one year after CI implantation, the subject developed spontaneous hydrocephalus, which was treated by inserting a shunt. Although cranial computed tomography was performed, the cause of the hydrocephalus could not be determined. The pediatrician and neurosurgeons therefore decided to perform a cranial MRI to check for stenosis of the cerebral aqueduct.

The MRI was conducted under general anesthesia with the CIs (and their magnets) in place. Fixation was supported via a head bandage. The resulting MR images were not diagnostically useful due to artefacts in the appropriate brain region (see Figs. 1 and 2). It was therefore decided to surgically remove both of the magnets during the same procedure and replace them with non-magnetic placeholder dummies to avoid these artefacts. A second MRI was performed directly afterwards.

Magnet removal was performed on the right side first. After sterilizing the skin, a cut was made at the rear edge of the implant close to the shunt (Fig. 3). The position of the implant coil and magnet were identified by placing an external coil over the implant. The incision was made in a distance of 1 cm from the external coil. Additionally in this case, as in most children, it was possible to palpate the rear edge because of the very thin skin of the skull. Magnet removal surgery with non-magnetic dummy placement and wound dressing by sewing took 40 minutes. The same procedure was performed on the left side, where no shunt was located, and took 25 minutes (Fig. 4). Upon wound closure, the MRI was performed.

The dummy magnets were in place for about 1 hour and 30 minutes. After sterilization, the wound was reopened, first on the right side. Replacing the dummy magnet with the new sterile magnet and closing the wound with final sutures took about 20 minutes. The same procedure was performed for the left side and in the same time.

The total surgical time for removing both original magnets, replacing them with dummy magnets, and replacing the dummy magnets with the new sterile magnets was 1 hour and 45 minutes, if the time for MRI performance is included, the total time was 3 hours and 15 minutes. In both ears, the appropriate tools for magnet removal and magnet insertion enabled unproblematic removal/insertion (Fig. 5). Also, there were no problems regarding the volume of blood loss: local anesthesia was injected with adrenaline which helped to reduce bleeding. No adverse reactions were observed.

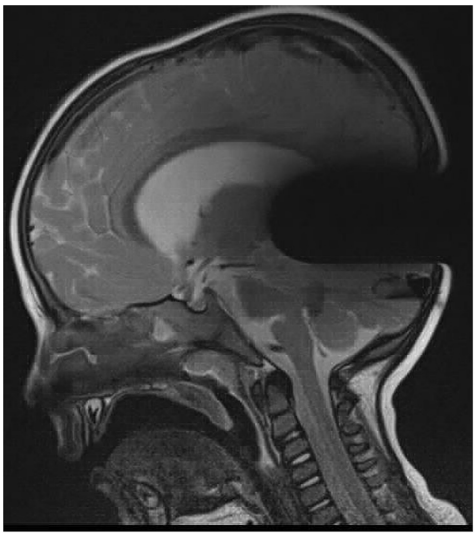

Fig. 2. MRI T2 TSE Sequence sagittal with magnets in place showing artefacts in the implant area resulting in distortions and signal voids.

After surgery, no wound problems on left side appeared. On right side above the implant, the subject had pressure-sensitive swelling, which was resolved after one week.

The MR images taken when the dummy magnets were in place clearly showed less artefact than the images taken with the normal implant magnets in place (compare Figs. 1 and 6). The residual artefact was due to metallic parts of CI. The images taken with the dummy magnet had only a small residual artefact and were diagnostically useful: a tumor was precluded as the cause for hydrocephalus. An arachnoidal cyst, which lead to agglutination and precluded the lymphatic flow from draining in the third ventricle

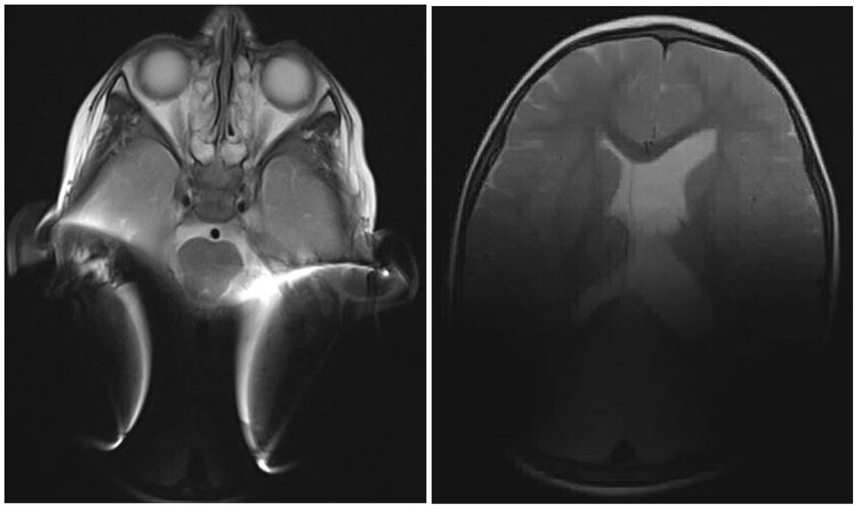

Fig. 1. MRI T2 TSE Sequence axial with bilateral CIs with magnets in place showing artefacts resulting in distortions and signal voids in the implant area on both sides.