B0 SHIMMING FOR MAGNETIC RESONANCE IMAGING NEAR IMPLANTS

In recent years, there has been a significant increase in the number of individuals with implants in their bodies, ranging from orthopaedic implants to cardiac devices and cochlear implants. These implants play a crucial role in improving patients' quality of life, but they can also present challenges when it comes to magnetic resonance imaging (MRI).

MRI is often essential for post-operative assessment, monitoring of co-morbidities, and evaluation of surrounding tissues. While many modern implants are labeled as MRI-compatible, there remains an inherent issue of magnetic field inhomogeneity near the implant site, causing severe image distortions and hence mis-registration of the spatial data or even worse: complete dephasing of the spins and signal loss, commonly referred to as the "signal blackout" effect. This limitation hinders the ability to obtain high-quality images in close proximity to the implant, limiting diagnostic accuracy and patient care.

One of the most effective way of addressing this challenge is during the MR image acquisition. MRI imaging sequences designed to minimize artifacts near implants can be beneficial solutions. However, there are potential drawbacks associated with these sequences such as prolonged scan time, limited availability and variable efficacy. Alternatively in this white paper, we present an advanced and local shim solution that directly counteracts the

Cochlear, dental and orthopedic implants cause severe susceptibility artifacts in MR images

B0 inhomogeneities introduced in the MRI field by the implant, significantly reducing the artifacts in the MRI images without adding substantial overhead on the scan time.

> “ There are over 400,000 patients with cochlear implants and the rate of cochlear implantation is increasing at 9% per annum” [1]

Innovative Technology

To address the challenges associated with imaging near implants, we present the ***Ersa*** *[2]* local shim solution. These advanced shim coil arrays target the region adjacent to the implant, specifically addressing the magnetic field inhomogeneity and recovering the lost signal.

The *Ersa* system incorporates lightweight, soft pad shim cushions that provide optimal patient comfort while enabling efficient signal recovery. The overhead on the scanning process is minimal, ensuring maximum usability and workflow efficiency.

Ersa soft shim cushion solution

Case Study

To evaluate the effectiveness of the *Ersa* Local Shim Cushions in imaging near implants, **a case study** [3] was conducted using a 3T Philips Ingenia MRI system [4].

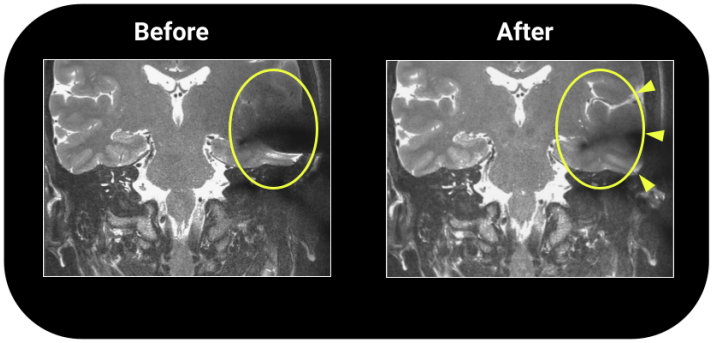
The study focused on imaging near MRI compatible cochlear implants. MRI assessment is often needed after surgery for the assessment of the electrode placement in the inner ear. The cochlear implant had removable external components and self-aligning internal parts. The internal part causes strong local magnetic field around it that interferes with MRI imaging. Local shimming close to the implant was performed using Ersa (cushion-embedded shim coils).

Anatomical images were acquired with a 2D TSE sequence with a TE of 100 ms and an in-plane resolution of 0.3mm x 0.3mm and a slice thickness of 0.9mm.

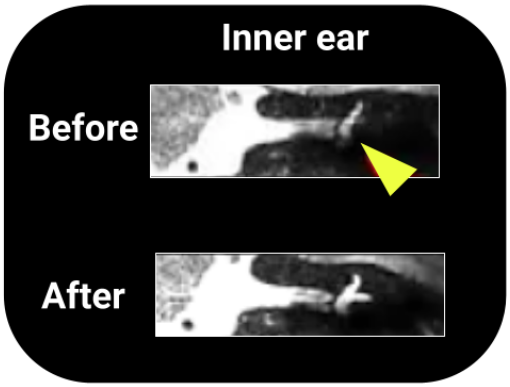
The results of the case study demonstrated significant improvements in imaging quality and signal recovery near the implant. The *Ersa* local shim arrays enabled **more than a 50% reduction** in signal void near the implant, effectively recovering a significant amount of anatomical details. This allows for better visualization and assessment of the anatomical structures near the implant site.

The presence of the implant causes through-plane distortion. So the symmetry between the left side and right side of the inner ear is lost in the Scanner images. This means that the inner ear close to the implant does not show up in its true position. By using the Ersa shim array, the symmetry between left and right is recovered.

Additionally, the MRI images obtained with the *Ersa* system enhanced visibility of the inner ear structures, enabling detailed examination and assessment.



T2-weighted anatomical images with and without the Ersa shim array showcasing the recovery of anatomical details and signal near the implant region



Inner ear structures near the cochlear implant become visible when using the local shim technology

Conclusion

The use of *Ersa* local shim array represents a novel advancement in MR imaging near implants. By specifically targeting the region adjacent to the implant, this innovative solution overcomes the challenges posed by magnetic field inhomogeneity and susceptibility artifacts, allowing for signal recovery and improved image quality.

The case study results highlight the significant benefits of the *Ersa* system in imaging near cochlear implants, providing valuable insights into the inner ear structures.

[1] Srinivasan, R., et al. "A review of the safety of MRI in cochlear implant patients with retained magnets." Clinical Radiology 74.12 (2019): 972-e9.

*[2] **CAUTION**: Not a medical device. Limited by Federal (or United States) law to investigational use.*

[3] Conducted at Uniklinikum Bielefeld

[4] All product and company names are the registered trademarks of their original owners. The use of any trade name or trademark is for identification and reference purposes only.

The local shim systems offered by MR Shim are customizable to any MRI setup or anatomical region. Learn more by visiting our website or contact us today to schedule a meeting

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