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(G) (POS-28) A wireless resonator layer for high-resolution TMJ MRI at 1.5 T

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INTRODUCTION
MRI provides highly detailed images that enable healthcare professionals to assess the joints and surroundings in great detail. While commercial MRI scanners typically come equipped with basic receive coils, such as the head receive array, RF coils tailored for specialized applications like TMJ MRI must be obtained separately. Consequently, TMJ MRI scans often use suboptimal head receive array 1-4 due to the lack of specialized coils.

In this study, we introduce a simple, low-cost, and easy-to-reproduce wireless resonator insert to enhance the quality of TMJ MRI at 1.5 Tesla. The wireless resonator shows a significant improvement in SNR and noticeably better imaging quality compared to the head array alone in both phantom and in vivo images.

METHODS
Figures 1A and 1B show the head neck receive array and a wireless resonator. Figure 1C illustrates the position of wireless resonator for TMJ MRI. Figure 1D depicts the circuit diagram of the wireless resonator which was tuned to 63.67 MHz, the passive detune circuit disables the wireless resonator during the transmit phase, similar to the designs in previous works 5-8 The centers of the wireless resonator pads are aligned with TMJ for optimal imaging performance. The body coil is used for RF transmission, while the head array is employed for RF reception.
We perform multiple tests to assess the performance with and without the wireless resonator inserted into the head array:
• The transmit field (B1+) map and RF power calibration for detuning effectiveness
• Phantom image for SNR measurement
• Volunteer image for clinical evaluation
The wireless resonator operates in receive-only mode, modifying the scanners'default parameter settings is unnecessary
Local board approved human procedures; participant provided written consent. Safety test conducted before imaging9.
RESULTS
Figure 2 compares axial B1+ with and without the wireless resonator insert. The difference between these two B1+ maps is <1%. Additionally, The RF power change for a 180-degree flip angle was under 1.5% with and without the wireless resonator. These affirm that the wireless insert remains highly transparent to RF power during the transmit phase.
In the context of TMJ MRI, where we typically focus on anatomical structures like the articular fossa, articular eminence, and disc, the average depth rarely exceeds 2.5 cm10. The SNR improvement (averaged over the red box in Figures 3C and 3D) achieved with the wireless resonator can reach up to 5.3 times at this depth. the SNR (averaged over the yellow box in Figures 3C and 3D), remains 2.4 times even at a depth of 4 cm.
Figure 4 displays volunteer TMJ images, acquired using multi-slice sagittal T1-weighted and PWD images. Combining the wireless resonator with the head array significantly improves image quality over using the head array alone. This aligns with our phantom study, where the wireless resonator consistently provided higher SNR. To achieve acceptable quality with just the head array, thicker slices or longer scan times are necessary11.

DISCUSSIONS
We chose the head array instead of the body coil as the primary coil for following reasons:
• It offers stronger mutual coupling, higher wireless power transfer efficiency, lower coil loss.

• This choice combines large array coverage with high local SNR, aiding TMJ MRI localization.
• Parallel imaging functionality. In Figure 5, the g-factor computations performed on a phantom with R-L acceleration factors ranging from 2 to 4. The comparison with g-factors obtained from a head array is also provided. The majority of commercially available TMJ coils do not possess parallel imaging capabilities11,12.

Prioritizing safety and comfort, a flexible printed circuit board coil is securely embedded in an MRI-compatible foam pad, which is only 20 mm thick and adaptable to different anatomical shapes. The coil operates exclusively in receive-only mode, avoiding interference with transmit signals and eliminating hotspots. For added safety, a fuse is included in the passive detune circuit in case of malfunction.

CONCLUSION
The combination of wireless RF resonators and phased arrays enhances SNR in specific regions and enables parallel imaging within existing MRI setups.

This approach could prove beneficial for imaging other anatomies, such as the thyroid, eye, and carotid artery. Different wireless RF resonators can also be integrated with diverse receive arrays to acquire extremity, breast, and body images tailored to specific anatomies.

Beyond using L/C resonators for wireless inserts, alternative solutions may involve volume-type wireless resonators or metamaterial-inspired designs 13,14

This advancement ensures affordability, streamlined workflow, and flexibility across different magnetic field strengths.

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Keyword-2

MRI

Keyword-3

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