A 3D Parallel Imaging Capable Transmit and 16-Channel Receive Array Knee Coil at 3T

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Introduction

With rapid development of 3T MRI technology many clinical efforts are transiting to the 3T field. The main advantages of 3T MRI are higher SNR, spatial and temporal resolution. In particular, combined with parallel imaging (PI) techniques, 3T MRI enables high image quality at shorter acquisition times. However, many issues become worse at 3T, such as higher SAR, more prominent pulsation/ flow artifact, etc [1]. For knee imaging at 3T the SAR issue can be minimized using a local transmitter [2][3]. Parallel imaging techniques, such as iPAT, SENSE, etc can also be used at 3T to further reduce SAR issues. Since the artery goes through the knee area and mainly in superior-inferior direction in normal imaging condition, the pulsation/flow artifact may obscure the critical area of the knee image at 3T [1]. Thus, choosing the correct phase-encoding direction with parallel imaging methods may reduce the artifact. An intuitive approach is to introduce the PI capability in all x, y and z directions so that clinical application can have more freedom to use any phase encoding directions with PI for different cases to optimize the images. However, due to dimension and space limitation and complexity of transmit-receive knee coil, the knee coil normally only has x and y direction PI capability and the total number of channels is less than 10 [2][3]. The proposed coil here consists of one cylindrical quadrature-driven (QD) birdcage coil as a local transmitter and two rows of 8-overlapped loop array coils as receiver coils, which are positioned inside the birdcage. The configuration of receiver coils is designed for parallel imaging in all three directions.

Methods

Fig.1(a) and (b) show the outside and inside of the transmit and 16-channel receive array knee coil, and Fig. 2 shows the concept drawings of the receiving loops. The inner diameter of the coil former is about 18 cm and the length of the former is around 23 cm. The transmitter coil is a 12-rung birdcage coil with the length 20cm.The length of each loop is 10 cm. Two rows of the loops provide FOV about 16 cm. The birdcage coil can be switched ON in transmit mode and OFF in receive mode using pin diodes switching circuit. Overlapping and low impedance preamplifiers are used to minimize mutual inductance coupling among all loops in receive mode [4]. The loops are decoupled from the birdcage transmitter coil using decoupling circuits in the transmit mode.

Results and Discussions

This coil was tested on a Siemens MAGNETOM 3T Trio with TIM MRI system. The parallel imaging performance of this coil especially in z direction and the resultant image quality were evaluated against a commercially available 8-channle array coil that has PI capability in x and y direction. Fig. 3 shows the coronal image of the 8-channel array coil in which a phase encoding was in left-right direction. The image shows pulsation/flow artifact which was marked by a red circle. Fig. 4 shows the coronal image of the proposed coil with the phase encoding in z direction and iPAT factor 2. A clear improvement is observed in the red circle marked area. The test results also showed good uniformity and coverage.

Conclusion

A 3D parallel imaging capable transmit and 16-channel receive array knee coil at 3T was built and tested. System tests showed good uniformity, coverage and significant improvement for reducing pulsation/flow artifact enabled by PI techniques in z direction.

Fig. 1 (a) Coil Photo (outside)

Fig. 1 (b) Coil Photo (inside)

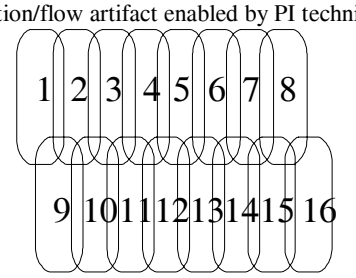

Fig. 2 Two rows of loops

Fig. 3 Coronal image without iPAT in Z direction

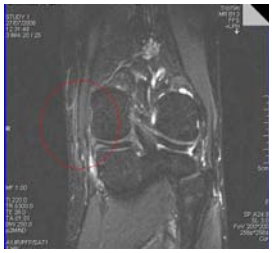

Fig. 4 Coronal image with iPAT factor 2 in Z direction.

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