A Noise Attenuating Device for MR imaging in Infants

W-C. Liu[1], N. Badridze[2], S. Paterson[2], J. Flax[2], S. C. Feldman[1], A. A. Benasich[2]
[1]Radiology, UMDNJ-NJMS, Newark, NJ, United States, [2]CMBN, Rutgers University, Newark, NJ, United States

Introduction

The strong acoustic noise generated from a MR scanner during imaging creates the potential for hearing damage [1,2]. In infants, this damage can be much more severe due to their higher sensory threshold and may remain unrecognized. Clinically, earplugs are used to reduce the noise level. However, the degree of noise reduction is very limited. In our hospital, in collaboration with Rutgers University Infancy Studies Laboratory, we developed a noise-attenuating device, which included earplugs, earmuffs, a foam-core helmet and a body wrap. In this study, the noise reduction of the helmet -earmuff combination was assessed using several standard imaging sequences.

Methods and Materials

(A) Development of the noise attenuating device

In general, the MRI noise is received by the ear through the ear canal and bone conduction through the skull and body. To reduce the noise through ear canal, we used silicone earplugs (McKeon, MI) and earmuffs (MAS). To attenuate bone conductance, we made a helmet from a silicon-based foam (3M) taking into account the specific Noise Reduction Coefficients (NRC) most optimal for the spectrum of auditory frequencies emitted during the specific MR imaging sequences. The helmet has a pair of earmuffs directly attached to the inner surface and a chinstrap to secure it to the subject's head. Another sheet of the same foam (20 x 10 x 2 inches) is used as a body wrap to reduce the vibrations passing through the body.

(B) Assessment

The assessment was performed on a GE 1.5T Echo Speed scanner. An audio microphone was positioned 5 feet away from the bore opening of the magnet with and without the protection of the helmet and earmuffs. The standard imaging sequences for T1, T2, proton density, 3D SPGR for volume and EPI were tested with a ball phantom (diameter of 10 cm) in a Pediatric Array coil (MRI devices). The MRI noises were recorded by a digital audio DAT recorder (SONY, TCD-D7) and analyzed with computer software later (SoundForge).

Results

The noise frequencies emitted from different MR imaging sequences ranged from 400 Hz-22,000Hz. Without helmet protection, the measured noise level ranged from 70 –120dB depending on frequencies and 40 – 80 dB with protection (Figure 1). The net noise reduction was about 30-40 dB.

Conclusion

The helmet-earmuff combination reduced noise levels by ~ 30-40 dB. Together with earplugs, helmet and body wrapping, this novel setting may be able to reduce noise even further (~50dB or above). This device provides significant amount of noise reduction and brings an additional level of safety during pediatric MR imaging.

References

1. Counter et.al, JMRI, 1997, 7(3):606-611
2. Ravicz et. al., J Acoust Soc Am. 2001, 1099(1):216-231

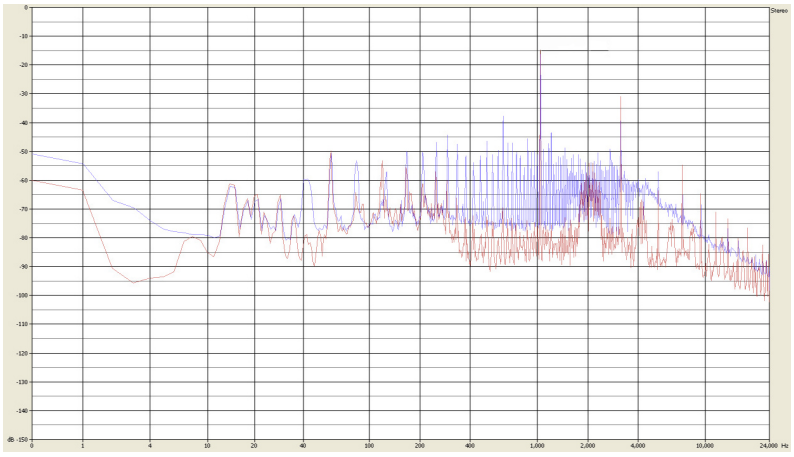

Figure 1. The blue line showed the audio level without the protection and the red line was the received audio level with the protection.