EFFECT OF 3T MRI NOISE ON ADULTS HEARING OBSERVED BY THE DYNAMIC AUDITORY BRAINSTEM RESPONSE TEST

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Target audience MR physicians, MR technician and radiologist

Purpose Magnetic resonance imaging (MRI) as a diagnostic method have been widely clinical application for over twenty years. A prominent disadvantage of MRI is the high level of noise produced during scanning process. The main source of noise during MRI procedure is produced by gradient switch. Despite the progress being made on gradient-coil design and construction, the desperate need for faster MRI techniques made the gradual increase of noise levels in clinical MRI scanning. The noise is not only hazardous for patients but also for operators who have to stay within the scanner room for long periods. It may cause the several adverse effects, such as simple annoyance, anxiety, difficulty in verbal communication, changes in blood pressure and pulse rate, and temporary or permanent hearing threshold shift[1]. P Radomskij[2] et.al proposed that there is a clear effect of MRI noise on cochlear function, despite the use of earplugs. So this study is aimed to explore whether the noise of 3T MRI has an influence on normal adults hearing.

Methods We obtained written informed consent from all participants, and the local ethics committee approved this study. *Subjects*: We performed head MRI to 29 healthy volunteers (aged from 18 to 25 years, mean of 22.28±1.509 years, 11 males, 18 females), Included criteria: All the volunteers passed the auditory brainstem response (ABR) hearing test previously and had neither experience of expose to excessive noise (>90dB) [3] nor wearing microphone for 24h before MRI. Excluded criteria: participants with outer ear deformities, otitis media, tympanic membrane perforation and obviously ear injury, etc. *MRI acquisition*: all the volunteers were weared the sponge earplugs and kept in a quiet state during the MRI scanning. MRI were performed in a 3T scanner (GE, Signa HDxt). The MRI scanning sequence parameters as shown below (Table1). The peak sound pressure level of 3T MRI sequence is range from 118.4 to 130.7 dB[1]. *Hearing testing process*: We performed the ABR audiometry within 24 hours before the MRI examination for the first time, and carry on the second audiometry within 20 minutes after the MRI scanning, Among all the 29 cases, 26 showed a hearing threshold, and we review their hearing in 25 days later. *Hearing test method*: this study used the brainstem evoke potential response instrument (Eclipse, Danish), we applied the button type electrode to put in the forehead, root of the nose, insilateral and contralateral mastoid respectively. All electrode impedance was less than 5000Ω, with a short sound stimulation, the fold stack was 1100, band-pass filter was 100-3000Hz, scan rate was 19.9Hz. Deliver stimulation: the stimulation intensity begin from 80dBnHL, and the intensity decreased at the level of 20 dB. We take the minimum hearing level that can generate V wave as the ABR V wave response threshold, and We regard this level as the hearing threshold of volunteers. All the participants were kept in a quiet state. *Statistical method*: the results were applied Wilcoxon matched-pairs test, SPSS 18. The statistical analysis include result of left and right ear's hearing before and after MRI, left and right ear's hearing before MRI and the review in 25 days later.

Table 1 MRI scanning sequence parameters

scanning sequence	TR (ms)	TE (ms)	FOV (cm)	Matrix	Slice thickness (mm)	Duration (min:sec)
3-Pl Loc	—	—	—	—	—	**00:25**
Asset cal	—	—	—	—	—	**00:06**
3D-T1 FSPGR	Auto	Auto	**24**	Auto	**1**	**05:43**
T2 Prop	**4200**	Auto	**24**	Auto	**4**	**03:22**
DTI	**15000**	Auto	**24**	**172×172**	**2.5**	**09:45**
DKI	**11000**	Auto	**24**	**172×172**	**4**	**21:05**
QSM	Auto	Auto	**22**	**256×256**	**2**	**5:13**
BOLD	**2000**	Auto	**24**	**64×64**	**4**	**06:10**

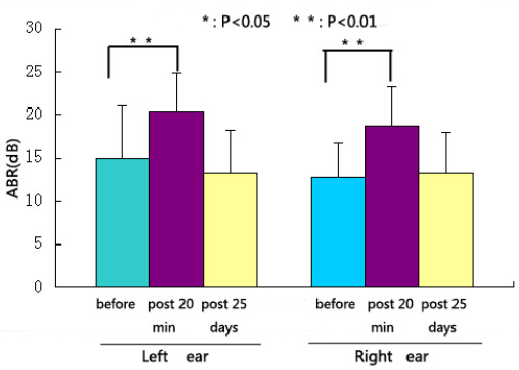

Fig.1 The statistics results of left and right ear

Results ABR hearing test results of 29 volunteers (58ears) before and after head MRI, there was 55% hearing threshold decline with both left and right ears. 10.3% hearing threshold declined in only left ear. 24.1% hearing threshold declined in only right ear. No significant hearing change was found in 10.3% of both ears. The decrease of left ear hearing was as mean of 5±4.528 dB and that of right ear hearing was as mean of 5±4.418 dB. Among 26 cases review in 25 days later, the left ear hearing threshold was 12.5±4.88 dB and the right ear hearing threshold was 12.5± 4.707 dB. There was significant difference of left and right ear hearing between before and 20 minutes after MRI ($p<0.01$) and no significant difference of both ear hearing between before MRI and the review in 25 days later. The statistics results were as shown in the Fig.1.

Discussion The impact of MRI noise on human hearing mainly depends on its time of duration, intensity, frequency, and the individual different sensibility[2]. The previous study had used the OAEs method to obtain the mean change as the OAE amplitude with 1.84 dB in participants undergoing MRI. Despite the use of earplugs, the changes in OAEs showed a clear effect of MRI noise on cochlear function[1]. But the study did not implement the follow up hearing test. In this study, ABR method was performed in succession as before MRI, 20 minutes after MRI and review in 25 days later. There was a hearing recover with different extend in almost all participants.

Conclusion The noise lasted close to 1 hour from 3T MRI scanning has a transient effect on adults hearing.

References 1. Mollasadeghi A, Mehrparvar AH, Atighechi S, et.al. Case Rep Radiol. Sensorineural Hearing Loss after Magnetic Resonance Imaging. 2013; 2013:510258. doi: 10.1155/2013/510258. Epub 2013 Jun 17. 2. P. Radomskij, M. A. Schmidt, C. W. Heron, and D. Prasher, "Effect of MRI noise on cochlear function," The Lancet, vol. 359, no.9316,pp.1485–1486,2002.3. M. McJury and F. G. Shellock, "Auditory noise associated with MR procedures: a review," Journal of Magnetic Resonance Imaging,vol.12,pp.37–45,2000.