Acoustic noise

The interaction of the static magnetic field with the imaging gradient fields during scanning results in the generation of substantial Lorentz forces, which in turn causes the gradient coils to flex creating acoustic noise.

These Lorentz forces are proportional to both the static magnetic field and to the gradient rise time. Higher field strength magnets and high-performance gradient systems therefore tend to produce greater levels of acoustic noise. Additionally, sequences which require higher gradient switching (e.g., high receiver bandwidth, high spatial resolution) as well as sequences which require large and frequent gradient changes (e.g., long echo train length, short echo spacings, short repetition times), will also have higher acoustic noise.

Typically echo planar imaging (EPI) sequences used in techniques such as diffusion weighted imaging (DWI) and perfusion imaging and functional MRI have the highest acoustic noise. High-resolution gradient echo or fast spin echo imaging, can also create high acoustic noise. Conversely, MRI manufacturers may offer options or sequences with slower gradient rise times, and the operator should be familiar with these. Sequences which avoid the use of hard gradient switching, producing minimal acoustic noise, are also available but typically have limited flexibility (e.g., 3D-T1w only).

Acoustic noise is measured in decibels, which is a logarithmic scale – an increase of 6 dB represents a doubling of the sound pressure. Typically, a weighting, to correct for frequency sensitivity is applied – most frequently the “A” weighting is used, and acoustic noise is reported in dB(A). Typical clinical MRI noise levels vary between approximately 80 and 100 dB(A).

Health effects and protection

Exposure to loud noise may be uncomfortable and may contribute to stress, anxiety, claustrophobia and patient movement. Sensitivity to noise may be greater for patients with hearing conditions, (e.g., tinnitus, recruitment or hypersensitivity) as well as learning difficulties and autism.

Temporary hearing impairment (threshold shift) can occur from exposure to loud sound and may be associated with tinnitus. Incidents of temporary threshold shift or tinnitus in staff, carers and patients have been reported to the MHRA after exposure to MR noise without ear protection. Permanent threshold shift can occur after exposure to extremely loud sounds, but the levels required are significantly above typical MRI.

The MHRA guidelines recommend that hearing protection always be provided for patients and volunteers unless it can be demonstrated that noise levels will not exceed 80 dB(A). Neonatal, paediatric and anaesthetised patients require greater caution and should always have hearing protection. Improper fit can impair the performance of hearing protection, therefore fit and function of hearing protection should always be verified. Special equipment may be needed for children and neonates.

Staff present in the scan room during scanning will also be exposed to noise. Occupational exposure is regulated by the Control of Noise at Work Regulations (2005). If the daily or weekly average noise exposure reaches 85 dB(A) then hearing protection must be provided to the employee.

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