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Magnetic field interactions in adjustable hydrocephalus shunts

Laboratory investigation

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Object. Exposing patients with ventricular shunts to magnetic fields and MR imaging procedures poses a significant risk of unintentional changes in shunt settings. Shunt valves can also generate considerable imaging artifacts. The purpose of this study was to determine the magnetic field safety and MR imaging compatibility of 5 adjustable models of hydrocephalus shunts.

Methods. The Codman Hakim (regular and with SiphonGuard), Miethke ProGAV, Medtronic Strata, Sophysa Sophy and Polaris programmable valves were tested in a low-intensity magnetic field, and then translational attraction (TA), magnetic torque (MT), and volume of artifacts on T1-weighted spin echo (SE) and gradient echo (GE) pulse sequences in a 3-T MR imaging unit were measured.

Results. The ProGAV and Polaris valves were immune to unintentional reprogramming by magnetic fields up to 3 T. Other valves randomly changed settings, starting from the intensity of field: Sophy valve 24 mT, Strata valve 30 mT, and both Codman Hakim programmable valves from 42 mT. Shunt performances in the 3-T MR imaging unit are reported in the order of compatibility: 1) Codman Hakim regular, TA = 0.005 N, MT = 0.000 Nm, GE = 30 cm^3, SE = 2 cm^3; 2) Miethke ProGAV, TA = 0.001 N, MT = 1.4×10^{-3} Nm, GE = 231 cm^3, SE = 13 cm^3; 3) Codman Hakim with SiphonGuard, TA = 0.005 N, MT = 2.3×10^{-3} Nm, GE = 233 cm^3, SE = 19 cm^3; 4) Medtronic Strata, TA = 0.27 N, MT = 18.0×10^{-3} Nm, GE = 484 cm^3, SE = 86 cm^3; 5) Sophysa Sophy, TA = 0.82 N, MT = 38.9×10^{-3} Nm, GE = 758 cm^3, SE = 72 cm^3; and 6) Sophysa Polaris, TA = 0.80 N, MT = 39.6×10^{-3} Nm, GE = 954 cm^3, SE = 100 cm^3.

Conclusions. All valves, with the exception of the Polaris and ProGAV models, are prone to unintentional reprogramming when exposed to heterogeneous magnetic fields stronger than 40 mT. All tested valves can be considered safe for 3-T MR imaging. All valves generated a distortion of the MR image, especially the GE sequences.
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KEY WORDS • **hydrocephalus** • **magnetic field** • **magnetic resonance imaging** • **safety** • **shunt**