Effects of static magnetic field strength on heart rate

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Introduction

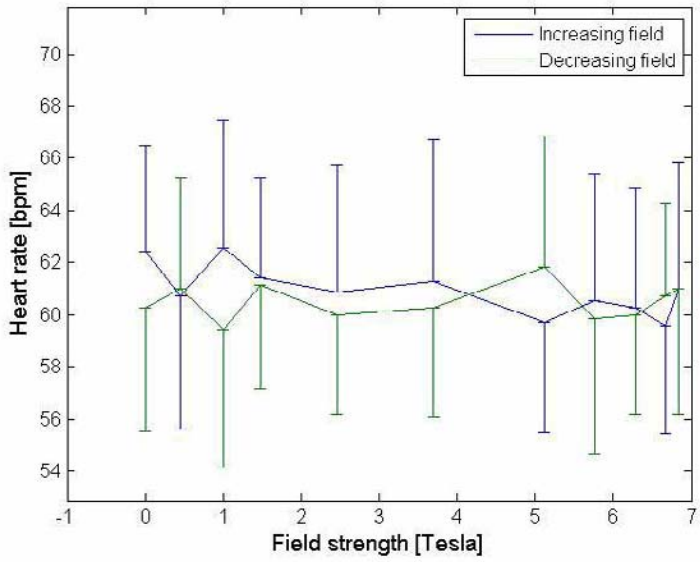
Human imaging at 7T is generally not believed to present health hazards because of exposure to the main static magnetic field. Several centers with experience of imaging at 7T have reported lack of physiological effects, including failure to observe cardiovascular changes, by comparing vital signs before, during and after exposure to magnetic fields. However, we were stimulated to perform a specific study of possible effects of exposure to high magnetic fields on heart rate because of anecdotal reports that significant effects had been seen in subjects subjected to MR scanning. Our preliminary study supports the previous work that such effects are not measureable.

Methods

Seven healthy male volunteers participated in the study. The patient bed for a Philips Achieva 7 Tesla scanner was detached from the scanner and rolled out of the magnet room to a position where the fringe field was negligible. Each subject was asked to lie supine on the bed. Heart rate was measured with the SpO2 probe of a patient monitor (InVivo Research 3150). The bed was then moved to a new station closer to the magnet. After 30 to 60 seconds in the new location, subject heart rate was recorded again (the delay was introduced to accommodate transient increases in cardiac rate that sometimes accompanied bed movement). Fifteen stations were used, ranging in field strength over 4 orders of magnitude, from approximately 7 Gauss to more than 6.8 Tesla at the position of the xyphoid. Field strengths at each station were obtained via cubic interpolation from known values from a site field plot. The measurements were repeated in the opposite order bringing the subject out of the scanner back to the first station (to control for possible anticipatory or other time dependent effects).

Results

Figure 1 shows the mean heart rate as a function of field strength. Error bars represent the standard deviation across subjects. The blue line shows the results as subjects were moved toward higher fields (i.e., toward the magnet) while the green line shows data from the return trip to low fields. A one-way ANOVA revealed no effect of field strength on heart rate ($p>0.99$).



Conclusions

Exposing human subjects to high magnetic fields demands some prudence because there are no clear thresholds of exposure below which biological effects can be positively ruled out. There are theoretical effects on the cardiovascular system such as magneto-hydrodynamic changes in electrical potentials, but we found no significant change in heart rate in our study, in agreement with the results of Chakeres et al (1). Anecdotal reports of changes seen elsewhere in heart rate caused by static magnetic fields are not consistent with our experimental results.

References

1. Chakeres DW, Kangarlu A, Boudoulas H, and Young DC. *J Magn Reson Imaging* 18: 346-352 (2003).