Purpose:
Irregular motion results in poor image quality, radiation targeting and tumor control. The aim of this study is to develop a novel respiratory motion control system using visual biofeedback combined with MRI and to demonstrate reduced respiratory motion artifacts and increase respiratory gating efficiency in MRI using the system.

Methods:
A visual biofeedback system has been combined with an MRI respiratory bellows belt at a 1.5T G.E. MRI system and at a 3T G.E. MRI system. The visual biofeedback system utilized (1) the external position information of the abdomen using an MR respiratory bellows belt to visually guide a patient's regular breathing within the magnet and (2) a respiratory gated Fast Spin Echo MR pulse sequence for MRI. The feasibility of respiratory motion control using the visual biofeedback within the MRI system has been tested in four volunteer studies without MRI scanning. Two MRI studies have been performed for image quality evaluation with/without the visual biofeedback system. All studies included a free breathing and a visual biofeedback breathing in a same day.

Results:
By using the visual biofeedback system with an MRI respiratory bellows belt, the respiratory motion reproducibility has been increased. Average RMSE (root mean square error) of breathing period has been reduced from 0.69s for free breathing to 0.38s for visual biofeedback breathing, while average RMSE of displacement changes insignificantly from 0.50cm of free breathing to 0.49cm of visual biofeedback breathing. In the obtained MR images, the image using visual biofeedback shows significant reduction of motion artefacts but respiratory gating efficiency improvement is insignificant with healthy volunteers.

Conclusions:
The study demonstrated the feasibility of respiratory motion control using visual biofeedback within the MRI system. This technique provides clinically applicable motion control in MRI scanning and improved MR image quality.