

The Relation Between Anticipatory Anxiety and Movement During an MR Examination

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Rationale and Objectives: During a magnetic resonance imaging (MRI) examination, patients are required to remain still to minimize motion that may compromise image quality and may make rescanning necessary. It is often assumed that anxiety, which is experienced by a considerable number of patients undergoing an MR examination, increases motion and decreases image quality. The present study explores the relationship between anxiety and movement of patients during an MR examination.

Materials and Methods: Anxiety was measured subjectively by means of the State Anxiety Inventory and a visual analogue scale for claustrophobia. Motion and image quality were measured in three different ways. First, software was used that allows an estimation of motion based on tracker scans between the clinical scans. Second, the MRI technician who performed the MR examination was asked to indicate the degree of motion artifacts and image quality for each patient. Third, after all scans had been collected, two radiologists evaluated each clinical scan.

Results: No or low correlations between anxiety and the distinct measures of motion and image quality were found for all three measures.

Conclusions: This finding shows that there is little evidence for the assumption that anxiety increases motion and decreases image quality during an MR examination.

Key Words: Anxiety; MRI; body movement; motion artifacts; image quality.

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Magnetic resonance imaging (MRI) is an important and widely used diagnostic tool in clinical practice. Unfortunately, MR examinations are associated with anxiety reactions in many patients. Studies have consistently shown that more than one third of patients undergoing an MR examination experience anxiety (1–4) and that approximately 15% of patients require sedation to be able to tolerate the examination (2,3,5). Besides concerns about the diagnosis, causes of anxiety include the length of the procedure and the loud noise of the scanner (1,2,6–8). In addition, anxiety may be because of the narrowness of the bore and associated movement restrictions (2,8). Having to remain still is often reported as the most unpleasant aspect of an MR examination (1,9).

Remaining still during an MR examination is necessary because body movement can reduce image quality and may consequently decrease diagnostic utility. In addition, degraded image quality may make it necessary to repeat a scan which increases examination time and consumes expensive resources. It has been reported that motion artifacts that impair diagnostic quality occur in up to 7% of all MR examinations (9–11).

It is often assumed that anxiety increases motion and consequently decreases image quality (3,12,13). This assumption may be based on the intuitive belief that anxiety interferes with an individual's ability to exert full control over his body movement. However, the few studies that have explored the relation between anxiety and motion artifacts during an MR examination have not found a correlation (6,9). In these studies, motion artifacts were either measured by asking radiologists to evaluate the clinical scans (9) or by software that detected the amount of motion artifacts across a scan after the clinical scans had been collected (6). It is possible that the clinical scans that were evaluated in terms of motion artifacts and image quality in these studies contained very few motion artifacts as MRI technicians had redone scans that had motion artifacts. This may explain why no correlation between anxiety and motion artifacts has been found in previous studies.

Research exploring the effect of anxiety on physiological responses more generally rather than in the specific context

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of an MR examination has shown that there is a correlation between muscle tension and anxiety (14–16) and that anxiety increases body movement (17). An increase in body movement due to anxiety can be explained by attentional control theory (18). Anxiety consumes attentional resources which impairs an individual's capacity to perform other tasks. In the context of an MR examination, anxiety may impair the patient from spending resources on remaining still. From a biological perspective, anxiety activates the sympathetic nervous system which prepares a fight or flight response. Epinephrine is released which increases heart rate, causes vasodilation in muscles, and leads to increased muscle tension to facilitate rapid mobilization (19).

Based on these insights, we hypothesize that anxiety increases body movement during an MR examination and consequently decreases the quality of the clinical images. The aim of the present study was to explore the link between anxiety and body movement as well as between anxiety and image quality. Motion and image quality were measured in three different ways to overcome limitations of previous studies. First, image analysis software that tracks body position was used to determine the degree of movement between individual clinical scans to get an overall indication of body movement during the entire MR examination. Second, MRI technicians indicated the number of retakes and the overall degree of motion artifacts and image quality during image acquisition. Third, after the clinical scans had been collected, two radiologists evaluated the clinical scans in terms of motion artifacts and image quality.

MATERIAL AND METHODS

The study was conducted at a diagnostic center which specializes in MR examinations of claustrophobic patients. The MRI room at the diagnostic center is equipped with a Panorama 1.0 T open MRI scanner (Philips Medical Systems, Best, the Netherlands). Most patients who are scheduled for an examination in the open MRI scanner are highly claustrophobic and are referred to the diagnostic center because they are claustrophobic or failed to complete an MRI scan in a different hospital in the past. The study was approved by the medical ethics committee.

Only patients older than 18 years were included in the study. In addition, only patients who had an MRI scan of the head were included because the software that was developed to measure movement was only available for scans of the head. All patients provided informed consent before their participation in the study.

SUBJECTS

A total of 39 (16 men and 23 women) outpatients with a mean age of 53 years (standard deviation [SD], 12 years) participated in the study. The present study was part of a larger study exploring different aspects of patient experience. This study

included 161 patients. Because the image analysis software that was used to measure motion was only available for scans of the head, only patients who had a scan of the head were involved in the present study. Moreover, motion tracker scans were only available for 39 of the 44 patients who had a head scan, so only these 39 patients were included in the present study. Patients who had a scan of the head [$M = 56.2$ {SD, 13.5}] had a significantly higher score on the State Anxiety Inventory before the MR examination than patients who had a scan of another body part [$M = 51.1$ {SD, 13.7}, $t(159) = 2.12$, $P = .036$]. Because only patients who had an MRI scan of the head were included in the study, all patients had a head-first examination, and for all patients, a head coil was used.

MEASURES

Anxiety

Anxiety was measured subjectively by means of the shortened 8-item Dutch translation of the State and Trait Anxiety Inventory (STAI) (20–24). Both state and trait anxiety levels were measured. The STAI is one of the most widely used instruments to measure anxiety in both clinical and research settings, and studies that have measured MRI-related anxiety have typically used the STAI (2,4,8,9,12,25). State anxiety (STAI_s) refers to the intensity of anxiety experienced in reaction to a specific event at a given time, characterized by subjective feelings of tension, apprehension, nervousness, and worry. Trait anxiety (STAI_t) refers to a more general and long-standing type of anxiety and reflects a person's continual tendency to react with state anxiety. Scores on both the STAI_s and the STAI_t were converted to the 20-item version to be able to compare scores to findings of other studies. Hence, scores can range between 20 and 80 with higher scores indicating a higher level of anxiety.

In addition to measuring STAI_s and STAI_t, claustrophobia was measured by means of a visual analogue scale (VAS) with “not at all” and “very much” as anchor points. Patients were instructed to place a mark on the 100-mm VAS corresponding to the amount of claustrophobia they experienced.

Motion Artifacts and Image Quality

Motion Tracker. To measure motion, image analysis software was used that allows the tracking of motion of the patient's head. The software has been developed by Philips Research Laboratories Europe specifically for the purpose of measuring body movement during an MR examination. The tracking was done by inserting motion tracker scans in the regular scan sequence and measuring differences in head position between clinical scans. A motion tracker scan was inserted before the first clinical scan and after every subsequent clinical scan to record the position of the head. Acquisition of a motion tracker scan took about 0.6 seconds. Because clinical scans of the head typically lasted between 2 and 8 minutes, a motion tracker scan was made every 2 to 8 minutes.

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