Using respiratory biofeedback games in pediatric MRI examinations to increase patient comfort and facilitate scanning – a pilot study

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Introduction

MRI examinations of pediatric patients can be challenging for several reasons, particularly because many children have difficulties in lying still, especially at younger ages. For some children the MRI examination can also feel uncomfortable or even frightening. The aim of this work is to alleviate the experience for children by introducing in respiratory controlled sequences a biofeedback game in which the child can focus on controlling the flight of a plane through his/her breathing. As a result of playing the game, the breathing pattern is also expected to become smoother with a more regular end-expiratory position, leading to more efficient and thus shorter examinations.

Method

A respiratory biofeedback game has been especially designed for pediatric patients (Figure 1). In the game, the altitude of a plane is controlled by the diaphragm position of the patient. The diaphragm position, measured through standard navigator echoes or a respiratory belt, is continuously, with a latency of less than 100 ms, transmitted to an external computer running the game. After a few respiratory cycles, a series of hoops appears at the end-expiratory position, as calculated by the software to be a suitable position for the patient. The hoops change colour when the plane (diaphragm) is within this range, visually guiding the child's breathing. In this particular example, the respiratory biofeedback was included in an ordinary scan of the lower abdomen, on a Philips Achieva 1.5T MRI scanner, with the given consent of both patient (11y), and guardians. Before the exam the patient was briefly instructed on how the game works and told to relax and breathe normally.

Figure 1: Screen shot from biofeedback game

Results

As part of a routine examination of the lower abdomen, a triggered sequence was run with the biofeedback game, followed by a sequence without biofeedback. The breathing pattern was logged for both sequences. During the game the patient quickly learned how to steer the plane through the hoops, the resulting breathing pattern is shown in Figure 2. When compared to the breathing pattern without biofeedback, shown in Figure 3, the breathing looks much more stable and regular.

The resultant image, when using biofeedback, is shown in Figure 4. A smooth and regular breathing is preferable during scanning as the breathing pattern has significant impact on image quality and scan efficiency, particularly in cardiac and abdominal scans. Given a task to focus on the children are also less likely to move during scanning leading to less motion artifacts, and resulting in overall improved image quality. Of equal importance, however, is the effect on the patient experience. At one point the biofeedback sequence was paused to ask the patient if the game should be removed, but the patient was most adamant that the game should remain.
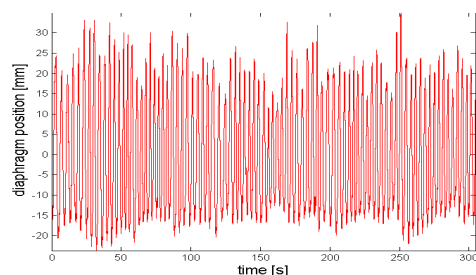

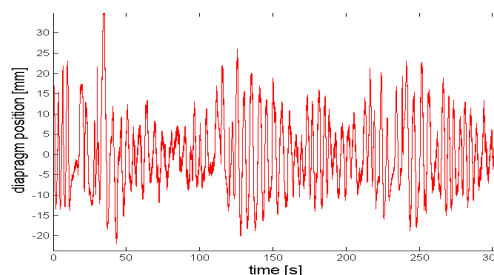**Figure 2: Breathing pattern with biofeedback**

Figure 3: Breathing pattern without biofeedback

Figure 4: Image acquired with the respiratory biofeedback on

Conclusions

As the biofeedback game presented here results in improved breathing profiles, this particular direction of work is very promising. Using respiratory biofeedback in pediatric MRI examinations shows a great deal of potential, both regarding improved image quality and faster scan times but also, and perhaps more importantly, in increased patient comfort since the patient can focus on the game during the examination.