Preliminary results of early detection of baseball elbow using low field magnetic resonance imaging specialized for small joints

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Introduction

Patients with baseball elbow and shoulder can return to play earlier if the disease is detected early. Therefore, medical check-ups have started in Japan in recent years. The main method for early detection of baseball elbow is ultrasonography (US) (1-3). US is a simple and quick procedure and is an excellent screening method with a low level of X-ray exposure. However, the results depend on the skill of the sonographer and therefore repeatability may not always be sufficiently high (4, 5).

In contrast, MRI has no X-ray exposure, high repeatability, and high objectivity. The usefulness of MRI for diagnosing baseball elbow has been reported by several studies (6-8). However, the MRI scanner is very expensive, and high magnetic field MRI, which is now used worldwide, has limitations in certain settings. For the examination, patients must enter a large cylindrical shaped coil, and therefore those with claustrophobia may not be able to tolerate the procedure. The scan may also be very stressful psychologically for elementary school boys and girls, irrespective of whether or not they are claustrophobic (9, 10). As a consequence of these reasons, screening for baseball elbow elementary school boys and girls using MRI at hospitals is unrealistic.

However, our institution owns a low magnetic field (0.2T) MRI specialized for examination of small joints of the upper and lower extremities. Because of the low magnetic field, there are no limitations on its location and the machine can be set up in standard research rooms without any additional construction. Moreover, the patient does not need to enter the large cylindrical coil because the machine is specialized for small joints. Patients just insert their dominant upper extremity into the compacted coil, with their body positioned mainly on the bed. The subjects can therefore talk with their parents or examiner during the examination, which may relieve psychological stress.

We considered that this low magnetic field MRI specialized for small joints was suitable for performing MRI screening of elementary baseball players. The purpose of this paper is to present the preliminary results of screening for baseball elbow using a low magnetic field MRI specialized for small joint of the extremities.

Figure 1A 11-yr-old girl having an MRI check-up for baseball elbow using a 0.2 T low magnetic field machine. Her body is positioned mainly on the bed and her left arm is inserted in the MRI machine.
For small subjects like this girl, we place a "yoga-mat" (pink) under the back to support the body naturally. This allows the subject to insert her arm deep into the machine

Materials & Methods

The Ethics Committee of our institution approved the study and associated survey. The study was performed between June-October 2014 (5 months) using a 0.2 T MRI C-SCAN (Italy). The subjects were active baseball players in the 4th - 6th sixth grades of elementary school. To recruit the subjects we sent invitations by email to the managers of the teams in our city, and 62 (59 males and 3 females) players accepted the invitation to participate in the study. We obtained written, informed consent from the parent(s) of all the subjects for their participation in the study.

Actual scan parameters are; a) Gradient echo coronal: TR=500msec TE=18msec Slice Thikness=3mm Matrix 256*192 Fov 180*180 FA=75 Scan time=1min39sec3 mm thickness, 11 slices, 1 min 40 s. b) Gradient echo with short TI inversion recovery (STIR) coronal: TR=1000 TE=25 Thikness=3mm matrix=256*192 Fov=180*180 FA=90 inversion time=803 mm thickness, 11 slices, 3 min 35 s. c) Gradient echo sagittal: 4.5 mm thickness, 11 slices, 1 min 40 s

Figure 1 shows a scan image. Images of the scan on the monitor were used for diagnosis that was carried out by one medical doctor specialized in orthopedics. Immediately after the scan, the doctor explained the MRI findings to the players and parent(s).

Figure 2 Normal MRI elbow images of an11-yr-old boy. A gradient echo coronal image can be obtained and mainly shows the anatomical structures around the elbow (left).
A gradient echo with a STIR image can be obtained of an abnormal site. These are scanned in the same plane (right). (MCL, arrows)

Results & Discussion

All 62 subjects completed the routine MRI examination successfully with no case of motion artifact that prevented diagnosis. A series of normal MRI images are shown in Figure 2.

Of the 62 players, 28 (45.2%) had positive findings on MRI that included 27 MCL injuries without avulsion fracture, and 1 edema of the olecranon. There were no cases of osteochondritis dissecans or epicondylar fragmentation. The prevalence of positive findings was 63.0% in the 27 pitchers and 31.4% in the 34 non-pitchers. This difference was statistically significant (P=0.014; Mann-Whitney u test). The findings associated with MCL injury were swelling, deflection, fluff, fraying, and a high signal in or around the ligament on STIR (Figure 3).

Although there are no previous data the very high positive rate of 45.2% we observed was unexpected. Harada et al. reported data on screening using US in 2006 (1) that showed 35 of 135 players (22.9%) had positive results. Watanabe et al. also carried out an US study on Japanese subjects in 2001 and showed that 89 of 316 (28.3%) players had injuries (3). However, these studies reported that players with positive results had damage to bone. According to the preliminary results of Harada's group, 33 positive players had epicondylar fragmentation, while 2 had early-stage osteochondritis dissescans (1). In contrast no subject was found to have bone damage in our study.

It is possible that spatial resolution of MRI is poorer than that of US. However there are numerous reports showing that early detection of bone damage, such as stress fractures or early osteochondritis dissescans that cannot be detected by radiography can be seen clearly on MRI scans (8-10). We hypothesized that the differences between the two methods may be due to differences in the subject groups or playing conditions (i.e. number of rubber baseball player, or season of scanning). However, the actual reason for the differences between the two procedures remains unknown.

Our finding of MCL injuries without avulsion, which occurs after union of the ethepiphyseal plate, is a new insight on baseball elbow.

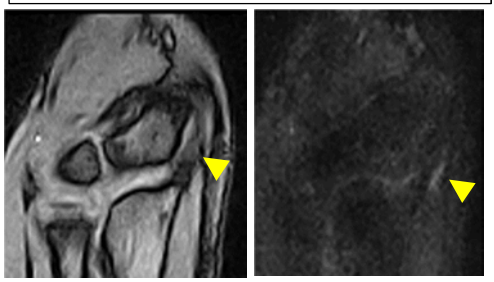

Figure 3 MCL injury of 12-yr-old boy. MCL is markedly swelled (left) with elevation of signal intensity in the ligament (arrowheads).
On STIR (right), abnormal high intensity surrounding MCL is also observed (arrowheads).

Conclusion

Low magnetic field MRI specialized for small joints was very useful for early detection of baseball elbow.

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