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Validity of radial magnetic resonance imaging to determine the extent of Bankart lesions☆,☆☆,☆☆☆,☆☆☆☆

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A R T I C L E I N F O

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A B S T R A C T

Purpose: The objectives were to compare conventional oblique coronal and axial images with radial images to determine the capacities of these modalities for visualizing sites in the glenoid labrum.
Materials and methods: The glenoid labra of 45 patients without a labrum injury and 30 patients with Bankart lesions were examined by magnetic resonance imaging using three different sections.
Results: The radial images permitted a greater range of assessment of the morphology of the glenoid labrum than the conventional images.
Conclusion: Radial magnetic resonance imaging is a useful method for evaluation of the glenoid labrum and enables wider visualization than conventional methods.

1. Introduction

The glenoid labrum frequently sustains injuries caused by sports trauma or other accidents. Representative labrum injuries include superior labrum anterior and posterior (SLAP) lesions and anteroinferior glenoid labrum injuries associated with traumatic shoulder dislocation (i.e., Bankart lesion). These lesions frequently cause discomfort to patients due to pain, impingement, and instability, and surgical treatment is occasionally required. Symptoms vary based on the site and the type of glenoid labrum injury. The surgical method selected for treatment depends on the extent and type of the lesion.

Preoperative magnetic resonance imaging (MRI) can provide useful information about the site and type of a labrum injury. In recent years, the use of MRI instruments with a high magnetic field and magnetic resonance (MR) arthrography has improved diagnostic accuracy [1–6]; however, some sites of the labrum are difficult to assess using these conventional imaging methods [7–9]. Therefore, the assessment of the extent of an injury has been insufficient. Preoperative assessments to determine the extent of a labrum injury would enable more accurate surgical planning [10]. Since March 2011, in addition to conventional oblique coronal and axial imaging methods (i.e., conventional MRI), we have used radial cross-sections (i.e., radial MRI) obtained using a 3.0 T MR instrument to assess patients with rotator cuff injuries [11]. Radial MRI may offer a good option for assessing the glenoid labrum, which is circumferentially in contact with the glenoid margin. To confirm this hypothesis, the capacities of conventional and radial MRI for the visualization of normal and injured anterior glenoid labra are compared in this report. Moreover, arthroscopic findings are compared with these MRI methods for assessing the extent of Bankart lesions. The purpose of this study was to determine the usefulness of radial MRI for evaluating the anterior glenoid labrum in comparison with conventional MRI.

2. Materials and methods

2.1. Patients without a labrum injury

The group of patients without a labrum injury included 45 individuals (representing 45 shoulders) who underwent MRI and arthroscopy for the repair of rotator cuff injuries between August 2011 and April 2014. These 45 patients included 24 men and 21 women with a mean age of 58.8 years (age range 35–75 years). Patients in this group were diagnosed by MRI as having rotator cuff injuries. Arthroscopy

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demonstrated no findings of injury to the glenoid labrum. The exclusion criteria were as follows: (1) SLAP lesions, (2) previous shoulder surgery on the affected shoulder, and (3) glenohumeral arthritis or inflammatory arthropathy of the affected shoulder. Seven patients were excluded according to these criteria.

2.2. Patients with a labrum injury

The group of patients with a labrum injury included 30 individuals (representing 30 shoulders) who underwent Bankart repair via arthroscopy between August 2011 and September 2014. These 30 patients included 20 men and 10 women with a mean age of 25.2 years (age range, 14–62 years). Patients in this group were diagnosed by MRI as having anteroinferior glenoid labrum injuries. The arthroscopic findings of these individuals demonstrated anteroinferior glenoid labrum lesions. The exclusion criteria were as follows: (1) a previous shoulder surgery on the affected shoulder, (2) glenohumeral arthritis or inflammatory arthropathy of the affected shoulder, and (3) deformity of the glenoid labrum after glenoid fracture. Five patients were excluded according to these criteria.

2.3. MRI protocol

An Achieva 3.0 T MR instrument (Philips Healthcare, Best, The Netherlands) was used. Imaging was performed using a dedicated shoulder coil (SENSE Flex M coil; Philips). Conventional images consisted of oblique coronal and axial images. For the oblique coronal images, the cross-section was established parallel to the scapula. For the axial images, the cross-section was established across the glenoid labrum. For the oblique sagittal images, the cross-section was established parallel to the articular surface of the scapula. The conditions for oblique coronal and axial imaging were as follows: fat-suppressed T2-weighted fast-spin echo imaging [i.e., repetition time (TR), 4000 ms; echo time (TE), 56 ms; echo train length (ETL), 17]; slice thickness, 3.0 mm; field of view, 150 mm × 150 mm; and acquisition matrix, 304 × 224 with a 512 × 512 reconstruction matrix. The conditions for oblique sagittal imaging were the following: fat-suppressed T2-weighted fast-spin echo imaging (TR, 5815 ms; TE, 100 ms; ETL, 16; slice thickness, 3.0 mm; field of view, 150 mm × 150 mm; acquisition matrix, 368 × 256 with a 512 × 512 reconstruction matrix).

For the radial cross-sections, the rotational axis was defined as the line connecting the center of the glenoid cavity and the center of the humeral head on the oblique sagittal plane. Twenty-four cross-sections were established circumferentially at 7.5° intervals. The imaging conditions were as follows: fat-suppressed T2-weighted fast-spin echo imaging (i.e., TR, 4600 ms; TE, 61 ms; ETL, 17); slice thickness, 3.0 mm; field of view, 150 mm × 150 mm; and acquisition matrix, 304 × 224 with a 512 × 512 reconstruction matrix. Twenty-four images were obtained during a period of approximately 4 min [11].

2.4. Evaluation of MR images

The glenoid labrum was assessed at the most superior part of the junction of the long head tendon of the biceps brachii and the inferior and anterior parts on the sagittal plane; these points were notated as 12:00, 6:00, and 3:00, respectively, based on their clock face positions as referenced in previous studies (Fig. 1A) [12,13]. The 7.5 angles formed between adjacent radial sections corresponded to 15 min on a clock face. In the oblique coronal and axial images, the glenoid labrum positions were calculated from the angles (α angle and β angle) formed by the two lines: one is connected from the 12:00 site to the 6:00 site, and the other connects the point where the cross-section contacts the margin of the glenoid cavity to the center point of the glenoid cavity. These positions were assessed according to a clock face (Fig. 1B, 1C).

For the patients without a labrum injury, images of the glenoid labrum were assessed as follows: a labrum with a clear outline and internal uniform low-signal intensity was deemed “clearly visible” (Fig. 2A), whereas a labrum with an unclear outline or that lacked internal uniform, low-signal intensity was deemed “not clearly visible” (Fig. 2B).

For those patients with a labrum injury, images of the glenoid labrum were assessed as follows: a labrum with a clear outline was deemed “clearly visible,” whereas a labrum with an unclear outline was deemed “not clearly visible”. For the images classified as clearly visible, the glenoid labrum was defined as “injured” if it demonstrated a clear border of internal high-signal intensity in uniform low-signal intensity (Fig. 2C) or there was an interruption of the continuity to the glenoid bone (Fig. 2D).

2.4.1. Range of glenoid labrum visualization in patients without a labrum injury

Radial, oblique coronal, and axial images were used to assess the range of the anterior glenoid labrum that could be clearly visualized in 15-min intervals (in clock face terms). We also compared the range of the glenoid labrum that could be visualized using conventionally obtained and radial section images.

2.4.2. Range of Glenoid labrum visualization in patients with a labrum injury

Radial, oblique coronal, and axial images were used to assess the range of each anterior glenoid labrum lesion. We compared the range of the injured glenoid labrum that could be visualized using conventionally obtained and radial section images.

2.5. Surgical correlation

The average time between MR examination and arthroscopic surgery was 30.2 days (range, 2–111 days). The surgeons preoperatively evaluated the conventional and radial MR images of labrum-injured patients. According to the arthroscopic findings from anterior and posterior portals, a labrum that was detached from the glenoid was determined to be a labrum injury. The extent of each glenoid labrum injury in arthroscopic findings was assessed in 30-min intervals (in clock face terms). Injured labra were found from 1:00 to 6:00.

2.6. Comparison of arthroscopic and MRI findings in patients with a labrum injury

The sites of labrum injury assessed by radial, oblique coronal, and axial images were compared in 30-min intervals (in clock face terms) from 1:00 to 6:00. The sensitivity, specificity and accuracy for the labrum injuries examined at each site were compared between conventional and radial MR images.

2.7. Statistical analysis

For the clearly visualized normal and injured glenoid labra, McNemar's test was used to compare differences at each site between radial and conventional MRI. p values < 0.05 were considered statistically significant. The Wilcoxon signed rank test was used to compare differences in diagnostic performance between radial and conventional MRI.

2.8. Intra- and inter-rater reliability

All MR images were evaluated twice over a 2-week interval by two independent raters who were certified orthopedic surgeons specializing in shoulder disorders. The raters were not informed about the diagnosis or other conditions of the patients. If the results from the two observers were inconsistent, a final consensus decision was obtained through discussion between the two observers at a later date.