European Journal of Radiology 84 (2015) 2242–2249

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

A feedback protocol improves the diagnostic performance of MR arthrography by experienced musculoskeletal radiologists in patients with traumatic anterior shoulder instability

Susan van Grinsven[a,*], Corné van Loon[a], Maarten van Gorp[b], Marjolijn van Kints[b], Peer Konings[a], Albert van Kampen[c]

[a] Department of Orthopaedics, Rijnstate Hospital, PO Box 9555, 6800 TA Arnhem, The Netherlands
[b] Department of Radiology, Rijnstate Hospital, PO Box 9555, 6800 TA Arnhem, The Netherlands
[c] Department of Orthopaedics, Radboud University Medical Centre, PO Box 9101, 6501 HB Nijmegen, The Netherlands

ARTICLE INFO

Article history:
Received 13 March 2015
Received in revised form 8 July 2015
Accepted 9 July 2015

Keywords:
Shoulder joint
Anterior traumatic shoulder dislocation
Magnetic resonance arthrography
Arthroscopy
Accuracy
Reproducibility

ABSTRACT

Purpose: To prospectively evaluate the diagnostic performance of magnetic-resonance-arthrography (MRA) by experienced musculoskeletal radiologists in patients with traumatic-anterior-shoulder-instability (TASI), after feedback protocol execution.
Materials and methods: Forty-five surgically confirmed MRA's were used to enhance personal feedback, to discuss differences in outcome between MRA assessment and surgical findings and to fine-tune definition interpretation agreement of 7 different TASI-related lesions, between experienced musculoskeletal radiologists and experienced orthopaedic shoulder surgeons. After execution of the feedback protocol 20 new, surgically confirmed, MRA's were assessed by 2 experienced musculoskeletal radiologists using a seven-lesion standardized scoring form. Kappa coefficients, sensitivity, specificity, and differences in percentage agreement or correct diagnosis (p-value, McNemar's test) were calculated per lesion and overall per 7 lesion types to assess whether diagnostic reproducibility and accuracy was improved.
Results: Per 7 lesion types, the overall kappa and percentage of agreement, between the 2 radiologists, were dramatically increased in comparison with our former study ($k = 0.81$ versus $k = 0.48$ and 90.7% versus 78.2%, respectively). The overall sensitivity of radiologist 1 increased from 45.9% to 87.8%, the overall sensitivity of radiologist 2 increased from 63.5% to 79.6% and the overall specificity of radiologist 2 increased from 80.1% to 85.7%. Furthermore, the overall percentage of correct diagnosis of both radiologist was also exceedingly higher (85.7% and 83.6%) compared to our former study (74.4% and 74.8%).
Conclusion: The implementation of our feedback protocol dramatically improved the reproducibility and accuracy of high field MRA by experienced musculoskeletal radiologist in patients with traumatic anterior shoulder instability.

1. Introduction

Off all joints in the human body, the shoulder joint is the most mobile one. This advantage in range of motion is however exchanged for a vulnerability to instability [1–3]. In the Netherlands the yearly incidence of shoulder dislocation is estimated at 38 per 100.000 persons [4]. 95% of these dislocation are in anterior direction [5,6]. As the recurrence rate is approximated at 80–90% in young patients [5], anterior shoulder instability is often surgically treated, to correct instability caused by soft tissue (rotator cuff, labroligamentous-complex, and capsule) and bony (greater humeral tuberosity, humeral head, and glenoid) lesions [3,6–11]. Diagnosis can be strongly suspected by patient history, physical examination, and standard X-rays alone [3,4,7,10,12–14], but additional diagnostic imaging is used to support clinical findings (lesion type, location, and severity) and to guide treatment decisions (nonsurgical, arthroscopic or open surgical approach) [1,3,5,8–11,15–19].

Currently, MRA[1] is described as the most accurate pre-arthroscopy diagnostic imaging technique for soft-tissue evalua-

* Corresponding author. Fax: +31 88 0057878.
E-mail addresses: svangrinsven@rijnstate.nl (S. van Grinsven), cvanloon@rijstate.nl (C. van Loon), mvangorp@rijnstate.nl (M. van Gorp), mvankints@rijnstate.nl (M. van Kints), albert.vankampen@radboudumc.nl (A. van Kampen).

[1] MRA: Magnetic resonance arthrography.

http://dx.doi.org/10.1016/j.ejrad.2015.07.016
0720-048X/

tion of the shoulder, being superior to conventional Magnetic Resonance Imaging for the detection of capsular–labroligamentous-complex and rotator cuff lesions [2,3,5,7–9,11,12,15,16,18–27] as the contrast medium distends the joint capsule, outlines intra-articular structures, and leaks into tears [10,11,13,26–28]. To increase the diagnostic performance of high field MRA even more, the use of experienced musculoskeletal radiologists and addition of the ABER[2]-position-view-sequence in the MRA protocol are highly advocated. Authors state that experienced musculoskeletal radiologist perform better than general radiologists [3,6,7,10,20,22,23,28] and ABER improves the visualisation of partial-thickness rotator cuff undersurface tears and lesions of the capsular–labroligamentous complex, through distraction and increased penetration of contract material into a tear [1,7,9–11,19,24,29–31].

Reviewing the literature, the reported diagnostic MRA reproducibility results of instability related lesions are highly variable with kappa's ranging from −0.03 to 0.84, but most authors describe "moderate" (0.41–0.60) to "substantial agreement" (0.61–080) [3,6,9,21,24,25,30,32]. The majority of the authors systematically report high diagnostic MRA accuracy rates for instability related lesions [2,8,10,13,16–21,25,27,30,33–35]. Sensitivities range from 79–100% and specificities from 85 to 100% [28], although a few author have mentioned much lower accuracy rates too [3,7,14,23,24].

If assessment of high field MRA's, preferably with the additional ABER, is performed by experienced radiologist specializing in musculoskeletal MRA, it should be possible to equal or to increase the substantial reproducibility (kappa: 0.61–0.80) and high accuracy rates (79–100%), mentioned in earlier literature [2,8–10,13,16–21,24,25,27,28,30,32–35]. We were however not able to approximate these results in two former studies. In our first study 2 radiologist retrospectively reviewed 61 high field MRA, without ABER. The agreement was "poor" (kappa: 0.21) and although the specificity of the most experienced musculoskeletal radiologist was in line with former literature, the sensitivity was only 50% [3]. In the second study we prospectively reviewed 51 MRA's, with ABER. The agreement between our two most experienced musculoskeletal radiologists was "moderate" (kappa: 0.48). Sensitivity ranged from 46 to 64% and specificity from 80 to 88% [7].

As a possible explanation for these disappointing reproducibility and accuracy rates we reasoned that the lack of standard personal feedback in our hospital, addressing the discrepancy between the MRA assessment of the radiologist (focussing on every abnormality or defect, even when it is of no consequence for the stability of the shoulder) and the conclusion of the orthopaedic surgeon after surgical stabilization (focussing entirely on stability related lesions), flattened the learning curve of our radiologists. A high degree of specialized experience could therefore still lead to a suboptimal diagnostic performance [7]. Unfortunately, there is no literature to confirm this. As earlier suggested by other authors, a further explanation could be that radiologists and orthopaedic surgeons interpretate the given definitions of assessed lesions in a different way, consequently leading to lower diagnostic accuracy of the radiologist [4,32]. There are, however, no studies available about how to improve the agreement of definition interpretation.

That is why we developed a feedback protocol in which radiologist systematically received personal feedback of their MRA assessment after surgery, enabling radiologists, and orthopaedic surgeons to discuss discrepancies and fine-tune their agreement about lesion definition interpretation. The aim of the present study is to evaluate the diagnostic performance of high field MRA by experienced musculoskeletal radiologists in patients with TASI[3], after feedback protocol execution. Our hypotheses is that the diagnostic reproducibility and accuracy will improve.

2. Materials and methods

In order to perform a prospective diagnostic reproducibility and accuracy study, the study protocol was designed before data collection was started. The Regional Ethics Committee of the Netherlands decided that no approval or informed consent were required. The study protocol was, however, approved by the local scientific committee of the Rijnstate hospital and the radiologic/orthopaedic department were instructed accordingly. The Rijnstate hospital is a large teaching hospital with 750 beds and an adherence of 425.000 inhabitants. All patients, visiting our secondary care setting with shoulder instability after reduced TASI, which were referred for an 1.5 T MRA between November 2012 and March 2014 and underwent stabilizing shoulder surgery by orthopaedic shoulder surgeon PK before April 2014, were considered for enrolment. Patients were excluded in case of previous shoulder surgery, record of shoulder procedure between MRI and stabilizing shoulder surgery, skeletal immaturity, general contra-indications for contrast agents, and/or MRI or missing ABER-view sequence. Ultimately, 20 high field surgery confirmed MRA's were included.

2.1. MRA (index test)

To obtain optimum imaging, the timeframe between arthrography and MRI was less than 30 minutes. According to the radiologists preference, an anterior approach was used to insert a, fluoroscopically guided, 21 gauge needle into the inferior or superior-medial quadrant of the humeral head. Confirmation of correct intra-articular needle position was obtained by injecting 2–3 cc iodinated contrast agent (Xenitix 300, Guerbet Nederland B.V., Gorinchem, the Netherlands) and 14–16 cc diluted gadolinium complex (Artirem, Guerbet Nederland B.V., Gorinchem, the Netherlands) into the glenohumeral joint. Shoulder MRI was performed according to a standardized study protocol (Table 1) with an 1.5 T Achieva system (Philips, Best, The Netherlands) and a Synergy flex-M surface shoulder coil or an 1.5 T Siemens Magnetom Avanto Tim 32 × 8 (Siemens AG, Munich, Germany) with a Small Extremity coil. Patient placement was supine with the arm slightly in abduction/exorotation. The patient's hand of the affected extremity was placed posterior to the contralateral aspect of the head or neck with a flexed elbow, in case of ABER.

2.2. Reference standard

After MRA imaging, the MRA report was send to the orthopaedic department to confirm clinical diagnosis and plan arthroscopic stabilisation. All arthroscopies were performed by the same orthopaedic surgeon (PK), with regional anaesthesia and an additional interscalene brachial plexus block. Before incision, the severity and directions of instability were tested. The patient was placed in either the lateral decubitus position or the beach chair position, with the arm slightly abducted and exorotated. According to protocol, a standard 4-mm 30-degree arthroscope was inserted using the classic posterior approach. Other instruments were inserted via two anterior portals. During arthroscopy, the shoulder was systematically inspected according to a seven-item scoring list rating the presence and severity of

[2] ABER: The ABduction-External-Rotating position view sequence.

[3] TASI: Traumatic anterior shoulder instability.