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Research Article

Values of Magnetic Resonance Imaging and Computed Tomography in the Diagnosis of Patients with Syndromes of Subacromial Impingement

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Subacromial impingement syndrome (SIS) is defined as pressurization and impingement between the acromion, the bursa under the acromion, and the rotator cuff during the abduction and elevation of the shoulder joint, resulting in pain and a functional disturbance of elevation. It is the most common disorder of the shoulder, accounting for 44-65% of all complaints of shoulder pain during a physician's office visit. The study was performed with the aim of valuing the magnetic resonance imaging (MRI) and computed tomography (CT) in diagnosing patients with SIS. A total of 68 patients with SIS were selected as study subjects and subjected to MRI and CT examinations. The diagnostic accuracy and sensitivity of MRI and CT were, respectively, 97.06 and 70.59% ($P < 0.05$); the detection rates of SIS grade I, grade II, and grade III by MRI were 91.67%, 96.77%, and 100%, respectively, which were significantly higher than 50%, 80.65%, and 68% by CT, respectively ($P < 0.05$). MRI and CT detection indicated that there was no significant difference in extensive rotator cuff tear, acromion stenosis, and normal acromion detected by MRI and CT ($P > 0.05$). In conclusion, the diagnostic accuracy, sensitivity, and detection rate of acromion of MRI were higher compared with those of CT examination, and MRI is more suitable in the clinical diagnosis of SIS.

1. Introduction

Subacromial impingement syndrome (SIS), as a result of the compression of suprahumeral structures, is a frequent cause of chronic anterior shoulder pain concomitant with limited range of motion, accounting for 50-70% of main complaints of shoulder pain in primary health care [1, 2]. SIS is characterized by a series of pathological changes, ranging from subacromial bursitis to rotator cuff tendinitis and full-thickness rotator cuff tear [3]. According to Roy et al. [4], SISs can be broadly classified into external or internal types. External impingement is caused by abnormal contact between the humeral head and extra-articular structures, thus resulting in subacromial or subcoracoid impingement. Internal impingement usually affects overhead-throwing athletes [5] and involves the structures located between the humeral head and the glenoid, which is separated into posterosuperior and anterosuperior subtypes. SIS encompasses a spectrum of subacromial pathologies, including rotator cuff tears, rotator cuff tendinosis, calcific tendinitis, tendonitis, and bursitis of the shoulder [6]. Results vary as different clinical tests, and imaging is helpful in evaluating the signs of SIS [7]. Magnetic resonance imaging (MRI) is an excellent noninvasive tool for the diagnosis of the pathologies of the shoulder [1, 8]. This imaging method has been reported to effectively demonstrate the soft tissue lesions upon SIS [9]. Computed tomography (CT) arthrography is a cost-effective, useful method used for the preoperative assessment of various shoulder pathologies, such as full-thickness rotator cuff tears [10] In this study, the MRI and CT technologies were performed to diagnose SIS, and the clinical pathological results were taken as the gold standard to analyze the diagnostic value of the MRI and CT technologies in diagnosing SIS, with focus on acromion morphology and A-H distance, in a bid to seek a scientific and effective way for the early diagnosis of SIS and to improve function recovery of patients.

2. Material and Methods

2.1. Eligibility of Study Subjects. In total, our study enrolled 68 patients who were diagnosed with SIS and received treatment in our hospital from July 2017 to September 2019. There were 35 males and 33 females, with age ranging from 25 to 70 years and with an average age of 47.56 ± 4.21 years, including 38 right shoulders with SIS and 30 left shoulders with SIS. Inclusion criteria were as follows: (a) diagnostic criteria of SIS, (b) the age is more than 25 years old, and (c) all signed the informed consent issued by the Ethics Committee of our hospital. Exclusion criteria were as follows: (a) patients with severe organic diseases of the cardiac, liver, and kidney; (b) patients with mental disorders; (c) patients with imaging contraindications; (d) patients complicated with severe cardiovascular and cerebrovascular diseases; and (e) patients with allergy to lidocaine.

2.2. Diagnosis of SIS. Diagnosis of SIS was performed as previously reported [11]. SIS is diagnosed if the patients have the following three or more symptoms: (a) a tenderness over the anterior margin of the acromion. (b) Neer impingement test shows a positive sign; the patient remains in a sitting position, while the examiner stands by the side of the patient's body with his scapula in one hand, passively elevating the affected arm from the ventral direction to cause impingement between the greater tuberosity and the acromion; a positive sign was described as pain from 60 to 120 abduction. (c) The pain of the shoulder joint in active activity is significantly stronger than that in passive activity. (d) Pain is felt upon shoulder abduction. (e) There are osteophytes on the acromion.

2.3. MRI and CT Examinations. All patients were examined by MRI and CT. A 1.5-Tesla Espree MRI scanner (Siemens, Erlangen, Germany) was used to examine the patient who was kept in the supine position, with lateral shoulder joint as the neutral position. A turbo spin-echo (TSE) sequence and a 3 cm diameter loop coil were applied, with parameters as below: parameters of T_2WI FS in the routine scanning axial position were set as TE 80 and TR 5400; T_1WI in the oblique coronal position was TE 20 and TR 500; PDWI was TE 30 and TR 4400; T_2WI was TE 100 and TR 4000. The parameters of T_2WI FS in the oblique position were TE 30 and TR 4400 with 3 mm thickness and 0.3 mm layer distance, FOV is $160 \times 160 \times 80$, and the matrix is 250×250. For CT examination, a 64-slice spiral CT (Philips, USA) was used, with scanning parameters set as follows: 120 kV tube voltage, 250 mAs tube current, 1 mm collimation, 5 mm scanning thickness, and 60 cm FOV were performed from the subscapular angle to the coracoid process. The images were uploaded to the ADW4.2 image processing workstation for processing, and the images were analyzed by three senior doctors.

2.4. Bigliani Classification and Acromion Humeral (A-H) Distance. Bigliani classification [12] was performed to type the acromion morphology of these SIS patients. Flat acromion was defined as type I, curved acromion as type II, and hooked acromion as type III. Besides, the A-H distance was measured by MRI and CT [13]. A-H distance less than 0.5 cm was defined as an extensive rotator cuff tear, 0.5-1.0 cm as an acromion stenosis, and 1.0-1.5 cm as a normal acromion.

Table 1: More SIS patients were diagnosed by MRI than CT.

Examination method	Accuracy	Sensitivity	Specificity
MRI	97.06	97.06	100.00
CT	70.59	70.59	100.00

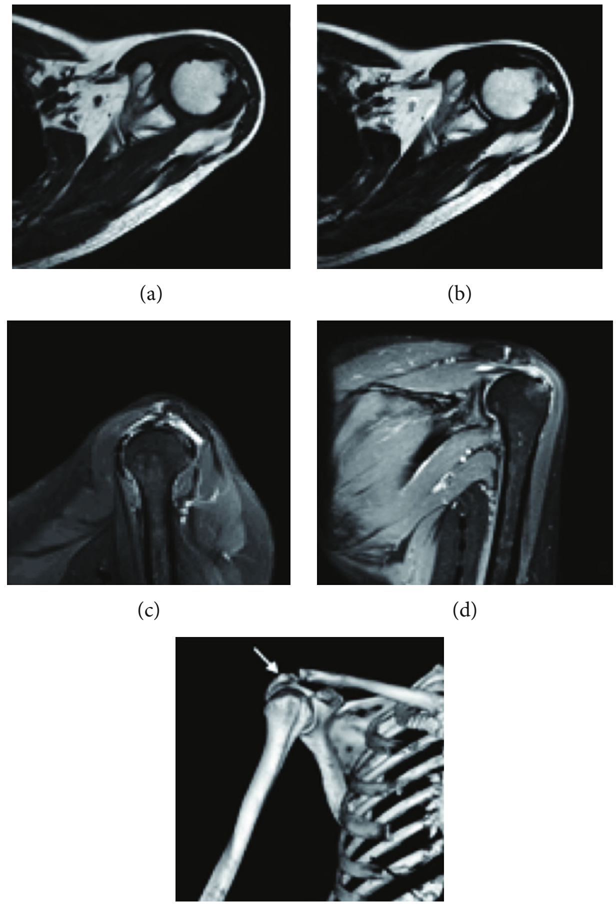
MRI: magnetic resonance imaging; CT: computed tomography.

2.5. Statistics. SPSS 20.0 software (IBM Corp., Armonk, NY) was used to process the data, and a chi-square test was performed for statistical analysis. $P < 0.05$ was considered to be statistically significance at a level of 5% (two-tailed).

3. Results

3.1. More SIS Patients Were Diagnosed by MRI than CT. In this study, a total of 68 patients were diagnosed as SIS by pathology. MRI examination confirmed 66 patients with SIS, 2 cases were missed, and none was misdiagnosed. CT examination confirmed 48 patients with SIS, 17 cases were missed, and 3 cases were misdiagnosed. These results suggested that MRI exhibited a better diagnostic performance for SIS than CT. As shown in Table 1, the diagnostic accuracy of MRI was 97.06% which was significantly higher than the 70.59% of CT ($\chi^2 = 17.569$, $P < 0.05$). The sensitivity of MRI was 97.06% which was significantly higher than the 70.59% of CT ($P < 0.05$).

3.2. MRI and CT Presentations. All 66 patients presented abnormal signal intensity on MRI and morphology in the supraspinatus tendon (Figures 1(a) and 1(b)), among which 22 patients (33%) with normal supraspinatus tendon and patchy hyperintense T2WI signal, 26 patients (40%) with increased or decreased thickness in supraspinatus tendon with abnormal and mingle signal, 13 patients (20%) with calcified tendinitis of supraspinatus muscle and nodule low T1WI and T2WI signals and high-density shadow in DR at 1-2 cm away from the greater tuberosity of the humerus, and 5 patients (7%) with full-thickness tears of the supraspinatus tendon, involving continuous hypointense signal interruption on oblique coronal T2WI, intermediate signal intensity on T1WI, and hyperintense signal intensity on T2WI. The patients mainly presented supraspinatus tendon injury on MRI, including 63 patients with thickened subacromial bursa with effusion, 41 patients with effusion in the shoulder joint, and 36 cases with glenoid labrum tear (Figures 1(c) and 1(d)). Results of CT examination showed 21 patients with hyperosteogeny in the acromion and acromioclavicular joint (Figure 1(e)), 28 cases with subacromial distance stenosis, 18 cases with the greater tuberosity of the humerus sclerosis, and 16 cases with calcification in the long head tendon and supraspinatus tendon of the musculus biceps brachii.



(a) (b) (c) (d) (e)

Figure 1: MRI and CT images of patients with SIS. T1WI (a) and T2WI (b) examined by MRI, which indicated the swelling condition of the supraspinatus tendon and uneven signal; oblique (c) and coronal (d) positions detected by MRI—partial tear of the supraspinatus tendon is shown in (c) and subacromial bursitis is seen in (d); (e) the CT three-dimensional reconstruction image of hook grade acromion, and hyperosteogeny occurred in the acromion margin.

3.3. Detection Rates of Acromion Morphology by MRI and CT. After pathological examination, there were 8 cases of grade I, 22 cases of grade II, and 38 cases of grade III. As shown in Table 2, the detection rates of grade I, grade II, and grade III by MRI were 91.67%, 96.77%, and 100%, respectively, which were significantly higher than 50.00%, 80.65%, and 68.00% by CT, respectively ($P < 0.05$).

Table 2: Detection rates of acromion morphology by MRI and CT.

Examination method	Grade I ($n = 12$)	Grade II ($n = 31$)	Grade III ($n = 25$)
MRI	11 (91.67)	30 (96.77)	25 (100)
CT	6 (50.00)	25 (80.65)	17 (68.00)
χ^2	5.042	4.026	9.524
P	0.025	0.045	0.002

MRI: magnetic resonance imaging; CT: computed tomography.

3.4. Detection of A-H Distance by MRI and CT. Measurement of the A-H distance could be used to assess the impact of rehabilitation or surgical interventions for rotator cuff tendinopathy. The A-H distance less than 0.5 cm was defined as an extensive rotator cuff tear, 0.5-1.0 cm as an acromion stenosis, and 1.0-1.5 cm as a normal acromion. MRI and CT detection indicated that there was no significant difference in extensive rotator cuff tear, acromion stenosis, and normal acromion detected by MRI and CT ($P < 0.05$, Table 3).

Table 3: Detection of A-H distance (cm) by MRI and CT.

	A-H distance < 0.5	A-H distance between 0.5 and 1.0	A-H distance between 1.0 and 1.5
MRI	10 (15.15)	19 (28.79)	37 (56.06)
CT	8 (16.67)	15 (31.25)	25 (52.08)

MRI: magnetic resonance imaging; CT: computed tomography.

4. Discussion

SIS represents a spectrum of pathology ranging from subacromial bursitis to rotator cuff tendinopathy and full-thickness rotator cuff tears. When the shoulder is abducted or lifted, repeated friction and impingement between the humerus and the acromion tissue leads to rotator cuff tear, tissue damage under the acromion, and functional degeneration. Shoulder function impairment and pain are the main clinical symptoms of SIS [3]. The diagnosis of SIS is based on the physical examination or history of patients. However, in clinical treatment, doctors should analyze the pathology degree of disease, A-H distance, and shoulder peak shape before appropriate treatments.

The pathological changes of SIS mainly include three stages [14]. In the first stage, hemorrhage and edema appeared in the acromion bursa and rotator cuff; in the second stage, obvious tendinitis and rotator cuff fibrosis appeared with thickening and partial cuff tearing; and in the third stage, full thickness tendon tears, bony changes, and tendon ruptures were observed [14]. In the clinic, MR multiplanar imaging is routinely used for the diagnosis of rotator cuff diseases. The main scanning planes are axial, oblique coronal, and oblique sagittal. Axial MRI can clearly show the shoulder joint capsule, the long head of the biceps femoris tendon, and the glenoid labrum of the shoulder; oblique coronal MRI clearly represents the rotator cuff and its muscle groups, acromion bursa, which is more sensitive to supraspinatus tendon injury and its surrounding bursa and fat layer lesion distribution; oblique sagittal MRI indicates the rotator cuff structure in the same layer and the tissue structure in the subacromial channel, which improve the diagnosis accuracy of rotator cuff injury and show the morphology of acromion perfectly. The normal supraspinatus tendon is oval or flat with a smooth edge and 1.0-1.2 cm thickness, and it connects to supraspinatus muscle at the 12 o'clock direction of the humeral head moving forward outside, gradually getting thinner and ending above the greater tubercle of the humerus. MRI shows a slightly hyperintense signal on T1WI and a hypointense signal on T2WI. The muscle tendon attachment is wide with a heterogeneous signal. In the early stage of the rotator cuff injury, enhanced strip signals of PDWI and T1WI in the tendon were observed by MRI. The tendons were notably thickened, with an unclear outline. In the middle stage of the rotator cuff injury, the patients with high signal intensity both on T1WI and T2WI were observed by MRI [15]. The direct signs of MRI are divided into two types: continued and interrupted tendons, retraction of the broken end, and increased signal intensity are diagnosed as a complete tear; increased signal intensity, morphological change, and rough edge are diagnosed as an incomplete tear. In this study, MRI and CT technologies were applied in the diagnosis of SIS. It was found that the diagnostic accuracy and sensitivity of MRI for SIS were significantly higher than that of CT, suggesting that MRI has a better diagnostic value. MRI potentially offers improved soft tissue contrast and spatial resolution, providing increased image detail, and it can clearly display bone joint and lesion tissue, with high resolution, multiple sequences, directions, and parameters [16]. MRI can evaluate the extent and configuration of rotator cuff abnormalities, document abnormalities of the cuff muscles and adjacent structures, and suggest mechanical imbalance within the cuff [17]. MRI can also provide information about RCT including tear dimensions, tear depth or thickness, tendon retraction, and tear shape that is required for optimal treatment planning and prognostic accuracy [18]. In this study, the detection rates of type I, type II, and type III after MRI examination were 91.67%, 96.77%, and 100%, respectively, which were significantly higher than those after examination (50.00%, 80.65%, and 68.00%, respectively), suggesting that MRI has a higher detection rate than CT in examining acromion morphology. MRI and CT examinations found that the normal subacromial distance of SIS patients was significantly higher than that of narrow acromial and extensive rotator cuff tears, but the detection rate of the normal subacromial distance of MRI was slightly higher than that of CT examination. MRI may show the degree of rotator cuff injury of SIS patients more clearly, but it is not clear when used to scan the acromial osteophyte and acromial shape. In the study reported by Rour and Jongsoon [19], MRI results revealed that patients with grade III SIS were more likely to have rotator cuff injury and outlet stenosis. The rotator cuff injury is mainly caused by the mechanical compression of the acromion to the rotator cuff in SIS. It can be seen that there is a close relevance between subacromial space stenosis and rotator cuff injury. The narrower the subacromial space stenosis is, the more prone to injury. Akyol et al. [20] reported that there was positive relevance among the incidence of acromion osteophyma, lesion extent, and patient's age. However, we could not perform age-stratified analysis due to the small sample size. In the future, we will recruit more SIS patients for age-stratified analysis to strength the diagnostic value of MRI for SIS.

In conclusion, MRI has higher diagnostic value than CT in SIS, exhibiting better detection rate in the diagnosis of the acromion shape and A-H distance. MRI can provide more comprehensive evidence for the clinical diagnosis and treatment of SIS.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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