Adjacent tissue involvement of acute inflammatory ankle arthritis on magnetic resonance imaging findings

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Abstract

Purpose The ankle joint and surrounding subtalar joint have several tendons in close proximity. This study was performed to investigate the concurrent adjacent tissue involvement on MRI findings when the surgical treatment is considered for an acute inflammatory arthritis of the ankle joint.

Methods Consecutive patients with acute inflammatory ankle arthritis who visited the emergency room and underwent MRI were included. After interobserver reliability testing of MRI findings, adjacent tissue involvement in the acute inflammatory ankle arthritis were evaluated including flexor hallucis longus (FHL), flexor digitorum longus (FDL), tibialis posterior (TP), peroneus longus (PL), peroneus brevis (PB), extensor digitorum longus (EDL), tibialis anterior (Tib Ant), extensor hallucis longus (EHL), subtalar joint, talus, tibia, and calcaneus.

Results Twenty-five patients (mean age 57.8 years; 16 males and nine females) were included. Of the 25 patients, 23 showed FHL involvement, 21 FDL, 21 TP, 15 PL, 15 PB, three EDL, 21 subtalar joint, six talus, six tibia, and five calcaneus on MR images. No Tib Ant or EHL involvement was observed on MR findings in acute inflammatory ankle arthritis.

Conclusions Patients with acute inflammatory ankle arthritis showed frequent concomitant surrounding tissue involvement on MRI, which included FHL, FDL, TP, and subtalar joint.

This needs to be considered when surgical drainage is planned for acute inflammatory ankle arthritis.

Introduction

Acute inflammatory ankle arthritis, including septic arthritis and gouty arthritis, are usually evaluated and managed in the emergency clinical situation, and considered for surgical drainage. The diagnosis of acute inflammatory arthritis is frequently inconclusive because of vague symptoms, negative bacterial cultures, and inconclusive joint fluid analysis. Acute septic arthritis is known to cause a rapid destruction of articular cartilage, and eventually leads to degenerative arthritis [12]. Therefore, it is a wise policy to perform a surgical drainage and irrigation when suspicion of septic arthritis arises. This is beneficial for reducing the late sequelae even when the diagnosis is inconclusive.

Septic arthritis is managed by surgical drainage of purulent joint fluid and debridement, and subsequent antibiotics. For thorough surgical drainage and debridement, the orthopaedic surgeons need to assess the extent of the disease preoperatively. Gadolinium enhanced MRI has been a useful tool to evaluate inflammatory ankle arthritis for diagnosis, and for the extent of both inflammatory bony and soft tissues [5, 16].

The ankle joint has a relatively thin joint capsule [4], and adjacent tissues including tendons and joints are very close to it [4, 6]. Therefore, there is always a possibility that the inflammatory arthritis of the ankle joint might spread to the adjacent tissues. This could have some clinical implications when surgical drainage and debridement are considered, but this has not been sufficiently documented.

Therefore, this study was performed to investigate the concurrent adjacent tissue involvement on MRI findings

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when the surgical treatment is considered for an acute inflammatory arthritis of ankle joint in the emergency room.

Materials and methods

This retrospective study was approved by the institutional review board at our hospital (tertiary referral centre). The patients who visited our emergency room with symptoms of acute inflammatory ankle arthritis requiring evaluation for a suspicion of septic ankle arthritis were included between July 2005 and April 2012. All patients underwent physical examination, gadolinium enhanced ankle MRI and blood test that included complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and uric acid. Joint fluid aspiration and analysis was performed for possible cases, which included cell count with differential count and fluid cultures. Time of symptom onset, body temperatures and weight bearing status were obtained from the chart review. Paediatric patients under the age of 20 years, postoperative infection, post-traumatic infection, and chronic inflammation were excluded from the study.

Acquisition of MR imaging

MR images were obtained on a 1.5-T system (Gyrosan NT Intera, Philips Healthcare) and a dedicated ankle-coil (C4 circular surface coil with an 80-mm diameter or SENSE Flex-M coil, Philips Healthcare). Coronal T1-weighted (TR/TE, 502–630/20–25) and sagittal T2-weighted sequences (3,224–4,049/90–100) were performed at 3-mm slice thickness and 0.3-mm interval, 140- to 170-mm² field of view, and 256×512 imaging matrix. Axial T1-weighted (400–600/15–22) and T2-weighted (4,427–6,074/80–100) images were obtained with a 100- to 130-mm² field of view. Axial (506–688/12–21), sagittal (569–780/15–25), and coronal (625–788/12–24) T1-weighted images with fat suppression were obtained after injection of 0.1 mmol/kg of gadodiamide (Omniscan, GE Healthcare).

MR evaluation of inflammatory ankle arthritis and adjacent tissue involvement

For all patients, MR findings of inflammatory ankle arthritis were confirmed on the basis of joint effusion and synovial enhancement. Adjacent tissue involvement was evaluated and recorded, including flexor hallucis longus (FHL), flexor digitorum longus (FDL), tibialis posterior (TP), extensor hallucis longus (EHL), extensor digitorum longus (EDL), tibialis anterior (Tib Ant), distal tibia, talus, calcaneus, and subtalar joint. These were according to MR findings of tenosynovial effusion (Fig. 1), bone enhancement (Fig. 2), and subtalar effusion (Fig. 3), which represent the possibility of tenosynovitis, osteomyelitis, and inflammatory subtalar arthritis, respectively.

Fig. 1 An axial MR image shows a large amount of tenosynovial effusion around flexor hallucis longus tendon (*arrow*) along with ankle joint effusion (*arrow heads*), suggesting acute inflammatory ankle arthritis complicated with possible inflammatory tenosynovitis

Reliability of qualitative MR findings of inflammatory ankle arthritis and adjacent tissue involvement

Three orthopaedic surgeons had a consensus building session regarding the MRI findings, based on the reports by a musculoskeletal radiologist. Presence of tenosynovitis was defined as tenosynovial effusion more than two millimetres,

Fig. 2 A sagittal MR image shows bone involvement of tibia (Ti), talus (Ta), and calcaneus (Cal), suggesting osteomyelitis concurrent with septic ankle arthritis (*arrow*) and infectious tenosynovitis of flexor hallucis longus (*arrow heads*)

Fig. 3 A sagittal MR image shows effusion and synovial enhancement at the ankle (*arrow heads*) and subtalar joints (*arrow*), suggesting inflammatory ankle arthritis with possible concurrent subtalar involvement

and osteomyelitis was defined as high signal intensity within bony structures on enhanced MR images or presence of abscess. Joint involvement was determined by synovial enhancement with effusion. The three orthopaedic surgeons independently recorded the adjacent tissue involvement on MR images, and the interobserver reliability of MR findings was evaluated.

Data analysis

Descriptive statistics were used to analyse the data. Interobserver reliability of qualitative MR findings were analysed using intraclass correlation coefficients (ICCs) [7, 14]. ICC was calculated in the setting of a two-way random effect model, a single measurement, and absolute agreement.

Results

A total of 25 patients were finally included in the data analysis. The mean age of the patients was 57.8 years (SD 18.9 years), and there were 16 male and nine female patients. All patients presented with ankle pain, painful motion, and local heat. Seven patients could walk with partial weight bearing on the involved feet, and 18 patients could not. Mean tympanic temperature was 37.6 °C (SD 0.6 °C), and the average time of symptom onset was 4.9 days (SD 4.5 days) before the MRI examination was performed. The

final diagnosis was septic arthritis with positive bacterial culture in six patients, septic arthritis with negative bacterial culture in nine patients, acute gouty arthritis in one patient, acute gouty arthritis combined with septic arthritis in one patient, and inconclusive in eight patients.

On the blood test, the mean white blood cell (WBC) count was 9,952 cells/ul (SD 3213 cells/ul; normal reference range, 4,000–10,000 cells/ul), and the mean C-reactive protein level was 6.7 mg/dl (SD 5.2 mg/dl; normal reference range, 0–0.5 mg/dl).

Joint fluid aspiration and analysis was possible for 17 patients, and the mean WBC count was 47,832 cells/ul (SD 32,530 cells/ul, normal reference range, 0–150 cells/ul) with 79.9 % of polymorphic nuclear cells (normal reference range, 0–25 %) in the joint fluid analysis. Joint fluid analysis was not possible for the remaining eight patients due to a paucity of aspirate fluid.

Interobserver reliability of MR findings were highest for tibia involvement (ICC 1.000) and lowest for EDL involvement (ICC 0.332) (Table 1).

Of the 25 patients included, 23 showed FHL involvement, 21 FDL, 21 TP, 15 PL, 15 PB, three EDL, 21 subtalar joint, six talus, six tibia, and five calcaneus on MR images. No Tib Ant and EHL involvement was observed on MR findings (Table 2).

Discussion

This study showed that a considerable proportion of patients with acute inflammatory ankle arthritis who visited an

Table 1 Interobserver reliability of qualitative adjacent tissue involvement on MRI

Adjacent tissue	ICC (95 % CI)
FHL	0.578 (0.351–0.765)
FDL	0.760 (0.595–0.876)
TP	0.760 (0.595–0.876)
PL	0.837 (0.713–0.918)
PB	0.889 (0.798–0.945)
EHL	NA
EDL	0.332 (0.086–0.587)
TA	NA
Tibia	1.000 (1.000–1.000)
Talus	0.809 (0.668–0.903)
Calcaneus	0.915 (0.844–0.959)
Subtalar joint	0.785 (0.632–0.890)

FHL flexor hallucis longus, *FDL* flexor digitorum longus, *TP* tibialis posterior, *PL* peroneus longus, *PB* peroneus brevis, *EHL* extensor hallucis longus, *EDL* extensor digitorum longus, *TA* tibialis anterior

NA all ratings were in complete agreement as “absence” or “not involved”

Table 2 Number of cases for the adjacent tissue involvement on MRI (out of total 25 cases)

	Adjacent tissue	N
	FHL	23
	FDL	21
	TP	21
	PL	15
	PB	15
<i>FHL</i> flexor hallucis longus, <i>FDL</i> flexor digitorum longus, <i>TP</i> tibialis posterior, <i>PL</i> peroneus longus, <i>PB</i> peroneus brevis, <i>EHL</i> extensor hallucis longus, <i>EDL</i> extensor digitorum longus, <i>TA</i> tibialis anterior	EHL	0
	EDL	3
	TA	0
	Tibia	6
	Talus	6
	Calcaneus	5
	Subtalar joint	21

emergency room had concurrent adjacent tissue involvement. This has some clinical implication because these patients probably need to undergo surgical drainage and it is important to evaluate the extent of the disease preoperatively. FHL, FDL, TP tendons, and subtalar joint showed frequent involvement in acute inflammatory ankle arthritis.

The specific diagnosis of acute inflammatory ankle arthritis is sometimes inconclusive. However, when septic arthritis cannot be excluded, surgical drainage could be a wise policy to reduce the late sequelae of septic ankle arthritis because infectious arthritis can cause rapid damage to articular cartilage and eventually long-term sequelae, including early osteoarthritis [12]. Septic ankle arthritis is believed to fall into a disease category that needs a sensitive approach although this could cause some degree of false positive diagnoses because negligence of the disease could be more disastrous than overtreatment. Furthermore, septic arthritis can occur concomitantly with other arthritis [17], and show negative culture results [13], and these cause additional difficulty in definitive diagnosis and treatment of septic ankle arthritis [10].

The orthopaedic surgeons need to know the extent of the septic ankle arthritis when surgical drainage is necessary. Complete drainage and debridement increases the success rate of the treatment with subsequent antibiotic administration. MRI has been a useful tool in evaluating the extent of the inflammatory ankle arthritis affecting both bone and soft tissues [5, 16]. However, the comprehensive adjacent tissue involvement has not been sufficiently documented on MR images, although this possibility and such cases have been reported [1–3, 8, 9, 11].

The ankle joint has a thin joint capsule [4]. The surrounding tendons and subtalar joint are very close to it [4, 6]. Therefore, inflammatory ankle arthritis has can spread directly to the adjacent structures causing concomitant inflammatory tenosynovitis and subtalar

arthritis. If the concomitant tenosynovitis and subtalar arthritis could not be excluded from the infectious cause, it is reasonable to perform surgical drainage for tenosynovium and subtalar joint, as well as for the ankle joint. Considering the frequent involvement of FHL, FDL, TP, and subtalar joint, posteromedial arthrotomy is preferable to other surgical approaches, and concomitant subtalar arthroscopy might be needed.

There have been several studies that have reported the communication between ankle joint and adjacent structures [1–3, 8, 9, 15]. These communications could possibly be caused by trauma or developmental defects. In cases of inflammatory arthritis, destruction of barriers between ankle joint and adjacent structures is another possible explanation. Whatever the reasons are, the communication or involvement of surrounding structures needs to be evaluated and highlighted in the treatment of inflammatory ankle arthritis considered for surgical drainage and debridement.

Flexor tendon groups and the subtalar joint showed higher concomitant involvement with inflammatory ankle arthritis than extensor tendon groups. The proximity of the flexor tendon and subtalar joint to the ankle joint might be a possible explanation for these results. However, it is not known whether direct invasion of inflammation or the communication between the structures is the cause.

Six of the 25 patients had bone involvement on MRI in this study, which is suggestive of osteomyelitis. These patients tended to have longer-term of symptoms than other patients without bone involvement. Relatively lower involvement of adjacent bony structures suggests the articular cartilage is an effective barrier for infectious or noninfectious inflammation.

Currently, the clinical interpretation of adjacent tissue involvement on MRI is somewhat uncertain as is inflammatory arthritis of ankle joint. Although inflammatory ankle arthritis was confirmed on the basis of joint effusion and synovial enhancement, these findings could not discriminate the infectious ankle arthritis from non-infectious inflammatory ankle arthritis. Also, for adjacent tissue involvement, there could be different clinical information, according to whether it is true infection and inflammation, or just reactive changes. More refined MR imaging techniques along with histological and microbiological studies provide more detailed interpretation for these MRI findings.

There are some limitations to be addressed in this study. First, this study was a retrospective one, and all of the clinical information was not available in medical records. Second, there are no quantitative criteria for adjacent tissue involvement, such as tenosynovitis, osteomyelitis, or septic arthritis. In addition, the inflammatory condition and non-inflammatory reactive changes on MR images could not be differentiated. Therefore, adjacent tissue involvement, in this study, needs to

be further investigated for its clinical implication in a future study. Third, the number of patients was quite small, and the final diagnosis was not confirmed for all patients. Therefore, statistical analysis between stratified groups was not possible.

In conclusion, a considerable proportion of patients that visited the emergency room for acute inflammatory ankle arthritis and were considered for possible surgical intervention, had concomitant surrounding tissue involvement on MRI. Frequently involved tissue included FHL, FDL, TP, and subtalar joint, and this needs to be taken into account when surgical drainage is planned for acute inflammatory ankle arthritis.

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