Mini-Review

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Sonographic detection of sacroiliitis - An appraisal

In the last decade, rheumatology saw an exponential rise in the use of Musculoskeletal Ultrasound (MSUS) as a diagnostic imaging modality. The ability of MSUS to detect inflammation of the sacroiliac joints (SIJ) in Spondyloarthritis (SpA) was also tested. Studies on sacroiliitis utilized different MSUS technologies: B-Mode US (BM US) to search for intraarticular effusion, synovitis, and measure the joint width; color Doppler (CD US) to detect low velocity blood flow as a marker for inflammation and Contrast-Enhanced US (CE US), able to show increased vascularity in the deeper part of the SIJ. Though, in general, most of these studies have promising results in the ability of MSUS to detect sacroiliitis, there are some important limitations of this method due to both anatomical and technological reasoning. The aim of this narrative review is to briefly outline the new data on US application to diagnose sacroiliitis and to discuss it in relation with SIJ anatomy. In addition, some important pitfalls that could be encountered when scanning these joints are noted.

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Introduction

Sacroiliac joint inflammation (sacroiliitis) is one of the hallmarks of Spondyloarthritis (SpA) [1]. The application of ultrasound (US) as a diagnostic tool in rheumatology is growing extensively in the last decade. Thus, the interest in the potential of US to assess the Sacroiliac Joints (SIJ) - one of the largest and most idiosyncratic joints in the human body, as well as a prima facie site of injury in SpA, has also been raised [2]. The aim of this narrative review is to briefly outline the new data on US application in sacroiliitis and to discuss it in relation with SIJ anatomy. In addition, some important pitfalls that could be encountered when scanning these joints are noted.

The studies performed in the last two decades have explored SIJ in the B-Mode US (BM US) for effusion, synovitis, and joint width; in color Doppler (CD US) for detecting low velocity blood flow with spectral wave analysis of its Resistant Index (RI). In addition, Contrast-Enhanced US (CE US) was used to detect sacroiliitis as well.

GS US findings

Fluid in the sacroiliac joint

Spadaro et al found SIJ effusion in 38.9% of the AS patients and only in 1.7% of the control subjects included in their study. In addition, the positive Likelihood Ratio (LR) for the presence of inflammatory Low Back Pain (LBP) was 2.67 for the patients with sonographically detected effusion. This result was equal to the positive LR of a combination of three SIJ pain provocation tests being positive simultaneously in a given joint [3]. Later, Bandinelli et al. examined sonographically 23 patients with early (≤ 3 years) SpA, comparing them to healthy controls. SIJ effusion was detected in 16/23 (69.5%) (7 bilaterally) patients but was not presented in any of the healthy subjects [4]. Paruchuri et al. examined 25 patients with suspected sacroiliitis, as well, comparing them to age matched controls. They found fluid in 22 (44%) of the examined SIJs, with 6 patients having fluid bilaterally and 9 - unilaterally [5]. It is worth mentioning that while Paruchuri et al. and Spadaro et al. examined their patients in prone position, Bandinelli et al. did so with patients positioned on the left side with knee bended to chest, which might bring to the discrepancy in the results.

SIJ synovitis

Synovitis was sought in two studies (Ghosh et al. Paruchuri et al.), both defining synovitis as a hyperechoic SIJ space. Paruchuri et al detect hyperechoic joint space (synovitis) in 84% (42 out of 50) examined joints and in none

of the control SIJs [5]. Contrary, Ghosh et al, detected hyperechogenicity in the SIJ space in only 10 (34.48%) of the 29 cases. The sensitivity and specificity of hyperechogenicity of the SIJ cleft on GS US in detecting Magnetic Resonance Imaging (MRI) proven sacroiliitis, were estimated to be 40% and 95% respectively [6].

SIJ width

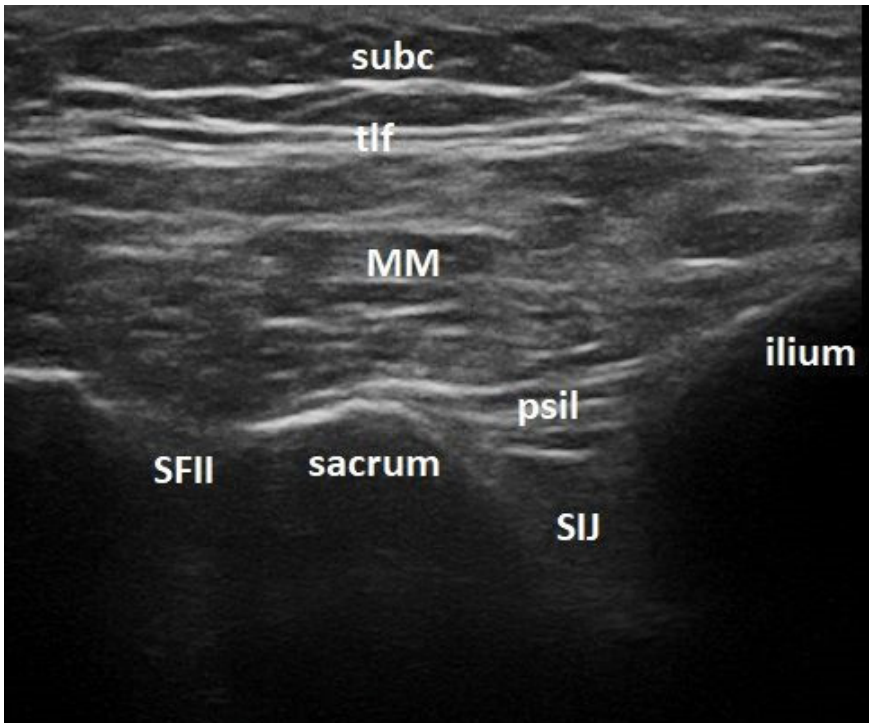
The data about the SIJ width in sacroiliitis is available from two studies (Bandinelli et al. and Paruchuri et al.), with totally 48 patients in total and the same number of healthy controls. In both studies, the width of the SIJ (distance between the ilium and the sacrum) was measured in the midline of the posterior part of the joint. Both studies found significant difference between the width of the joint in active sacroiliitis (2.2 cm in right, 2.3 cm in left) and the width in age-matched controls (1.6 and 1.7 cm in right and left respectively) with surprisingly concordant results [4,5].

CDUS findings

Chronologically, however, the first study that assessed the possible application of US in the diagnosis of SIJ inflammation, used CDUS [7]. This study found high sensitivity of CDUS (100%) in patients with active sacroiliitis, but this lacked specificity as vascularization was also found in healthy controls and in patients with osteoarthritis. The RI of the vessels detected by CDUS was however significantly lower in patients with sacroiliitis.

Several later studies also used CDUS to detect vascularization in the region of the posterior SIJ as a sign of inflammation and all of them reported considerably more flow signals in patients with SpA, as well as a lower RI on spectral wave analysis, in these patients. The largest of these studies involved 161 AS patients (Hu et al.). 90.7% of patients, who had active disease (BASDAI > 4) had vascularization around the dorsal SIJs, compared to 38.5% in the inactive group (BASDAI < 4.0). The RI values in the active group were significantly lower [8]. More recently, Ghosh et al. conducted a study in 29 patients with inflammatory LBP and normal X-ray and 32 controls, comparing the CDUS findings with MRI. They found that the observation of three or more flow signals on CDUS and a RI below 0.605 correlated well with the MRI proven cases of sacroiliitis [6]. Finally, Rosa et al, found a sensitivity of 54% and a specificity of 82% for the CD US to diagnose axial SpA on a patient level [9].

Some studies have also further investigated how these CDUS findings change with treatment. For example, Jiang et al. found that compared to baseline, fewer



SIJ: sacroiliac joint; SFII: second sacral foramen; psil: posterior sacroiliac ligament; MM: multifidus muscle; tlf: thoracolumbar fascia; subc: subcutaneous tissue

Figure 1. Ultrasound image of the sacroiliac joint with the transducer positioned semi obliquely, shows well the posterior sacroiliac ligament which defines the joint upper border.

SIJs exhibited blood flow signals after the treatment in Infliximab in AS patients [10]. In another study, the RI values significantly increased in the subset of SpA patients who underwent anti-TNF therapy [7].

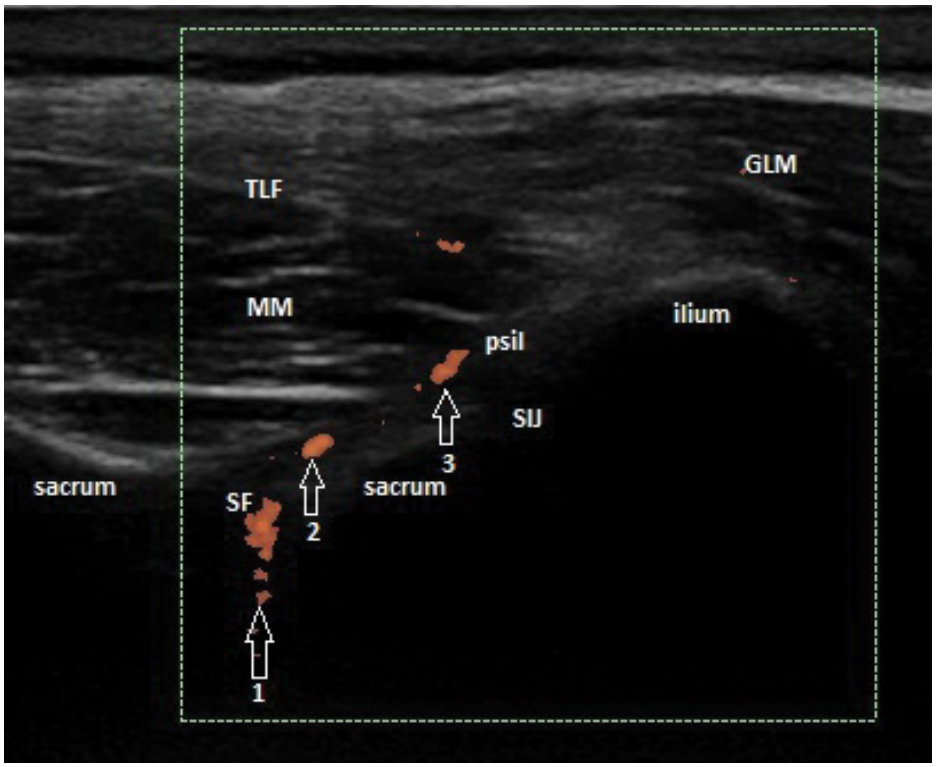
CEUS findings

Klauser et al measured the depth of the contrast US enhancement in the dorsocaudal part of the SIJ in 42 SpA patients and 21 controls [10]. The enhancement depth into the joint cleft was 18.5 mm (range 16-22.1 mm) in the clinically active SIJs. That was significantly deeper compared to both inactive joints of patients (3.6 mm, range 0-12 mm), and the healthy controls (3.1 mm, range 0-7.8 mm). The authors pointed out that while vascularization around the dorsal superficial SIJ could be seen in many healthy subjects, the extension of this vascularity into the deeper parts of the joint is what differed the symptomatic patients.

Discussion

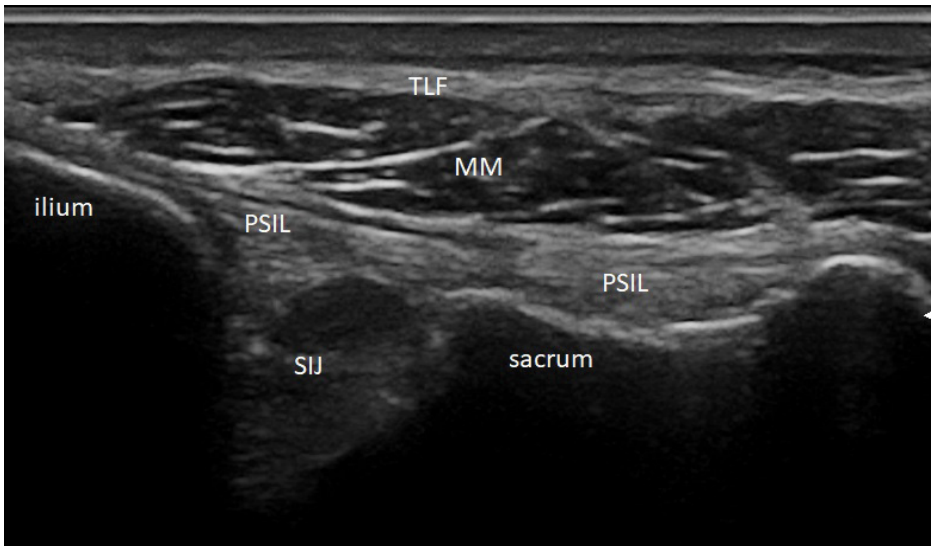
SIJ has a unique anatomy with a smaller synovial (caudal) and larger enthesial (cranial) parts. The joint line extends deeply in anterolateral direction (as viewed by the sonographer in a prone patient). This (unlike the most other commonly scanned human joints) allows for sonographical evaluation of only the most superficial posterior part of the joint, which, by itself, could be difficult to differentiate from the periarticular tissues dorsally of the SIJ. Here, in authors experience, a good landmark is the Posterior Sacroiliac Ligament (PSIL), which is readily identifiable by US and constitutes a reinforcement of the posterior SIJ capsule [11] (Figure 1). Accordingly, in US assessment of the SIJ, the findings detected under the PSIL, might be considered intraarticular, while those that are above it will represent pathology in the soft tissues posterior to the joint. Taking this in account, it is doubtful whether all of the flow signals reported by the studies utilizing CDUS were detected really inside the SIJ, or in the periarticular tissues, as neither of the above mentioned studies reported where the flow signals were detected in relation to PSIL. This problem was only solved in the studies utilizing CE US, where vascularization deep in the joint cleft was possible to be detected and was found to be augmented in sacroiliitis.

In addition, one had to bear in mind that superficial vessels in the posterior SIJ region are also commonly found in healthy subjects. For example, Pakkafahli et al. reported vascularization near the dorsal part of the



SIJ: sacroiliac joint; SF: sacral foramina, psil: posterior sacroiliac ligament; MM: multifidus muscle; tlf: thoracolumbar fascia, GLM: gluteus maximus muscle

Figure 2. Power Doppler transverse ultrasound image of the middle part of the sacroiliac joint shows a vessel exiting the sacral foramina (arrow 1), then coursing under the PSIL inside the SIJ (arrow 2) and finally piercing the ligament to go superficially (arrow 3).



SIJ: sacroiliac joint; psil: posterior sacroiliac ligament; MM:-multifidus muscle; TLF: thoracolumbar fascia

Figure 3. B-Mode semi-oblique image of the middle part of the sacroiliac joint shows various echogenicity under the PSIL, thus inside the SIJ cavity.

SIJ, caused by branches of the sacral arteries, in 13 out of 23 healthy controls [12] and Klauser et al found vascularization in 12 out of 21 healthy controls [10]. Furthermore, in a CDUS study, McGrath et al actually used the vascular signature of the dorsal sacral arteries to identify the dorsal sacral nerve rami beneath the PSIL in healthy individuals [13]. The vessels accompanying nerves could be identified in 62% of the subjects, which is again in correlation with the above figures. These nerves and their vessels emerge from the respective sacral foramina, course in a fascia layers beneath the PSIL (thus in the joint cavity) and then pierce the ligament to go superficially. These vessels could be frequently observed in the authors experience as well (Figure 2). Thus, caution should be taken especially when interpreting flow signals, that are close to the sacrum.

The BM US finding in SIJs could also pose difficulties in interpretation. Firstly, the OMERACT definition for joint fluid as "an abnormal hypoechoic or anechoic intra-articular material that was displaceable and compressible but did not exhibit Doppler signal" is difficult to apply for the SIJ, considering the depth and the anatomical characteristics of this joint. Secondly, hyperechogenicity in the joint cleft as a marker for synovitis could be also a doubtful finding as this may depend on the echogenicity of the overlaying tissues - in this case subcutaneous fat, the multifidus muscles and PSIL, which, in authors experience, could vary in different patients. On the other hand, beneath the PSIL, there is a fibro adipose tissue, that could also be of various echogenicity (Figure 3) [13]. In this situation the SIJ space width may remain the most objective marker for the joint pseudo-dilatation and then narrowing connected with SpA progress. There is enough data on the morphometric characteristics of SIJs coming from X-ray studies [14], but generally there is a need for larger studies to confirm that this is applicable to the US examination of the SIJs as well, as currently the total number of patients in the presented studies is low. In addition, the SIJ width depends on the sex and age, so these parameters should be taken in account too [14,15].

Conclusion

Lastly, when comparing the US to the MRI in sacroiliitis, it should be noted that MRI definition for sacroiliitis requires the detection of periarticular Bone Marrow Edema (BME) with certain parameters. The detection of synovitis, capsulitis or enthesitis on MRI, without BME, is insufficient to diagnose sacroiliitis in SpA, while exactly these entities is what US could possibly detect assessing the SIJs and their presence was used to diagnose sacroiliitis sonographically.

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