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# Magnetic Resonance Imaging/Ultrasound Fusion-Guided Corticosteroid Injection to Synovial and Ligamentous Portion of Sacroiliac Joint in Patients with Axial Spondyloarthritis

## Aksiyel Spondiloartrit Hastalarında Sakroiliak Eklemin Sinoviyal ve Ligamentöz Kısımlarına Manyetik Rezonans Görüntüleme/Ultrasonografi Füzyonu Rehberliğinde Kortikosteroid Enjeksiyonu

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## ABSTRACT

**Objectives:** The objective of the study was to retrospectively evaluate the feasibility of the magnetic resonance imaging (MRI)-ultrasonography (US) fusion system for the guidance of sacroiliac joint (SIJ) injections and the clinical results of patients who underwent intra-articular and peri-articular injections.

**Methods:** In this study, MRI-US fusion-guided SIJ injections in 10 patients with active sacroiliitis were evaluated retrospectively. Injections were made in the synovial part of the SIJ in 5 patients and in the ligamentous part in 5 patients.

**Results:** Injections were successful in treating pain in all patients. There was no significant difference in clinical responses (post-injection 2nd week and 3rd month) between synovial or ligamentous injection groups.

**Conclusion:** The MRI-US fusion method is an effective and reliable option for SIJ injection guidance. There is no difference in the effectiveness of corticosteroid injections into the synovial or ligamentous compartment in the management of sacroiliitis in spondyloarthritis patients.

**Keywords:** Image fusion technique; intra-articular injection; periarticular injection; sacroiliitis; spondyloarthritis; ultrasonography.

## ÖZET

**Amaç:** Bu çalışmada, sakroiliak eklem enjeksiyonlarının rehberliğinde manyetik rezonans görüntüleme/ultrasonografi füzyon sisteminin uygulanabilirliği ile intraartiküler ve periartiküler enjeksiyon yapılan hastaların klinik sonuçlarının retrospektif olarak değerlendirilmesi amaçlandı.

**Yöntem:** Çalışmada, aktif sakroiliit olan 10 hastada manyetik rezonans görüntüleme/ultrasonografi füzyon rehberliğinde yapılmış olan sakroiliak eklem enjeksiyonları retrospektif olarak değerlendirildi. Enjeksiyonlar beş hastada sakroiliak eklemin sinoviyal kısmına, beş hastada ligamentöz kısma yapıldı.

**Bulgular:** Enjeksiyonlar tüm hastalarda ağrı tedavisi açısından başarılıydı. Sinoviyal veya ligamentöz enjeksiyon grupları arasında klinik yanıtlarda (enjeksiyon sonrası ikinci hafta ve üçüncü ay) istatistiksel olarak anlamlı bir fark yoktu.

**Sonuç:** Manyetik rezonans görüntüleme/ultrasonografi füzyon yöntemi, sakroiliak eklem enjeksiyon rehberliği için etkili ve güvenilir bir seçenektir. Spondiloartrit hastalarında sakroiliit tedavisinde sinoviyal veya ligamentöz kompartımana yapılan kortikosteroid enjeksiyonlarının etkinliği arasında fark yoktur.

**Anahtar sözcükler:** Görüntüleme füzyon tekniği; intraartiküler enjeksiyon; periartiküler enjeksiyon; sakroiliit; spondiloartrit; ultrasonografi.

Axial spondyloarthritis (AxSpA) is a chronic inflammatory disease that mostly begins in the sacroiliac joint (SIJ), causing new bone formation and characteristic inflammatory changes in the SIJ, spine, and entheses.[1] Nonsteroidal anti-inflammatory drugs (NSAID), TNF inhibitors (TNFi), IL-17 inhibitors (IL17i), and tofacitinib are used in AxSpA treatment.[2,3] In case of isolated active sacroiliitis despite medical treatment, local glucocorticoid (GC) injections are recommended.[3] SIJ GC injections are successfully used in patients with sacroiliitis.[4-12] SIJ injections can be done intra-articularly (synovial) or peri-articularly (ligamentous). Results in studies comparing the effectiveness of intra-articular and peri-articular injections are contradictory.

Since the accuracy of unguided injections is low, fluoroscopy (FL), computed tomography (CT), magnetic resonance imaging (MRI), or ultrasonography (US) guidance are used for more accurate injections.[10,13] Recently, with the development of fusion imaging methods, it has been possible to use cross-sectional imaging methods such as MRI and CT together with US systems.[14] Successful results have been found in SIJ injections performed under the guidance of fusion of MRI or CT images with US.[14-16]

The aim of this study is to retrospectively evaluate the feasibility of the MRI-US fusion system for the guidance of SIJ injections and the clinical results of patients who underwent intra-articular and periarticular injections.

## Methods

### Patient Characteristics and Clinical Evaluation

Among the patients followed up with spondyloarthritis (SpA) in our clinic, patients who underwent US-MRI-guided SIJ GC injection between March and December 2020 were retrospectively screened. Exclusion criteria were the presence of SIJ pathologies other than acute sacroiliitis (chronic sacroiliitis, degenerative findings, and infection) and concomitant hip joint or lumbar pathologies. In total, 9 out of 19 patients were not included due to exclusion criteria. 8 of 10 patients had AxSpA and 2 had psoriatic arthritis (PsA). There were 8 female and 2 male patients, mean age was 37.6 years. All AxSpA patients were receiving NSAID treatment, 2 of them were additionally using sulfasalazine. One of the PsA patients was on metotrexate and the other was on secukinumab treatment.

Before the injection, the patient's pain was evaluated with visual analog scale (VAS), and it was recorded whether the synovial or ligamentous part was targeted for the injection. The part where bone marrow edema is more/prominent in sacroiliac MRI was selected as the compartment to be injected. VAS scores were re-evaluated at 2 weeks and 3 months after the injection by face-to-face or phone calls.

### Injection Procedure

Informed consent form was obtained from all patients before the procedure. Procedures were performed using 1–6 MHz curved array transducer (ARIETTA 850, Hitachi, Tokyo, Japan). The patients were placed in the prone position with a pillow under the abdomen, the injection area was sterilized, and a sterile cover placed over the probe. A sensor was attached to the probe and a magnetic field generator was placed near the injection site (Fig. 1a). Thus, it was ensured that the movements of the ultrasound transducer in the spatial plane were followed within the magnetic field provided by the generator. MRI images previously taken at the aforementioned position were uploaded to the US system through CD-ROM in DICOM format. After that, the matching of MRI and real-time US images was started. First of all, the US image at the same level with the MRI section selected for plane registration was displayed (Fig. 1b).

For synovial injections, the section at the level of the second sacral foramen was chosen, as stated by Klauser et al.,[17] to increase the possibility of the needle tip being in the joint. Ligamentous injections were done at the level between the S1-S2 spinous processes as described by Saunders et al.[18] The MRI and US images were then displayed in a split screen, and the anatomical structures that could be easily identified on both the MRI section and the US screen were matched for point registration (Figs. 2 and 3). After the registration was

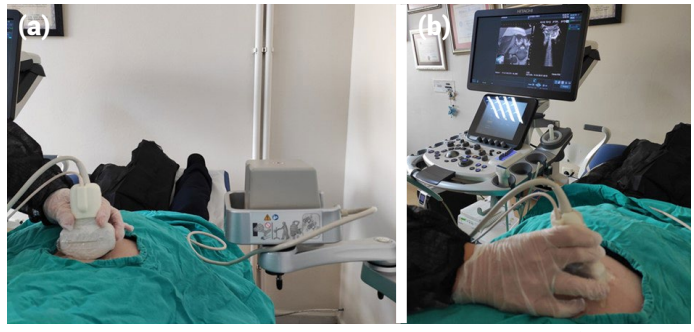


**Figure 1**. **(a)** The sensor linked to the ultrasonography (US) transducer, the magnetic field generator placed close to injection site. **(b)** View of magnetic resonance imaging and real-time US on split screen for plane registration.

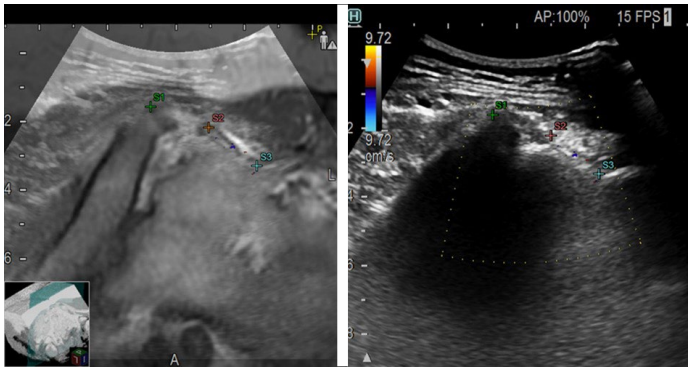

**Figure 2**. Plane and point registration at the level of 2nd sacral foramen for synovial injections. Magnetic resonance imaging on the left and real-time ultrasonography images on the right are matched by placing S1, S2 and S3 points.

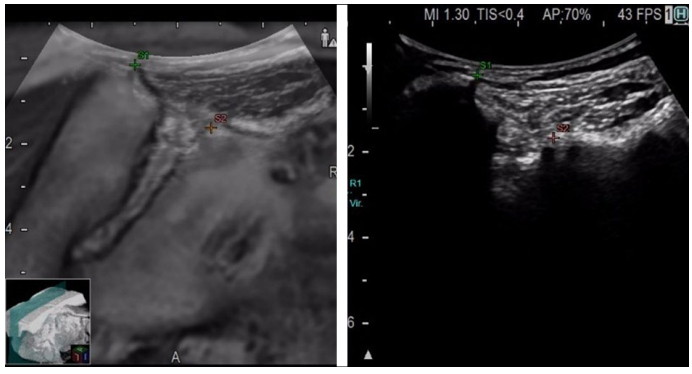

**Figure 3**. Plane and point registration at the level between S1 and S2 spinous processes for ligamentous injections. Magnetic resonance imaging on the left and real-time ultrasonography images on the right are matched by placing S1 and S2 points.

completed, it was ensured that the MRI and US images displayed on the split screen were moving synchronously. MRI and US images were then superimposed, and this image was used to guide the injection.

### Statistical Evaluation

IBM SPSS Statistics 22 (SPSS IBM, Turkey) programs were used for statistical analysis. The suitability of the parameters to the normal distribution was evaluated by the Kolmogorov-Smirnov and Shapiro Wilks tests, and it was found that the parameters did not show a normal distribution. Mann–Whitney U test was used for the comparison of parameters between two groups, and Wilcoxon sign test was used for in-group comparison. Significance was evaluated at the $p<0.05$ level.

## Results

A total of 10 patients, all unilateral, received SIJ GC injections. The mean age was 37.6 years. Patient characteristics, target SIJ portion, and pain scores are presented in Table 1.

Evaluation of VAS according to injection sites is presented in Table 2. There is no statistically significant difference in pre-injection VAS levels between patients who underwent synovial and ligamentous injection ($p>0.05$). Post-injection 2$^{nd}$ week VAS levels of patients who underwent ligamentous injection were significantly lower than those who received synovial injection ($p=0.042$; $p<0.05$). There is no statistically significant difference in post-injection 3$^{rd}$ month VAS levels between patients who underwent synovial and ligamentous injection ($p>0.05$).

In cases with synovial injection; the decreases in post-injection 2$^{nd}$ week and 3$^{rd}$ month VAS levels according to pre-injection VAS level are statistically significant ($p<0.05$).

In cases with ligamentous injection; the decreases in post-injection 2$^{nd}$ week and 3$^{rd}$ month VAS levels according to pre-injection VAS level are statistically significant ($p<0.05$).

**Table 1. Patient characteristics and pain scores**

| Patient | Sex/Age/Disease | Pre-inj VAS | Post-inj 2$^{nd}$ week VAS | Post-inj 3$^{rd}$ month VAS | Injection target |
|---|---|---|---|---|---|
| 1 | F/40/AxSpA | 9 | 2 | 2 | Synovial |
| 2 | F/45/AxSpA | 10 | 2 | 5 | Ligamentous |
| 3 | F/46/PsA | 10 | 2 | 2 | Synovial |
| 4 | M/38/AxSpA | 9 | 3 | 4 | Synovial |
| 5 | F/32/AxSpA | 10 | 2 | 1 | Synovial |
| 6 | M/22/AxSpA | 9 | 1 | 0 | Ligamentous |
| 7 | F/35/AxSpA | 10 | 1 | 1 | Ligamentous |
| 8 | F/38/AxSpA | 10 | 2 | 3 | Synovial |
| 9 | F/40/PsA | 8 | 2 | 1 | Ligamentous |
| 10 | F/40/AxSpA | 10 | 1 | 1 | Ligamentous |

AxSpA: Axial spondyloarthritis; PsA: Psoriatic arthritis; VAS: Visual analog scale.

Table 2. Evaluation of VAS according to injection sites

| VAS | Mean±SD (median) | | [1]p |
|---|---|---|---|
| | Synovial | Ligamentous | |
| Pre-injection | 9.6±0.5 (10) | 9.4±0.9 (10) | 0.811 |
| Post-injection 2nd week | 2.2±0.4 (2) | 1.4±0.5 (1) | 0.042* |
| Post-injection 3rd month | 2.4±1.1 (2) | 1.4±2.1 (1) | 0.167 |
| Pre-inj – Post-inj 2nd week [2]p | 0.039* | 0.041* | |
| Pre-inj – Post-inj 3rd month [2]p | 0.042* | 0.042* | |

[1]Mann Whitney U Test. [2]Wilcoxon sign test. *p<0.05. VAS: Visual analog scale.

There is no statistically significant difference between the patients who received synovial and ligamentous injection in terms of the amount of decrease in VAS level seen in the post-injection 2nd week according to the pre-injection VAS level (p>0.05).

There is no statistically significant difference between the patients who received synovial and ligamentous injection in terms of the amount of decrease in VAS level seen in the post-injection 3rd month according to the pre-injection VAS level (p>0.05). Evaluation of VAS changes according to injection sites is presented in Table 3.

## Discussion

SIJ has a complex anatomy with an anteroinferiorly synovial and posterosuperiorly ligamentous structure. This complexity raised the question of which part of the SIJ should the injectate be given. SIJ injections can be performed intra-articularly or peri-articularly. In the literature, while the intra-articular location corresponds to the synovial part of the SIJ, there is a discrepancy in terms of the definition of the periarticular location. Murakami et al.[19] defined the periarticular location as the region of ligaments supporting the SIJ in the cranial part of the SIJ. Althoff et al.[20] described injections into the retroarticular space as periarticular, while Hartung et al.[21] observed that the injectate was distributed into the posterior soft tissues in periarticular injections. Intra-articular SIJ GC injections have been found to be effective and safe in SpA patients with active sacroiliitis in many studies.[6,7,12] In the study of Luukkainen et al.,[8] in which periarticular SIJ injections were administered to 20 seronegative SpA patients with sacroiliitis, a significant improvement was found in the pain scores in the GC group compared to the placebo group. There are studies about whether injections should be done intra-articularly in patients with sacroiliitis or periarticular injections are sufficient. Althoff et al.[20] evaluated intra-articular (n=22) and periarticular (n=7). GC injections of SIJ in 29 SpA patients with active sacroiliitis; there was a statistically significant improvement in pain scores in the intra-articular group during the 6-month follow-up, while there was no significant reduction in pain in the periarticular group, but they stated that periarticular injections may be beneficial in ankylosed joints or enthesitis in posterior ligamentous structures. Conversely, similar clinical results were observed between the two groups in 20 SIJ GC injections performed intra-articularly (n=8) or periarticularly (n=12) in the study by Hartung et al.[21] Furthermore, in another study evaluating 39 SIJ GC injections in 34 patients, no significant difference was found between the intra-articular and peri-articular injection groups.[11] Similarly, we did not find a significant difference between the ligamentous and synovial injection groups in terms of change in VAS. Although the results regarding the superiority of intra-articular injections over periarticular injections are conflicting, periarticular SIJ GC injections seem to be sufficient in the treatment of sacroiliitis. However, the definition of periarticular injection may need to be clarified.[22] In this study, we used the term ligamentous instead of periarticular, which is frequently used in the literature and has uncertainty in its definition. Injections into the ligamentous portion of the SIJ were done as described by Saunders et al.[18] Results in patients who had injection into the ligamentous portion were successful, consistent with previous studies demonstrating the efficacy of periarticular injections although there are dif-

Table 3. Evaluation of VAS changes according to injection sites

| VAS change | Ort±SS (median) | | p |
|---|---|---|---|
| | Synovial | Ligamentous | |
| 2nd week | 7.4±0.9 (8) | 8±1.2 (8) | 0.262 |
| 3rd month | 7.2±1.5 (7) | 8±2 (9) | 0.390 |

Mann Whitney U-test. VAS: Visual analog scale.

ferences between them in terms of the definition of the periarticular area.[8,11,21] It has been shown in MRI studies that bone marrow edema, one of the most important findings showing inflammation in SIJ in axial SpA patients, is not uncommon in the ligamentous part of the joint and entheseal compartments.[23,24] The study by Sakamoto et al.[25] evaluating the mechanoreceptors in SIJ and adjacent tissues showed that most of these receptors are nociceptive. In total, 26 of the 29 receptors were found in the posterior sacroiliac ligament, 3 in the adjacent muscles, and 93% were located in the upper 2/3 of the SIJ, which is mostly ligamentous. Therefore, the extra-articular area can also be a source of pain. The area of the joint where SIJ injections should be applied can be demonstrated by comparative studies.

FL, CT, MRI, and US are used to guide SIJ injections to increase accuracy, as the success of blind injections is low.[10,13] All these imaging modalities used for guiding injections have some advantages and disadvantages. In studies evaluating the accuracy of SIJ injections in terms of intra-articular location, FL appears to be accurate in 80-96% of injections.[13] Intra-articular placement of the needle tip under CT guidance was found to be 76% in one study.[20] Both FL and CT are safe and frequently preferred methods for guidance of SIJ injections with high accuracy, but high radiation exposure limits their use although radiation reduction protocols are currently used.[26] Intra-articular localization was achieved in 90.4% of real-time MRI-guided SIJ injections in a study.[27] However, the use of MRI in interventional procedures is limited because it is a time-consuming and expensive method. US is a safe, fast, easy-to-apply, radiation-free method. There are studies showing that US is less accurate in terms of intra-articular needle placement compared to FL.[26,28] Results regarding the accuracy of US in SIJ injections have inconsistent results ranging from 37.5% to 96%.[13,21,29] This discrepancy may be related to higher ages of the patients in the sample group, or narrowing, ankylosis, and bone spurs in the SIJ due to inflammatory or degenerative processes.[21,30] Another handicap of US during SIJ injections is that the needle tip cannot be followed after reaching the joint space.[14] As the tip of the needle goes through the hypoechoic cleft between the sacrum and the ilium, it cannot be followed further due to the acoustic shadowing caused by the ilium. All these disadvantages can be eliminated using multiple imaging methods together. Imaging fusion technologies are used in soft-tissue biopsies because they provide good navigation for the target tissue. Recently, the availability of fusion technologies to guide musculoskeletal interventions has been evaluated in in vitro[31] and in vivo[32,33] studies. There are studies showing that SIJ injections can also be successfully performed with the guidance of US and MRI or CT fusion method. Burke et al. [15] found the SIJ injection they made to one patient under the guidance of US-MRI fusion to be successful in terms of symptomatic recovery. In the study of Zacchino et al.,[16] 7 SIJ injections were administered to 6 patients with sacroiliac pain syndrome under the guidance of US-MRI fusion. The results were found to be successful in terms of spatial accuracy, and an 80% reduction in pain was achieved in all patients. In the study of Klauser et al.,[14] in which US-CT-guided SIJ injections were performed in cadavers and patients; accuracy of the injections, and success in terms of pain scores were evaluated. All 10 SIJ injections in 5 cadavers were confirmed to be intra-articular. In the patient group, pain scores were significantly reduced in all 10 SIJ injections in 7 patients. In our study, in accordance with the results of other fusion studies, SIJ injections in all patients were successful in terms of change in VAS scores.

There are some limitations in our study. First of all, the number of patients evaluated is relatively small. Although these results show that US-MRI fusion can be used successfully for the guidance of SIJ injections, further large-scale studies are needed. Another limitation is that injections guided by US alone were not evaluated as a control group, and therefore the fusion technique could not be compared in terms of superiority to US guidance. Last but not the least, the accuracy of injections targeting the synovial portion of the SIJ has not been confirmed by control imaging with contrast agent administration.

## Conclusion

US-MRI fusion guidance can be used successfully in SIJ injections. Although problems such as narrowing, ankylosis, and bone spurs in the SIJ due to inflammatory or degenerative processes can reduce the accuracy of US-guided injections, anatomical structures that cannot be normally assessed by US can be seen thanks to the 3-dimensional joint configuration provided by MRI. Furthermore, it provides cost-effective since MRI images taken once can be reused for repetitive injections. Comparative studies with a large number of patients are necessary to evaluate the feasibility of the fusion method. There is no difference in the effectiveness of GC injections into the synovial or ligamentous compartment in the management of sacroiliitis in SpA patients. Both methods are reliable.

**Disclosures**

**Ethics Committee Approval:** University of Health Sciences Fatih Sultan Mehmet Training and Research Hospital, E-17073117-050.06, 01.09.2021.

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**Conflict of Interest:** None declared.

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