

Sacroiliac pain and CT-guided steroid injection treatment: high-grade arthritis has an adverse effect on outcomes in long-term follow-up

B. SAVRAN SAHIN¹, E. AKTAS¹, B. HABERAL², A. HARMAN³,
A. CANAN YAZICI⁴, H. KAYGUSUZ¹, B.K. ARIBAS¹

¹Department of Radiology, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkey

²Department of Orthopaedics and Traumatology, Baskent University, Ankara, Turkey

³Department of Radiology, Baskent University, Ankara, Turkey

⁴Department of Biostatistics, Baskent University, Ankara, Turkey

Abstract. – OBJECTIVE: The sacroiliac joint (SIJ) is one of the major sources of low back pain that can lead to severe morbidity. Possible SIJ pain requires a thorough evaluation and treatment option. The purpose of this study was to analyze the possible relationships between computed tomography (CT) grading of SIJ arthritis and the effectiveness of intraarticular steroid injection treatment under CT guidance.

PATIENTS AND METHODS: A total of 61 patients with SIJ pain who were treated with CT guided intraarticular steroid injection were retrospectively reviewed. Visual analog scale (VAS) scores for pain control were recorded for short-term (day after injection, first week, third week) and long-term (sixth months and final control) follow-up times. SIJ arthritis was graded using CT images according to the New York criteria. Patients were assigned into low-grade (0, 1 and 2) and high-grade (3 and 4) groups. The relationship between arthritis grades and VAS scores in short and long-term follow-ups were statistically analyzed.

RESULTS: Mean age and follow-up was 54.8 years (range: 41-68 years) and 27.8 months (range: 24-36 months), respectively. In 40 patients there was low-grade arthritis, while 21 patients were characterized on having high-grade sacroiliac arthritis detected during the radiological evaluation. There was no statistically significant difference between low and high-grade arthritis in regard to short-term VAS scores. On contrary, for long-term VAS scores, there was significant difference between low- and high-grade arthritis.

CONCLUSIONS: Steroid injection treatment for SIJ pain is not effective on a long-term basis for patients with high-grade arthritis, and although they have had decreased VAS scores in the short-term, after 2 years of follow-up, their

VAS scores significantly increased leading to symptomatic sacroiliac joint pain.

Key Words:

Computed tomography, Injection, Arthritis, Grade, Sacroiliac pain.

Introduction

Low back pain is a common condition, which has lifetime prevalence between 60-80% and remains a huge socioeconomic burden worldwide^{1,2}. It has a multifactorial basis conditioned upon a variety of factors³ including, most commonly, lumbar intervertebral discs⁴, symptomatic facet joints of the vertebrae^{5,6}, and finally, sacroiliac joints (SIJ)⁷. Although numerous treatments have been advocated for the treatment of SIJ pain, there still exist various controversies on the effectiveness of the available treatment options^{8,9}. Hence, understanding the etiological factors and their pathologic pathways is an important issue in order to clarify the efficacy of the various treatment alternatives.

In the literature, the SIJ pain has been recently indicated as a major source of low back pain. It can originate from both the joint capsule and the posterior ligamentous tissues with various etiological factors including direct trauma, repetitive and torsional forces, rheumatologic inflammation, or idiopathic onset and arthritis^{8,10,11}. Steroid injection into the SIJ under the guidance of computed tomography (CT) is one of the treatment alternatives for these pa-

tients with SIJ pain; however, this requires further investigation for the understanding of its long-term efficacy^{7,9,12-14}. Although there are various studies analyzing the effectiveness of intra-articular steroid injection methods for SIJ pain relief in regards to different guiding methods and follow-up periods^{7,8,14-18}, there is no single study analyzing the effectiveness of SIJ injections in regard to patients' characteristics including the grading of sacroiliac joint arthritis. CT of the SI joints may be used for arthritis grading detection of structural changes; CT is superior to conventional radiography for detecting bony changes related to SIJ. Magnetic resonance imaging (MRI) can detect bone edema and fatty conversion in the subchondral marrow. It can also demonstrate joint inflammation in the synovial joint. However, MRI cannot visualize the bony structures and arthritis as effectively as CT, and the role of SIJ pain diagnosis using resonance imaging is still a matter of discussion, especially for non-inflammatory SIJ pathologies. Although there is no firm consensus on the relative merits of CT versus MRI in the grading of SIJ arthritis, CT is superior to MRI in the evaluation of the bony structure of the SIJ and associated sclerosis, osteophytes and/or ankylosis.

It is unknown if the grade of SIJ arthritis affects the outcomes of the intra-articular injection treatment. The purpose of this study was to analyze the possible relationships between SIJ arthritis grading using CT imaging and the outcomes of the intra-articular steroid injection treatment under CT guidance for patients with SIJ pain; patients were followed up for two years.

Patients and Methods

Study Group

Between January 2009 and December 2013, all patients with SIJ pain, who were treated with CT guided intra-articular steroid and local anesthetic injection, were reviewed for this study. All patients in the study group had active SIJ pain requiring treatment and most importantly, all had fulfilled the criteria previously described by Murakami et al⁹ indicating that their origin of pain was the SIJ (Table I).

SIJ pain persisting for at least 2 months with a failed conservative treatment (failure to respond to nonsteroidal anti-inflammatory therapy for a period of 4 weeks) was accepted as the major indication for injection therapy. Patient history, physical examination, laboratory findings and radiological imaging tools including CT and MRI scans, if needed were used for the establishment of the diagnosis of SIJ pain¹¹. Previous pelvic-lumbosacral surgery or any fracture history regarding posterior pelvic ring and degenerative arthritis of the hip joints that can radiate to the posterior pelvic ring mimicking any SIJ pathology were accepted as the exclusion criteria. Disc pathologies of the lumbar region and spondyloarthropathies were also included in the analysis if they had no signs of radiculopathy or radiating pain.

During enrollment, 67 patients (30 males and 37 females) were found to be eligible. Written informed consent was given to all patients prior to injection. Six patients were lost during the follow-up. Therefore, a total of 61 patients were evaluated for the final analysis.

Table I. Patients who fulfilled the criteria described in the table were accepted into the study group with the diagnosis of Sacroiliac joint pain.

Criteria for the diagnosis of Sacroiliac joint (SIJ) pain
Laterally located pain over the SIJ line
Positive findings on at least one of the following three provocation tests for SIJ pain:
Gaenslen's test (the hip joint is flexed maximally on one side and the opposite hip joint is extended, stressing both sacroiliac joints simultaneously)
Patrick's test (Flexion, Abduction External Rotation-FABERE test)
Newton's test (Thigh hyperflexion test)
Negative response to Kemp's test which is one of the pain provocation tests for sciatica (Patient's trunk rotates obliquely downward in the affected lumbosacral area. Positive if Lower back pain that radiates into lower extremities)
No disorders in the hip joint
No signs of lumbar radiculopathy
No findings suspicious of infectious arthritis on the laboratory investigation or on plain radiographs

Injection Technique

The same interventional radiologist (A.H.) performed all injections with the technique previously described by Bollow et al¹⁶. The details of the injection technique were previously described in another study⁷. Briefly, patients were placed in a prone position on the CT table (Somatom plus-Siemens AG, Munich, Germany). After scouting the pelvis, the SIJs were scanned with a section thickness of 4 mm and a table advancement of 8 mm. The images were viewed in the bone window on a Somatom plus CT scanner (Siemens AG, Munich, Germany). The most suitable access to the synovial articular compartment bilaterally was determined accordingly and set as the table position. After local anesthetic (10 ml of 2% lidocaine per joint, Adeka, Istanbul, Turkey) administration, the needle tip (1.2 mm diameter = 18 gauge, 50 to 100 mm length; Angiomed Germany, Karlsruhe, Germany) was positioned in the articular cavity, and prior to injection, 0.5 ml of hypertonic saline solution was injected into the joint space for provocation of the pain¹⁸. After positive provocation test, a mixture of long-term corticosteroid (80 mg triamcinolone acetate, Sinokort-A, E, Istanbul, Turkey) and local anesthetic (4 cc bupivacaine hydrochloride, Chirocaine, Abbott, IL, USA) was injected.

Data Collection and Radiographic Evaluation

All patients' data including demographics and smoking history were retrospectively reviewed by one investigator (B.S.), using a computerized patient database and medical records. Visual analog scale (VAS) was used for the evaluation of pain before and after injection¹⁹. The VAS consisted of a 100-mm horizontal line, which has two end points with the words "no pain" and "worst pain imaginable." All the patients were asked to mark the line at the point that best represented the intensity of his or her pain. The VAS numeric value was determined in millimeters from "no pain" to the point marked by the patient¹⁹. If the VAS score was below 50, the injection was accepted as "successful". The scores including the day after injection, first and third week controls were grouped as "short-term", while scores including sixth months and at final control were grouped as "long-term". As a result, two VAS score groups (*short and long-terms*) were retrospectively reviewed for each patient. Additionally, time to return to daily activities for patients was also recorded for the evaluation of the functional outcomes.

All radiographic evaluations were performed by one investigator (B.S.). All sacro-iliac CT images of the patients were retrospectively reviewed using the Picture Archiving and Communication System (PACS ver.1.0, Interpacs systems, Ankara, Turkey) of the radiology department. All examinations were performed with 4-mm-thick contiguous slices in a semi-coronal plane parallel to the anterior border of the sacrum with a high-resolution algorithm²⁰. Age and gender of the patients were blinded on the system in order to prevent any bias. Each joint sacroiliac arthritis was graded according to the modified New York criteria and assigned one of five grades: 0, normal; 1, some blurring of the joint margins-suspicious; 2, abnormal with erosions or sclerosis; 3, unequivocal abnormal, moderate, or advanced arthritis showing one or more of: erosion, sclerosis, widening, narrowing, and partial ankylosis; 4, total ankylosis²¹. The grades 0, 1 and 2 were grouped as *low-grade* arthritis and grades 3 and 4 were grouped as *high-grade* arthritis.

Statistical Analysis

Shapiro-Wilk's test was used to assess the normality of distributions of the variables, and Levene's test was used to assess the homogeneity of variances in the different groups. If parametric test assumptions are available, two independent group means were compared by Student's *t* test. Dependent group means were compared by paired *t* test. If parametric test assumptions are not available, Mann Whitney U test was used for comparisons of independent groups' medians. Dependent groups' medians were compared by Wilcoxon test. The results of statistical analysis were expressed as number of observations (*n*), mean $\pm$ standard deviation, median, minimum-maximum values and interquartile ranges (IQR). Statistical analyses were performed by SPSS software (Statistical Package for the Social Sciences, version 17.0, SSPS Inc., Chicago, IL, USA). A *p* value < 0.05 was considered statistically significant.

Results

The mean age and mean follow-up period was 54.8 years (range: 41-68 years) and 27.8 months (range: 24-36 months), respectively. In 40 patients there was low-grade and in 21 patients there were high-grade sacroiliac arthritis detected during the

radiological evaluation (Table II). The normality of distributions and homogeneity of the variables was found comparable statistically between low and high-grade patients. There were only 7 bilateral injections (4 low grade and 3 high-grade), which were analyzed separately. Ten out of 61 patients (16.3%) needed a second injection due to VAS scores greater than 50 (median VAS: 70, min-max: 55-95, IQR: 21.50) the day after injection. All these patients had high-grade arthritis (8 grade-3 and 2 grade-4). There were no intra- or post-injection complications recorded. The mean time for return to normal daily activities for low and high grade patients was 5.6 (range 3-7 days) and 5.9 days (range 3-8 days), respectively. There was no statistically significant difference between low and high grade patients in regard to time to return to daily activities ($p = 0.421$).

The median VAS scores for male and female patients and for smokers and non-smokers in short and long-term follow-up were summarized in Table III. There were no statistically significant differences between gender and smoking habits in regard to short and long term VAS scores ($p = 0.782$ and 0.655 for short and long-term VAS scores for gender and $p = 0.479$ and 0.621 for short and long-term VAS scores for smoking habits, respectively). Gender difference and smoking habits do not have a significant effect on the outcomes of sacroiliac steroid injection in short and long-term follow-up.

The median VAS scores for low and high-grade arthritis and short and long-term follow-up were summarized in Table IV. There was no statistically significant difference between low and high-grade arthritis in regard to short-term VAS scores ($p = 0.719$). On the contrary, for long-term VAS scores, there was significant difference between low and high-grade arthritis. So, although there is no difference in effectiveness of steroid injection on a short-term basis, regardless of the grade, its long-term efficacy significantly reduces if the patient has a high-grade arthritis. In addition, the comparison of median VAS scores between short-term and long-term follow-ups also

revealed that although there was no statistically significant difference of VAS scores in regard to low-grade patients ($p = 0.208$), in high-grade arthritis, short and long-term follow-up VAS scores were significantly different ($p = 0.007$) (Table V).

Discussion

This is one of the first studies in the literature analyzing the relationship between SIJ arthritis (diagnosed by CT) and the effectiveness of steroid injection as a treatment option. Although the outcomes of this technique have been previously published in the literature with various study populations^{7,16,17}, the relationship between the degree of SIJ arthritis and the effectiveness of injection treatment has not been previously described.

SIJ Pain and Treatment Alternatives

SIJ is a diarthrodial joint with a strongly supported network of muscles and ligaments and has various connections and neural innervations, including lumbosacral nerve roots, and surrounding soft tissues supporting the stability of the pelvic ring¹¹. For this reason it is unable to function in isolation; anatomically and biomechanically it shares its muscles and innervations with the hip and lumbosacral joints. As a result, it was widely accepted that SIJ arthritis could be the source of low back pain that might require meticulous intervention and treatment²². For this reason, in recent years, various studies have been published in the literature analyzing the possible etiologic factors and treatment alternatives including non-interventional conservative management addressing the underlying pathology, as well as interventional management with radiologically guided para- or intra-articular steroid injections for SIJ pain^{9,12,23}. Nevertheless, the best treatment method is still a matter of debate, and data regarding long-term clinical benefits of SIJ injections is scarce and inconclusive.

Table II. The sacroiliac arthritis grades and total percentages according to computerized tomography evaluation.

Arthritis grades	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Total
Low-grade	10	17	13	N/A	N/A	40 (65.5%)
High-grade	N/A	N/A	N/A	17	4	21 (34.5%)

N/A: Not Applicable.

Table III. The median VAS scores with minimum-maximum values and interquartile ranges for male and female patients and smoking habitus in pre-injection and short and long-term follow-ups.

VAS scores (min-max)	Pre-injection	Short-term	Long-term follow-up
Gender			
Male	92 (80-100)	18.6 (0-60)	22 (0-82)
Female	89.5 (80-100)	18 (0-86)	25.7 (0-65)
<i>p</i> values*	0.547	0.782	0.655
Smoking habitus			
Yes	88.5 (80-100)	15 (0-70)	20 (0-70)
No	95 (80-100)	19.5 (0-80)	23.5 (0-65)
<i>p</i> values*	0.325	0.479	0.621

Min: Minimum; Max: Maximum; $p < 0.05$ is significance level; Mann-Whitney test.

Table IV. The median VAS scores with minimum-maximum values and interquartile ranges for low and high-grade arthritis in pre-injection and short and long-term follow-ups.

VAS scores, min-max	Pre-injection	Short-term	Long-term follow-up
Arthritis grade			
Low-grade	90 (80-100)	18.2 (0-86)	10 (0-65)
High-grade	89 (80-98)	18.5 (0-61)	45 (28-82)
<i>p</i> values*	0.430	0.719	< 0.05

Min: Minimum; Max: Maximum; $p < 0.05$ is significance level; Mann-Whitney test.

SIJ arthritis is one of the major causes of SIJ pain and can be the result of various factors including advanced age, overuse injuries, obesity and inflammatory problems^{24,25}. For this reason, evaluation of the etiological factors and grading of this SIJ arthritis is one of the main concerns in the literature in regard to diagnosis standardization, and understanding the pathology so an effective treatment of the SIJ pain can be achieved. Among the treatment alternatives, intra-articular SIJ injections with steroid and local anesthetics often serve the dual function of being therapeutic and aiding in diagnosis. To summarize these studies, although most investigators have found radiologically guided SIJ injections to provide good to excellent pain relief lasting from six months to one-year period^{7-9,12-14,16-18}, none had analyzed if SIJ arthritis had an effect on out-

comes in long-term after injection treatment. For this reason, in our study, we have tried to figure out, specifically, the effect of SIJ arthritis and other patient co-factors including gender and smoking habit on the efficiency of CT guided intra-articular steroid injection treatment for the SIJ pain.

Radiologic Evaluation and Diagnosis of SIJ Pain

While conventional radiography is still the first imaging method used to evaluate SIJs in patients with a clinical suspicion of SIJ pain, a number of studies have demonstrated that use of sectional imaging of SIJs is much superior to X-rays, allowing for earlier and a more precise diagnosis^{10,26,27}. CT imaging of SIJs has been reported to be significantly superior to convention-

Table V. The comparisons of median VAS scores between short and long-term follow ups in regard to grade of SIJ arthritis.

Comparisons*	Short vs. long term median VAS scores
Low-grade arthritis	$p = 0.208$
High-grade arthritis	$p = 0.007$

$p < 0.05$ is significance level; Wilcoxon signed rank test.

al radiography in staging of erosions and osseous sclerosis and can be easily used for the diagnostic purposes in patients with SIJ pain²⁷. MRI, on the other hand, is a useful tool, especially for analyzing the soft tissue components of the SIJ and detecting peripheral bony edema seen in the inflammatory processes like sacroiliitis. Nevertheless, although MRI is useful for the diagnosis of inflammatory sacroiliitis, it has very limited use for SIJ arthritis grading. In our study, we did not use MRI routinely as a diagnostic tool for SIJ pain; it was only used for patients with possible inflammatory arthritis. In the literature, apart from radiologic evaluation, the gold standard method is still accepted as the intraarticular stimulation of pain via injection for the diagnosis of SIJ pain^{13,18,28}. In this study, we have used CT-guided provocative saline injection prior to steroid injection and confirmed that all patients had pain mimicking their clinical symptoms. In addition, we have used CT imaging for the evaluation SIJ arthritis and used New York Criteria for grading as we believe that the bony structures and the grade of SIJ arthritis can be more precisely visible with CT imaging²¹.

The New York criteria were originally revised in 1967 and modified in 1984 by van Der Linden et al²¹ for the grading of plain radiographs in patients with SIJ pain. Since then, conventional radiography using these criteria has been one of the major scoring system used in the diagnosis and grading of SIJ arthritis. They have also been successfully applied for CT imaging²⁶. In a recent study by Geijer et al²⁹, New York grading criteria were also validated with the CT imaging and proposed as a scoring system for the grading of SIJ arthritis. In our study, we also used these criteria with CT imaging for the grading of the SIJ arthritis and hypothesized whether the grade of SIJ arthritis would have an effect on the outcomes of steroid injection treatment.

Clinical Outcomes

SIJ steroid injection therapy is one of the treatment alternatives for SIJ pain that needs careful evaluation with respect to its effectiveness for short and long-term pain relief. In the literature, there have been various reports regarding the patients' pain scores, complications and functional results^{8,13,16,17,23}. In a previous study by Sahin et al⁷, CT guided SIJ steroid injection was reported as a safe and effective method in the long term with a 69.5% success rate after minimum 2-years

of follow-up. In other studies, similar results with more than 50% success rates were reported in the literature^{8,9,17}. Nevertheless, the patients' factors including gender difference, smoking habits or the grade of SIJ arthritis and its effect on the outcomes were never measured in these studies. For this reason, in the current study, we have evaluated these factors and analyzed if they have an effect on the outcomes of steroid injection treatment.

Although, it has been widely accepted in the literature that SIJ pain is more commonly seen in smokers and female patients¹¹, data is inconclusive regarding the effect of gender differences and smoking history on steroid injection treatment. The studies in the literature have generally demonstrated higher frequencies of SIJ pain and higher VAS scores in smokers and female patients after the injection treatments³⁰. On contrary, in a study by Irwin et al³¹, 158 patients underwent SIJ injection and no significant difference was reported between smokers and male and female patients in regards to effectiveness of the injection treatment. Nevertheless, these studies in the literature did not have homogeneous study populations and have different guiding methods for the injection treatment. In our study, gender differences and smoking had no statistically significant influence on the outcomes of the steroid injection treatment.

We also determined that the grade of SIJ arthritis had a statistically significant relationship with the outcomes of the steroid injection. Although short-term follow-up did not reveal any differences of VAS scores between patients with low- and high-grade SIJ arthritis, long-term follow-up patients with high-grade arthritis had a significantly higher VAS scores compared with low-grade patients. It is well known that increased age is a risk factor for the joint degeneration especially for the weight-bearing joints³⁰. We had also comparable results, finding that increased age is significantly associated with an increased grade of SIJ arthritis, leading to the significantly higher VAS scores on long-term follow-up.

Our study has some limitations that must be addressed. First of all, the current study is a retrospective study with no control group. Second, there were only 21 patients with high-grade arthritis. So, a larger study population with more high-grade patients can give more valuable outcomes. Third, although it is well known in the literature that body mass indices had an effect on

SIJ pain³¹, we did include it as a parameter into our study as the retrospective data was lacking this information. Finally, the follow-up period could be lengthened in a prospective manner with more patients and a control group.

Conclusions

Steroid injection treatment for SIJ pain is not effective on a long-term basis for patients with high-grade arthritis, and although they have had decreased VAS scores in the short-term, after 2 years of follow-up, their VAS scores significantly increased leading to symptomatic sacroiliac joint pain. In future studies, prospective randomized trials must be designed in order to have more precise conclusions.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

References

- 1) CHAKRAVERTY R, DIAS R. Audit of conservative management of chronic low back pain in a secondary care setting--part I: facet joint and sacroiliac joint interventions. *Acupunct Med* 2004; 22: 207-213.
- 2) DREYFUSS P, MICHAELSEN M, PAUZA K, McLARTY J, BOGDUK N. The value of medical history and physical examination in diagnosing sacroiliac joint pain. *Spine (Phila Pa 1976)* 1996; 21: 2594-2602.
- 3) CABITZA P, RANDELLI P. Efficacy and safety of eperisone in patients with low back pain: a double blind randomized study. *Eur Rev Med Pharmacol Sci* 2008; 12: 229-235.
- 4) SCHWARZER AC, APRILL CN, DERBY R, FORTIN J, KINE G, BOGDUK N. The prevalence and clinical features of internal disc disruption in patients with chronic low back pain. *Spine* 1995; 20: 1878-1883.
- 5) MANCHIKANTI L, MANCHIKANTI KN, CASH KA, SINGH V, GIORDANO J. Age-related prevalence of facet-joint involvement in chronic neck and low back pain. *Pain Physician* 2008; 11: 67-75.
- 6) SCHWARZER AC, WANG SC, BOGDUK N, McNAUGHT PJ, LAURENT R. Prevalence and clinical features of lumbar zygapophysial joint pain: a study in an Australian population with chronic low back pain. *Ann Rheum Dis* 1995; 54: 100-106.
- 7) SAHIN O, HARMAN A, AKGUN R, TUNCAY I. An intraarticular sacroiliac steroid injection under the guidance of computed tomography for relieving sacroiliac joint pain: a clinical outcome study with two years of follow-up. *Turk J Rheumatol* 2012; 27: 165-173.
- 8) HANSEN HC, MCKENZIE-BROWN AM, COHEN SP, SWICE-GOOD JR, COLSON JD, MANCHIKANTI L. Sacroiliac joint interventions: a systematic review. *Pain Physician* 2007; 10: 165-184.
- 9) MURAKAMI E, TANAKA Y, AIZAWA T, ISHIZUKA M, KOKUBUN S. Effect of periarticular and intraarticular lidocaine injections for sacroiliac joint pain: prospective comparative study. *J Orthop Sci* 2007; 12: 274-280.
- 10) COHEN SP. Sacroiliac joint pain: a comprehensive review of anatomy, diagnosis, and treatment. *Anesth Analg* 2005; 101: 1440-1453.
- 11) FOLEY BS, BUSCHBACHER RM. Sacroiliac joint pain: anatomy, biomechanics, diagnosis, and treatment. *Am J Phys Med Rehabil* 2006; 85: 997-1006.
- 12) HARTUNG W, ROSS CJ, STRAUB R, FEUERBACH S, SCHOLMERICH J, FLECK M, HEROLD T. Ultrasound-guided sacroiliac joint injection in patients with established sacroiliitis: precise IA injection verified by MRI scanning does not predict clinical outcome. *Rheumatology* 2010; 49: 1479-1482.
- 13) LUUKKAINEN RK, WENNERSTRAND PV, KAUTIAINEN HH, SANILA MT, ASIKAINEN EL. Efficacy of periarticular corticosteroid treatment of the sacroiliac joint in non-spondylarthropathic patients with chronic low back pain in the region of the sacroiliac joint. *Clin Exp Rheumatol* 2002; 20: 52-54.
- 14) STAAL JB, DE BIE R, DE VET HC, HILDEBRANDT J, NELEMANS P. Injection therapy for subacute and chronic low-back pain. *Cochrane Database Syst Rev* 2008; 16: CD001824.
- 15) MIGLIORE A, BIZZI E, MASSAFRA U, VACCA F, MARTIN MARTIN LS, GRANATA M, TORMENTA S. A new technical contribution for ultrasound-guided injections of sacro-iliac joints. *Eur Rev Med Pharmacol Sci* 2009; 14: 465-469.
- 16) BOLLOW M, BRAUN J, TAUPITZ M, HABERLE J, REIBHAUER BH, PARIS S, MUTZE S, SEYREKBASAN F, WOLF KJ, HAMM B. CT-guided intraarticular corticosteroid injection into the sacroiliac joints in patients with spondyloarthropathy: indication and follow-up with contrast-enhanced MRI. *J Comput Assist Tomogr* 1996; 20: 512-521.
- 17) BRAUN J, BOLLOW M, SEYREKBASAN F, HABERLE HJ, EGGENS U, MERTZ A, DISTLER A, SIEPER J. Computed tomography guided corticosteroid injection of the sacroiliac joint in patients with spondyloarthropathy with sacroiliitis: clinical outcome and followup by dynamic magnetic resonance imaging. *J Rheumatol* 1996; 23: 659-664.
- 18) Maigne JY, AVALIKLIS A, PFEFER F. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. *Spine* 1996; 21: 1889-1892.
- 19) BODIAN CA, FREEDMAN G, HOSSAIN S, EISENKRAFT JB, BELIN Y. The visual analog scale for pain: clinical significance in postoperative patients. *Anesthesiology* 2001; 95: 1356-1361.

- 20) LAWSON TL, FOLEY WD, CARRERA GF, BERLAND LL. The sacroiliac joints: anatomic, plain roentgenographic, and computed tomographic analysis. *J Comput Assist Tomogr* 1982; 6: 307-314.
- 21) VAN DER LINDEN S, VALKENBURG HA, CATS A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. *Arthritis Rheum* 1984; 27: 361-368.
- 22) BOWEN V, CASSIDY JD. Macroscopic and microscopic anatomy of the sacroiliac joint from embryonic life until the eighth decade. *Spine (Phila Pa)* 1976; 1981; 6: 620-628.
- 23) MCKENZIE-BROWN AM, SHAH RV, SEHGAL N, EVERETT C.R. A systematic review of sacroiliac joint interventions. *Pain Physician* 2005; 8: 115-125.
- 24) DePALMA MJ, KETCHUM JM, SAULLO T. What is the source of chronic low back pain and does age play a role? *Pain Med* 2011; 12: 224-233.
- 25) DePALMA MJ, KETCHUM JM, SAULLO TR. Etiology of chronic low back pain in patients having undergone lumbar fusion. *Pain Med* 2011; 12: 732-739.
- 26) GEUER M, SIHLBOM H, GOTHLIN JH, NORDBORG E. The role of CT in the diagnosis of sacro-iliitis. *Acta Radiol* 1998; 39: 265-268.
- 27) PUHAKKA KB, JURIK AG, EGUND N, SCHIOTTZ-CHRISTENSEN B, STENGAARD-PEDERSEN K, VAN OVEREEM HANSEN G, CHRISTIANSEN JV. Imaging of sacroiliitis in early seronegative spondylarthropathy. Assessment of abnormalities by MR in comparison with radiography and CT. *Acta Radiol* 2003; 44: 218-229.
- 28) VAN DER WURFF P. Clinical diagnostic tests for the sacroiliac joint: motion and palpation tests. *Aust J Physiother* 2006; 52: 308.
- 29) GEUER M, GADEHOLT GOTHLIN G, GOTHLIN JH. The validity of the New York radiological grading criteria in diagnosing sacroiliitis by computed tomography. *Acta Radiol* 2009; 50: 664-673.
- 30) WALKER JM. The sacroiliac joint: a critical review. *Phys Ther* 1992; 72: 903-916.
- 31) IRWIN RW, WATSON T, MINICK RP, AMBROSIOUS WT. Age, body mass index, and gender differences in sacroiliac joint pathology. *Am J Phys Med Rehabil* 2007; 86: 37-44.