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Measurement of Sacroiliac Joint Volume Using Live Fluoroscopy

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Background: The sacroiliac joint (SIJ) is one source of mechanical low back pain. According to previous reports, volumes of 1.26-1.5 ml of contrast were required to SIJ until a firm endpoint resistance was reached or subjects reported discomfort. By contrast, up to 5 ml of injectate volume is recommended for SIJ block in some text books. We used live fluoroscopy to investigate the precise volume of injectate for IA SIJ.

Methods: IA SIJ injection under live fluoroscopic guidance was performed using a mixture of contrast and local anesthetic as an injectate to patients with suspected symptomatic mechanical SIJ pain. The solution was injected until a firm endpoint resistance was produced and the operator confirmed that there was no further expansion of the injectate out of SIJ space. The volume of the solution injected was recorded.

Results: Data from 55 SIJ injections in 40 patients were analyzed. The volume of injectate necessary for IA SIJ filling was 1.45 ± 0.44 ml. The minimum volume used was 0.7 ml and the maximum was 2.5 ml. The volume of the injectate had no clinically significant correlation with gender, age, weight, height, BMI, affected side and duration of symptom.

Conclusions: Our result revealed that similar volume is needed to fill the SIJ compared to previous reports. The volume of the injectate had no clinically significant correlation with patients' demographics, making it difficult to predict an adequate volume of injectate in advance for IA SIJ block.

Key Words: sacroiliac joint, volume, fluoroscopy, intra-articular injection.

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INTRODUCTION

The sacroiliac joint (SIJ) is one source of mechanical low back pain. According to previous reports, volumes of 1.26-1.5 ml of contrast media was required to SIJ until a firm endpoint resistance was reached or subjects reported discomfort [1,2]. By contrast, up to 5 ml of injectate volume is recommended for SIJ block in some text books [3]. Methods of intra-articular (IA) SIJ injection varied widely in previous studies. Usually a small dose of contrast media was injected in advance for diagnostic blocks. After confirmation of needle positioning in the SIJ space, an appointed volume of local anesthetic was injected intra-articularly [4-13]. In studies examining arthrographic findings using contrast media, a local anesthetic was also injected after administration of contrast [14-19]. Thus, it was possible that the local anesthetic spilled over into several extra-articular (EA) structures and the IA spread of local anesthetic

was not sufficient to achieve an effective block [15,20-22]. There were only a few studies investigating the volume of injectate required for IA SIJ injection [15,23]. In these two studies, authors got intermittent fluoroscopic images to confirm needle placement within SIJ and they injected to SIJ until a firm endpoint resistance was reached or subjects reported discomfort. In present study, injection was performed under live fluoroscopic guidance to inject IA SIJ selectively to minimize leakage of injectate and to confirm the injectate restricted to the articular space.

MATERIALS AND METHODS

This retrospective study was approved by the hospital's Institutional Review Board (Ref. 4-2013-0458), and the requirement for written consent was waived. The records of patients who underwent IA SIJ injection under live fluoroscopic guidance in the outpatient department for pain management between October 2012 and February 2013 were reviewed. Patients aged between 20 and 80 years old were included if they (a) had low back and buttock pain below the level of L4 at least one month in duration regardless of the presence or absence of leg pain, (b) their 11-point numerical rating scale (NRS, 0 = no pain, 10 = worst pain) score was three or more, and (c) they had tenderness overlying the sacroiliac joint. Patients were excluded if they had a spondyloarthropathy or lumbosacral pain which had been improved after lumbar medial branch block. Patients who underwent SIJ injections with other spinal injections, or who had a disc herniation, radicular pain caused by lumbar spinal stenosis, lumbosacral radiculopathy or neurogenic claudication were also excluded.

IA SIJ injection was performed under live fluoroscopic guidance according to a modified technique described by Fortin et al [15]. Patients were first placed in a prone position on the examination table. After sterile preparation and draping, a 23-G, 6-cm block needle was inserted at the inferior aspect of the SIJ, and was then advanced under fluoroscopic guidance to the inferior-most aspect of the joint just superior to the inferior recess so that the needle and the SIJ were in the same radiological frame. A 5-ml syringe filled with 3 ml of a solution composed of 1.5 ml of 2% lidocaine and 1.5 ml of contrast media was connected to the needle. Under live fluoroscopic guidance, the solution was injected until a firm endpoint resistance was produced and there was no further expansion of the SIJ space. The volume of the solution injected was recorded. During the procedure, anteroposterior, oblique and lateral images were obtained to detect and minimize the leakage of injectate (Fig. 1). In case of subjects with poor endpoint resistance, administration of injectate was stopped once leakage was detected, and the volume of injectate was recorded.

Initial patient data including age, sex, height, weight, body mass index (BMI), symptomatic side of SIJ pain and duration of

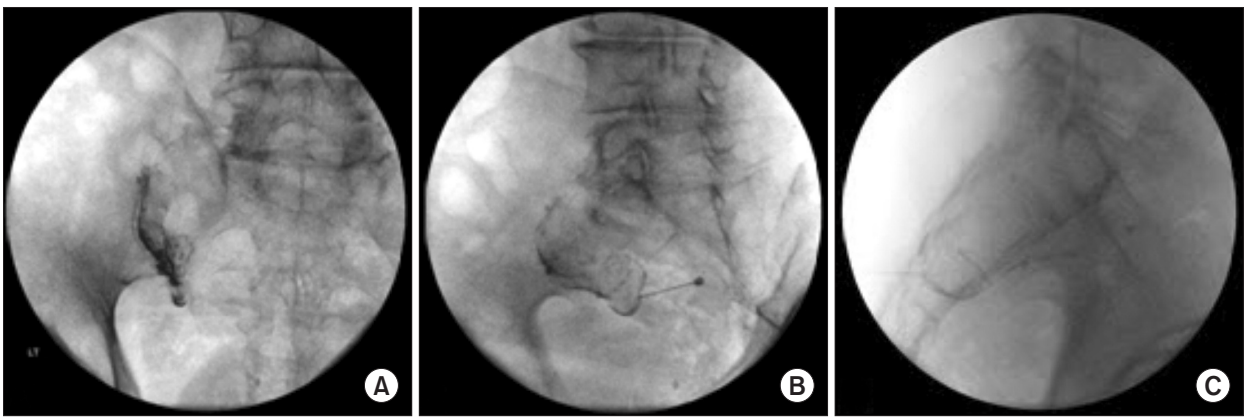

Fig. 1. Anteroposterior (A), right anterior oblique (B), and lateral views (C) of successfully performed left sacroiliac joint arthrogram. The injectate was inserted until a firm endpoint resistance was encountered, the image inside the sacroiliac joint did not expand further, and no leakage of injectate was confirmed.

symptoms before SIJ injection were collected. During SIJ injection, injected volume without leakage, or volume up to the occurrence of leakage was recorded. NRS pain score data were obtained just before and 15 minutes after SIJ injection.

Continuous data are presented as mean ± standard deviation or median (range). The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. Correlations between the volume of the injectate and age, weight, height, body mass index (BMI), duration of symptoms, NRS scores and response rate of NRS scores were analyzed using the Pearson correlation test. Additionally, differences in the volume of injectate according to sex and side of injection were analyzed using the independent t-test. The statistical analysis was conducted using the Statistical Package for the Social Sciences 18.0 for Windows (SPSS Inc., Chicago, IL, USA). A P value < 0.05 was considered statistically significant.

RESULTS

All 52 patients initially met the inclusion criteria. Each injection was considered to be a different case for patients requiring separate SIJ injections to the left and right side when injections were performed on different days. The total 69 SIJ injections were performed in outpatient department. Among these, 14 SIJ injections were excluded because they were performed along with a lumbar transforaminal epidural injection or a caudal block. Data from 55 SIJ injections in 40 patients were analyzed. Patient characteristics and the volume of the injectate are shown in Table 1. Responses 15 minutes after IA SIJ injection are shown in Table 2. 18 subjects (32.7%) responded 100% reduction in NRS scores, while 3 patients' (5.5%) NRS score did not improve at all.

The volume of injectate necessary for IA SIJ injection was 1.66 ± 0.27 ml for males and 1.40 ± 0.46 ml for females and the total average was 1.45 ± 0.44 ml. The minimum volume was 0.7 ml with a maximum of 2.5 ml. 6 patients reached poor endpoint resistance and injection was stopped once leakage was detected. In spite of a statistically normal distribution, the data showed a diverse distribution with 9 (16%) cases requiring 2.0 ml, 8 (15%) cases requiring 0.8 ml, which is close to the minimum value, and 7

Table 1. Patient characteristics and volume of injectate required

	Total group
Sex (M/F)	10/45
Age, years	57 (25-78)
Weight, kg	60 (42-85)
Height, cm	158.8 ± 7.8 (143-185)
BMI	23.8 (16.8-31.8)
Side (right/left)	34/21
Duration of symptoms, months	6 (1-120)
Volume of injectate, ml	1.45 ± 0.44 (0.7-2.5)

Values represent mean ± standard deviation (range) or median (range). BMI: body mass index.

Table 2. The degree of response 15 minutes after intra-articular sacroiliac joint injection

NRS pain score	
100%	18 (32.7)
≥ 75% and < 100%	5 (9.1)
≥ 50% and < 75%	27 (49.1)
> 0% and < 50%	2 (3.6)
0%	3 (5.5)

Values represent the number of patients (%). NRS: numerical rating scale.

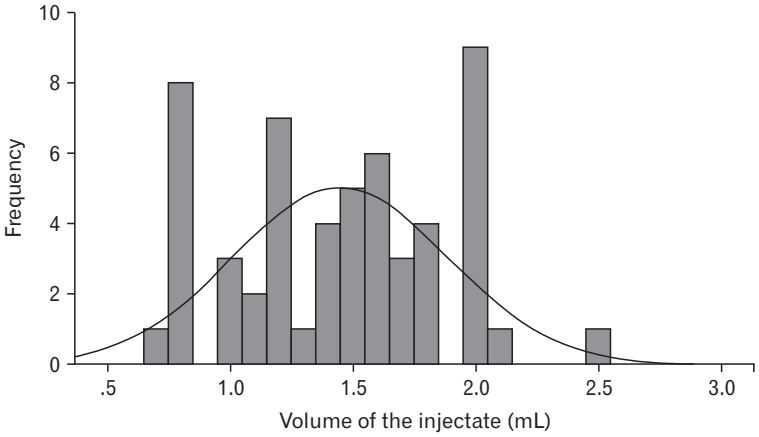

Fig. 2. Distribution of the injectate volume measured from selective intra-articular sacroiliac joint injection using live fluoroscopy.

(13%) cases requiring 1.2 ml, which is lower than the average (Fig. 2). There was no difference in the injected volume according to sex, age, the side of injection, NRS scores before and after the injection and response rate of NRS scores after injection. The volume of injectate had a statistical relation with weight but had low correlation ($r = 0.366$, $P = 0.017$). IA SIJ injection was performed without complications in all cases, including temporary sciatic palsy or other sustained deleterious effects.

DISCUSSION

The SIJ has been shown to be a source of 10% to 27% of suspected cases with chronic low back pain utilizing controlled comparative local anesthetic blocks [24], but one of the difficulties of treatment of SIJ pain is diagnostic ambiguity [25,26]. There have been many attempts to improve the accuracy for identifying the cause of SIJ pain. Controlled local anesthetic blocks are one such proposed method [27]. However, the diagnostic validity of fluoroscopically guided IA SIJ injection is still not well established [2]. One of the primary causes of reduced diagnostic accuracy during IA SIJ injection is the possibility of injectate leakage. In a study of plain radiographic and computed tomographic (CT) analysis of 76 SIJs using fluoroscopically guided SIJ arthrography, Fortin et al. reported contrast leakages in 61% of cases [20]. SIJ pain is known to be caused by both EA and IA sources [28-30]. In cases of anesthetic leakage during a diagnostic SIJ block, pain relief after the block may result from anesthetic effects on EA sources of SIJ pain rather than IA structures [14,15]. In contrast, IA injection of anesthetic without leakage that relieves SIJ pain corroborates the SIJ itself as the source of pain [8,17].

In most of the studies that used diagnostic SIJ injection as a reference standard, a small dose of contrast media was injected to confirm needle positioning in the SIJ space, and then an appointed volume between 1-5 ml of local anesthetic was injected uniformly as a diagnostic block [4-13]. In one study which arthrographic findings were reported after contrast media injection, the injected volume was quite similar between subjects [14]. In another study, the researchers assessed whether the slow contrast injection to SIJ caused familiar pain and then instilled a small volume below 1.5 ml of local anesthetic [17,18]. In another study, 0.5-1.0 ml of contrast was used during SIJ injection, and then the same volume of local anesthetic was injected [19]. Since they injected contrast media and then a local anesthetic separately, it is not obvious whether the local anesthetic leaked or spread effectively throughout the IA space. The method of IA SIJ injection and volume used thus varied significantly from study to study, and in some cases the procedure was described incompletely. The chance of injectate spillover into adjacent structures or incomplete IA SIJ block may be high. The effect of this methodological variability may create uncertainty in determining the cause of discordant

responses to diagnostic SIJ blocks and identifying the actual pain generators of SIJ pain. In the present study, the authors performed SIJ injections under live fluoroscopic guidance to minimize leakage of injectate into adjacent structures and to confirm that IA local anesthetic spread thoroughly. A mixture, rather than separate aliquots, of contrast and local anesthetic, was injected for complete IA SIJ anesthetic block.

Dreyfuss et al. reported that multi-site, multi-depth sacral lateral branch blocks ameliorated the pain by ligamentous probing in 70% of cases, but did not effectively block the discomfort caused by SIJ capsular distension [23]. These findings mean that lateral branch radiofrequency (RF) denervation was more effective at alleviating EA SIJ pain. In addition, as the SIJ is innervated by L5-S2 ventral rami as well as L5-S3 dorsal rami according to most studies [31], the patients with SIJ pain caused by only IA pathology would not be appropriate candidates for RF denervation of the dorsal SIJ [32]. It is possible that patients who respond well to diagnostic IA SIJ injection may have unfavorable outcomes with RF denervation of the dorsal SIJ and who poorly respond to IA SIJ injection may improve pain after lateral branch RF. Using live fluoroscopy shown in the present study may help to measure the proper volume of local anesthetics in diagnostic block of SIJ and to evaluate the cause of SIJ pain.

In the present study, the maximum volume of injectate that caused endpoint resistance or leakage during IA SIJ injection averaged 1.42 ± 0.42 ml, which was comparable to the findings of previous studies in healthy volunteers [15,23]. The range varied from 0.7 ml to 2.5 ml, and had an asymmetrical distribution. Specifically, the distribution appeared bimodal with a large number of cases requiring 2.0 ml and 0.8 ml of injectate (9 [16%] and 8 [15%] cases, respectively). Of 9 patients requiring 2.0 ml of injected volume, 3 patients were with poor endpoint resistance. In previous study measuring volume of injectate to SIJ, subjects with poor endpoint resistance were injected more than 2 ml of volume and had significant subligamentous extravasation [15]. There may have relation between injected volume and poor end point resistance, but further studies are needed. In addition, all 8 patients requiring 0.8ml of injected volume were female.

The volume of injectate necessary for IA SIJ injection was 1.66 ± 0.27 ml for males and 1.40 ± 0.46 ml for females with no statistical difference. In previous study, there were no significant difference between male and female subjects in injected volume of SIJ (5 females ; average 1.6 ml, 5 males ; average 1.7 ml) [15]. However, the results of the present study may result from small number of male patients compared with that of female patients (M : F = 10 : 45). In addition, the volume of injectate had a statistical relation with weight but had low correlation ($r = 0.366$, $P = 0.017$). This also might be the result of the small number of male subjects, but greater numbers will be complied. Based on the results from the present study it would be difficult to predict an adequate volume of injectate because there were no clinical or demographic characteristics.

This study is limited by the inherent flaws associated with the retrospective nature of this analysis. To compare the SIJ volume of symptomatic and symptom free subjects, SIJ injection in two separate groups is the most reasonable approach. However, it has many problems including the invasiveness of block itself to symptom free subjects and increased exposure to radiation.

Pathologic changes affecting many different SI joint structures can lead to SIJ pain. These include capsular or synovial disruption, capsular and ligamentous tension, hypomobility or hypermobility, extraneous compression or shearing forces, abnormal joint mechanics, microfractures or macrofractures, chondromalacia, soft tissue injury, and inflammation [24]. In the present study, there were no x-ray or CT images to evaluate pathologic findings of SIJ in inclusion criteria. Further assessment of the correlation between radiologic findings and SIJ volume warrant consideration.

In addition, live fluoroscopy was used to evaluate needle positioning and injectate administration in this study. According to Fortin et al, postarthrography CT is more sensitive for detecting the extravasation of a small quantity of contrast compared to plain-film arthrograms [20]. It is not clear whether live fluoroscopy is sensitive enough to detect the leakage of contrast. However, the authors considered live fluoroscopy to be an alternative to postarthrography CT [33].

In conclusion, volume of injectate for IA SIJ under live fluoroscopic guidance in patients with symptomatic mechanical SIJ pain was approximately 1.4 ml, but varied from 0.7-2.5 ml. There were no other variables of predictive value for determining an adequate

volume of IA injectate. The selective and complete IA SIJ block method presented in this study may be a useful technique to evaluate the cause of SIJ pain.

REFERENCES

1. Szadek KM, van der Wurff P, van Tulder MW, Zuurmond WW, Perez RS: Diagnostic validity of criteria for sacroiliac joint pain: a systematic review. J pain 2009; 10: 354-68.
2. Simopoulos TT, Manchikanti L, Singh V, Gupta S, Hameed H, Diwan S, et al: A systematic evaluation of prevalence and diagnostic accuracy of sacroiliac joint interventions. Pain physician 2012; 15: E305-E44.
3. Kim DH, Kim KH, Kim YC: Minimally invasive percutaneous spinal techniques, Saunders: Elsevier Inc 2012: 184-91
4. Slipman CW, Jackson HB, Lipetz JS, Chan KT, Lenrow D, Vresilovic EJ: Sacroiliac joint pain referral zones. Arch Phys Med Rehabil 2000; 81: 334-8.
5. van der Wurff P, Buijs EJ, Groen GJ: Intensity mapping of pain referral areas in sacroiliac joint pain patients. J Manipulative Physiol Ther 2006; 29: 190-5.
6. van der Wurff P, Buijs EJ, Groen GJ: A multitest regimen of pain provocation tests as an aid to reduce unnecessary minimally invasive sacroiliac joint procedures. Arch Phys Med Rehabil 2006; 87: 10-4.
7. Maigne JY, Boulahdour H, Chatellier G: Value of quantitative radionuclide bone scanning in the diagnosis of sacroiliac joint syndrome in 32 patients with low back pain. Eur Spine J 1998; 7: 328-31.
8. Maigne JY, Aivaliklis A, Pfefer F: Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. Spine (Phila, Pa 1976) 1996; 21: 1889-92.
9. Slipman CW, Sterenfeld EB, Chou LH, Herzog R, Vresilovic E: The value of radionuclide imaging in the diagnosis of sacroiliac joint syndrome. Spine (Phila, Pa 1976) 1996; 21: 2251-4.
10. Slipman CW, Sterenfeld EB, Chou LH, Herzog R Vresilovic E: The predictive value of provocative sacroiliac joint stress maneuvers in the diagnosis of sacroiliac joint syndrome. Arch Phys Med Rehabil 1998; 79: 288-92.
11. Slipman CW, Lipetz JS, Plastaras CT, Jackson HB, Vresilovic EJ, Lenrow DA, et al: Fluoroscopically guided therapeutic sacroiliac joint injections for sacroiliac joint syndrome. Am J Phys Med Rehabil 2001; 80: 425-32.
12. Stanford G, Burnham RS: Is it useful to repeat sacroiliac joint provocative tests post-block? Pain med 2010; 11: 1774-6.
13. Broadhurst NA, Bond MJ: Pain provocation tests for the assessment of sacroiliac joint dysfunction. J Spinal Disord 1998; 11: 341-5.
14. Schwarzer AC, Aprill CN, Bogduk N: The sacroiliac joint in chronic low back pain. Spine (Phila, Pa 1976) 1995; 20: 31-7.
15. Fortin JD, Dwyer AP, West S, Pier J: Sacroiliac joint: pain referral maps upon applying a new injection/arthrography technique. Part I: Asymptomatic volunteers. Spine (Phila, Pa 1976) 1994; 19: 1475-82.
16. 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: 2594-602.
17. Laslett M, Aprill CN, McDonald B, Young SB: Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. Man Ther 2005; 10: 207-18.
18. Laslett M, Young SB, Aprill CN, McDonald B: Diagnosing painful sacroiliac joints: A validity study of a McKenzie evaluation and sacroiliac provocation tests. Aus J Physiother 2003; 49: 89-97.
19. Manchikanti L, Singh V, Pampati V, Damron KS, Barnhill RC, Beyer C, et al: Evaluation of the relative contributions of various structures in chronic low back pain. Pain physician 2001; 4: 308-16.
20. Fortin JD, Washington WJ, Falco FJ: Three pathways between the sacroiliac joint and neural structures. AJNR Am J Neuroradiol

1999; 20: 1429-34.
21. Berthelot JM, Labat JJ, Le Goff B, Gouin F, Maugars Y: Provocative sacroiliac joint maneuvers and sacroiliac joint block are unreliable for diagnosing sacroiliac joint pain. Joint Bone Spine 2006; 73: 17-23.
22. McGrath MC: Composite sacroiliac joint pain provocation tests: A question of clinical significance. International Journal of Osteopathic Medicine Mar 2010; 13: 24-30.
23. Dreyfuss P, Henning T, Malladi N, Goldstein B, Bogduk N: The ability of multi-site, multi-depth sacral lateral branch blocks to anesthetize the sacroiliac joint complex. Pain Med 2009; 10: 679-88.
24. Kim KH: Spinal joint pain syndrome. Korean J Pain 2008; 21: 1-10.
25. Cohen SP: Sacroiliac joint pain: a comprehensive review of anatomy, diagnosis, and treatment. Anesth Analg 2005; 101: 1440-53.
26. Cohen SP, Chen Y, Neufeld NJ: Sacroiliac joint pain: a comprehensive review of epidemiology, diagnosis and treatment. Expert Rev Neurother 2013; 13: 99-116.
27. Bogduk N, McGuirk B: Medical management of acute chronic low back pain : an evidence-based approach. Amsterdam ; Boston: Elsevier; 2002.
28. Yin W, Willard F, Carreiro J, Dreyfuss P: Sensory stimulation-guided sacroiliac joint radiofrequency neurotomy: technique based on neuroanatomy of the dorsal sacral plexus. Spine (Phila, Pa 1976) 2003; 28: 2419-25.
29. 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: 274-80.
30. Borowsky CD, Fagen G: Sources of sacroiliac region pain: insights gained from a study comparing standard intra-articular injection with a technique combining intra- and peri-articular injection. Arch Phys Med Rehabil 2008; 89: 2048-56.
31. Forst SL, Wheeler MT, Fortin JD, Vilensky JA: The sacroiliac joint: anatomy, physiology and clinical significance. Pain Physician 2006; 9: 61-7.
32. Cohen SP, Strassels SA, Kurihara C, Crooks Mt, Erdek MA, Forsythe A, et al: Outcome predictors for sacroiliac joint (lateral branch) radiofrequency denervation. Reg Anesth Pain Med 2009; 34: 206-14.
33. Smuck M, Fuller BJ, Chiodo A, Benny B, Singaracharlu B, Tong H, et al: Accuracy of intermittent fluoroscopy to detect intravascular injection during transforaminal epidural injections. Spine (Phila, Pa 1976) 2008; 33(7): E205-E10.