This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

ORIGINAL ARTICLE

Corticosteroid, Platelet-Rich Plasma, and Ozone Injections for Sinus Tarsi Syndrome

Serdar Toy, MD*
Kutsi Tuncer, MD†
Murat Topal, MD‡
Ali Aydı̇n, MD†

*Department of Orthopedics and Traumatology, Ağrı Training and Research Hospital, Ağrı, Turkey. Dr. Toy is now with Istanbul Basaksehir Pine and Sakura City Hospital, Istanbul, Turkey.
†Department of Orthopedics and Traumatology, Ataturk University Faculty of Medicine, Erzurum, Turkey. Dr. Tuncer is now with Department of Orthopedics and Traumatology, Altinbas University Medical Park, Bahçelievler Hastanesi, Istanbul, Turkey.
‡Department of Orthopedics and Traumatology, Kastamonu University Faculty of Medicine, Kastamonu, Turkey.

Corresponding author: Serdar Toy, MD; Istanbul Basaksehir Pine and Sakura City Hospital, Department of Orthopedics and Traumatology. Basaksehir Olimpiyat Bulvari Yolu, 34480, Basaksehir, Istanbul, Turkey. (E-mail: serdartoy737@gmail.com)

Background: Sinus tarsi syndrome is characterized by permanent pain on the anterolateral side of the ankle. This pain occurs due to chronic inflammation, characterized by fibrotic tissue remnants and synovitis accumulation after repeated traumatic injuries. Few studies have documented the outcome of injection treatments for sinus tarsi syndrome. We sought to
determine the effects of corticosteroid and local anesthetic, platelet-rich plasma, and ozone injection on the sinus tarsi syndrome.

**Methods:** Sixty patients diagnosed with sinus tarsi syndrome were randomly divided into three groups. Patients in the first group received corticosteroid and local anesthetic, patients in the second group received platelet-rich plasma, and patients in the third group were given ozone injections. Outcome measures were Visual Analog Scale (VAS), American Orthopedic Foot and Ankle Society Ankle-Hindfoot Scale (AOFAS), Foot Function Index (FFI), and Foot-Ankle Outcome Score (FAOS). Outcome measures were evaluated by comparing pre-intervention and post-injection 1-month, 3-month, and 6-month follow-ups.

**Results:** At the end of the 1st month, third month, and sixth month after injection, significant improvements were observed in all three groups compared to the baseline (p < .001 for all comparisons). In the 1st and third months, the improvements in AOFAS scores were similar in Groups 1 and 3; those in Group 2 were lower (p = .001 and p = .004, respectively). In the 1st month, the improvements in FAOS scores were similar in Groups 2 and 3; those in Group 1 were higher (p < .001). During the 6-month follow-up period, there was no statistically significant difference in VAS and FFI results between all three groups (p > .05).

**Conclusions:** Corticosteroid and local anesthetic or platelet-rich plasma or ozone injections could provide clinically significant functional improvement for at least six months in patients with sinus tarsi syndrome.
The sinus tarsi is a cone-shaped canal located in the hindfoot, bordered by the talus and the calcaneus. This canal contains the structures that contribute to the stability and proprioception of the ankle. These structures are the extrinsic ligaments (calcaneofibular and deltoid ligament), the intrinsic ligaments (the interosseous, the talocalcaneal ligament, and the cervical ligament), and the medial, lateral, and intermediate roots of the inferior extensor retinaculum.

Historically, O' Connor first described the sinus tarsi syndrome in a report of 200 cases. O' Connor reported that ligamentous injuries in the foot structure caused the sinus tarsi syndrome. In other studies, various factors such as damage to sinus tarsi ligaments, bleeding into sinus tarsi, arthritis or synovitis of the subtalar joint, and chronic fibro-adipose inflammation have been considered as causes of persistent pain in sinus tarsi syndrome. In 1997, Schwarzenbach et al. described post-traumatic fibrotic changes in the walls and surrounding tissues that caused deterioration of venous outflow and increased pressure in the sinus tarsi. In recent studies, synovitis and fibrous tissue residues following ligament injuries have been reported to cause sinus tarsi syndrome.

Sinus tarsi syndrome occurs mainly due to a traumatic lateral ankle sprain or multiple ankle sprains. Ankle sprain accounts for 10% - 30% of all sports injuries, and in some sports activities may constitute up to 40 to 56% of injuries. Inversion ankle sprains are estimated
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

to be about 2 to 7% in 10,000 people per day \(^{16-20}\). One million people also visit emergency services, clinics, and offices each year for acute ankle traumas \(^{21,22}\). These sprains damage the intrinsic ligaments. These ligaments injuries trigger the accumulation of fibrotic tissue and hypertrophic synovium in the sinus tarsi \(^3\). This condition is seen in 70% of patients with sinus tarsi syndrome \(^2,3\).

The pathognomonic symptom of sinus tarsi syndrome is persistent pain on the anterolateral side of the ankle \(^3\). The pain is aggravated when standing, walking on uneven ground, or during supination and adduction movements of the foot \(^2\). The sinus tarsi syndrome causes functional instability in the hindfoot \(^2,4\). This instability also provides a more excellent range of motion in the subtalar joint. This extreme movement increases the forces against the ligaments of the sinus tarsi. In response to these increasing forces, the synovium accumulates within the joint. The accumulation of the synovium causes subtalar joint synovitis. Infiltration of fibrotic tissue remnants and synovitis in the sinus tarsi cavity causes chronic inflammation and ankle pain \(^3\).

Magnetic resonance imaging (MRI) is the most commonly used method in diagnosing sinus tarsi syndrome. MRI could show the disruption of ligament structures, filling the sinus tarsi space with fluid or scar tissue, and degenerative changes in the subtalar joint \(^3\). Treatment of sinus tarsi syndrome could be conservative or operative. The conservative treatment includes nonsteroidal anti-inflammatory drugs (NSAIDs), local gels, ice therapy,
physiotherapy, or corticosteroid injections in the sinus tarsi \(^2,4\). If conservative treatment fails, operative treatment should be considered as a last resort \(^4\).

The primary pathology in sinus tarsi syndrome is thought to be a chronic inflammatory process caused by the hypertrophic synovium that develops in that area due to fibrotic tissue accumulation and ligament injuries \(^10,11\). Corticosteroid and local anesthetic (CLA), platelet-rich plasma (PRP), and ozone injections have been used to treat chronic inflammatory processes, synovitis, and degenerative changes \(^24,36\).

As far as we know, there were very few studies using injections to treat sinus tarsi syndrome, and only corticosteroid injections were used in those studies \(^27,28\). Komprda \(^27\) reported that 73 of 116 patients showed improvement after a series of injections given at weekly intervals. Kuwada \(^38\) declared that 21 of the 88 patients had long-term relief after physical therapy and one injection per week for two weeks.

This randomized clinical trial aimed to determine the effect of CLA, PRP, and Ozone injections to treat sinus tarsi syndrome in patients at 1-month, 3-month, and 6-month follow-ups.

In this study, we hypothesized that patients with sinus tarsi syndrome might benefit from PRP or ozone injections at least as much as CLA injections in terms of pain, functional disability, and clinical symptoms.
METHODS

This study was designed as prospective research. A six-month follow-up of the patients was planned in this study. Ethical approval was obtained from the Clinical Research Ethics Committee (IRB number: B.30.2.ATA.0.01.00/288, date: 29.11.2018). Signed informed consent was obtained from all patients who volunteered to participate in this study. This study was conducted with three randomized experimental groups. All stages of this study were carried out in a University Hospital. The same researcher did the interventions and data collection. In this study, a non-blind study protocol was conducted.

All patients included in this study were diagnosed with sinus tarsi syndrome in the outpatient clinic. We evaluated the ankle radiographs and magnetic resonance imaging (MRI) of all patients to rule out ankle sprains, calcaneal or talar fractures, peroneal tendonitis, subtalar joint arthritis, and tarsal tunnel syndromes. The inclusion criteria consisted of skeletally mature patients with anterolateral ankle pain, failure of conservative treatment for three months (NSAIDs, physiotherapy, and local gels), and no previous injections. The exclusion criteria consisted of patients with skin lesions on the anterolateral side of the ankle, diabetes mellitus, chronic kidney disease, chronic liver disease, hypo/hyperthyroidism, immune suppression, collagen connective tissue disease, pregnancy, lactation, platelet count <100000 platelets/µL, hemoglobin level <10 g/dl, and known steroid or ozone allergy.
This study was initiated with 60 patients. The patients were numbered from 1 to 60 and randomly allocated into three groups using https://www.randomizer.org/. CLA injection was applied to the patients in group 1, PRP injection to the patients in group 2, and ozone injection to the patients in group 3. While the patients in Group 1 regularly attended follow-up visits, four patients from Group 2 and Group 3 were excluded due to incomplete follow-up. This study was conducted with a total of 56 patients (Figure 1).

Corticosteroid and Local Anesthetic Injection

In group 1, each patient was placed in the supine position on the examination table for sinus tarsi injections. The foot of the patient was forced to invert to widen the subtalar joint space (Figure 2). A soft area was detected 1 cm in front of and 1 cm below the lateral malleolus tip. The area to be injected was cleaned three times with Povidone 10% Topical Antiseptic Solution and allowed to dry. The researcher wore sterile gloves. In the CLA group, 2 ml Diprosan® [Betamethasone dipropionate 6.43 mg (equivalent to 5.0 mg betamethasone) Betamethasone sodium phosphate 2.63 mg (equivalent to 2.0 mg betamethasone)] was used as corticosteroid, and 1 ml Buvasin® 0.5% (Bupivacaine HCl) was used as a local anesthetic (Figure 3). CLA injection was applied to the sinus tarsi cavity towards the medial malleolus with an injector inserted through the soft point on the anterolateral ankle. This injection was administered only once during treatment.
Care was taken to enter the sinus tarsi cavity with minimal trauma. Injection-related trauma was not observed in any of the patients in our study. Each patient was recommended to apply cold therapy/ice to the injection site for the first two days after injection \(^{42}\). The cold therapy/ice was described as applying ice packs wrapped in a towel to the injection site for 10 minutes every hour.

As far as we know, Komprda\(^{37}\) and Kuwada\(^{38}\) performed more than one corticosteroid injection to treat sinus tarsi syndrome in their studies. In our study, we preferred to administer the CLA injection only once to compare the treatment efficacy with other groups. We also chose a single-dose of CLA injection to avoid local side effects (Infection, subcutaneous atrophy, and skin depigmentation) of repeated corticosteroid injections \(^{41}\).

The price of 2 ml Diprospar* administered to patients was 3.30 USD, while 1 ml Buvasin* 0.5% is 2.30 USD. The total cost was calculated at 5.60 USD.

**Platelet-rich Plasma Injection**

In the PRP group, a 10 ml volume of whole blood was taken from the basilica or antecubital vein of the upper limb in an injector containing 2 ml citrate dextrose. The collected blood was transferred to the t-lab autologous PRP kit (T-Biotechnology Ltd*, Bursa, Turkey). The PRP kit was centrifuged at 2000 rpm for 8 minutes in 8C0D Centrifuge CE (YUDA Medical Equipment Co., Ltd*, Jining City, Shandong Province, China). After centrifugation, plasma accumulated at
the top, buffy coat with platelets and leukocytes at the middle, and erythrocytes at the bottom of the PRP tube. We obtained approximately 2.5 ml of platelet-rich plasma from the top of the middle part of the centrifuged blood via an injector (Figure 4). The patients were placed in the supine position on the examination table. The area to be injected was cleaned three times with Povidone 10% Topical Antiseptic Solution® and allowed to dry. The researcher wore sterile gloves. The PRP injection was applied to the sinus tarsi canal towards the medial malleolus with an injector inserted through the soft point on the anterolateral ankle.

The PRP injection was administered only once during treatment. The PRP kit price was calculated as 40.00 USD.

Ozone Injection

Medical ozone was prepared by a silent electrical discharge from pure oxygen and pure ozone using a medical ozone generator (Humazon® ProMedic, Humares® GmbH, Bruchsal, Germany). The patients were placed in the supine position on the examination table. The area to be injected was cleaned three times with Povidone 10% Topical Antiseptic Solution® and allowed to dry. The researcher wore sterile gloves. Ozone injections were administered into the sinus tarsi cavity as six cc ozone (O₃) at a 10 μg/mL concentration only once during treatment. The cost of the ozone injection was 20.00 USD.
In our study, five patients in group 3 had symptoms similar to steroid flushing that lasted 1-2 days after injection. Cold therapy/ice application was recommended to these patients, and the patients were invited for daily control. These symptoms resolved after two days.

**Outcome Measures**

All patients were assessed using a Visual Analog Scale (VAS) \(^{43}\), the American Orthopedic Foot and Ankle Society Ankle-Hindfoot Scale (AOFAS) \(^{44}\), the Foot Function Index (FFI) \(^{45}\), and the Foot-Ankle Outcome Score (FAOS) \(^{46}\). The assessments were done by patient self-reporting before the interventions and at 1-month, 3-month, and 6-month follow-ups.

The VAS evaluates the level of pain by assigning a score between 0 and 10; 0 represents no pain, and 10 represents the worst pain level. The reliability of VAS for disability is moderate to good. There has also been reported a strong correlation between VAS and pain. However, its validity is questionable when compared to other tests \(^{47}\).

The AOFAS scale assesses foot pain, function, and alignment. The best score is 100 and indicates goodness, while the lowest score is 0, showing the worst possible condition of the patient. The moderate correlation, satisfactory reliability, and responsiveness observed in studies indicate that the subjective component of the AOFAS clinical rating scales provides quality of life information that refers to an acceptable validity regarding conditions affecting the foot and ankle \(^{48,49}\).
The FFI measures the impact on the function of the foot pathology in pain, disability, and activity restriction. The FFI consists of 23 items divided into three subscales. The FFI appears to be an appropriate tool for low-functioning individuals with foot disorders. On the other hand, it might not be suitable for individuals who function at or above the independent daily living activities.

The FAOS measures the symptoms and functional limitations of the foot and ankle. FAOS consists of 42 questions divided into five different subscales about the patient: pain (nine questions); symptoms such as stiffness, swelling, and range of motion (seven questions); daily life activities (17 questions); the ability to perform sports and recreational activities (five questions); quality of life regarding the foot/ankle (four questions). Answers are given on a five-point Likert scale. Total and subscores are calculated by adding the scores of individual questions. The total score is coded on a 0-100 scale, and 100 indicates no symptoms or limitations. Roos et al. reported that the FAOS met the criteria of validity and reliability. They concluded that FAOS appeared to be useful for evaluating patient outcomes regarding foot and ankle problems.

Statistical Analysis

Using a formula to detect an effect size $f=0.5$ with 90% power in a one-way between-subjects ANOVA (three groups, alpha = .05), G*Power (Version 3.1.9.4, Franz Faul, Universitat Kiel,
Germany) suggests we would need 18 participants in each group (N = 54)\textsuperscript{52}. Demographic data and other categorical data before and after the treatments were reported as frequency and percentages. The arithmetic means and standard deviation were calculated for the numerical variables. The distribution characteristics of the data were determined by the Shapiro-Wilk test, while Levene's test calculated the homogeneity of variances. Statistical analysis was performed using SPSS for Windows 22.0 (IBM Corp., Armonk, NY, USA)\textsuperscript{53}. The Paired-Samples t-test was used to evaluate the parametric values of the two related groups. To assess the non-parametric values of the two related groups, they were analyzed with Wilcoxon. The Chi-Square test analyzed the difference between independent groups. The Repeated Measures ANOVA test evaluated data of all three groups at the initial evaluation and the 1st, 3rd, and 6th months. The comparison between the groups was performed using the Multivariate ANOVA (MANOVA) test. Games-Howell, one of the post-hoc tests, was used to understand which groups differ between groups. \( P < .05 \) was considered statistically significant.

RESULTS

Demographic data

This study was conducted with 56 patients, which consisted of 20 patients in the CLA group, 18 patients in the PRP group, and 18 patients in the ozone group. In our study, the number of
female patients was 26 (46.4%), and the number of male patients was 30 (53.6%). The mean age of the patients was 40.71 (range, 20-68) (Table 1).

Visual Analog Scale

There was no statistically significant difference in the VAS between the three groups at the initial evaluation. Before the procedure, the mean VAS of all patients was found to be 7.79 ± 1.49. During the follow-up of the patients, a significant decrease in the VAS was found in all groups. However, one patient in the ozone group did not significantly improve clinical symptoms throughout the study. At the end of the 6th month, the VAS in group 1 was 2.45±1.82, the score of group 2 was 2.00±0.84, and the score of group 3 was 3.11±2.61 (Table 2).

American Orthopedic Foot and Ankle Society Ankle-Hindfoot Scale

At the time of the initial examination, the patients with the worst value on the AOFAS were in group 2. There also was a statistically significant difference between group 2 and the others. Before the injection, the mean AOFAS was 53.57±11.8 for all patients. There was significant clinical improvement in all three groups throughout the study. At the end of the first and third months, the clinical improvement was significantly in favor of the CLA group. At the end of the study, there was no significant difference between the three groups (Table 3).
Foot Function Index

There was no statistically significant difference between the three groups for the FFI at the first assessment time. Clinical improvement (decrease in FFI) was evident in all patients during follow-up. Besides, no statistically significant difference was found between the results of the FFI of the three groups during the follow-up period (Table 4).

Foot-Ankle Outcome Score

The patients with the worst scores on the FAOS were in group 2 at the initial examination time. There also was a statistically significant difference between group 2 and the others. Clinical improvement (increase in FAOS) was observed in all patients during follow-up periods. The worst scores were obtained in group 2 at the end of the first and third months. There also were significant differences between group 2 and the other groups. However, there was no significant difference between the three groups at the end of the study (Table 5).

DISCUSSION

This study has been the first study in which three different non-surgical treatments were applied to patients in whom conservative treatment failed in sinus tarsi syndrome. These three non-surgical treatments were CLA injection, PRF injection, and ozone injection. Our study aimed to determine the effects of CLA, PRF, and ozone injections on sinus tarsi syndrome. The most striking finding in our study was that the results of PRP or ozone injections, which were
not used in the treatment of sinus tarsi syndrome before, were similar to the results of CLA injection.

At 1-month follow-up, the best results were seen in the group treated with CLA injection. The ozone group demonstrated findings close to the CLA group. The PRP group received the lowest results at the end of the first month. The test results of the patients in the PRP group were also slightly lower than those of the other two groups at 3-month follow-up. The results of group 1 and group 3 were similar at 3-month follow-up. At the end of the study, the results of the three groups were close to each other, and there was no significant difference between the groups.

Conservative treatments or surgical treatments have been used to treat sinus tarsi syndrome\textsuperscript{1-3,5,37,38,41}. Conservative interventions such as bandaging to restrain the joint’s hypermobility, heel pads, proprioception exercises, cold compression and elevation, NSAIDs, and ultrasound treatment are considered the first-line treatment protocol. The corticosteroid injections might be applied to the sinus tarsi cavity when the first-line treatment protocol fails\textsuperscript{54,55}. Surgical management is indicated when conservative methods fail to relieve the symptoms. The surgical procedure includes removing the fat pad and fibrotic tissue in the sinus tarsi and removing the hypertrophic synovium. Various arthroscopic and open techniques are recommended for surgery to treat sinus tarsi syndrome\textsuperscript{2,5,56,57}. 
As far as we know, there were very few studies reporting local corticosteroid injections to treat sinus tarsi syndrome. Taillard et al. 2 mentioned that local anesthetic and corticosteroid injections administered five or six times at weekly intervals were effective in 2/3 of the patients. Komprda 37 reported a complete recovery of 73 patients using this method in a study on 116 patients with a significant reduction in the symptoms of 25 patients. In our study, we preferred to apply CLA injection to compare the treatment efficiency with the other two injections and avoid local side effects. In our study, we found significant improvements in the clinical symptoms of all patients in group 1 during the follow-up period. The best results were obtained in the CLA group after a one-month follow-up. We observed that the results in the CLA group decreased at the 3-month and 6-month follow-ups. We thought this reduction was due to a single-dose injection.

Samra et al. 58 treated a total of 21 Rugby Union players with ankle syndesmosis injuries. He applied the same conservative methods to all patients, applied PRP to only ten patients. They reported that a single autologous PRP injection might accelerate a safe and triumphant return to Rugby Union, with improved functional capacity and reduced fear avoidance. Laver et al. 31 treated 16 elite athletes diagnosed with a high ankle sprain with either an ultrasound-guided LP-PRP injection with a rehabilitation program or a rehabilitation program alone. They reported that the LP-PRP group returned to play in a shorter amount of time. In our study, we observed the clinical improvement in all patients in the PRP group. The clinical results of
patients in the PRP group were stable throughout the study after injection. We thought that a single-dose of PRP injection provided a sufficient and sustainable clinical improvement in the 6-month follow-up.

In a study published in 2012, Moretti reported that 20 athletes with ankle sprain had a significant decrease in pain scores of athletes following ozone treatment and hyaluronic acid administration. In our study, significant improvement in clinical symptoms was observed in 17 (94.44%) of 18 patients in the ozone group during the follow-up period. Clinical results of patients in this group were stable during three months of follow-up after injection. We thought a single dose of ozone injection provided a sufficient and sustainable clinical improvement in a 3-month follow-up.

The results of the groups in our study varied over time. As far as we know, more than a single-dose of injections was used to treat sinus tarsi syndrome. In this study, a single-dose of injections was administered to each patient to compare the effectiveness of the three injections. We thought that the effectiveness of the single-dose of these three injections decreased over time. All three injections were effective in treating sinus tarsi syndrome, but a single-dose of injections was insufficient. We recommend at least two or more injections at intervals to provide effective treatment for sinus tarsi syndrome.

There were several limitations to this study. The sample size of patients with sinus tarsi syndrome in each group was small. The follow-up period for this study was only six months.
Moreover, an unblinded study protocol was performed, and an unblinded administration was used during the injections. Future long-term studies with larger sample sizes and blind study protocols are needed to elucidate our findings.

CONCLUSION

In this study, we found that PRP and ozone injections were as effective as CLA to treat sinus tarsi syndrome. Each of these three injections could provide clinically significant functional improvement for at least six months in patients with sinus tarsi syndrome.

Conflict of Interest: All of the authors declared no conflict of interest.

Financial Disclosure: The authors declared that this study had received no financial support.

REFERENCES


This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.


Table 1. Demographic distribution of the patients

<table>
<thead>
<tr>
<th></th>
<th>ALL PATIENTS</th>
<th>GROUP 1 (Corticosteroid)</th>
<th>GROUP 2 (PRP)</th>
<th>GROUP 3 (Ozone)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td>26 (46.4%)</td>
<td>11 (55%)</td>
<td>9 (50%)</td>
<td>6 (33.3%)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td>30 (53.6%)</td>
<td>9 (45%)</td>
<td>9 (50%)</td>
<td>12 (66.6%)</td>
</tr>
<tr>
<td><strong>RIGHT</strong></td>
<td>27 (48.2%)</td>
<td>9 (45%)</td>
<td>6 (33.3%)</td>
<td>12 (66.6%)</td>
</tr>
<tr>
<td><strong>LEFT</strong></td>
<td>29 (51.8%)</td>
<td>11 (55%)</td>
<td>12 (66.6%)</td>
<td>6 (33.3%)</td>
</tr>
<tr>
<td><strong>AGE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD (min-max)</td>
<td>40.71±11.63 (20-68)</td>
<td>41.65±12.7 (20-68)</td>
<td>42.38±11.26 (25-53)</td>
<td>38±10.9 (24-56)</td>
</tr>
</tbody>
</table>

PRP: Platelet-rich Plasma; n: Number; SD: standard deviation; min: minimum; max: maximum
Table 2. Statistical analysis data of Visual Analog Scale results obtained from patients

<table>
<thead>
<tr>
<th>VAS</th>
<th>All patients (n=56)</th>
<th>Group 1 (n=20)</th>
<th>Group 2 (n=18)</th>
<th>Group 3 (n=18)</th>
<th>P-Value a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td></td>
</tr>
<tr>
<td>Before intervention</td>
<td>7.79±1.49</td>
<td>7.80±1.50</td>
<td>7.33±1.60</td>
<td>8.22±1.30</td>
<td>0.207</td>
</tr>
<tr>
<td>Post-injection 1st month</td>
<td>1.61±1.31</td>
<td>1.05±0.99</td>
<td>2.00±0.84</td>
<td>1.83±1.79</td>
<td>0.055</td>
</tr>
<tr>
<td>Post-injection 3rd month</td>
<td>1.75±1.28</td>
<td>1.45±1.05</td>
<td>2.00±0.84</td>
<td>1.83±1.79</td>
<td>0.403</td>
</tr>
<tr>
<td>Post-injection 6th month</td>
<td>2.51±1.91</td>
<td>2.45±1.82</td>
<td>2.00±0.84</td>
<td>3.11±2.61</td>
<td>0.219</td>
</tr>
<tr>
<td>P-Value f</td>
<td>&lt;0.001**</td>
<td>&lt;0.001**</td>
<td>&lt;0.001**</td>
<td>&lt;0.001**</td>
<td></td>
</tr>
</tbody>
</table>

VAS: Visual Analog Scale; n: Number; SD: Standard Deviation; Gr: Group; Stat. Diff.: Statistical Differences

a: Multivariate ANOVA (MANOVA) test analysis of results from all 3 groups
f: Repeated measures ANOVA test analysis of results between before intervention and post-injections
7: Games-Howell, one of the Post-hoc tests, was used.

** P<0.001
Table 3. Statistical analysis data of AOFAS results obtained from patients

<table>
<thead>
<tr>
<th>AOFAS</th>
<th>All patients (n=56)</th>
<th>Group 1 (n=20)</th>
<th>Group 2 (n=18)</th>
<th>Group 3 (n=18)</th>
<th>P-Value*</th>
<th>Stat. Diff.† (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before intervention</td>
<td>53.57±11.8</td>
<td>56.50±5.83</td>
<td>48.00±13.0</td>
<td>55.89±13.9</td>
<td>0.049*</td>
<td></td>
</tr>
<tr>
<td>Post-injection 1st month</td>
<td>83.61±7.65</td>
<td>88.30±2.02</td>
<td>80.00±3.36</td>
<td>82.00±11.4</td>
<td>0.001*</td>
<td>Gr 1→Gr 2 (&lt;0.001**)</td>
</tr>
<tr>
<td>Post-injection 3rd month</td>
<td>82.70±8.07</td>
<td>86.95±4.50</td>
<td>78.67±4.22</td>
<td>82.00±11.4</td>
<td>0.004*</td>
<td>Gr 1→Gr 2 (&lt;0.001**)</td>
</tr>
<tr>
<td>Post-injection 6th month</td>
<td>76.50±11.6</td>
<td>76.05±13.1</td>
<td>78.67±4.22</td>
<td>74.83±14.9</td>
<td>0.611</td>
<td></td>
</tr>
</tbody>
</table>

AOFAS: American Orthopedic Foot and Ankle Society Ankle-Hindfoot Scale; n: Number; SD: Standard Deviation; Gr: Group; Stat. Diff.: Statistical Differences

*: Multivariate ANOVA (MANOVA) test of results from all 3 groups
†: Repeated measures ANOVA test analysis of results between before intervention and post-injections
‡: Games-Howell, one of the Post-hoc tests was used.

* P<0.05
** P<0.001
Table 4. Statistical analysis data of the Foot Function index results obtained from patients

<table>
<thead>
<tr>
<th>FFI</th>
<th>All patients (n=56) Mean±SD</th>
<th>Group 1 (n=20) Mean±SD</th>
<th>Group 2 (n=18) Mean±SD</th>
<th>Group 3 (n=18) Mean±SD</th>
<th>P-Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before intervention</td>
<td>72.09±10.96</td>
<td>71.72±10.42</td>
<td>74.07±14.52</td>
<td>70.51±7.03</td>
<td>0.620</td>
</tr>
<tr>
<td>Post-injection 1st month</td>
<td>20.28±9.91</td>
<td>16.61±2.66</td>
<td>23.35±10.62</td>
<td>21.30±13.04</td>
<td>0.096</td>
</tr>
<tr>
<td>Post-injection 3rd month</td>
<td>21.78±10.60</td>
<td>18.61±6.85</td>
<td>25.78±10.59</td>
<td>21.30±13.04</td>
<td>0.110</td>
</tr>
<tr>
<td>Post-injection 6th month</td>
<td>27.80±13.80</td>
<td>29.45±13.72</td>
<td>25.78±10.59</td>
<td>27.98±16.91</td>
<td>0.722</td>
</tr>
</tbody>
</table>

P-Valueb <0.001**   <0.001**   <0.001**   <0.001**

FFI: Foot Function Index; n: Number; SD: Standard Deviation; Gr: Group; Stat. Diff.: Statistical Differences
a: Multivariate ANOVA (MANOVA) test analysis of results from all 3 groups
b: Repeated measures ANOVA test analysis of results between before intervention and post-injections
* P<0.05
** P<0.001
Table 5. Statistical analysis data of the Foot-Ankle Outcome Score results obtained from patients

<table>
<thead>
<tr>
<th>FAOS</th>
<th>All patients (n=56) Mean ± SD</th>
<th>Group 1 (n=20) Mean ± SD</th>
<th>Group 2 (n:18) Mean ± SD</th>
<th>Group 3 (n=18) Mean ± SD</th>
<th>P-Value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Stat. Diff.&lt;sup&gt;b&lt;/sup&gt; (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before intervention</td>
<td>39.10±7.31</td>
<td>35.93±5.38</td>
<td>45.55±6.0</td>
<td>36.18±6.29</td>
<td>&lt;0.001&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Gr1→Gr2</td>
</tr>
<tr>
<td>Post-injection 1&lt;sup&gt;st&lt;/sup&gt; month</td>
<td>81.47±8.27</td>
<td>87.61±3.23</td>
<td>75.40±2.2</td>
<td>80.71±10.9</td>
<td>&lt;0.001&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Gr1→Gr2</td>
</tr>
<tr>
<td>Post-injection 3&lt;sup&gt;rd&lt;/sup&gt; month</td>
<td>80.62±8.11</td>
<td>85.23±5.47</td>
<td>75.40±2.2</td>
<td>80.71±10.9</td>
<td>&lt;0.001&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Gr1→Gr2</td>
</tr>
<tr>
<td>Post-injection 6&lt;sup&gt;th&lt;/sup&gt; month</td>
<td>74.88±10.8</td>
<td>75.32±11.3</td>
<td>75.40±2.2</td>
<td>73.86±15.0</td>
<td>0.893</td>
<td></td>
</tr>
</tbody>
</table>

P-Value<sup>c</sup> <0.001<sup>**</sup> <0.001<sup>**</sup> <0.001<sup>**</sup> <0.001<sup>**</sup>

FAOS: Foot-Ankle Outcome Score; n: Number; SD: Standard Deviation; Gr: Group; Stat. Diff.: Statistical Differences
<sup>a</sup>: Multivariate ANOVA (MANOVA) test analysis of results from all 3 groups
<sup>b</sup>: Repeated measures ANOVA test analysis of results between before intervention and post-injections
<sup>c</sup>: Games-Howell, one of the Post-hoc tests, was used.

* P<0.05
** P<0.001
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

Figure 1: Study case flow chart
Figure 2: The patient's foot was forced to invert to enlarge the subtalar joint (A). A soft area was detected 1 cm in front of and 1 cm below the lateral malleolus (B).
Figure 3: Intra-articular Corticosteroid and local anesthetic injection
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

**Figure 4:** A centrifuge device used to prepare plasma-rich plasma (PRP) (A). During PRP preparation, an empty tube of the same weight was placed opposite the PRP kit to balance the device (B). Plasma was obtained after centrifugation (C) while the PRP was drawn into the injector (D). The resulting PRP (E). When injecting PRP into the sinus tarsi cavity (F).
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.