The European Research Journal 2023;9(1):155-163 Original Article

DOI: 10.18621/eurj.1213036 *Orthopaedics and Traumatology*

Clinical and radiological results of posterior ankle endoscopy treatment for the flexor hallusis longus tenosynovitis and os trigonum syndrome

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ABSTRACT

Objectives: This study investigated the effect of two portal posterior ankle arthroscopy (PAA) procedures using American Orthopaedic Foot and Ankle Society (AOFAS) and Visual Analog Scale (VAS) scores for the treatment of patients with ankle pain associated with Os trigonum (OT) and Flexor hallusis longus (FHL) tenosynovitis. The effect of PAA treatment on the degree and localization of effusion around the FHL tendon was also investigated.

Methods: Between March 2016 and August 2021, 41 patients who underwent PAA with the diagnosis of OT and stenosing FHL tenosynovitis, whose arthroscopy video records could be reviewed retrospectively, and who had at least 1 year of follow-up results were included in the study. Patients in the pediatric age group, diabetes patients, patients with inflammatory disease, and those with subtalar and tibiotalar osteoarthritis were excluded from the study. Preoperative and postoperative physical examinations, lateral radiography of the pressing foot, MRI, and the VAS and AOFAS scores were evaluated. In the statistical analysis, data were statistically analyzed using SPSS 19.0 (SPSS, Chicago, Illinois, USA). $p < 0.05$ was accepted as statistically significant.

Results: The mean age was 35.6 years (range: 19-55), among which the mean age of the women was 36.2 years (range: 24-48), and the mean age of the men was 35.2 years (range: 19-55). The mean follow-up was 34 months (range: 14-62). The AOFAS value increased from 38.61 ± 7.176 preoperatively to 89.83 ± 6.34 at the postoperative follow-up, and the difference was statistically significant ($p < 0.001$). Five patients fully regained their normal function (AOFAS score = 100 points). The VAS value increased from 90 ± 5.916 preoperatively to 18.682 ± 7.688 at the last postoperative follow-up, and the difference was statistically significant ($p < 0.001$). Pre-PAA FHL tenosynovitis was seen only in zone 1 in 26 patients, zones 1 and 2 in 14 patients, and in zones 1, 2, and 3 in two patients. There was no significant decrease in effusion in the magnetic resonance imaging (MRI) at 1 month after the PAA ($p = 0.117$). A significant decrease in effusion was observed in the MRI taken at the last control ($p < 0.001$).

Conclusions: In the treatment of patients with ankle pain associated with OT and FHL tenosynovitis, the two-portal PAA treatment was observed to be an effective method that resulted in significant improvement in the AOFAS and VAS scores.

Keywords: Ankle, arthroscopy, flexor hallusis longus, os trigonum

Received: **December 1, 2022;** *Accepted:* **December 14, 2022;** *Published Online:* **December 15, 2022**

e-ISSN: 2149-3189

How to cite this article: *Saylık M. Clinical and radiological results of posterior ankle endoscopy treatment for the flexor hallusis longus tenosynovitis and os trigonum syndrome. Eur Res J 2023;9(1):155-163. DOI: 10.18621/eurj.1213036*

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The two-portal endoscopic approach to the back of the foot was first described by van Dijk *et al*. [1]. It has been reported that posterior ankle arthroscopy (PAA) can be used in the treatment of os trigonum syndrome (OTS), flexor hallucis longus (FHL) tenosynovitis, bone and soft tissue impingements, free osteochondritis, and talus osteochondral lesions (TOL). In addition, PAA is an important option for the treatment of synovitis, tenosynovitis, subtalar joint pathologies, hypertrophic posterior talar process, Haglund deformity, and Achilles tendon pathologies [2, 3].

At the level of the ankle, the FHL tendon passes through the flexor retinaculum adjacent to the medial aspect of the talar process posteromedial to the talus and inferior to the sustentaculum tali via a fibrous tunnel. In the presence of OT, the FHL tendon sheath is compressed and narrowed, and stenosing tenosynovitis develops [1]. The effusion seen in the magnetic resonance imaging (MRI) around the FHL often develops due to stenosing tenosynovitis developing in the fibro-osseous tunnel region [4].

The OT is the most common accessory bone of the foot. It is posterolateral to the talus, triangular or oval, usually single-parted, and approximately 1 cm in size. While it is often asymptomatic, symptoms may be seen in persistent posterior ankle pain and posterior impingement syndrome known as OTS [5, 6].

OTS with stenosing FHL tenosynovitis is one reason for posterior ankle impingement syndrome. A radiological diagnosis of OT in the absence of any complaint has no clinical significance. However, in patients with OT compression and FHL tenosynovitis, PAA is required in the presence of such symptoms as pain, swelling, joint stiffness, locking, instability, and a feeling of insecurity in the posterior and inner part of the ankle, despite conservative treatment for more than 3 months [7].

This study investigated the effect of two portal PAA procedures on the American Orthopaedic Foot and Ankle Society (AOFAS) and Visual Analog Scale (VAS) scores in the treatment of patients with ankle pain associated with OT and FHL tenosynovitis. The effect of PAA treatment on the degree and localization of effusion around the FHL tendon was also investigated.

METHODS

A retrospective evaluation was conducted on 62 patients who received PAA for effusion due to OT and stenosing FHL tenosynovitis between March 2016 and August 2021 and whose arthroscopy video records could be retrospectively reviewed. Forty-one of these patients who had at least 1 year of follow-ups and complete records were included in the study. Diabetic patients, patients with systemic inflammatory diseases, and those with talotibial and subtalar joint osteoarthritis were excluded. No neurovascular deficits were observed. Consent was obtained from the patients included in the study.

OT was diagnosed with a lateral radiograph of the foot taken in a standing position (Fig. 1A). In addition to the standing lateral radiograph, a lateral radiograph taken with the ankle in plantar flexion (Fig. 1B)

Fig. 1. (A) OT (white arrow) image on the lateral radiograph of the pressing foot. (B) Posterior compression (black arrow image) image on the lateral radiograph taken while the foot is in plantar flexion.

showed OT posterior impingement syndrome.
A physical examination, lateral radiography, computed tomography (CT), and MRI (Figs. 2A, 2B, 2C) were used for the diagnosis of OT and FHL tenosynovitis. Pre-operative and post-operative evaluations were performed by a physical examination, lateral radiography, MRI, VAS, and AOFAS. Clinical and radiologic results at the pre-operative and final follow-ups were compared.

Pain posterolateral to the ankle and a positive impingement test on the physical examination were typical findings for OT. Pain and swelling in the medial aspect of the ankle were seen in all patients with FHL tenosynovitis. There was local tenderness, crackling on palpation, and a mobile nodule in the medial aspect of the ankle in the localization corresponding to the fibro-osseous tunnel entrance of the FHL. Frequent ankle sprains and a feeling of emptiness in OT were the most common complaints of the patients. In FHL tenosynovitis, the pain increased with thumb dorsiflexion.

If accessory OT was suspected, a further evaluation was carried out with a 3D ankle CT or MRI. The degree and localization of FHL tenosynovitis before PAA were determined using an MRI. The three-zone differentiation described by Lui *et al*. [8] for FHL tenosynovitis was used. Zone 1 is located between the tendon–muscle belly junctional zone and sustentaculum tali, zone 2 is between the sustentaculum tali and the Henry nodule of the foot sole, and zone 3 is at the distal end of the Henry nodule until the endpoint of the phalanx of FHL. The localization and level of FHL tenosynovitis were evaluated through an MRI after PAA. The presence of effusion was divided into three groups (Moderate-Mild-None).

Conservative treatment included soft heel support, ice application, nonsteroidal anti-inflammatory drugs, restriction of hyperflexion, and physiotherapy. PAA was performed in patients who did not respond to conservative treatment for more than four months.

The clinical status of the ankle-hindfoot was evaluated using the AOFAS Ankle-Hindfoot Assessment System, first published in Foot and Ankle International in 1994. According to this scale, pain contributes 40 points (none, mild-occasional, moderate-daily, severe-almost always), function (activity limitations, need for support, maximum walking distance-blocks, walking surfaces, gait abnormality, loss of flexion-extension motion, hindfoot inversion-eversion motion) contributes 50 points, and degree of ankle and hindfoot varus-valgus and foot–ankle alignment contributes 10 points. Lower point scores indicate a poor result.
The VAS score was divided into three groups according to the pain scale of the World Health Organization. A score of less than three was considered mild pain, three to six was mild-moderate pain, and more than six constituted moderate-severe pain.

Surgical Technique

All PAAs in this study were performed in a single center by the same surgeon who was experienced in ankle arthroscopy. General or spinal anesthesia was used. A tourniquet was applied to the proximal thigh while the patient was in the supine position, and then the patient was moved to the prone position. The foot was moved outward from the operating table to perform plantar flexion and dorsiflexion, and the ankle was elevated with the support of a green sterile drape.

Fig. 2. (A) OT (white arrow) image on ankle sagittal MR section. (B) Degree and localization of effusion (white arrow) due to FHL tenosynovitis on sagittal MR section of the foot. (C) Degree and localization of effusion (white arrow) due to FHL tenosynovitis on axial MR section of the foot.

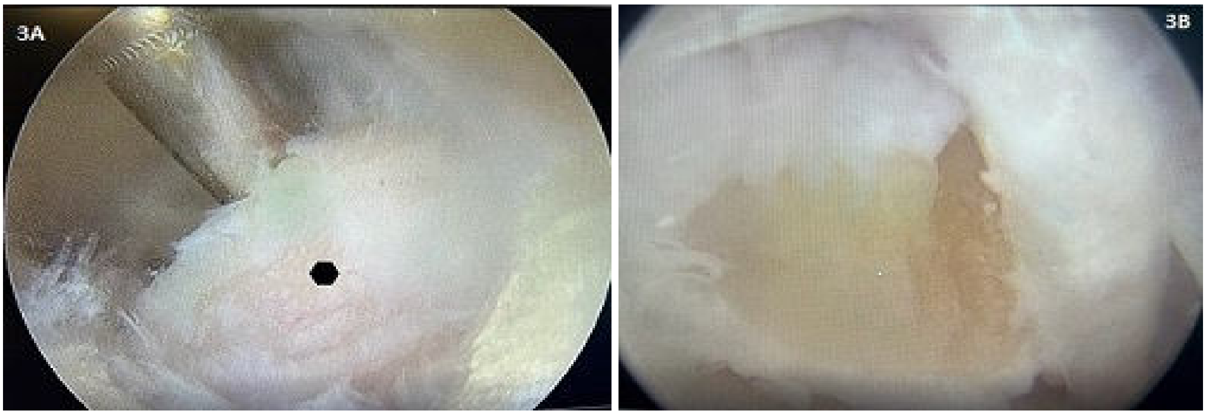

Fig. 3. (A) Separation of the OT (polygon) from the posterior talofibular ligament, flexor retinaculum, posterior talocalcaneal ligament by Sheaver. (B) Excision of OT with bone sheaver and position with FHL after synovectomy.

The two portal techniques described by Van Dijk [1] were applied. The lateral portal was opened lateral to the Achilles tendon at the malleolar junction line. Great care was taken to avoid damage to the small saphenous vein and nerve. The medial portal was opened at the same level as the lateral portal and medial to the Achilles tendon. The lateral portal served as the visualization portal, while the medial portal served as the process portal. A synovectomy was performed through these portals in the safe area between the posterior region of the tibiotalar and subtalar joint and the Achilles tendon without damaging the neurovascular structures. The subtalar joint was imaged first. By moving slightly upward and medially from the joint, the OT and FHL tendons were visible behind the talus. Since this vascular nerve bundle passes in front of the FHL tendon, crossing in front of it was avoided. The OT was loosened from the surrounding tissues (posterior talofibular ligament, flexor retinaculum, posterior talocalcaneal ligament) with a shaver and the released OT (Fig. 3A) was removed from the joint with a grasping punch. The OT was removed as a single 12-20 mm piece. If the OT was whole with the talus, it was excised using a bone bur (Fig. 3B). Stiffness and impingement in the tendon sheath, similar to de Quervain's tenosynovitis, which developed in FHL, was resolved by separating the flexor retinaculum from the posterior talar process using arthroscopic cutting scissors and a shaver. Surrounding adhesions were also loosened with a shaver. Aspiration was performed along the FHL tendon. The hallux was flexed and dorsiflexed, and it was observed that the FHL tendon moved easily in the sheath. The arthroscopic intervention was terminated by placing a skin suture on the portals. A compressive bandage was applied around the foot and ankle. On the first evening post-surgery, the area was compressed with support to the maximum pain threshold the patient could tolerate. After the second week, controlled compression without support was applied. After the first month, patients were permitted to resume light daily activities. The second month allowed for a return to active life, and the third month allowed for light sports. There were no intraoperative complications. Post-operatively, pa-

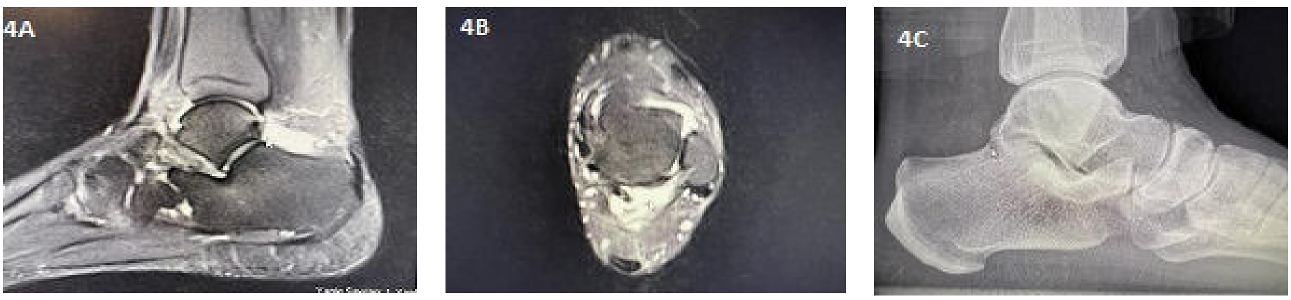

Fig. 4. (A) FHL effusion grade and localization (white arrow) in the ankle sagittal MR section after PAA. (B) FHL effusion degree and localization (white arrow) on ankle axial MR section after PAA. (C) Excision of the OT on the lateral radiograph of the pressing foot at the last follow-up after PAA (white arrow).

tients were evaluated with sagittal-axial MRI (Figs. 4A and 4B) and lateral radiograph (Fig. 4C)

Statistical Analysis

Data were statistically analyzed using the SPSS 19.0 (SPSS, Chicago, Illinois, USA) program. Pre- and post-operative AOFAS midfoot scores and VAS scores were analyzed by paired t-test. Pearson correlation coefficient was used to analyze whether significant correlation exists between the parameters. Two-tailed hypothesis was considered in the analyses, and the significant differences were accepted if p value was < 0.05.

RESULTS

A retrospective evaluation was conducted on 41 patients who underwent PAA for OT and FHL tenosynovitis between March 2016 and August 2021. The mean patient age was 35.6 years (range: 19-55), with the mean female age being 36.2 years (range: 24-48) and the mean male age being 35.2 years (range: 19-55). The mean follow-up period was 34 months (range: 14-62). A table indicating the scores of the demographic characteristics of the patients was made (Table 1).

The AOFAS value pre-PAA increased from 61.5 ± 11.7 to 90.4 ± 9.35 at the final follow-up, with this difference being statistically significant ($p < 0.001$). Five patients completely regained normal function (an AOFAS score of 100 points).

The pre-operative VAS value of 88.5 ± 7.3 increased to 43.5 ± 5.2 at the final follow-up, with this difference also being statistically significant ($p < 0.001$).

There was a significant difference between preoperative VAS and postoperative VAS ($p < 0.001$), and there was a significant difference between preoperative AOFAS and postoperative AOFAS ($p < 0.001$).

Pearson correlation test was performed which showed the relationship of all parameters with each other (Table 2). There is no significant difference between age and scores, but the degree of FHL involvement ($p = 0.019$), and the number of traumas ($p = 0.031$) increase significantly as age increase.

The degree of preoperative FHL involvement has no efffect on the results, but as the degree of postoperative FHL involvement increases, the postoperative VAS score alsıo increases ($p = 0.017$).

The higher the preoperative AOFAS score, the lower the preoperative VAS ($p = 0.011$), and the higher the postoperative AOFAS score, the lower the postoperative VAS score ($p = 0.000$).

It was observed that the preoperative AOFAS score did not affect the postoperative AOFAS score ($p = 0.091$), and the preoperative VAS score did not affect the postoperative VAS score ($p = 0.787$) as well.

Prior to PAA, FHL tenosynovitis was observed in zone 1 in 26 patients, in zones 1 and 2 in 14 patients, and in zones 1, 2, and 3 in two patients. In the final follow-up MRI, there was a significant decrease in effusion ($p < 0.001$).

Post-PAA complications included superficial infections treated with oral anti-biotherapy in two patients, stiffness requiring physiotherapy in three patients, mild plantar paresthesia in one patient, and sural nerve paresthesia in two patients. There was no evidence of deep infection, persistent pain, dysesthesia, or major complications requiring re-operation. No

Table 1. The patients demograpfic characteristics scores

	Males (n = 27)	Females (n = 14)	Total (n = 41)
Age (mean)	35.2	36.2	35.6
Preop AOFAS Score	38.4	38.9	38.6
Postop. AOFAS Score	89.7	90.1	89.8
Preop. VAS Score	8.9	9.3	9.0
Postop. VAS Score	1.8	1.7	1.8

Preop = Preoperative, Postop = Postoperative, AOFAS = American Orthopaedic Foot and Ankle Society, VAS = Visual Analog Scale patients were subjected to revision.

There were seven patients with pes planovalgus and three with plantar fasciitis. For plantar fasciitis, a local lidocaine and corticosteroid injection was administered intraoperatively; no surgery was performed. Patients with pes planovalgus were fitted with special insoles.

DISCUSSION

In this study, FHL tenosynovectomy and OT resection provided significant improvement in the AOFAS and VAS values of PAA for patients with OT and FHL tenosynovitis and ankle pain.

Plantar flexion of the first metatarsophalangeal joint and the first finger interphalangeal joint is the primary function of the FHL tendon. Its secondary function is to support the subtalar joint and thumb joints and restrict passive dorsiflexion of the first metatarsophalangeal joint [4, 9]. When the ankle is excessively plantar flexed, angular incompatibility occurs between the FHL and fibro-osseous tunnel. The FHL tendon can be subjected to abnormal stress during an ankle sprain in excessive plantar flexion, and tenosynovitis may develop [4]. The fact that all patients except

Table 2. Pearson correlation test was performed which showed the relationship of all parameters with each other

		Age (n= 41)	Preop AOFAS (n = 41)	Postop AOFAS (n = 41)	Preop VAS (n = 41)	Postop VAS (n = 41)	Preop FHL (n = 41)	Postop FHL (n = 41)	Ankle Trauma (n = 41)
Age	Pearson Correlation	1	-.090	.006	.083	-.070	.365*	-.088	.337*
	Sig. (2-tailed)		.577	.969	.604	.662	**.019**	.585	**.031**
Preop AOFAS	Pearson Correlation	-.090	1	.268	-.395*	-.083	.272	-.126	.289
	Sig. (2-tailed)	.577		.091	**.011**	.604	.086	.433	.067
Postop AOFAS	Pearson Correlation	.006	.268	1	.207	-.621**	.299	-.253	.180
	Sig. (2-tailed)	.969	.091		.195	**< .001**	.058	.111	.261
Preop VAS	Pearson Correlation	.083	-.395*	.207	1	.044	.088	.032	.238
	Sig. (2-tailed)	.604	**.011**	.195		.787	.584	.841	.134
Postop VAS	Pearson Correlation	-.070	-.083	-.621**	.044	1	-.121	.370*	.006
	Sig. (2-tailed)	.662	.604	**< .001**	.787		.450	**.017**	.972
Preop FHL	Pearson Correlation	.365*	.272	.299	.088	-.121	1	-.083	.306
	Sig. (2-tailed)	**.019**	.086	.058	.584	.450		.604	.052
Postop FHL	Pearson Correlation	-.088	-.126	-.253	.032	.370*	-.083	1	-.098
	Sig. (2-tailed)	.585	.433	.111	.841	**.017**	.604		.543
Ankle Trauma	Pearson Correlation	.337*	.289	.180	.238	.006	.306	-.098	1
	Sig. (2-tailed)	**.031**	.067	.261	.134	.972	.052	.543	

Preop = Preoperative, Postop = Postoperative, AOFAS = American Orthopaedic Foot and Ankle Society, VAS = Visual Analog Scale, FHL = Flexor Hallusis Longus for eight had a history of ankle sprain in our study supports this result.

Effusion due to FHL tenosynovitis can be seen along the tendon trace, but tenosynovitis was most reported at the level of the fibro-osseous tunnel located posterior to the medial malleolus [10]. In the present study, effusion was most seen in zone 1 between the proximal FHL tendon (behind the medial malleolus) and the sustentaculum tali.

OTS can be diagnosed clinically and radiologically. The initial evaluation method to observe OT is a lateral weight-bearing foot radiography. Furthermore, in a sagittal proton density MRI, OT bone marrow edema and signal changes can be observed, and bone scintigraphy of the involved area will demonstrate an increase in activity [11]. In addition to a lateral weight-bearing foot radiography, an impingement between the posterior malleolus and Os trigonum may be observed in a lateral plantar flexion foot radiography [12]. For OT diagnosis in the present research, lateral weight-bearing foot radiography, lateral foot radiography in flexion, and MRI methods were utilized.

The most common cause of posterior ankle impingement is OT syndrome, accompanied by stenosing FHL tenosynovitis. Conservative therapy is recommended as the primary method for this syndrome. However, patients should be informed that conservative therapy is time-intensive and that symptoms may not be fully alleviated [13, 14]. Conservative therapy has been shown to produce better results in patients who do not actively exercise [15], with another study reporting that conservative therapy methods can produce successful results in approximately 60% of OT syndrome patients [16]. In the present study, without making a distinction between those who exercised and those who did not, PAA was applied to patients for whom successful results could not be achieved despite receiving conservative therapy. Conservative therapy was chosen as the initial treatment option. No results regarding the number of patients receiving conservative therapy who did not require surgery are available from the present research, as this was outside of the scope of this study.

Previous research has reported that for some patients who did not respond to conservative therapy, open or arthroscopic FHL tenolysis and OT excision can be used [15, 17]. These options have come to the forefront as arthroscopic approaches have become favored and because they result in less scar formation, less postoperative pain, a decrease in general morbidity, and allow for the early return to daily activities. Treatment with PAA has been reported to be the gold standard in the treatment of posterior impingement syndrome, OT, and FHL tenosynovitis due to benefits such as detailed imaging of the ankle posterior, faster recovery, return to sports, low morbidity, and less postoperative pain [18, 19]. However, difficulties related to the application of FHL tenolysis and OT excision include the length of learning required for ankle arthroscopy, particularly PAA, and the proximity of the portals to neurovascular structures.

In treatments of massive effusion occurring due to FHL tenosynovitis in patients undergoing extensive synovectomy via open surgery, there have been reports that effusion relapsed in both the proximal and distal of the fibro-osseous tunnel [20]. Patient satisfaction was 80% for PAA and 85%–92% for open surgery in a study comparing PAA and open tenosynovectomy treatments for FHL tenosynovitis. While the recovery time to return to average activities for open surgery was reported to be 12–25 weeks, the recovery time for PAA was 6–8 weeks. However, no statistical significance was reported between these results [21]. Since the present study had limited experience treating FHL tenosynovitis and OT with open surgery, no results related to this difference could be reported.

Previous research has shown that after PAA was used to treat stenosing FHL tenosynovitis, good or excellent results were reported in 70% of patients, and 81% returned to their pre-surgery activity levels [10]. Other research has reported that AOFAS scores increased to 83.2 from 48.7 in patients who underwent tenolysis and a synovectomy for stenosing FHL tenosynovitis [18]. In the present study, the AOFAS scores for 22 patients (55%) were 90 or higher after PAA.

One study observed OT in 50 of 59 patients who underwent PAA for posterior ankle impingement syndrome, a large posterior talar eminence in 14 patients, and FHL tenosynovitis in eight patients. The mid-phase results of the PAA treatment were reported to be good, and the rate of return to sports was high [22]. In another study, in which PAA was commmonly used to treat OT syndrome, there was a significant improvement after arthroscopy [23]. In their study, Morelli *et* *al*. [24] reported that after a mean 38.9-month follow-up in PAA and OT excision, the mean AOFAS score increased from 67.8 pre-surgery to 96 post-surgery. Again, in a similar study, it was reported that the mean AOFAS score increased from 43 to 87 in the last follow-up [25]. In the present study, the outcomes of patients who received PAA for both OT and stenosing FHL tenosynovitis were evaluated.

Successful outcomes were reported in studies where OT and FHL tenosynovitis occurred concurrently and were treated with PAA. PAA has been reported to be an effective and safe method in the surgical treatment of both OT and stenosing FHL tenosynovitis [10, 26]. In another study, it was reported that PAA should be the accepted standard in the treatment of pathologies related to the feet due to the low complication rate and faster recovery time [27]. In one study, in the 1-year follow-up of patients whose OT excision and massive effusion around FHL were treated with synovectomy and whose tendon sheath excision was treated with PAA, massive effusion did not reoccur [4]. In the present study, the amount of effusion detected through the MRI before PAA was reduced by at least one degree, and in six patients, it completely disappeared.

Ribbans *et al*. [28] reported 3.7% nerve damage and 0.96% wound site complications after PAA. The present research observed a superficial infection in two patients, stiffness requiring physiotherapy in three patients, mild plantar paresthesia in one patient, and sural nerve paresthesia in two patients.

Limitations

The main advantage of this study is the fact that it is one of the few that combined OT and stenosing FHL tenosynovitis, along with the outcomes of treating both pathologies with PAA. However, this study did have some limitations. Since the study was retrospective, there were some natural deficiencies. Furthermore, there were no results comparing conservative therapy and surgery results. A final limitation is that the pediatric age group was not included, and thus, there were no results for this age group.

CONCLUSION

In the treatment of patients with ankle pain associated with OT and FHL tenosynovitis, two-portal PAA treatment was observed to be an effective method that resulted in significant improvement in the AOFAS and VAS scores. No significant relationship was observed between effusion localization and degree and VAS and AOFAS scores after PAA. The treatment of OT and stenosing FHL tenosynovitis with PAA is considered a safe method due to the low complication rates.

Authors' Contribution

Study Conception: MS; Study Design: MS; Supervision: MS; Funding: MS; Materials: MS; Data Collection and/or Processing: MS; Statistical Analysis and/or Data Interpretation: MS; Literature Review: MS; Manuscript Preparation: MS and Critical Review: MS.

Conflict of interest

The author disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The author disclosed that they did not receive any grant during conduction or writing of this study.

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