Os Trigonum Excision in Dancers via an Open Posteromedial Approach

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Abstract

Background: An os trigonum is a potential source of posterior ankle pain in dancers, often associated with flexor hallucis longus (FHL) pathology. Options for operative excision include open excision, subtalar arthroscopy, and posterior endoscopy. The purpose of this paper was to present a series of dancers who underwent excision of a symptomatic os trigonum via an open posteromedial approach.

Methods: This study is a retrospective case series of 40 ankles in 38 dancers who underwent os trigonum excision via an open posteromedial approach with FHL tenolysis between 2000 and 2013. All patients were interviewed and charts retrospectively analyzed. Collected variables included pre- and postoperative pain level, time to return to dance, and subjective satisfaction. The average age was 19.2 years; ballet was the primary dance form in 36 (95%) of patient-cases. Eight (20%) of the patient-cases were professional dancers, and 30 (75%) were students or preprofessional dancers.

Results: Average preoperative pain level was 7.7/10, which decreased to 0.6/10 postoperatively. Seventeen (42.5%) experienced concurrent preoperation-associated FHL symptomatology, all of whom experienced relief postoperatively. The average time to return to dance was 7.9 weeks, and time to pain-free dance was 17.7 weeks. Of the 37 patient-cases desiring to return to dance, 35 (94.6%) returned to their preoperative level of dance. There were no neurovascular or other major complications. Four (10%) had minor wound complications that resolved, and 38 cases (95%) considered the procedure a success.

Conclusion: Open posteromedial excision of an os trigonum in dancers provided satisfactory pain relief, return to dance, and complication rates compared to other approaches, and allowed for identifying and treating any associated FHL pathology.

Level of Evidence: Level IV, retrospective case series.

Keywords: Os trigonum, posterior ankle impingement syndrome, dance injuries

Introduction

First described in 1804 by Rosenmuller, the os trigonum is the second most common accessory bone of the foot.9,18 It is the result of a secondary ossification center that mineralizes between the ages of 8 and 13 which fails to fuse to the lateral tubercle of the posterior process of the talus.5,9,35 Os trigonum syndrome, a variant of posterior ankle impingement syndrome (PAIS), is caused by compression of the os trigonum and surrounding soft tissue between the posterior aspect of the distal tibia and the calcaneus.15,37

Os trigonum syndrome occurs when the patient’s ankle is in plantarflexion. The impingement primarily produces posterolateral ankle pain, although posteromedial pain may often be produced as well.5,16-18 PAIS can also be caused by enlarged posterior talar processes, scar tissue in the posterior ankle joint, fracture of the Stieda process, accessory muscles, or inflammation of posterior ankle ligaments.4,14,35,54 This article focused solely on PAIS caused by an os trigonum.

Os trigonum syndrome can be caused by overuse injury or acute trauma.9,12,25,41,43,54 Overuse injury is the primary mechanism of injury,12,25 with microtrauma or stress to the os trigonum and posterior ankle capsule...
occurring with repetitive plantarflexion. 9,21,40,45,54 Acute trauma to the area can cause slight movement of the os trigonum, initiating symptoms of impingement that had not been previously present. 54 Os trigonum syndrome most often presents in classical ballet dancers because of the activity’s demand to be fully weightbearing on a hyperplantarflexed ankle when in releve en pointe or demipointe, as well as nonweightbearing plantarflexion while in a tendu position. 9,18,24,40,43,53 The syndrome may also be seen in soccer players, downhill runners, or football kickers, who also utilize a forced repetitive plantarflexed ankle position in their activities. 1,5,9,15,43 The level of pain does not necessarily correlate to the size of the os trigonum, and many dancers with an os trigonum will remain asymptomatic. 16,17,24,40,45 Some dancers who have a nonpainful os trigonum may feel a bony end point when attempting plantarflexion, preventing them from achieving full pointe position. 6,44

Flexor hallucis longus (FHL) tendonitis, also known as “dancer’s tendonitis,” has been reported to occur in 63% to 85% of cases of os trigonum syndrome. 16,17,43,45,49,54 The FHL tendon runs in the groove between the medial and lateral tubercles of the posterior talus through a fibro-osseous tunnel behind the medial malleolus. 9,43,45 During repetitive dorsiflexion of the first metatarsophalangeal joint and plantarflexion of the ankle, as occurs with releve in demipointe position in ballet, the tendon is pulled into the tunnel, which can result in tendinitis, tenosynovitis, and occasional “triggering.” 1,9,17,18,21,23,24,43

When conservative management has failed, operative intervention to excise the symptomatic os trigonum may be indicated. 3,6,16,22 Several operative approaches have been reported, including via open posterolateral and posteromedial incisions, as well as posterior endoscopy and subtalar arthroscopy. 7 Each of these approaches have certain advantages as well as limitations. The purpose of this article was to present a series of dancers who underwent excision of a symptomatic os trigonum via an open posteromedial approach. Exclusion criteria included patients who were nondancers, procedures that utilized a posterolateral or arthroscopic approach, staged procedures, and posterior ankle impingement not caused by an os trigonum. Six cases of os trigonum excision via a posterolateral incision, 1 staged procedure, 1 nondancer, and 5 posterior talar process resections were excluded, for a total of 13 excluded cases. Of the 55 cases that met the inclusion criteria, 15 patients were lost to follow-up, leaving a total of 40 cases of os trigonum excision in dancers via posteromedial approach that were included in the study. Two patients underwent surgery on both ankles.

There were 39 female and 1 male cases with a mean age of 19.2 years (range, 13 to 39 years; 95% confidence interval [CI], 17.3 to 21.0) (Table 1), evenly divided between right and left ankles. The mean postoperative follow-up was 4 years (range, 6 months to 12 years). All patients with less than 2-year follow-up (n=12) were pain free at the time of interview. Ballet was the primary dance form in 36 (90%) of the cases, whereas 3 (7.5%) of the cases were primarily modern dancers. One (2.5%) was a salsa dancer. The patients, however, practiced an average of 2.5 (range, 1 to 6) different types of dance. Eight (20%) of the patient cases were professional dancers, 30 (75%) were serious student or preprofessional dancers, and 2 (5%) were recreational dancers. On average, the patients danced 20.7 hours per week (range, 6 to 40 hours; 95% CI, 17.6 to 23.8) before the onset of symptoms. After the onset of symptoms, the average hours of dance decreased to 15.4 hours per week (range, 0 to 40; 95% CI, 11.3 to 19.5).

Patients stated their symptoms were exacerbated by pointe, tendu, releve, and/or jumping. On physical examination, all patients experienced pain with forced passive plantarflexion of the ankle, as well as tenderness to palpation of the posteromedial and/or posterolateral aspect of the ankle joint in the region of the os trigonum. Clicking upon forced plantarflexion was often elicited by further inversion/eversion in this position. Prior to considering surgery, all of the patients failed conservative treatment, which included physical therapy, cortisone injections (8 cases), electrical stimulation, immobilization, nonsteroidal anti-inflammatory drugs (NSAIDs), acupuncture, and rest. The cases waited an average of 17.6 months after the onset of symptoms before undergoing excision. Seventeen of the 40 patient cases (42.5%) experienced FHL symptomatology (triggering, clicking/crepitus at the entrance of the tendon sheath posterior to the medial malleolus, decreased tendon excursion) in conjunction with posterior ankle pain.

Diagnosis of a symptomatic os trigonum causing restriction of dance secondary to posterior ankle impingement was made by history, physical examination, radiographs, and MRI. The study was approved by the Institutional Review Board of the New York University School of Medicine.

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References 5, 15-17, 19, 22, 43, 45, 51, 53.
Operative Technique

The patient was in a supine position with a bump placed under the contralateral hip. A thigh tourniquet was used. The extremity was placed in a figure-of-4 position. An approximately 3-cm slightly curvilinear longitudinal incision was made midway between the posterior aspect of the medial malleolus and the anterior aspect of the Achilles tendon over the palpated FHL tendon and flexor retinaculum exposed (Figure 1A). The retinaculum was longitudinally incised over the posteromedial neurovascular bundle and calcaneal branch of the tibial nerve identified. The neurovascular bundle was gently retracted anteriorly, exposing the FHL tendon and tendon sheath, which was distinguished by passive motion of the great toe. The FHL tendon sheath was incised over 2.5-3 cm. A tenosynovectomy and debridement of the FHL was performed as required (Figures 1B). Unimpeded excursion of the FHL was confirmed and then it was gently retracted anteriorly together with the neurovascular bundle, exposing the posterior capsule overlying the os trigonum and posterior talocalcaneal joint. Location of the os trigonum was aided by probing with a Freer elevator. A longitudinal capsulotomy was centered over the os trigonum, which was sharply dissected out of the capsule and removed (Figures 1C, 1D). Any additional posterior bony or soft tissue impingement visualized during range of motion of the ankle was resected. The capsule was closed with a 2-0 absorbable suture with the ankle in neutral dorsiflexion, and the subcutaneous and skin layers were closed.

Postoperatively, the ankle was placed in a removable boot for approximately 2 weeks, with partial to full weight-bearing as tolerated. All patients were discharged on the day of surgery. Range of motion was encouraged after the initial 2 to 3 postoperative days. Formal physical therapy was initiated after 2 weeks. Dancers were progressed to full dance as tolerated at approximately 6 weeks.

Data Collection/Statistical Methods/Outcome Measurement

Eligible patients were identified through a review of medical records. Final follow-up and data collection was performed by telephone interview. Patients initially contacted within 2 years of surgery who were still not pain free were reinterviewed after 2 years.

Collected variables included patient demographics, side of operation, types of dance participated in, level of dance prior to symptom onset, level of dance once symptoms began, positions that exacerbated the pain, duration of symptoms prior to surgery, preoperative treatments attempted, preoperative and postoperative level of pain on a numeric pain rating scale of 0 to 10, presence of FHL symptomatology prior to surgery and relief after surgery, ability and time to return to dance, postoperative wound complications, and time until fully pain free.

All patients were asked to respond to the following questions on the subjective satisfaction questionnaire: (1) Did you feel like your surgery was a success? (2) Would you undergo the procedure again if you were in the same situation? (3) Would you recommend the surgery to other patients?

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Table 1. Patient Demographics and Behaviors.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Patients, n=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female n (%)</td>
<td>39 (97.5)</td>
</tr>
<tr>
<td>Age at operation, average, (range) [95% CI]</td>
<td>19.2 (13-39) [17.3, 21.0]</td>
</tr>
<tr>
<td>Side of operation</td>
<td></td>
</tr>
<tr>
<td>Right, n (%)</td>
<td>20 (50)</td>
</tr>
<tr>
<td>Primary dance form practiced</td>
<td></td>
</tr>
<tr>
<td>Ballet, n (%)</td>
<td>36 (90)</td>
</tr>
<tr>
<td>Number of dance forms practiced, average (range) [95% CI]</td>
<td>2.5 (1-6) [2.1, 2.8]</td>
</tr>
<tr>
<td>Level of dance prior to symptom onset</td>
<td></td>
</tr>
<tr>
<td>Professional (≥40 h/wk), n (%)</td>
<td>6 (15)</td>
</tr>
<tr>
<td>Preprofessional (16 ≤ x &lt; 40 h/wk), n (%)</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>Recreational (&lt;16 h/wk), n (%)</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>Hours of dance practiced per week, presymptom, average (range) [95% CI]</td>
<td>20.7 (6-40) [17.6, 23.8]</td>
</tr>
<tr>
<td>Hours of dance practiced per week, while symptomatic, average, (range) [95% CI]</td>
<td>15.4 (0-40) [11.3, 19.5]</td>
</tr>
<tr>
<td>Change in hours of dance per week after symptom onset, average, (range) [95% CI]</td>
<td>5.3 (0-30) [2.7, 7.9]</td>
</tr>
<tr>
<td>Percentage change in hours of dance per week, average</td>
<td>30.4</td>
</tr>
<tr>
<td>Duration of symptoms prior to surgery, average (range) [95% CI], mo</td>
<td>17.6 (1-120) [11.7, 23.5]</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.
Results

The average pain level prior to surgery was 7.7 (range, 4 to 10; 95% CI, 7.2 to 8.1) (Table 2). Postoperatively, the average level of pain was 0.6 (range, 0-6; 95% CI, 0.3 to 1.0), with an average 90.8% improvement in pain score. As noted, 42.5% of the patient cases had FHL symptomaticology prior to surgery. All of these 17 patients experienced relief from FHL symptoms after surgery.

All patients experienced subjective and objective improvement in their total plantarflexion range of motion. On average, it took 7.9 weeks (range, 3 to 20 weeks, 95% CI, 6.9 to 9.0) to return to dance, and 17.7 weeks (range, 6 to 52 weeks, 95% CI, 14.5 to 20.9) to return to full dance completely pain-free (Table 2). One patient was excluded from the latter calculation; she had concurrent peroneal tendinitis pain that was persistent and prevented her from returning to dance completely. Of the 40 patient cases that underwent surgery, 3 decided not to return to dance due to personal reasons. Of the remaining 37 cases, 35 (94.6%) were able to return to their preinjury level of dance. The 2 patients who did not return to their preinjury level of dance included the dancer with peroneal tendinitis, discussed above, and a ballet dancer who, although she returned to ballet and modern dance, was unable to return to her preinjury level of pointe because of postero-medial scar tissue.

No patient had a major postoperative complication. Four patients had minor complications (10%), including 2 with keloid formation, 1 with a superficial infection treated successfully with oral antibiotics, and 1 with a superficial wound dehiscence, which progressed to full healing (Table 2).

Subjectively, 38 (95%) of the patient cases considered the procedure a success and would undergo the procedure again if given the choice (Table 2). All 40 (100%) would recommend the surgery to other patients with a symptomatic os trigonum.

Discussion

The presence of an os trigonum is a potential source of posterior ankle pain during plantarflexion in a dancer. Os trigonum syndrome is frequently misdiagnosed as peroneal tendinitis in a dancer with posterolateral ankle pain.17,18 The incidence of os trigonum syndrome is not fully elucidated because many dancers and athletes are treated by primary care doctors or sports trainers for ankle pain with conservative treatment, without necessitating the escalation of care to an orthopedist.9

Radiographic studies are essential in the diagnosis and management of the dancer with a painful os trigonum. Lateral radiographs of the foot or ankle in neutral or preferably in plantarflexion with 20 to 25 degrees of external rotation can demonstrate bony abnormalities like an os trigonum (Figure 2) or an enlarged bony talar prominence.1,18,26,43,45

Figure 1. (A) Flexor retinaculum with visualized underlying neurovascular bundle. (B) Neurovascular bundle retracted, FHL tendon sheath being released. (C) FHL retracted anteriorly, capsulotomy over palpated os trigonum. (D) Excision of os trigonum following dissection from capsule. FHL, flexor hallucis longus.
Magnetic resonance images (MRIs) show the 3-dimensional shape and are more sensitive for diagnosing and more fully evaluating posterior ankle impingement, because they can show radiographically occult os trigonum, pseudarthrosis, bone marrow edema, sclerosis, cystic changes, synovitis, and inflammatory changes of the os trigonum (Figure 3).7,28 MRIs also allow for assessment of the FHL tendon, showing abnormalities of the tendon sheath, or nodules or small tears in the tendon itself.9,41,43,45 In our study, all patients underwent MRI evaluation preoperatively.1 Ultrasonography was not felt to contribute enough additional radiologic information to supplant the need for MRI, and therefore was not used.

The current management for symptomatic os trigonum in the dance population is not standardized. Primary treatment of os trigonum syndrome is conservative, which involves physical therapy, restrictive taping, NSAIDs, and activity modification.3,6,9,16,17,24,45,54 Conservative treatment is often less successful in the chronic setting. After a period of relative rest, symptoms are often diminished but they frequently recur on return to provocative dance activities.26,45

The use of local corticosteroid injection(s) has been found to be relatively successful in the athletic population by

### Table 2. Pain Levels, Return to Sport, and Complication Rate.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Patients, n=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain scores (0-10 scale)</td>
<td></td>
</tr>
<tr>
<td>Prior to surgery, average (range) [95% CI]</td>
<td>7.7 (4-10) [7.2, 8.1]</td>
</tr>
<tr>
<td>After recovering from surgery, average (range) [95% CI]</td>
<td>0.6 (0-6) [0.3, 1.0]</td>
</tr>
<tr>
<td>Percent improvement, average (range) [95% CI]</td>
<td>90.8 (24-100) [85.8-95.8]</td>
</tr>
<tr>
<td>FHL triggering</td>
<td></td>
</tr>
<tr>
<td>Number of patients who experienced FHL triggering prior to surgery, n (%)</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>Number of patients with FHL triggering relieved postoperatively, n (%)</td>
<td>17 (100)</td>
</tr>
<tr>
<td>Return to dance</td>
<td></td>
</tr>
<tr>
<td>Yes, n (%)</td>
<td>35 (94.6)</td>
</tr>
<tr>
<td>Time to return to sport</td>
<td></td>
</tr>
<tr>
<td>Time to return to dance after surgery, average (range, 95% CI), wk</td>
<td>7.9 (3-20) [6.8, 9.0]</td>
</tr>
<tr>
<td>Time to return to dance pain free, average (range) [95% CI], wk</td>
<td>17.7 (6-52) [14.5, 20.9]</td>
</tr>
<tr>
<td>Minor complications</td>
<td></td>
</tr>
<tr>
<td>Keloid scar, n (%)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Superficial infection, n (%)</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>Wound dehiscence, n (%)</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>4 (10)</td>
</tr>
<tr>
<td>Major complicationsd</td>
<td></td>
</tr>
<tr>
<td>Yes, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Subjective questionnaire</td>
<td></td>
</tr>
<tr>
<td>Considered operation a “success,” n (%)</td>
<td>38 (95)</td>
</tr>
<tr>
<td>Would repeat procedure, n (%)</td>
<td>38 (95)</td>
</tr>
<tr>
<td>Would recommend to other dancers with os trigonum, n (%)</td>
<td>40 (100)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; FHL, flexor hallucis longus.

*Percentage reflects percent of those with FHL triggering who experienced relief after surgery.

* n = 37; 3 patients excluded from this category because of personal choice not to return to dance for reasons other than ankle pain (2 went to college and stopped dancing, 1 did not complete physical therapy because wanted to stop dancing).

* n = 39, 1 patient with persistent lateral peroneal pain removed, unrelated to os trigonum.

*Major complications include nerve damage, neuropaxia, arterial damage, requiring additional procedure.

*Same 2 patients answered “no”: One patient with postoperative weakness would not “repeat the procedure,” other with lateral ankle pain secondary to peroneal tendonitis (not professional dancer, and did not resume for personal reasons).

Figure 2. Lateral radiograph showing an os trigonum with foot in plantarflexion.
Mouhsine, et al\textsuperscript{27}; however, many discourage the routine use of corticosteroid injections in dancers and the serious athletic population because of the potential deleterious effects on the posterior ankle structures.\textsuperscript{6,9,26,33,42,54}

For those dancers who have failed conservative treatment, surgery to remove the os trigonum and address any associated pathology may be utilized. Current operative options include posterior endoscopy, subtalar arthroscopy, and open excision via posterolateral or posteromedial approaches.\textsuperscript{29} Posterior ankle endoscopy, first introduced by Van Dijk et al, allows for a minimally invasive technique with small incisions.\textsuperscript{37,43,50,51} In this approach, the posteromedial and posterolateral portals place the medial neurovascular bundle and sural nerve at risk, respectively.\textsuperscript{9,37,43,50} The endoscopic approach requires the surgeon to partially resect the posterior capsule, posterior tibiofibular ligament, and posterior talocalcaneal ligament without the opportunity for repair.\textsuperscript{50} Additionally, the FHL tendon sheath is not easily visualized by an arthroscopic approach, and its release is difficult. We believe that preservation of the posterior capsule and complete evaluation of the FHL tendon and tendon sheath are of paramount importance in the dancer population. The occasional presence of anatomic variants, such as the peroneoecalcaneus internus muscle ("false FHL") or accessory soleus (Figure 4), may predispose posterior hindfoot arthroscopy to a greater risk of potential neurovascular injury if not recognized.\textsuperscript{1,24}

The subtalar arthroscopic approach, described by several papers, is technically challenging because of the relatively small subtalar joint space.\textsuperscript{2,20,30,32} The limited available studies have all shown improvement of visual analog scores (VAS) and American Orthopaedic Foot & Ankle Society (AOFAS) scores, with the most common complication being sural nerve palsies.\textsuperscript{2,20,30,32} Additionally, the subtalar approach is limited by the inability to concomitantly treat FHL pathologies.\textsuperscript{2}

Open procedures to excise an os trigonum are performed via either a posterolateral or posteromedial approach. Many surgeons preferring a posterolateral approach are under the assumption that the approach is safer and easier, although there are no recent studies to support this claim.\textsuperscript{28} With the posterolateral approach, care must be taken to avoid the sural nerve and small saphenous vein.\textsuperscript{5,15,22,28,50} In a series of 41 patients (2 dancers) who underwent os trigonum excision via a posterolateral approach, there were 4 transient and 4 permanent injuries to the sural nerve.\textsuperscript{1} In addition, one must still be aware when using the posterolateral approach that the medial neurovascular bundle is located just deep (medial) to the FHL (Figure 5), especially because the os trigonum is typically located more medially.\textsuperscript{9,17}

Because of the high incidence of concurrent FHL tenosynovitis with os trigonum syndrome in dancers, we believe the FHL tendon should always be inspected intraoperatively.\textsuperscript{16,17,36,43,45,49,54} The FHL tendon is difficult to assess and release via the posterolateral approach, because the tendon lies deep within the operative exposure.\textsuperscript{17} It is the authors’ belief and experience that persistent posterior/posteromedial pain in a dancer who has undergone complete excision of an os trigonum via a posterolateral approach is often due to unaddressed FHL tendon or tendon sheath pathology. This may account for

References 8, 13, 16-19, 22, 29, 31, 32, 47, 50, 52.
the relatively high incidence (67%) of occasional pain in the operative area experienced by dancers who have undergone excision of an os trigonum via posterolateral approach, reported by Marotta et al.\textsuperscript{26}

The authors’ preferred operative approach to excise a symptomatic os trigonum recalcitrant to conservative management is via an open posteromedial technique. The medial neurovascular bundle is easily identified and protected throughout the procedure, lessening its chance of injury. As the os trigonum is often more medially positioned, the posteromedial incision allows for easier access, as well as providing improved cosmesis. Unlike endoscopic approaches, which resect the capsule/os trigonum, the os is dissected from its surrounding capsule allowing for capsular repair, thereby theoretically decreasing operative morbidity.\textsuperscript{22,50}

Most studies recommend the posteromedial approach in patients who have concurrent FHL tendon pathology because of easier visualization of the tendon.\textsuperscript{9,16,17,19} Of note, positive pathologic findings of the FHL (tenosynovitis, abrasion/fraying of the tendon at the entrance of the tendon sheath) were often noted during our surgery in dancers who did not display preoperative FHL symptomatology. Because of the strong association of FHL pathology and os trigonum syndrome in the dancer population, all patients indicated for os trigonum excision underwent an FHL tenolysis, and, as required, tenosynovectomy. No patient in our study was noted to have any adverse consequences of the addition of FHL tenolysis to the os trigonum excision, thus lending support to the procedure in the dance population.

Labs et al. used an open posteromedial approach and included only dancers in his study; however, all cases of PAI were included in the study, and FHL tenolysis was only performed in 50%, when determined to be clinically necessary.\textsuperscript{22} De Landevoisin et al published the first pediatric series of 5 excisions via a posteromedial approach, and Rogers et al published on 6 posteromedial excisions on 5 horizontal jump athletes.\textsuperscript{38}

Prior to surgery, our patients’ average pain level was 7.7 (range, 4 to 10), and improved to 0.6 (range, 0 to 6) postoperatively. In a study by Ahn et al that looked at VAS scores in patients who had either arthroscopic or posterior endoscopic removal of os trigonum, the VAS score improved from 6.5 to 1.2.\textsuperscript{2} This was similar to a study by Park et al on os trigonum excision via subtalar arthroscopy, which showed a decrease in VAS from 6.7 to 1.5.\textsuperscript{32} Our improvement in VAS scores therefore compares favorably with endoscopic and arthroscopic procedures.

Our patients initially returned to dance class at an average of 7.9 weeks, and fully returned to prior level of dance at 17.7 weeks. Labs et al studied 24 dancers with PAI, and had a 72-day (10-week) average return to full weightbearing and preoperative range of motion, although that does not imply return to full sport.\textsuperscript{22} In the Park et al study, whose cohort was 87% amateur or professional elite athletes (although no dancers), they had mean return to sport in 6.7 weeks.\textsuperscript{25} The Ahn study had an average return to sport of 7.5 to 8 weeks but noted that in the 3 dancers, they were able to resume full pointe and jumping at 10 weeks.\textsuperscript{2} A similar discrepancy for dancers was noted in the Guo et al study, which showed an average of 11.9 weeks to return to sport for their patient population following open excision, but 16 weeks for the dancer subset.\textsuperscript{15} The longer recovery time for dancers is likely due to the increased demands of dance on the posterior ankle; the return to dance in the literature is consistent with our study’s results.

Our study sample had no neurovascular or other major complications. Several other studies using the posteromedial approach for PAI excision or FHL tenolysis have reported no permanent injury to the medial neurovascular bundle. The Labs et al study had 1 patient with temporary tibial nerve paralysis and 2 patients with hematomas, 1 that required reoperation.\textsuperscript{22} The Kolettis et al study on FHL release in dancers via a posteromedial approach, as well as the de Landevoisin and Rogers studies, described no major complications.\textsuperscript{11,21,38} Therefore, the posteromedial approach has been shown by our study and others to carry a decreased risk of neurovascular injury in comparison to the posterolateral approach.\textsuperscript{36}

The strength of our study was that we limited the inclusion criteria to dancers with symptomatic os trigonum, excluding other causes of posterior ankle impingement. Although a larger series, Spicer et al did not limit their cases of posterior ankle impingement to an os trigonum.\textsuperscript{46} Different causes of PAI is a confounding variable and may result in different short-term outcomes, affecting pain scores at follow-up and return to sport. To our knowledge,
our study is the largest cohort of dancers to undergo excision of an os trigonum via a posteromedial approach.

The retrospective nature of our study was a major limitation. A study by Toolan et al showed that patients tend to retrospectively recall their ankle pain as worse than they would prospectively. In addition, there was a lack of standardization of preoperative and postoperative function and pain scoring. We did not utilize the AOFAS hindfoot score to assess clinical outcomes, as it has not been validated for the measurement of os trigonum symptoms and is not ideal for assessing a young and active patient population. Another limitation of the study was that 15 patients were lost to follow-up. We also recognize that our findings in the dance population may not be applicable to other athletic populations.

In conclusion, the open posteromedial approach to the excision of a symptomatic os trigonum in a dancer was a safe, reliable, and effective alternative to other arthroscopic, endoscopic, or open approaches to posterior ankle impingement. The enhanced ability to evaluate and treat associated FHL pathology have made the posteromedial approach the authors’ preferred technique.

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