The Journal of Foot & Ankle Surgery 58 (2019) 236–242

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Calcific Insertional Achilles Tendinopathy-Achilles Repair With Flexor Hallucis Longus Tendon Transfer: Case Series and Surgical Technique

Michael A. Howell, DPM[1], Timothy P. McConn, DPM, AACFAS[1], Karl R. Saltrick, DPM, FACFAS[2], Alan R. Catanzariti, DPM, FACFAS[3]

[1] *Resident, Division of Foot and Ankle Surgery, West Penn Hospital, Allegheny Health Network, Pittsburgh, PA*
[2] *Faculty, Division of Foot and Ankle Surgery, West Penn Hospital, Allegheny Health Network, Pittsburgh, PA*
[3] *Director of Residency Training, Division of Foot and Ankle Surgery, West Penn Hospital, Allegheny Health Network, Pittsburgh, PA*

ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
Achilles tendonitis
flexor hallucis longus tendon transfer
insertional calcification
insertional tendinosis
retrocalcaneal bursitis

ABSTRACT

Calcific insertional Achilles tendinopathy (CIAT) is a relatively common musculoskeletal entity that results in significant pain and disability, as well as posterior muscle group weakness. There is a lack of evidence criteria to support the timing of operative intervention, choice of procedures, or whether equinus requires treatment. The purpose of this study was to retrospectively review 45 patients (48 feet) who have undergone surgical management of CIAT with concomitant posterior muscle group weakness with the single heel rise testing. All patients underwent debridement and repair of the Achilles tendon with reattachment of the Achilles tendon to the calcaneus, ostectomy of the calcaneus, and flexor hallucis longus tendon transfer. Those patients with equinus also underwent gastrocnemius recession. The focus includes patient-reported satisfaction, time to return to normal shoe gear, and the incidence of revision surgery. The overall average of time to weightbearing was 4.3 weeks. After surgery, 73.3% (n = 33) of the 45 patients responded to the following question: "Would you have this surgery done again?" Of these patients, 93.9% (n = 31) responded "Yes" and 6.1% (n = 2) responded "Unsure." Of the same 33 patients, 84.8% (n = 28) responded that they were "Very Satisfied" with the procedure and 15.2% (n = 5) responded that they were "Satisfied." Twelve patients (26.7%) did not respond to either question. One of the 12 patients (8.3%) who did not respond had bilateral procedures. None of the patients experienced tendon rupture, deep vein thrombosis, or the need for revision surgery. Four patients (8%) experienced a superficial infection, whereas 1 patient (2%) had development of a deep infection. No correlations were found when looking at the relationship between body mass index and return to weightbearing/normal shoe gear with Spearman analysis.

Calcific insertional Achilles tendinopathy (CIAT) is a relatively common musculoskeletal entity that results in significant pain and disability, including posterior muscle group weakness. CIAT should be differentiated from mid-substance Achilles tendinopathy. Kvist et al (1), in a large retrospective study of competitive and recreational athletes with Achilles tendon problems, reported that 66% of patients had noninsertional tendinopathy, whereas 23% had either retrocalcaneal bursitis or insertional tendinopathy. In a comparative laboratory study, it was found that the altered production of collagen, an increase in type II and type III, may be 1 reason for the histopathologic alterations seen with CIAT (2). The stress-shielded side of the enthesis shows a tendency to develop cartilagelike or atrophic changes from lack of tensile load (3).

The cause of CIAT is most likely multifactorial, with both intrinsic and extrinsic factors. Intrinsic factors include Haglund's deformity, muscle weakness, hind foot malalignment, high body mass index (BMI), increasing age, inflammatory arthropathies, corticosteroid use, diabetes mellitus, hypertension, obesity, gout, hyperostotic conditions, lipidemias, and quinolone antibiotics. A multitude of extrinsic factors also exist that include inappropriate footwear, training errors, and generalized overuse that results in excessive load on the Achilles tendon (4). Nonoperative management for CIAT includes both traditional and nontraditional therapeutic interventions. Traditional therapies include nonsteroidal antiinflammatory medications, oral steroids, heel lifts, night splints, orthotic therapy to address underlying mechanical abnormalities, foot gear modifications, ice massage, posterior muscle group stretching, and eccentric exercises. Nontraditional therapies include ultrasound-guided dextrose or polidocanol sclerosing injections, extracorporeal shock wave therapy, and cryoultrasound therapy (5). Although eccentric loading was the common modality found in a systematic review of management of CIAT, the literature suggests that eccentric exercises may not be as effective in the treatment of insertional Achilles tendinopathy (6). Kearney and Costa (7), in a

Financial Disclosure: None reported.
Conflict of Interest: None reported.
Address correspondence to: Alan R. Catanzariti, XX, West Penn Hospital, 4800 Friendship Avenue, Pittsburgh, PA 15224.
E-mail address: Alan.Catanzariti@ahn.org (A.R. Catanzariti).

1067-2516/$ - see front matter © 2018 by the American College of Foot and Ankle Surgeons. All rights reserved.
https://doi.org/10.1053/j.jfas.2018.08.021

systematic review, demonstrated that there is consensus among authors that conservative treatments should be tried before operative interventions; however, there is no consensus regarding the length of time conservative measures should be continued before they are considered unsuccessful. When considering physical therapy, there should be an understanding that conventional Achilles tendon stretching exercises can aggravate CIAT.

Surgical management of CIAT is considered when nonoperative therapy of 3 to 6 months has been unsuccessful. Surgical therapy of CIAT should be comprehensive, addressing all pathological components. Principles of surgical management should include (1) thorough debridement of hypertrophic and diseased Achilles tendon, bursa, enthesophytes, and paratenon; (2) decompression of the distal Achilles tendon by resection of the posterior superior calcaneal prominence; (3) tendon reconstruction, which might include regional tissue rearrangements/advancements, tendon transfer, or tendon replacement; (4) posterior muscle group lengthening to address equinus; and (5) osteotomy of the calcaneus to address structural deformity. The authors also believe significant posterior muscle group weakness must be identified, as well as addressed with a tendon transfer.

The purpose of this study was to retrospectively review the outcomes of patient-reported satisfaction in those who have undergone surgical management of CIAT based on the aforementioned surgical principles critical for symptom relief and successful outcomes. The authors also describe a surgical technique that includes debridement and repair of the Achilles tendon, ostectomy of the calcaneus, gastrocnemius recession, and flexor hallucis longus (FHL) tendon transfer. The focus includes functional patient-reported satisfaction, BMI, and time to return to normal shoe gear, as well as the incidence of revision surgery. Furthermore, complications such as infection, wound dehiscence, incidence of deep vein thrombosis (DVT), and decreased postoperative function/pain after the procedure were recorded.

Patients and Methods

A retrospective case series was conducted on 45 consecutive patients (48 feet) who underwent surgical management of CIAT between the years 2011 and 2016. We used an institutional clinical practice database and the appropriate International Classification of Diseases, 9th revision, and Common Procedural Terminology codes to identify the patients.

Each patient underwent a course of nonoperative therapy and had weightbearing radiographs taken of their affected foot. Additionally, all patients had magnetic resonance imaging (MRI) of the affected foot. All patients underwent debridement and repair of the Achilles tendon, ostectomy of the calcaneus, reattachment of the Achilles tendon to the calcaneus, and FHL tendon transfer. Exclusion criteria included patients with incomplete medical or surgical records and patients under the age of 18. A patient satisfaction questionnaire was obtained at the final follow-up period via a phone call for all patients who underwent surgical intervention.

Preoperative Evaluation

Preoperative evaluation included a thorough history of present illness, focusing on those factors that directly affect symptoms, especially in patients such as industrial workers and athletes. Comorbidities that directly affect CIAT, such as systemic diseases associated with enthesopathies, were also identified.

Physical examination included inspection for the specific foot type. Nonneurologic cavus foot deformity is often associated with CIAT, especially when the deformity predominately involves the hind foot. Both open and closed kinetic chain evaluations are important when evaluating foot deformity. Structural deformity with concomitant misalignment were identified and addressed during surgical management of CIAT. Focal areas of tenderness within the insertion of the Achilles tendon, as well as other areas of the retrocalcaneal region, were noted. Hypertrophy, nodularity, or both of the Achilles tendon about its insertion were also noted, because these findings are consistent with tendinopathy. Ankle joint range of motion was evaluated with the knee both extended and flexed. We tried to ascertain whether the deformity involved only the gastrocnemius or the soleus, as well when equinus was present. Surgical management addressing the equinus was then planned accordingly. The muscle tone and calf girth was compared with the contralateral extremity to determine the degree of weakness. Additionally, single and double heel rise were evaluated. The inability to perform a single heel rise on the affected extremity was consistent with posterior muscle group weakness. All patients in this study were found to have significant posterior muscle group weakness, and transfer of the FHL tendon was performed to address this component of the patient's condition.

Radiographic examination included weightbearing lateral and axial views. Lateral radiographs can identify an increased calcaneal inclination angle, Haglund's deformity, a large retrocalcaneal prominence, and calcification about the insertion of the Achilles tendon. Axial views can demonstrate varus deformity, as well as calcifications. Debridement of calcifications, enthesophytes, and osseous prominences, as well as structural realignment, are important components of surgical management.

Preoperative MRI was performed on all patients in this study for surgical planning and prognostic purposes. The success rate with nonsurgical treatment decreases significantly once intrasubstance changes consistent with tendinosis are present on MRI. Furthermore, long-standing disease is associated with poor surgical outcomes and a greater rate of reoperation. Nicholson et al (8) found that tendons with greater intrasubstance degeneration, as documented on sagittal MRI, often required operative intervention because of pathology that was resistant to conservative management given the progression of degeneration. Thus patients demonstrating advanced tendinosis in the absence of acute inflammation are likely to require an operative procedure for resolution of their symptoms (9). In a prospective study of 57 patients with CIAT, MRI was found to have a sensitivity and specificity of 95% and 50%, respectively (10). Khan et al (10) found that both clinical baseline scores and MRI severity were associated with outcomes. Therefore, MRI can provide prognostic information for guiding treatment at various stages of CIAT. The authors performed MRI on all patients diagnosed with CIAT as a baseline.

Surgical Technique

Surgery was performed with the patient under general anesthesia and in a prone position. A bump under the contralateral hip will rotate the foot into an ideal position, especially in obese patients. The surgical table can be further rotated, if necessary; however, the patient must be adequately secured. The authors prefer a well-padded pneumatic thigh tourniquet.

A gastrocnemius recession is considered when equinus is present. This is performed through a linear incision placed distal to the medial head of the gastrocnemius muscle. A gastrocnemius-soleus recession can also be performed if necessary. This is often an intraoperative decision based on the severity of equinus.

A serpentine incision was made over the posterior aspect of the heel. This incision begins just distal to the mid-substance region of the Achilles tendon and extends to the plantar heel (Fig. 1). However, this is often determined by the proximal extent of tendinosis identified on MRI. This incision should be long enough to avoid excess tension on the wound edges. The serpentine nature of this incision also helps to reduce skin tension. This approach provides access to the distal Achilles tendon for debridement and repair, ostectomy of the calcaneus, and transfer of the FHL tendon. Care was taken to avoid undermining during dissection. The depth of the proximal portion of this initial incision should extend to the paratenon, whereas the distal portion extends to the periosteum overlying the calcaneus. The paratenon is incised and retracted.

A full-thickness linear incision was then made into the distal Achilles tendon, extending onto the calcaneus to the level of bone. Soft tissues are dissected from the posterior calcaneus, including medial and lateral. This allowed adequate access to the posterior-superior aspect of the calcaneus, as well as any insertional enthesophytes. The Achilles tendon has a vast and diffuse insertion into the calcaneus. A substantial portion of the Achilles tendon remains attached to the calcaneus, even after what appears to be

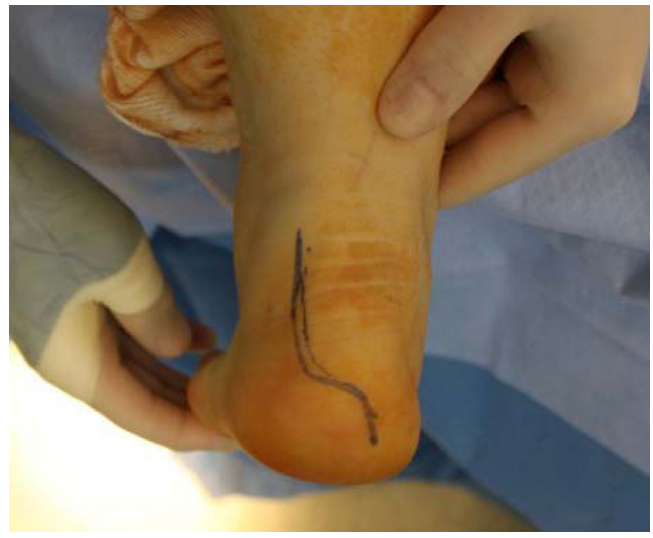

Fig. 1. Preferred incision placement.

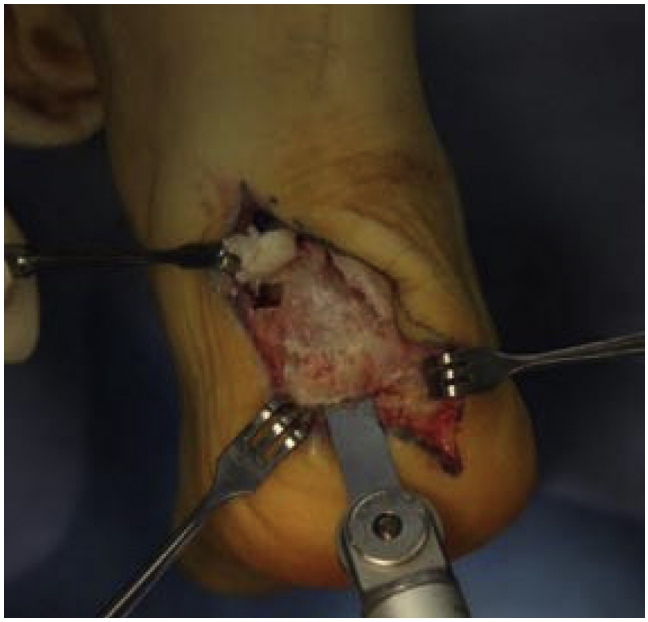

Fig. 2. Decompression of the posterior heel with a saw blade and sharp dissection.

extensive dissection, such that the foot will plantarflex with a Thompson's test. A sagittal saw was then used to resect a generous portion of bone to adequately decompress the distal aspect of the Achilles tendon (Fig. 2). This bone was resected from inferior to superior, with care taken to avoid the subtalar joint. The starting point should be distal to any insertional calcification or enthesophytes so that they are incorporated into the bony resection. A rasp or burr can be used to smooth any rough areas, especially the medial and lateral borders of the posterior calcaneus.

Attention was then directed to the medial and lateral segments of the distal Achilles tendon. These portions of the tendon are thoroughly debrided. This should include any diseased or hypertrophic tendon, as well as calcifications within the tendon itself. The tendon was repaired before closure.

A self-retaining retractor was placed proximally within the incised portion of the Achilles tendon for harvest of the FHL tendon. This provides access to the posterior aspect of the lower leg, where the fascia is identified and incised. The FHL muscle belly lies just beneath the fascia. Umbilical tape was placed around the FHL muscle and tendon, which was then traced distally toward the tarsal tunnel. The foot and hallux were maximally plantarflexed, and the FHL tendon was transected just before it enters the tarsal tunnel. The tendon should be cut under complete visualization with care taken to avoid neurovascular injury. The tendon end was then sutured in a whipstitch fashion in preparation for transfer (Fig. 3).

The FHL tendon was then transferred into the posterior calcaneus. Various techniques can be used to accomplish transfer. The authors prefer to transfer the tendon as far posterior as possible to maintain the mechanical advantage provided by a long lever arm. Additionally, we prefer to maintain the foot in slight plantar flexion during the transfer. We built our Achilles tendon repair and reattachment around the position of the FHL transfer. Furthermore, we apply dorsiflexion pressure with cast to maintain muscle tone after surgery. Our preferred technique for FHL tendon transfer is to deliver an interference screw into the posterior calcaneus while the tendon is maintained under tension.

The Achilles tendon was then reattached to the calcaneus. There are several techniques available to accomplish reattachment. The authors used a knotless 4-anchor, double-row fixation construct (Achilles Midsubstance SpeedBridge™ system, Arthrex, Naples, FL) securing the Achilles tendon to the insertional footprint (Fig. 4). The Achilles tendon was then reapproximated side to side with absorbable suture. The paratenon is sometimes closed in a separate layer. Skin closure was then performed in standard fashion. The preoperative and postoperative MRIs both show the decompressed region of the posterior heel, as well as anchor fixation (Fig. 5).

Postoperative Management

Postoperative management included a non-weightbearing short-leg cast or fracture brace maintained for 3 to 4 weeks. The authors prefer a cast with dorsiflexion pressure on the foot to maintain muscle tension and to reduce the incidence of atrophy during convalescence. Sutures were maintained for approximately 3 weeks. The 4-point crutch gait began in a fracture brace after cast removal and progressed to full weightbearing over the next 2 weeks. Patients were then transitioned from a fracture brace to a supportive shoe with a heel lift at approximately 6 weeks after surgery. The authors institute a course of formal physical therapy after patients are ambulating in standard footgear, including gait training, reconditioning, and posterior muscle group strengthening.

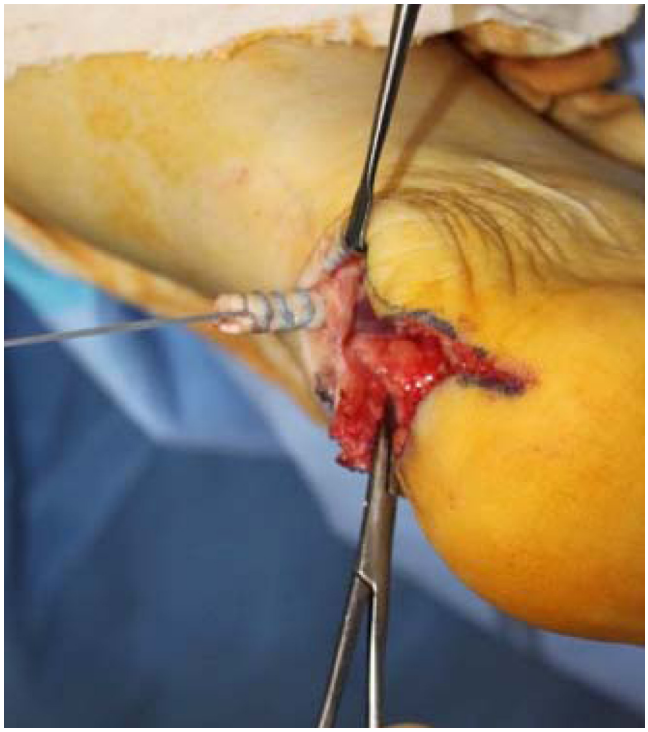

Fig. 3. The harvested flexor hallucis longus tendon whipstitched in preparation for transfer.

Results

We reviewed the medical records of 45 patients (48 feet) diagnosed with CIAT who underwent surgery between 2011 and 2016. Surgical procedures included debridement and repair of the Achilles tendon, ostectomy of the calcaneus, reattachment of the Achilles tendon to the calcaneus, and FHL tendon transfer. The study population included 15 men and 30 women. The mean age at time of surgery was 53.3 ± 8.8 (range 30 to 67) years. The affected lower extremity was on the right side for 24 patients, left side for 18 patients, and bilateral for 3 patients. There was a minimum 8-week window between the bilateral cases. The average BMI was 36.11 (range 25.1 to 55.7). A description of patient demographic data is presented in Table 1. The overall average of time to weightbearing was 4.3 weeks, whereas time to shoe gear was 7.3 weeks. The postoperative follow-up duration was 16.41(range 6 to 45) months.

After surgery, 35 patients included in the study completed a patient satisfaction questionnaire at final follow-up: 30 patients (86%) were very satisfied with the outcome of the procedure and would have the operation again, 3 patients (9%) were satisfied with the outcome of the procedure and would have the operation again, and 2 patients (6%) were satisfied with the outcome of the procedure but were unsure whether they would have the operation again. None of the patients experienced tendon rupture, DVT, or the need for revision surgery. In the acute postoperative window, 4 patients (8%) experienced a superficial infection, whereas 1 patient (2%) had development of a deep infection. All 4 patients had a history of diabetes mellitus. Patient outcomes are listed in Table 2 for all 45 patients included in the study. Preoperative classification of the study population by overweight and obesity using BMI (kg/m^2) (n = 45) is listed in Table 3. Spearman's rank-order correlation analysis was used to examine the relationship between BMI (kg/m^2) and time to weightbearing measured in weeks. Results indicate

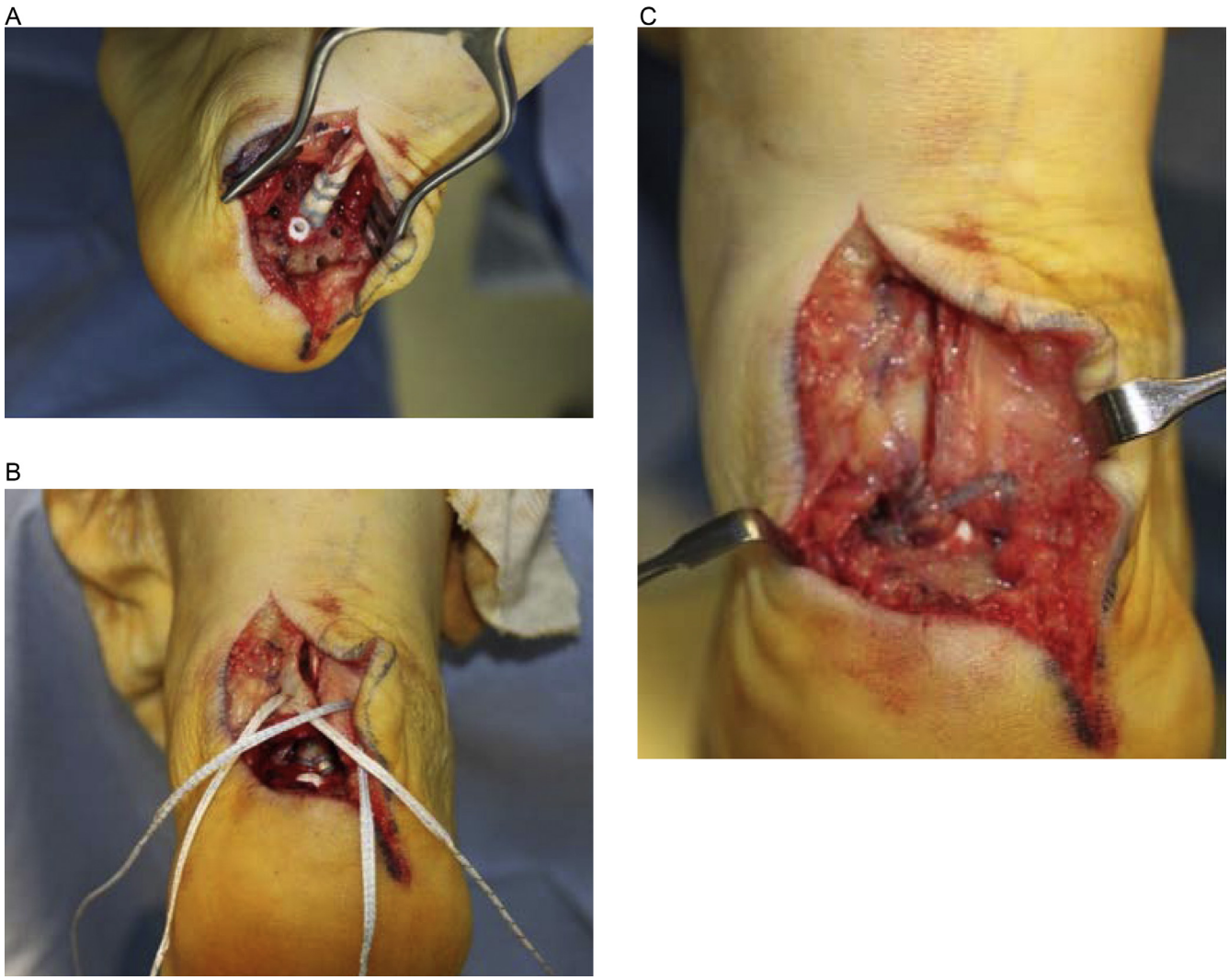

Fig. 4. The flexor hallucis longus tendon held in place with a bio-tenodesis screw and interference fit (*A*). The Achilles tendon secured to the calcaneus with the Achilles Midsubstance SpeedBridge construct (Arthrex, Naples, FL) (*B, C*).

a nonsignificant and negative correlation for all patients (Spearman's rho [N = 45] = −0.24, $p = .12$), males (Spearman's rho [N = 15] = −0.33, $p = .23$), and females (Spearman's rho [N = 30] = −0.20, $p = .29$) (Table 4, Fig. 6). Spearman's rank-order correlation analysis was also performed to examine the relationship between BMI (kg/m^2) and time to shoe gear measured in weeks. Results indicate a nonsignificant and negative correlation for all patients (Spearman's rho [N = 45] = −0.053, $p = .73$), males (Spearman's rho [N = 15] = −0.15, $p = .60$), and females (Spearman's rho [N = 30] = −0.11, $p = .58$) (Table 5, Fig. 7). Median time to weightbearing and shoe gear in weeks by classification of overweight and obesity using BMI (kg/m^2) is seen in Table 6. Data analysis was performed using IBM SPSS version 24.0 (IBM, Armonk, NY).

Discussion

CIAT often includes retrocalcaneal bursitis, Haglund's deformity, insertional calcification, insertional paratenonitis, insertional tendinosis, equinus deformity, and sometimes systemic enthesopathies. CIAT leads to pain, discomfort, and functional limitations experienced by the patient. The pathogenesis of CIAT is unclear. Advanced imaging, especially MRI, can provide prognostic information to guide treatment. Unfortunately, the success rate with nonsurgical treatment decreases significantly once intrasubstance changes consistent with tendinosis are present on MRI (8). In 24% to 45.5% of patients with Achilles tendinopathy, conservative management is unsuccessful, and surgery should be considered (9). Surgery should be considered in those patients who experience refractory disease, disability, weakness, and MRI changes consistent with tendinosis. Furthermore, it is important to keep in mind that long-standing disease is associated with poor surgical outcomes and a greater rate of reoperation (11). Therefore, the decision to implement nonoperative care for a specific period of time before proceeding with surgery might adversely affect the surgical outcome. The timing of surgery should be based on objective factors such as clinical findings and MRI results, as well as the patient's response to nonoperative treatment.

Elias et al (12) studied 40 patients with a diagnosis of CIAT who underwent Achilles debridement and FHL transfer. The investigators found improved visual analogue scale and American Orthopaedic Foot and Ankle Society scores with no loss of ankle plantar flexion strength. In a retrospective study of 29 procedures, Hartog (13) reported on 26 patients and found significantly lower functional scores before FHL transfer for CIAT, with an average preoperative American Orthopaedic Foot and Ankle Society hind foot score of 41.7. This included 26 patients and found a higher magnitude of improvement in patients older than 50 years. Wapner et al (14) described results of FHL transfer for insertional Achilles tendinopathy in 17 patients (age range 25 to 71 years) with high satisfaction and return to function. Hunt et al (15) performed

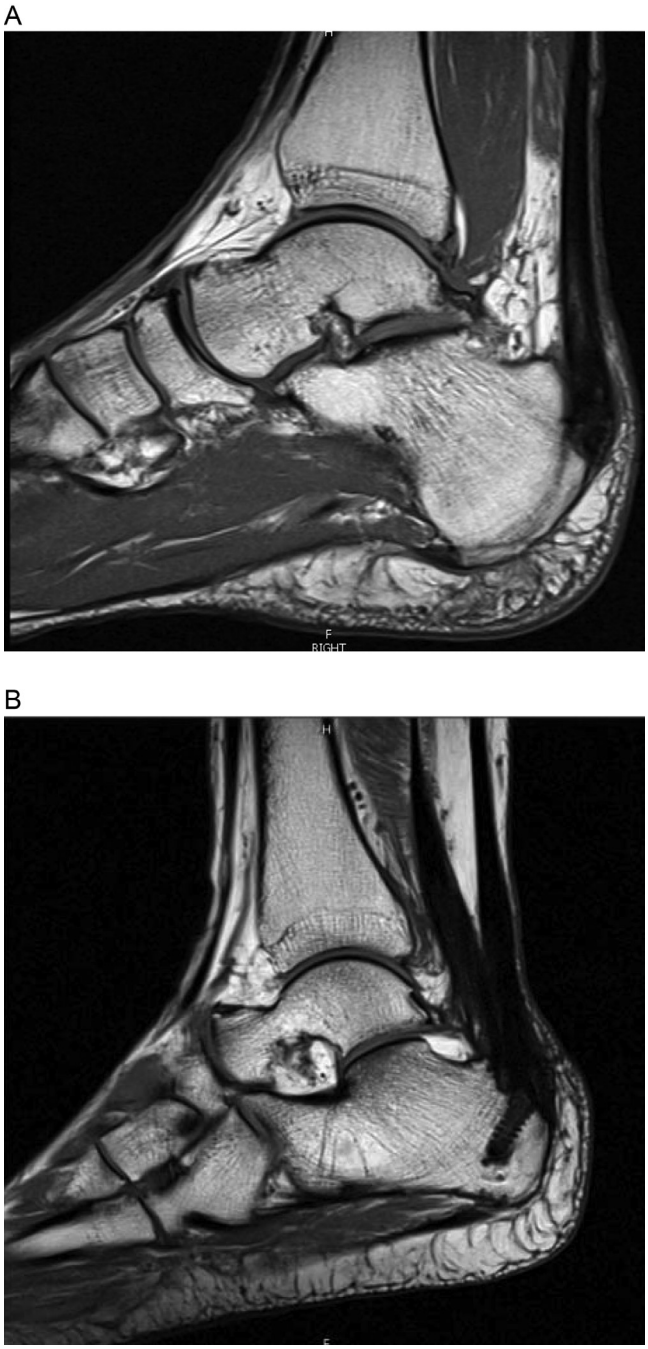

Fig. 5. Preoperative (A) and postoperative (B) magnetic resonance imaging comparison of calcific insertional Achilles tendinopathy repair with flexor hallucis longus transfer and the Achilles Midsubstance SpeedBridge construct.

a prospective randomized series of 39 patients older than 50 years comparing Achilles decompression and debridement alone (control group) or Achilles decompression and debridement augmented with FHL transfer. The authors reported greater ankle plantar flexion strength in the FHL augmentation group and no difference in hallux plantar flexion strength between groups at 1 year. Schon et al (16) reported significant improvement in physical function and pain intensity in a group of 46 inactive, older, overweight patients. As far as function of the hallux is concerned with regard to FHL tendon transfer, Coull et al (17) used functional assessment and pedobarography. Although there was measurable weakness and decreased function, there was no translation into noticeable morbidity. Furthermore, Frenette and Jackson (18) described

Table 1
Patient demographics (N = 48 feet in 45 patients)

Age (mean; range)	53.33; 30 to 67
Sex (n)	30 F; 15 M
BMI (mean; range)	36.11; 25.1 to 55.7
Laterality (n)	27 R; 21 L
Comorbidities (n; %)	
HTN	20; 44%
DM	11; 24%
OA	8; 17%
HLD	7; 15%
GERD	7; 15%
Hypothyroid	5; 11%
Tobacco use (n; %)	14; 31%

Abbreviations: DM, diabetes mellitus; F, female; GERD, gastroesophageal reflux disease; HLD, hyperlipidemia; HTN, hypertension; L, left; M, male; OA, osteoarthritis; R, right.

3 professional athletes who had returned to their respective sports at the same level after penetrating lacerations of the FHL that had not been amenable to surgical repair.

Patients who present with CIAT often complain of disability and pain. Disability is often a patient's primary complaint. Although they may have pain, some patients are most concerned about concomitant weakness and functional deficits. These patients are oftentimes disabled from their occupation, their ability to exercise, or their ability to maintain a relatively active lifestyle. Posterior muscle group weakness can be addressed during surgical intervention for CIAT with an FHL tendon transfer. FHL tendon transfer will enhance muscle strength and power. FHL tendon transfer also provides a template for tensioning the Achilles tendon during reattachment. Furthermore, tendon transfer might also permit earlier return to weightbearing, as well as earlier and more aggressive rehabilitation. Incorporating tendon transfer into surgical management of CIAT directly addresses posterior muscle group weakness and enhances function. Many of the patients in our study were employed in industrial, custodial, factory, or warehouse work, as well as other similarly demanding jobs. Additionally, several of our patients were unable to exercise or walk because of weakness. Some experienced suprastructural problems secondary to compensatory gait from posterior muscle group weakness. Surgical management of posterior muscle group weakness with FHL tendon transfer might allow these patients to return to their presymptom activity level sooner. Improved functional outcomes, as well as an increased plantar flexion strength, has been demonstrated after FHL tendon transfer to address posterior muscle group weakness.

Surgical treatment of insertional Achilles tendinosis should be considered for those patients in whom conservative therapy failed after 3 to 6 months (19). The authors have described a technique that addresses all pathological aspects of CIAT, allowing the patient to return to their preinjury/presymptom activity level. Our results compare with other similar studies. The authors have added the FHL transfer to address posterior muscle group weakness, which is identified before surgery by inability to perform a single heel rise, as well as decreased calf girth and decreased muscle tone relative to the contralateral limb. Additionally, these patients often have complaints of weakness and

Table 2
Patient outcomes (N = 48 feet in 45 patients)

Time to weightbearing in weeks (median; range)	4.33; 3 to 8
Time to shoe gear in weeks (median; range)	7.29; 4 to 2
Complications (n; %)	
Rerupture	0; 0%
Superficial infection	4; 8%
Deep infection	1; 2%
Deep vein thrombosis	0; 0%
Revision surgery	0; 0%
Follow-up (months) (mean; range)	16.41; 6 to 45

Table 3
Preoperative classification of the study population by overweight and obesity using body mass index (kg/m^2) (N = 45)

Variable	Count (%)
Obesity classification by BMI (kg/m^2)	
All patients (n = 45)	
Underweight: <18.5	0
Normal: 18.5 to 24.9	0
Overweight: 25.0 to 29.9	8 (17.7)
Obesity class I: 30.0 to 34.9	13 (28.9)
Obesity class II: 35.0 to 39.9	13 (28.9)
Obesity class III (extreme): 40.0+	11 (24.4)
Females (n = 30)	
Underweight: <18.5	0
Normal: 18.5 to 24.9	0
Overweight: 25.0 to 29.9	1 (3.3)
Obesity class I: 30.0 to 34.9	8 (26.7)
Obesity class II: 35.0 to 39.9	10 (33.3)
Obesity class III (extreme): 40.0+	11 (36.7)
Males (n = 15)	
Underweight: <18.5	0
Normal: 18.5 to 24.9	0
Overweight: 25.0 to 29.9	7 (46.7)
Obesity class I: 30.0 to 34.9	5 (33.3)
Obesity class II: 35.0 to 39.9	3 (20.0)
Obesity class III (extreme): 40.0+	0

Abbreviation: BMI, body mass index.
Classification of Overweight and Obesity by BMI.

Table 4
Times to weightbearing and shoe gear in weeks for the study population (N = 48 feet)

Variable	Median (range)
Time to weightbearing in weeks	
All patients (n = 48)	4.0 (2.0 to 8.0)
Males (n = 15)	5.0 (2.0 to 8.0)
Females (n = 30)	4.0 (2.0 to 7.0)
Time to shoe gear in weeks	
All patients (n = 48)	7.0 (4.0 to 12.0)
Males (n = 15)	7.0 (4.0 to 11.0)
Females (n = 30)	7.5 (4.0 to 12.0)

Table 5
Correlation of time to weightbearing and shoe gear in weeks by body mass index (kg/m^2)

Variable	Correlation coefficient (Spearman's rho)	*p* Value
Time to weightbearing in weeks		
All patients (N = 45)	−0.24	.12
Males (n = 15)	−0.33	.23
Females (n = 30)	−0.20	.29
Time to shoe gear in weeks		
All patients (N = 45)	−0.053	.73
Males (n = 15)	−0.15	.60
Females (n = 30)	−0.11	.58

functional deficits. The authors have permitted earlier weightbearing, as well as a return to standard foot gear and rehabilitation with experience. Prolonged non-weightbearing results in overall deconditioning and further atrophy of the posterior muscle group. FHL tendon transfer allows for earlier return to weightbearing.

In this study, 35 patients included in the study completed a patient satisfaction questionnaire at final follow-up. Thirty patients (86%) were very satisfied with the outcome of the procedure and would have the operation again, 3 patients (9%) were satisfied with the outcome of the procedure and would have the operation again, and 2 patients (6%) were satisfied with the outcome of the procedure but were unsure whether they would have the operation again. None of the patients experienced tendon rupture, DVT, or the need for revision surgery. In the acute postoperative window, 4 patients (8%) experienced a superficial infection, whereas 1 patient (2%) had development of a deep infection. All 4 patients had a history of diabetes mellitus. There was no significant difference related to BMI and the time to weightbearing, as well as time to return to normal shoe gear.

This study has several limitations and weaknesses. We included only a minimum of 6 months of follow-up, which is relatively short. Another drawback is the retrospective design and all of the inherent problems with retrospective studies. Additionally, our lack of a preoperative scoring system makes it difficult to quantify the patients' subjective improvement. Furthermore, we were unable to reach out to 10 of the 45 patients to fill out the patient satisfaction survey. Finally, 2 different surgeons contributed patients to this study, and even subtle differences in technique could have

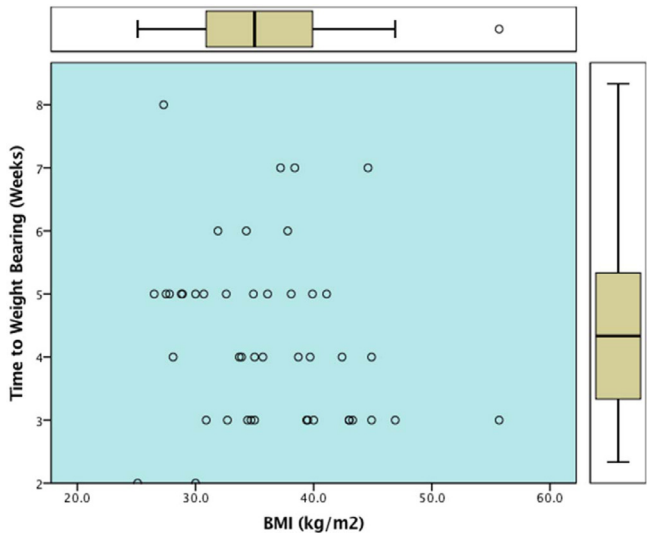

Fig. 6. Correlation of time to weightbearing in weeks and body mass index (kg/m^2).

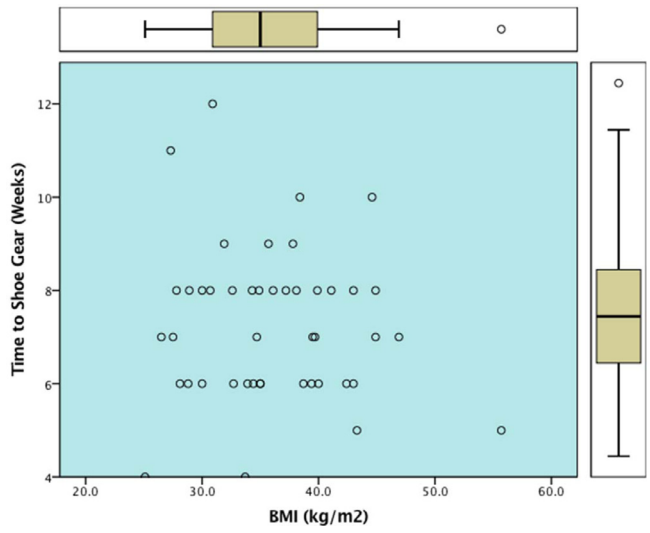

Fig. 7. Correlation of time to shoe gear in weeks and body mass index (kg/m^2).

Table 6
Median time to weightbearing and shoe gear in weeks by classification of overweight and obesity using body mass index (kg/m^2)

Variable	Overweight (n = 8) (BMI 20.0 to 25.9)	Obesity class I (n = 13) (BMI 30.0 to 34.9)	Obesity class II (n = 13) (BMI 35.0 to 39.9)	Obesity class III (extreme) (n = 11) (BMI 40.0+)
Time to weightbearing in weeks	5.0 (2.0 to 8.0)	4.0 (2.0 to 6.0)	4.0 (3.0 to 7.0)	3.0 (3.0 to 7.0)
Time to shoe gear in weeks	7.0 (4.0 to 11.0)	8.0 (4.0 to 12.0)	8.0 (6.0 to 10.0)	7.0 (5.0 to 10.0)

Abbreviation: BMI, body mass index.

affected the outcomes. There is an obvious need for evidence-based medicine studies evaluating outcomes and for properly conducted scientific research to establish appropriate treatment protocols.

Previous studies have shown that patients diagnosed with CIAT experience significantly lower function scores before intervention. When nonoperative therapy has been exhausted, operative treatment that addresses all pathologic components of CIAT should be considered. There are no evidence-based data to support the timing of operative invention, choice of procedures, or whether equinus requires treatment. Achilles detachment-reattachment with FHL tendon transfer encompasses the principles of surgical management of CIAT by addressing all components of this pathologic entity. Based on patient satisfaction scores in this study, this surgical approach appears to be an effective intervention; however, further investigation using prospective measures could verify the advantages of FHL transfer for surgical treatment of CIAT. A comparative study with a cohort of patients undergoing surgical management without FHL transfer might objectively demonstrate whether the FHL transfer provides significant benefit.

In conclusion, many patients respond to Achilles repair/debridement and simple ostectomy of the calcaneus. However, we believe that an FHL tendon transfer should be considered in those patients with objective signs of posterior muscle group weakness (decreased muscle tone, decreased calf girth, and inability to perform a single heel rise). Furthermore, patients experiencing subjective symptoms consistent with weakness and functional issues, or patients who are disabled from an occupation or specific activity, should be considered for an FHL tendon transfer.

References

1. Kvist M. Achilles tendon injuries in athletes. Ann Chir Gynaecol 1991;80:188–201.
2. Maffulli N, Reaper J, Ewen SW, Waterson SW, Barrass V. Chondral metaplasia in calcific insertional tendinopathy of the Achilles tendon. Clin J Sport Med 2006;16:329–334.
3. Vogel KG, Ordog A, Pogany G, Olah J. Proteoglycans in the compressed region of the human tibialis posterior tendon and in ligaments. J Orthop Res 1993;11:68–77.
4. Johnson KW, Zalavaras C, Thordardson DB. Surgical management of insertional calcific Achilles tendinosis with a central tendon splitting approach. Foot Ankle Int 2006;27:245–250.
5. Roche AJ, Calder JDF. Achilles tendinopathy: a review of the current concepts of treatment. Bone Joint J 2013;95-B:1299–1307.
6. Alfredson H, Pietila T, Jonsson P, Lorentzon R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. Am J Sports Med 1998;26:360–366.
7. Kearney R, Costa ML. Insertional Achilles tendinopathy management: a systematic review. Foot Ankle Int 2010;31:689–694.
8. Nicholson CW, Berlet GC, Lee TH. Prediction of the success of non-operative treatment of insertional Achilles tendinosis based on MRI. Foot Ankle Int 2007;28:472–477.
9. Maffulli N, Sharma P, Luscombe KL. Achilles tendinopathy: etiology and management. J R Soc Med 2004;97:472–476.
10. Khan KM, Forster BB, Robinson J, Cheong Y, Louis L, Maclean L, Taunton JE. Are ultrasound and magnetic resonance imaging of value in assessment of Achilles tendon disorders? A two year prospective study. Br J Sports Med 2003;37:149–153.
11. Maffulli N, Binfield PM, Moore D, King JB. Surgical decompression of chronic central core lesions of the Achilles tendon. Am J Sports Med 1999;27:747–752.
12. Elias I, Raikin SM, Besser MP, Nazarian LN. Outcomes of chronic insertional Achilles tendinosis using FHL autograft through single incision. Foot Ankle Int 2009;30:197–204.
13. Den Hartog BD. Flexor hallucis longus transfer for chronic Achilles tendinosis. Foot Ankle Int 2003;24:233–237.
14. Wapner KL, Pavlock GS, Hecht PJ, Naselli F, Walther R. Repair of chronic Achilles tendon rupture with flexor hallucis longus tendon transfer. Foot Ankle 1993;14:443–449.
15. Hunt KJ, Cohen BE, Davis WH, Anderson RB, Jones CP. Surgical treatment of insertional Achilles tendinopathy with or without flexor hallucis longus tendon transfer: a prospective, randomized study. Foot Ankle Int 2015;36:998–1005.
16. Schon LC, Shores JL, Faro FD, Vora AM, Camire LM, Guyton GP. Flexor hallucis longus tendon transfer in treatment of Achilles tendinosis. J Bone Joint Surg Am 2013;95:54–60.
17. Coull R, Flavin R, Stephens M. Flexor hallucis longus tendon transfer: evaluation of postoperative morbidity. Foot Ankle Int 2003;24:931–934.
18. Frenette JP, Jackson DW. Lacerations of the flexor hallucis longus in the young athlete. J Bone Joint Surg Am 1977;59:673–677.
19. Witt BL, Hyer CF. Achilles tendon reattachment after surgical treatment of insertional tendinosis using the suture bridge technique: a case series. J Foot Ankle Surg 2012;51(487–493).