Clinical Outcomes of Flexor Hallucis Longus Transfer for the Treatment of Achilles Tendinosis Rupture

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Objective: *To evaluate the clinical outcomes of flexor hallucis longus transfer for the treatment of Achilles tendinosis rupture and the postoperative morbidity of the hallux.*
Material and Method: *A retrospective study was performed in the patients with Achilles tendinosis rupture who underwent the flexor hallucis longus transfer from January 2001 to December 2007. The preoperative and postoperative AOFAS scale for ankle-hindfoot of the affected ankle and the hallux metatarsophalangeal-interphalangeal scale of both halluces were compared and analyzed.*
Results: *12 patients were included in the study, with the average age of 50 and the average duration of the symptoms of 4.7 weeks. After the average follow-up period of 22.5 months, all patients were satisfied with their clinical outcomes and the AOFAS score for ankle-hindfoot significantly improved from 54.6 points to 92.9 points whereas the hallux metatarsophalangeal-interphalangeal scale of the hallux was slightly decrease.*
Conclusion: *Good functional outcomes of the ankle and less morbidity of the hallux could be achieved through the use of flexor hallucis longus transfer for the treatment of Achilles tendinosis rupture. Further studies aimed at the confirming the results should be performed due to the small number of patient and the mix of acute and chronic ruptures.*

Keywords: *Achilles tendinosis, Rupture, Flexor hallucis longus transfer*

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Achilles tendinosis is an intratendinous degeneration due to atrophy with an unknown etiology and pathogenesis. Histologically, there is non-inflammatory intratendinous collagen degeneration with fiber disorientation, hypocellularity, scattered vascular ingrowth, occasional local necrosis or calcification[1]. This intratendinous lesion usually progresses and can result in a partial or complete rupture, which can cause marked pain, instability and dysfunction of the ankle[2]. Although patients usually have a palpable depression in the tendon and some weakness in ankle plantar flexion, delayed or missed diagnosis of Achilles tendinosis rupture by primary treating physicians is a relatively common occurrence[3].

The treatment of delayed Achilles tendinosis rupture is challenging as the tendon ends not only have retracted but also have to be debrided more to get healthy stumps for repair. Many techniques for repair of the chronic Achilles tendon rupture have been described. They include bridging the gap with either autologous or synthetic material. But in the situation of a significant gap, poor tendon vascularity and a smaller tendon remnant on the calcaneal side for repair, a tendon transfer seems to be the treatment of choice for the restoration of the Achilles tendon function. Among various kinds of tendons that have been used in the transfer[4-6], the flexor hallucis longus proposed by Hansen[7] has received the most notoriety.

Although some studies investigated the outcomes of flexor hallucis longus transfers for the augmentation of chronic Achilles tendon disorders with or without rupture[8-11], few studies have reported postoperative morbidity[12] of the hallux after the loss of the flexor hallucis longus tendon. The authors propose that good function of the ankle and less morbidity of the hallux can be achieved through the

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use of debridement and flexor hallucis longus transfer for treatment of an Achilles tendinosis rupture.

Material and Method

From January 2001 to December 2007, 12 ankles (12 patients) with Achilles tendinosis ruptures were treated through debridement and flexor hallucis longus transfers and were followed-up for more than 1 year (Table 1). The group of patients consisted of 9 females and 3 males. The average age of the patients at the time of surgery was 50 (SD 7.9, range 39 to 65) and the average follow-up period was 22.5 months (SD 9.9, range 12 to 36). The average duration of the symptoms was 4.7 weeks (SD 4.1, range 1 to 12). Four patients had osteoarthritis of the knee joints that was more severe on the contralateral side and a high body mass index (more than 30 kg/m^2) was observed in most of the female patients. No patient had experienced a direct blow or significant injury to the ankle but 3 patients had a history of injection of steroids around the Achilles tendon by other physicians before the ruptures.

A complete clinical examination was performed preoperatively, including the Thompson test, fitness for anesthesia and neurovascular status of the limb, especially of the sural nerve. Once the diagnosis was confirmed, the patient was informed about the operative technique and the risks involved before consent was obtained.

Operative technique

The surgery was performed with the double-incision technique described by Wapner[4]. The patient was positioned supine and a posterior longitudinal incision was made along the medial border of the Achilles tendon to expose the tendinosis rupture (Fig. 1). The filamentous tendon remnant on the calcaneus was debrided and the proximal tendon stump with gross degenerative change was excised until the healthy stump was exposed. A separate incision was made on the medial border of the foot, just above the level of the abductor muscle, from the navicular to the head of the first metatarsal. The abductor hallucis and flexor hallucis brevis were retracted plantarward to expose the flexor hallucis longus and the flexor digitorum longus tendons which are located in the deep part of the mid-foot. The fibrous connected between the flexor hallucis longus and flexor digitorum longus at the knot of Henry were identified and released to further free the flexor hallucis longus tendon. After the medial plantar branch of the medial plantar nerve was retracted, the flexor hallucis longus was divided as far distally as possible and pulled from mid-foot into the posterior incision. Two drill holes were placed perpendicularly in the posterior medial portion of the calcaneus, 1 centimeter below the Achilles tendon insertion, and a large towel clip was used to complete the tunnel for

Table 1. Characteristics of the patients

Variable	Value
Gender	
Male	3
Female	9
Age	
< 41	1
41-50	5
51-60	5
> 60	1
BMI (Mean, SD)	30 ± 4.16
Mechanism of injury	
Walking	7
Running	1
Jumping	1
Falling	3
Associated disorders	
Knee OA	
Bilateral	2
Contralateral	4
Others	1
None	5
Steroid injection use (no)	3
Gap length after excision (cm)	6 ± 0.64
Follow-up period (months)	22.5 ± 9.9

BMI = body mass index, OA = osteoarthritis

Fig. 1 Intra-operative finding of Achilles tendinosis rupture

Fig. 2 Postoperative debridement and flexor hallucis longus transfer

the passage of the tendon through the bone. After the flexor hallucis longus tendon was pulled through the tunnel in the calcaneus, it was tensioned with the ankle in maximum plantar flexion, woven from distal to proximal through the Achilles tendon and sutured without any augmentation (Fig. 2). Haemeostasis was done and the paratenon was repaired when present or viable. Then the wound was closed in layers. Compressive dressing and plaster splints were applied so that the physiologic equinus of the ankle could be maintained.

Postoperatively, a short leg cast was applied to the ankle in physiologic equinus and retained for 2 weeks until a review in the outpatient clinic, when the cast was gradually changed every 2 weeks to a lesser degree of equinus. After 6 weeks, the ankle was placed in a neutral position, a short leg walking cast was applied, and weight bearing began. After 8 weeks the cast was removed and the ankle exercises, including range of motion, strength and endurance were initiated.

Follow-up management

The clinical outcomes and complications were assessed on each visit in the outpatient clinic. Subjective assessment of ankle-hindfoot pain, function and stability was performed before the operation and 1 year after by the use of the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale[13]. At every quarterly visit the heel-floor distance of both ankles was measured while the patients were standing on their toes so that the plantar flexion strength of the ankles could be identified. The hallux was observed for any deformity and limitation of movement. After 1 year, the AOFAS hallux metatarsophalangeal-interphalangeal scale[13] was obtained, thus pain, function and alignment of both the affected and un-affected hallux could be assessed together with the assessment for the dorsiflexion range of motion on both ankles and the patients' satisfaction.

Statistical analysis

The data were presented as means with standard deviation (SD). Wilcoxon signed ranks test was used to identify the following statistical differences between subgroups of clinical outcomes a) the differences between the preoperative and postoperative AOFAS ankle-hindfoot scale b) the difference between the affected and unaffected ankle range of motion and heel-floor distance and c) the difference between the affected and unaffected AOFAS hallux metatarsophalangeal-interphalangeal scale. A p-value level of < 0.05 was considered as statistically significant. The statistical analyses were performed using Statistical Product and Service Solutions (SPSS) for Windows, version 15.0 (SPSS Inc. Chicago, IL, U.S.A).

Results

Demographic data of included patients was shown in Table 1. The main symptoms of the patients were weakness, poor balance, limited walking distance and pain. All patients experienced a marked weakness in the active plantar flexion and walked with a limp. The defect in the Achilles tendon was palpable which most of patients had a positive Thompson test finding. Four patients presented signs of acute rupture, including ecchymosis, swelling and point tenderness. At the time of the operation, a complete rupture of the Achilles tendon just above its insertion on the calcaneus was observed in every patient. The proximal tendon segment showed extensive tendinopathy changes, including a loss of tendon fiber, nodularity and local necrosis, compatible with tendinosis rupture. The average tendon gap after excision and debridement of the tendinosis segments was 6 centimeters (SD 0.64, range 5 to 7) and only a smaller tendon remnant remained on the calcaneal side for repair.

The Achilles tendon function could be restored and significant pain improvement could be achieved in all patients without any wounds or neurovascular complications. Although some calf hypotrophy was observed in most patients, all patients could walk in a normal gait pattern and no re-rupture of the tendon was observed during the time of the follow-up. Of the cases, 9 (75%) had an excellent result,

Table 2. Results of ankle dorsiflexion and heel-floor distance assessment

	Affected	Unaffected	% deficit	Mean difference	p-value*
Dorsiflexion ROM	17.5	19.6	10.71%	-2.1	0.025
Heel-floor distance	5.58	6.83	18.30%	-1.25	0.005

* Wilcoxon ranks test

2 (16.7%) had a good result and 1 (8.3%) had a fair result. The mean AOFAS ankle-hindfoot scale improved from 54.6 (SD 6, range 45 to 63) preoperatively to 92.9 points (SD 9, range 72 to 100) postoperatively ($p = 0.002$). The affected ankle had a significant dorsiflexion deficit of 10.71% ($p = 0.025$) and a heel-floor distance deficit of 18.3% ($p = 0.005$) (Table 2).

The mean AOFAS hallux metatarsophalangeal-interphalangeal scale of the affected hallux (92.2 ± 5, range 82 to 95) was significant less than the mean of unaffected hallux (99.6 ± 1.4, range 95 to 100) ($p = 0.001$). All patients had a hallux interphalangeal motion deficit but no hallux deformity was observed in most of them.

Discussion

The Achilles tendinosis rupture is not a rare condition. It usually occurs in middle-aged women with a high body mass index and other concomitant disorders of the lower extremities. Patients usually have delayed definite treatment because they do not expect such a severe injury after a minor trauma and do not consult their physicians immediately. Also the diagnosis is often missed by the primary treating physicians.

The poor quality of the tendon remnants and a significant gap of more than 5 centimeters make direct repair of the tendon impossible and a tendon transfer becomes the treatment of choice. The flexor hallucis longus transfer has more advantage than the other treatments because it provides more durability and strength within the ordinary axis of contraction and maintains the normal muscle balance of the ankle[4].

The present study shows a successful treatment of Achilles tendinosis ruptures through debridement and a flexor hallucis longus transfer. The clinical outcome as measured by the AOFAS ankle-hindfoot scale at a mean of 92.9 compares favorably to previous studies used a flexor hallucis longus transfer as an augmentation or supplementation after debridement of the tendinosis[10-15]. Pain was reduced significantly and a normal gait pattern could be achieved in all patients. A mild restriction of the ankle dorsiflexion was observed but more than 10 degrees of ankle dorsiflexion remained and it did not cause any functional problems. The limited dorsiflexion of the ankle should be from the ankle set in maximum plantar flexion while the flexor hallucis longus tendon was sutured. The clinical outcomes were also correlated with the patients' concomitant disorders. One patient with a fair clinical outcome also suffered from a degenerative lumbar and knees.

Loss of plantar flexion strength was a common functional deficit after the treatment of Achilles tendinosis or a rupture. The plantar flexion strength deficit of the flexor hallucis longus transfer or augmentation after Cybex testing varied from 23 to 33 percent[9,10,15]. Although the authors had set the tension of the flexor hallucis longus transfer at maximum plantar flexion, the heel-floor distance while the patients were standing on their toes of the affected side was still less than that of the unaffected side, especially in the early period. However, such weakness was not of any clinical importance and the plantar flexion strength improved significantly after 6 months (Fig. 3).

The donor site morbidity associated with loss of flexor hallucis longus function was accessed and it

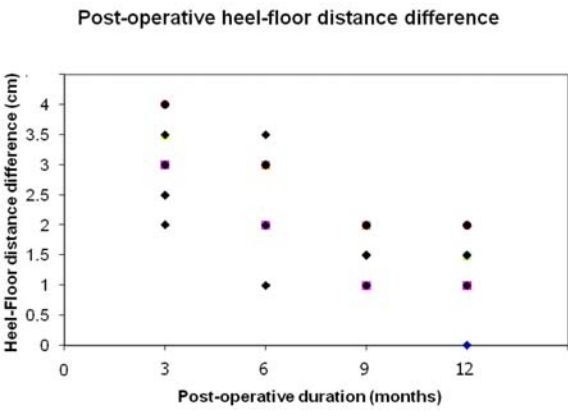

Fig. 3 The postoperative heel-floor distance difference of both ankles

was found that all patients had lost their active hallux interphalangeal joint flexion but none of them had hyperextension deformity of the interphalangeal joint. Although the affected hallux had a significantly lower the mean AOFAS Hallux Metatarsophalangeal-Interphalangeal scale than the unaffected hallux, the difference of the means was less than 10% and might not be observed by the patients. No patient complained about this morbidity except one, who had a problem while wearing flip-flops. However, the pedobarographic study by Coull et al[12] found no significant increase in the loading of the first or second metatarsophalangeal joints suggesting that the transfer metatarsalgia may complicate a flexor hallucis longus tendon transfer.

There is still controversy about the treatment methods of the Achilles tendon defects more than 5 centimeters among the flexor hallucis longus tendon transfer alone and combined with V-Y myotendinous lengthening for augmentation[16]. However, although the patients presented had the defects of more than 5 centimeters, no adequate healthy distal stump remained for direct repair. The weaknesses of the present study was the limited number of the patients and the mix of acute and chronic ruptures as well as a lack of quantitative measurement of ankle and hallux strength with specific equipment.

Conclusion

In conclusion, good pain relief and functional restoration of the ankle with less morbidity of the hallux can be achieved with the use of debridement and flexor hallucis longus transfer for treatment of an Achilles tendinosis rupture. Nevertheless, further investigations aimed at confirming clinical outcomes of flexor hallucis longus transfer for the treatment of Achilles tendinosis rupture in the larger population would be useful.

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ผลของการผ่าตัดย้ายเอ็นงอนิ้วหัวแม่เท้ามาเชื่อมต่อเอ็นร้อยหวายที่ฉีกขาดจากการอักเสบเรื้อรัง

ปิยชาติ สุทธินาค, ประชา สืบพงษ์ศิริ

วัตถุประสงค์: *เพื่อประเมินผลการรักษาผู้ป่วยที่มีเอ็นร้อยหวายฉีกขาด จากการอักเสบเรื้อรังด้วยการผ่าตัดย้ายเอ็นงอนิ้วหัวแม่เท้ามาเชื่อมต่อ และผลกระทบที่เกิดขึ้นกับนิ้วหัวแม่เท้า*

วัสดุและวิธีการ: *ทำการเก็บรวบรวมข้อมูลย้อนหลังในผู้ป่วยที่มีเอ็นร้อยหวายฉีกขาดจากการอักเสบเรื้อรัง และได้รับการผ่าตัดย้ายเอ็นงอนิ้วหัวแม่เท้ามาเชื่อมต่อ ตั้งแต่เดือนมกราคม พ.ศ. 2544 ถึง เดือนธันวาคม พ.ศ. 2550 โดยใช้แบบประเมินวัดผลทางคลินิกเปรียบเทียบผลการรักษาก่อนและหลัง*

ผลการศึกษา: *จากการประเมินวัดผลทางคลินิกในผู้ป่วยจำนวน 12 ราย มีอายุเฉลี่ยอยู่ 50 ปี โดยมีอาการมาเป็นระยะเวลาเฉลี่ย 4.7 สัปดาห์ พบว่าภายหลังการติดตามการรักษาผู้ป่วยเป็นระยะเวลาเฉลี่ย 22.5 เดือน ผู้ป่วยสามารถกลับมาใช้งานข้อเท้าได้ดีขึ้นอย่างมีนัยสำคัญทางสถิติ ทั้งนี้จะเห็นว่าค่าเฉลี่ย AOFAS score ดีขึ้นจาก 54.6 คะแนน มาเป็น 92.9 คะแนน ในขณะที่ hallux metatarsophalangeal-interphalangeal scale ลดลงเพียงเล็กน้อยจาก 99.6 คะแนน มาเป็น 92.2 คะแนน*

สรุป: *การผ่าตัดย้ายเส้นเอ็นงอนิ้วหัวแม่เท้ามาเชื่อมต่อ สามารถใช้ได้ผลดีในผู้ป่วยเอ็นร้อยหวายฉีกขาดจากการอักเสบเรื้อรัง และแม้ว่าจะมีการสูญเสียสมรรถภาพของนิ้วหัวแม่เท้าเกิดขึ้นบ้างแต่ก็ไม่มีผลทางคลินิก*