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Changes in plantar pressure distribution after Achilles tendon augmentation with flexor hallucis longus transfer

F. Hahn [a,*], C. Maiwald [b], Th. Horstmann [b], P. Vienne [a]

[a] Department of Orthopaedics, University of Zurich, Balgrist, Forchstrasse 340, CH-8008 Zurich, Switzerland
[b] Medical Clinic, Department of Sports Medicine, University of Tuebingen, Germany

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Abstract

Background. Augmentation of the Achilles tendon with flexor hallucis longus is an established method to treat neglected ruptures and severe cases of chronic tendinopathy. After transfer of the muscle/tendon, good pain reduction and improved plantar flexion have been reported. To date, only one study has investigated the effect of FHL transfer on forefoot biomechanics. Theoretically, there should be a partial transfer of forefoot loading towards the lateral metatarsal heads during push-off, resulting in an asymmetric gait.

Methods. 13 patients were examined clinically and using pedobarography with a mean follow-up of 46 months (minimum 24) after Achilles tendon augmentation with flexor hallucis longus. Parameters of the forefoot were investigated to detect differences in pressure and force distribution, load transfer to other areas of the forefoot, and asymmetries compared to the non-operated leg. The results are discussed with regard to clinical relevance.

Findings. Clinically, there were no subjective or objective gait asymmetries. All patients were free of pain and without restrictions during normal walking. In general, pedobarography showed an unloading of the first toe with a load transfer to the metatarsal heads on the operated side. All results featured high inter-subject and within-subject variability.

Interpretation. Due to the high within-subject variability, there is inconsistency within the results making interpretation difficult. However, the results confirm the hypothesis that unloading of the first toe during push-off and an asymmetrical loading pattern can be measured after harvesting of the flexor hallucis longus. The clinical situation of the patients did not reflect a visible amount of gait asymmetry. Differences in loading patterns 2 years after flexor hallucis longus transfer for Achilles tendon augmentation appear to be well compensated.
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Keywords: Achilles tendon augmentation; Gait asymmetry; Pedobarography

1. Introduction

Achilles tendon (AT) disorders are one of the most common overuse disorders in both athletes and non-athletes. With 10% of the adult American population involved in running activities, there is a reported annual incidence of AT disorders between 7% and 9% (Paavola et al., 2002; Schepsis et al., 1999). Treatment of neglected ruptures and chronic tendinopathy is difficult. Most patients can be successfully treated with initial physiotherapy, anti-inflammatory medication and shoe modifications, but a relevant number of patients continue to suffer from chronic pain and functional impairment. Surgical procedures have been developed to improve the situation for such patients. Due to the chronic character of the problem, there are often structural defects and even complete chronic ruptures of the Achilles tendon (Maffulli et al., 2001; Martin et al., 2005; Monroe et al., 2000; Paavola et al., 2002; Vulpiani et al., 2003; Wapner et al., 1993; Wilcox et al., 2000). Moreover, atrophy of the involved muscles (gastrocnemius, surae) is observed which leads to insufficiency during

* Corresponding author.
E-mail address: frederikhahn@t-online.de (F. Hahn).

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plantar flexion in these patients (Takao et al., 2003). Augmentation techniques with passive grafts can only address the mechanical aspect of the structural defect of the Achilles tendon, but fail to improve the muscular weakness. In order to also compensate for the muscular insufficiency, transfers of musculotendinous units are becoming more and more common (Mann et al., 1991; Turco and Spinella, 1987; Wapner et al., 1993). For chronic neglected ruptures and Achilles tendinopathies with functional insufficiency, the augmentation with flexor hallucis longus (FHL) has shown good clinical results in several studies (Coull et al., 2003; Martin et al., 2005; Monroe et al., 2000; Wapner and Hecht, 1994; Wapner et al., 1993; Wilcox et al., 2000).

For a musculotendinous transfer there are two requirements. First, it should ensure good function in the target area, and second, the transfer should neither lead to complications nor to relevant interference of physiological balance at the donor site. When using the FHL in Achilles tendon augmentation, this means improved plantar flexion of the ankle and no disturbances in the forefoot during gait, especially during the final push-off phase where the FHL normally plays an important role (Hayafune et al., 1999; Hughes et al., 1990).

Restoration of good function and pain relief after AT augmentation with a transfer of the FHL has been documented in several studies (Coull et al., 2003; Den Hartog, 2003; Martin et al., 2005; Monroe et al., 2000; Wapner et al., 1993; Wilcox et al., 2000). However, the effect of FHL removal on forefoot function has not been examined in detail. Most studies do not show detailed results on donor site morbidity. If mentioned at all, assessment of morbidity is restricted to questioning patients whether they can describe a subjective impairment during walking, or by measuring the range of motion of the big toe. None of these studies reports relevant problems of harvesting the FHL tendon (Den Hartog, 2003; Martin et al., 2005; Monroe et al., 2000; Wapner et al., 1993; Wilcox et al., 2000). Only one study evaluated the postoperative morbidity after harvesting the FHL tendon with regard to functional aspects (Coull et al., 2003).

The purpose of the present study is to specifically analyze the gait pattern of patients after FHL transfer for the treatment of neglected ruptures and chronic Achilles tendinopathy. Based on the hypothesis that withdrawal of the FHL results in a load transfer to the more lateral metatarsal heads, asymmetries in forefoot gait patterns were analyzed using pedobarography.

2. Surgical procedure

The surgical technique described by Wapner (Wapner et al., 1993) was performed on all patients. This two incision technique begins with a short incision at the medial border of the midfoot. After subcutaneous preparation, the tendons of the FHL and the flexor digitorum longus (FDL) are identified and the FHL tendon is cut off distally. The remaining distal stump is tightly sewn into the FDL tendon with a non-resorbable fiber to provide some active flexion of the big toe via the FDL (Fig. 1). Through a second incision along the medial aspect of the AT, the site is displayed and a local debridement performed. In addition, the FHL is identified and mobilized. Now the tendinous distal portion of the FHL at the midfoot can be retracted into the proximal operation site. With a length of approximately 8 cm, the FHL tendon is woven from distal to proximal through the AT (Fig. 2). The procedure is continued until the full length of the harvested tendon is used. This leads to a strong augmentation over a length of approximately 6.5 cm.

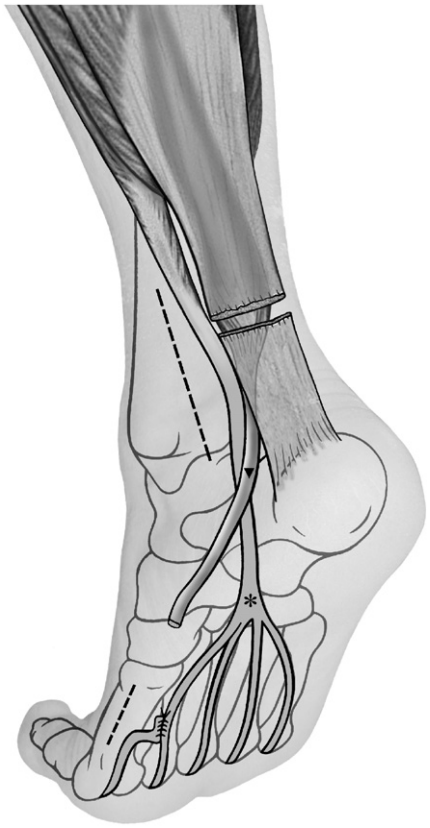

Fig. 1. Proximal incision at medial midfoot with the distal stump of the flexor hallucis longus tendon sewed to the flexor digitorum longus tendon (∗). The proximal portion (▼) is mobilized and later retracted into the proximal incision. ---- = skin incision at midfoot and hindfoot.

3. Methods

Between October 1999 and April 2003, 16 patients underwent augmentation of the AT with transfer of the FHL tendon. All patients were diagnosed with painful chronic rupture or chronic degenerative Achilles tendinopathy by clinical history and physical examination. In 6 patients, preoperative magnetic resonance imaging was performed to confirm the diagnosis. All patients had an insufficient response to a minimal conservative treatment of 3 months (range 4–96) with anti-inflammatory medication, physiotherapy, and shoe modifications to correct

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