

Early postoperative results of endoscopic transfer of the flexor hallucis longus muscle for the treatment of chronic Achilles tendon rupture

Resultados pós-operatórios precoces da transferência endoscópica do flexor longo do hálux para o tratamento da ruptura crônica do tendão de Aquiles

Daniel Baumfeld¹, André Rocha Figueiredo², Tiago Baumfeld³, Luis Fernando de Araújo Junior⁴, Benjamim Macedo⁵, Thiago Alexandre Alves Silva⁶, Fernando Raduan⁷, Caio Nery⁸

ABSTRACT

Objective: Chronic lesions of the Calcaneal Tendon (CT) involve proximal retraction of the tendon, and have poorer functional results than those observed in acute ruptures. Transfer of the Flexor Hallucis Longus (FHL) muscle is a well-established treatment option, usually performed by open surgery. The objective of this work is to report a series of chronic ruptures/re-ruptures of the CT, treated through endoscopic transfer of the FHL. **Methods:** Six patients with chronic lesions or re-ruptures of the AT were treated with endoscopic transfer of the FHL - four men and two women, with an average age of 50 years. All the lesions were located in zone 2 of the AT (2-6cm proximal to its insertion). The mean follow-up time was nine months (5-12 months). Three patients underwent an associated procedure for repair of a preexisting gap in the AT, through the minimally invasive surgery technique. The average surgery time was 56 minutes. **Results:** All the patients presented good improvement in Achilles Tendon Rupture Score (ATRS), with a mean of 17.8 in the pre- and 83.3 in the postoperative period. All the patients were capable of standing on tiptoe, without limitation. None of the patients reported loss of functional strength of the hallux during daily activities. **Conclusion:** In this case series, the endoscopic transfer of the FHL proved a safe

RESUMO

Objetivo: As lesões crônicas do Tendão Calcâneo (TC) cursam com retração proximal do tendão e têm resultados funcionais piores que os observados nas rupturas agudas. A transferência do Flexor Longo do Hálux (FLH) é uma opção de tratamento bem estabelecida, usualmente realizada por via aberta. O objetivo deste trabalho é reportar uma série de casos de rupturas crônicas/re-rupturas do TC, tratados através de transferência endoscópica do FLH. **Métodos:** Seis pacientes portadores de lesões crônicas ou re-rupturas do TA foram tratados com transferência endoscópica do FLH. Quatro homens e duas mulheres, com média de idade de 50 anos. Todas as lesões eram localizadas na zona 2 do TA (2-6cm proximal à sua inserção). O seguimento médio foi de nove meses (5-12 meses). Três pacientes foram submetidos a procedimento associado para reparo de gap preexistente no TA, por meio de técnica cirúrgica minimamente invasiva. Em média, foram despendidos 56 minutos na realização da cirurgia. **Resultados:** Todos os pacientes apresentaram grande melhora nos valores do *Achilles Tendon Rupture Score* (ATRS), com média de 17,8 no pré e 83,3 no pós-operatório. Todos os pacientes foram capazes de realizar apoio na ponta dos pés, sem limitação. Nenhum dos pacientes reportou perda de força funcional do hálux

¹ Universidade Federal de Minas Gerais. Assistant Professor – UFMG – Universidade Federal de Minas Gerais, Brazil.

² Specialist in Foot and Ankle Medicine and Surgery at Hospital Felício Rocho and Hospital Madre Teresa, Belo Horizonte, MG, Brazil.

³ Hospital das Clínicas – Belo Horizonte, MG, Brazil. Orthopedic and Traumatology Resident at Hospital das Clínicas/UFMG, Belo Horizonte, MG, Brazil.

⁴ Hospital São Marcos, Uberaba, MG, Brazil. Specialist in Foot and Ankle Medicine and Surgery at UNIFESP – Escola Paulista de Medicina.

⁵ Hospital Felício Rocho, Belo Horizonte, MG, Brazil. Specialist in Foot and Ankle Medicine and Surgery at UNIFESP – Escola Paulista de Medicina.

⁶ Hospital Madre Teresa, Belo Horizonte, MG, Brazil. Specialist in Foot and Ankle Medicine and Surgery at UNIFESP – Escola Paulista de Medicina.

⁷ UNIFESP, SP, Brazil. Specialist in Foot and Ankle Medicine and Surgery at UNIFESP – Escola Paulista de Medicina.

⁸ Associate Professor – UNIFESP – Escola Paulista de Medicina, SP, Brazil.

Correspondence to:

Daniel Baumfeld
Rua dos Pampas, 990 – Torre 1/Apto 1701 – Prado
Zip Code: 30411-030 – Belo Horizonte, MG, Brazil
E-mail: danielbaumfeld@gmail.com

Conflict of interest:

Caio Nery is a consultant/speaker for Arthrex, USA.
All the other authors declare that there are no conflicts of interest.

Funding:

none reported.

Received on:

October 29, 2016

Accepted on:

May 15, 2017

and viable option for the treatment of chronic lesions of the CT. Other studies are needed, to compare this technique with the open procedure, which is still the gold standard.

Keywords:

Achilles tendon; Rupture; Tendon transfer; Endoscopy

INTRODUCTION

Chronic degeneration of the calcaneal tendon is observed in cases of neglected lesions or in re-ruptures. In these cases, the biological regenerative capacity of the tendon is impaired and there is a predisposition for muscle insufficiency of the gastrocnemius-soleus complex⁽¹⁾.

Chronic calcaneal tendon ruptures are hard to treat due to the proximal retraction of the tendon and the loss of contractility of the triceps surae. Function is often impaired, leading to lameness, inability to run or to climb stairs. Calf hypotrophy and palpable gap may be present, although absence of the gap does not rule out the diagnosis⁽²⁾.

The management of acute and chronic calcaneal tendon ruptures is usually different due to the retraction and atrophy of the remaining stumps in chronic cases. Moreover, the expected outcome following treatment of chronic rupture or re-rupture of the calcaneal tendon is related to injury time, skin conditions, muscle excursion capacity, and patient comorbidities^(3,4).

Various procedures for the treatment of this condition are described in the literature, such as V-Y myotendinous advancement of the gastrocnemius-soleus complex or reflecting of the proximal portion of the calcaneal tendon, described by Bosworth⁽³⁾. Other surgical techniques use peroneus brevis, flexor digitorum longus or flexor hallucis longus⁽⁵⁻⁷⁾ tendon transfers. All of these surgical procedures have exhibited satisfactory clinical results, despite the possibility of persistent deficits in ankle plantar flexion strength and of peak torque^(4-6,8).

Endoscopic assistance for flexor hallucis longus transfer has received considerable attention in recent literature⁽⁹⁾. In 2016, Lui et al. described an endoscopic technique with flexor hallucis longus tenotomy distal to the knot of Henry, achieving good results⁽¹⁰⁾.

The purpose of this case series was to report the preliminary results of six patients undergoing endoscopic

durante as atividades diárias. **Conclusão:** Nessa série de casos, a técnica de transferência endoscópica do FLH demonstrou-se como uma opção segura e viável para o tratamento das lesões crônicas do TC. Outros estudos se mostram necessários para a comparação entre essa técnica e o procedimento aberto, padrão ouro até o presente momento.

Descritores:

Tendão do calcâneo; Ruptura; Transferência tendinosa; Endoscopia

transfer of the flexor hallucis longus to treat chronic lesions or re-ruptures of the calcaneal tendon. We describe the surgical technique with flexor hallucis longus tenotomy proximal to the knot of Henry, expanding the indications of posterior endoscopy of the ankle.

METHODS

Between June 2015 and February 2016, six patients with chronic lesion or re-rupture of the calcaneal tendon were treated with endoscopic-assisted flexor hallucis longus transfer in a non-consecutive manner. Four men and two women with a mean age of 50 years (33-65 years) were included. Four left tendons and two right tendons were involved. All the lesions were located in zone 2 of the calcaneal tendon (2-6cm proximal to its insertion).

One patient had sustained an acute lesion re-rupture (previously treated conservatively) and all the other five had chronic lesions, ranging from 6 to 28 weeks. All of them presented with anti-gravity equinus of the foot, limped while walking, and were unable to perform monopodal elevation. The minimum follow-up was five months and the maximum follow-up one year. Four of the subjects had a palpable gap, which was approached through the Percutaneous Achilles Repair System (PARS - Arthrex, USA).

All the patients were assessed and operated on by the same foot and ankle surgeon. The Achilles Tendon Rupture Score (ATRS) was applied in the pre- and postoperative periods (at three months of follow-up) in all patients⁽¹¹⁾. This score was used as it is validated in the Portuguese language. This study was approved by the institutional review board of our hospital.

Surgical technique

The surgical procedure was performed with sedation and anesthesia by neuroaxis blockade. The patients were placed in ventral decubitus on an operating table, with

a tourniquet applied to the thigh. A 4.0mm 300 series arthroscope and 4.0mm shaver were used.

We performed posterior ankle endoscopy using the posterolateral and posteromedial portals as described by van Dijk⁽¹²⁾ (Figure 1).



Figure 1 | Posterior ankle endoscopy.

The posterolateral portal was initially used for viewing and the posteromedial portal for instrumentation. The switch between portals was done as needed to achieve adequate posterior visualization. The flexor hallucis longus tendon was identified following debridement with the shaver (Figure 2). In order to confirm the correct tendon, the hallux was mobilized passively to observe the tendon movement.

The flexor hallucis longus tendon is a deep structure, except at the level of the hallux. Its route can be divided into three zones. Zone 1 is located posterior to the ankle. In zone 2, the pathway of the flexor hallucis longus tendon starts in the osteofibrous tunnel formed at the level of the posterior talar tubercles, passes under the sustentaculum tali, and ends at the level of the knot of Henry. The portion of the flexor hallucis longus tendon distal to the knot of Henry is located in zone 3, up to its insertion in the distal phalanx of the hallux⁽¹³⁾.

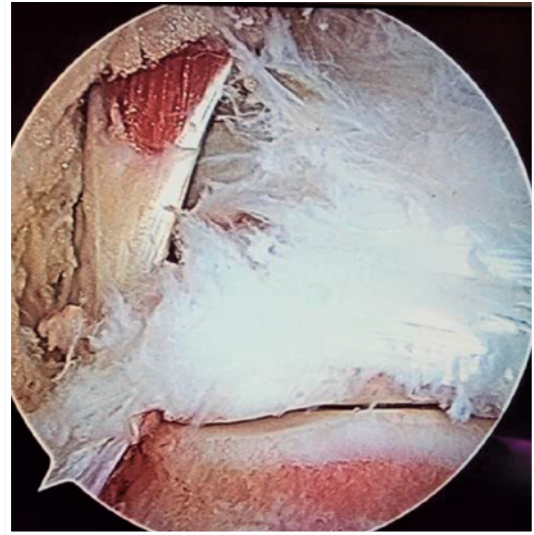


Figure 2 | Flexor hallucis longus: identification after debridement.

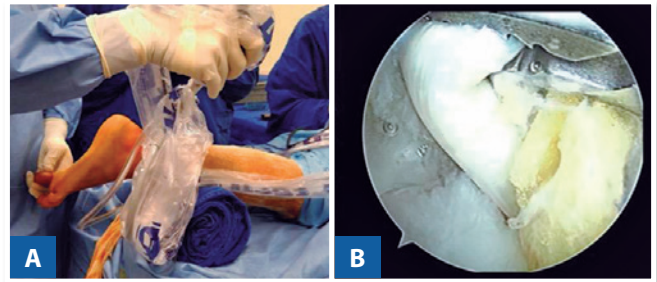


Figure 3 | A) Ankle and hallux positioned in maximum plantar flexion, seeking the maximum length of the tendon. B) Ancillary forceps for proximal traction of the flexor hallucis longus tendon.

After adequate identification of the flexor hallucis longus in zone 1, the ankle and the hallux were positioned in maximum plantar flexion. Using ancillary forceps for proximal traction of the tendon, aiming to achieve its maximum length, we performed its tenotomy at the most distal point possible (Figure 3). The free proximal stump of the flexor hallucis longus was externalized through the medial portal and 2.0mm non-absorbable FiberWire® Krackow sutures were used (Figure 4).

We then prepared the calcaneal tunnel under radioscopic and endoscopic visualization through the posterolateral portal (Figure 5). After this, we drilled the tunnel achieving a length of 30mm and a diameter of 7.0mm. The tip of the flexor hallucis longus tendon was passed through the tunnel and externalized on the plantar surface of the foot with the assistance of the guidewire. The ankle was positioned at five to ten degrees of plantar flexion (physiological



Figure 4 | Free stump of the flexor hallucis longus externalized through the medial portal with Krakow sutures.



Figure 5 | Preparation of the calcaneal tunnel under endoscopy and radiosopic visualization through the posterolateral portal.

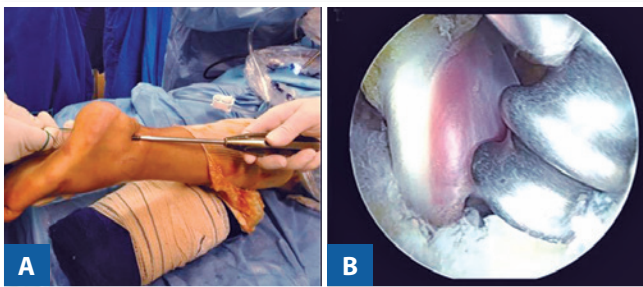


Figure 6 | A) External visualization of the introduction of the interference screw. B) Endoscopic visualization of the tunnel with the flexor hallucis longus tendon and the interference screw.

equinus), and the appropriate tension in the flexor hallucis longus was checked through the traction of the non-absorbable suture wire. After confirming adequate tension, by restoring anti-gravity equinus, the flexor hallucis longus tendon was fixed to the bone tunnel using a metal or absorbable interference screw (7/25mm) (Figure 6). When necessary, the calcaneal tendon gap was sutured using the PARS technique (Arthrex, USA) to bring the tendon stumps together.

Skin sutures were applied in the usual manner and the foot was immobilized in a splint, positioned at 10 degrees of plantar flexion. All patients underwent the same postoperative protocol using immobilization with splint in plantar flexion for two weeks followed by cast boot with weight bearing and progression of the plantar position to neutral over the next four weeks. The stitches were removed at the time of removal of the plaster cast. After they started to use the boot, the patients were encouraged to mobilize their ankles actively. Formal physiotherapy began after the removal of the cast boot.

RESULTS

Table 1 shows the six patients in our study. The mean follow-up of this series was nine months (ranging from 5-12 months). Four patients underwent an associated procedure (PARS - Arthrex, USA) in the calcaneal tendon to repair the pre-existing gap.

All patients with chronic lesions had tendon degeneration above 50%. Surgery averaged 56 minutes, with the time ranging from 45 to 70 minutes. There were no complications in the follow-up time, nor were any complaints relating to wound healing reported. All patients had a vast improvement in Achilles Tendon Rupture Score (ATRS) values, with an average of 17.8 in the preoperative period and 83.3 in the postoperative period.

All patients were able to stand on tiptoe in the postoperative period, without limitations. The patients were cleared for impact activities after they became asymptomatic and recovered the strength of the posterior muscles of the leg (subjective evaluation). After the tendon transfer, none of the patients reported loss of functional strength of the hallux during their daily living or athletic activities, returning to their pre-injury levels.

DISCUSSION

This study reports our experience with the flexor hallucis longus endoscopy-assisted transfer technique, performed

Table 1 | Clinical data of the operated patients

| | P1 | P2 | P3 | P4 | P5 | P6 |
|-------------------|--------------|--------------------|--------------|---------------|---------------|------------|
| Sex | F | M | F | F | M | F |
| Age | 65 | 33 | 52 | 60 | 43 | 47 |
| Time of injury | 4 months | Acute (RE-rupture) | 6 months | 7 months | 6 weeks | 2 months |
| GAP | Not palpable | Palpable | Not palpable | Palpable <1cm | Palpable >1cm | Palpable |
| Skin | Atrophic | Normal | Atrophic | Normal | Normal | Atrophic |
| Follow-up | 8 months | 12 months | 5 months | 11 months | 6 months | 12 months |
| Length of surgery | 60 minutes | 56 minutes | 45 minutes | 48 minutes | 70 minutes | 61 minutes |
| Associated PARS | No | Yes | No | No | Yes | Yes |
| Pre ATRS | 17 | 13 | 28 | 11 | 16 | 22 |
| Post ATRS | 83 | 87 | 82 | 79 | 85 | 84 |

in six cases of chronic rupture or re-rupture of the calcaneal tendon, with an average of nine months follow-up. Regarding the functional results, quantified by the Achilles Tendon Rupture Score (ATRS), our findings were similar to those reported by other authors^(1,3,4-6).

Chronic calcaneal tendon rupture can be treated through direct repair, calcaneal tendon advancement tenoplasty, local tendon transfer or reconstruction with autologous, allogeneic or synthetic grafts^(2,5,14). The best type of surgery for the treatment of this lesion remains undetermined⁽⁶⁾. The treatment of choice depends on the size of the gap after debridement of the tendon stumps. Defects greater than 5cm can be treated with isolated tendon transfer with or without V-Y advancement⁽¹⁵⁾. The flexor hallucis longus is one of the tendons of choice used for calcaneal tendon reconstruction, which is usually performed by open approach. The reason for this preference is due to the strong musculature of the flexor hallucis longus, which has its force generated at the same time as the triceps surae. Although the flexor hallucis longus has seldom been described in the literature with the use of peroneus brevis, the former acts on lateral stabilization of the ankle and is an important eversor, which is why the flexor hallucis longus was the tendon of choice in this study^(4,7).

The transfer of the flexor hallucis longus to the calcaneus is traditionally performed through one or two long incisions with extensive dissection of soft parts⁽²⁾. In the open surgical approach with longitudinal incision, there is sometimes detachment of the peritendon, responsible for the blood supply to the injured tendon⁽¹²⁾. The rates of wound complication among patients undergoing surgical treatment of chronic calcaneal tendon lesions range from 2.5% to 4%. Some authors have reported an overall rate of complications of 36% in open procedures and of 10% in percutaneous repairs^(6,8).

The use of an endoscopic technique allows direct visualization of the calcaneal tendon stumps, without the use of an additional incision, and the tenotomy of the flexor hallucis longus proximal to the knot of Henry, transferring it to the calcaneus in a minimally invasive manner. This approach reduces morbidity and the chances of postoperative complications compared to the open procedure. It is known, however, that in very large gaps, greater than 5cm, the flexor hallucis longus tendon length when tenotomized proximal to the knot of Henry may be short. In such cases, techniques with tenotomy distal to the knot of Henry may be used^(9,10).

Because of its short follow-up and small number of patients, this study reports preliminary observations. Although we have not observed any complications in our case series, this procedure is very demanding in technical terms, requires a high level of arthroscopic experience from the surgeon, and is associated with complications such as fixation failure and neurovascular bundle injury^(9,12,13). Other studies are needed to compare this technique with the open procedure, which has been the gold standard up to now.

CONCLUSION

In this case series, the endoscopic transfer of the flexor hallucis longus with tenotomy proximal to the knot of Henry is a safe and viable option for patients with chronic rupture/re-rupture of the calcaneal tendon and small gaps (<5 cm).

REFERENCES

1. Cretnik A, Frank A. Incidence and outcome of rupture of the Achilles tendon. *Wien Klin Wochenschr.* 2004;116(Suppl 2):33-8.
2. Myerson MS. Achilles tendon ruptures. *Instr Course Lect.* 1999;48: 219-30.

3. Elias I, Besser M, Nazarian LN, Raikin SM. Reconstruction for missed or neglected Achilles tendon rupture with V-Y lengthening and flexor hallucis longus tendon transfer through one incision. *Foot Ankle Int.* 2007;28(12):1238-48.
4. Hahn F, Meyer P, Maiwald C, Zanetti M, Vienne P. Treatment of chronic achilles tendinopathy and ruptures with flexor hallucis tendon transfer: clinical outcome and MRI findings. *Foot Ankle Int.* 2008;29(8):794-802.
5. Gabel S, Manoli A 2nd. Neglected rupture of the Achilles tendon. *Foot Ankle Int.* 1994;15(9):512-7.
6. Khan RJ, Fick D, Brammar TJ, Crawford J, Parker MJ. Interventions for treating acute Achilles tendon ruptures. *Cochrane Database Syst Rev.* 2004(3):CD003674.
7. 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(8):443-9.
8. Dalton GP, Wapner KL, Hecht PJ. Complications of Achilles and posterior tibial tendon surgeries. *Clin Orthop Relat Res.* 2001;(391):133-9.
9. Goncalves S, Caetano R, Corte-Real N. Salvage flexor hallucis longus transfer for a failed achilles repair: endoscopic technique. *Arthrosc Tech.* 2015;4(5):e411-6
10. Lui TH, Chan WC, Maffulli N. Endoscopic flexor hallucis longus tendon transfer for chronic Achilles tendon rupture. *Sports Med Arthrosc.* 2016;24(1):38-41.
11. Zambelli R, Pinto RZ, Magalhães JM, Lopes FA, Castilho RS, Baumfeld D, et al. Development of the Brazilian Portuguese version of the Achilles Tendon Total Rupture Score (ATRS BrP): a cross-cultural adaptation with reliability and construct validity evaluation. *BMC Sports Sci Med Rehabil.* 2016;8:11.
12. van Dijk CN. Hindfoot endoscopy. *Foot Ankle Clin.* 2006;11(2):391-414.
13. DeMaio M, Paine R, Drez DJ Jr. Achilles tendonitis. *Orthopedics.* 1995;18(2):195-204.
14. Neufeld SK, Farber DC. Tendon transfers in the treatment of Achilles' tendon disorders. *Foot Ankle Clin.* 2014;19(1):73-86.
15. Schmidt-Rohlfing B, Graf J, Schneider U, Niethard FU. The blood supply of the Achilles tendon. *Int Orthop.* 1992;16(1):29-31.