Ultrasound to Prevent Sural Nerve Injury in Achilles Tendon Repair. A Cadaveric Study

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ABSTRACT

Introduction: Minimally invasive techniques are preferred to treat acute Achilles tendon ruptures. They represent an option to avoid integumentary complications, and sural nerve injury is one of its main problems. This study aims to verify the usefulness of ultrasound in preventing sural nerve injury during Achilles repair with percutaneous techniques. **Materials and Methods:** Study in 12 cadaveric pieces. We recreated an injury at the level of the Achilles tendon, 5 cm proximally to its distal insertion. In one of the cadaver limbs, the sural nerve and/or its satellite vein were identified by ultrasonography. We repaired the sural nerve percutaneously with two needles at the proximal level and two needles at the distal level of the lesion and represented the path of the sural nerve. In the contralateral limb, the sural nerve was not identified by ultrasound. We performed the percutaneous repair of the injuries using the Ma & Griffith technique. **Results:** In the ultrasound group, no sural nerve injuries were identified. In the control group, two sural nerve injuries were observed (p=0.6). In all cases, the identification of the sural nerve by ultrasound was correct. **Conclusion:** Ultrasound assistance in the percutaneous treatment of Achilles tendon injuries is an effective and reliable method to prevent sural nerve injuries.

Keywords: Acute Achilles tendon rupture; sural nerve injury; ultrasonography; percutaneous techniques; cadaver study.

Level of Evidence: III

Ecografía para prevenir lesiones del nervio sural en la reparación del tendón de Aquiles. Estudio cadavérico

RESUMEN

Introducción: Las técnicas mínimamente invasivas son las preferidas para tratar las roturas agudas del tendón de Aquiles. Representan una opción para evitar las complicaciones tegumentarias, y la lesión del nervio sural es uno de sus principales problemas. El objetivo de este estudio fue comprobar la utilidad de la ecografía para prevenir la lesión del nervio sural durante la reparación del tendón de Aquiles con técnicas percutáneas. **Materiales y Métodos**: Estudio en 12 piezas cadavéricas. Se recreó una lesión en el tendón de Aquiles 5 cm proximales de su inserción distal. En uno de los miembros del cadáver, se identificó el nervio sural o su vena satélite mediante ecografía. Se reparó el nervio sural por vía percutánea con dos agujas proximales y dos agujas distales a la lesión, y se representó el recorrido del nervio sural. En el miembro contralateral, no se identificó el nervio sural mediante ecografía. Se efectuó la reparación percutánea de las lesiones mediante la técnica de Ma y Griffith. **Resultados:** En el grupo ecográfico, no se identificaron lesiones del nervio sural. En el grupo de control, se observaron dos lesiones del nervio sural (p = 0,6). En todos los casos, la identificación del nervio sural mediante ecografía fue correcta. **Conclusión:** La asistencia ecográfica en el tratamiento percutáneo de las lesiones del tendón de Aquiles es un método eficaz y confiable para evitar las lesiones del nervio sural.

Palabras clave: Rotura; tendón de Aquiles; nervio sural; ecografía; técnicas percutáneas; estudio cadavérico.

Nivel de Evidencia: III

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INTRODUCTION

Surgical techniques used for acute Achilles tendon repair have evolved over the last 50 years. Classically, lesions were treated with an open technique, and the sutures used to join the ends varied.[1] In 1977, Ma and Griffith introduced the percutaneous technique as an option that avoided integumentary complications and offered advantages, such as the possibility of performing it under local anesthesia. The main disadvantage of the percutaneous techniques was the injury to the sural nerve, due to its entrapment together with the subcutaneous tissue in the suture loop.[2]

In 2002, Assal et al. described a minimally invasive technique in which, through a small proximal approach and implementation of specific instruments, the sutures introduced percutaneously were rescued and finally located between the paratenon and the subcutaneous tissue. This avoided the possible compression of the sural nerve within the loop when tying and tightening the suture, resulting in a marked reduction in the injury rate.[3,4]

Currently, minimally invasive techniques are preferred to treat acute Achilles tendon tears.[5,6] Paradoxically, despite the above, sural nerve injury remains one of the main complications described with these techniques, in this case, not by entrapment, but by a direct puncture.[7]

The wide variability of the anatomy of the sural nerve does not allow the generation of predefined anatomical landmarks that ensure a reliable percutaneous entry.[8,9]

Several studies have proved the usefulness of ultrasound to guide sutures during repair as a reliable, safe and fast method,[10-12] but they do not establish protocols or verify the methodology to avoid injuring the sural nerve during the procedure.

The objective of this study was to verify the usefulness of ultrasound guidance to prevent sural nerve injury during Achilles tendon repair with percutaneous techniques.

MATERIALS AND METHODS

We carried out an experimental, prospective study. Six cold-preserved human cadavers without prior fixation techniques were used; in total, 12 pieces were used (both lower limbs of each cadaver).

A transverse lesion in the Achilles tendon was recreated 5 cm proximal to its distal insertion using a minimally invasive approach from its posterior aspect, approximately 2 cm (Figure 1).

In one of the cadaver limbs, the sural nerve or its satellite vein (lesser saphenous vein) was identified by ultrasound (BSCAN-1 3.5MHz) (ultrasound group). The sural nerve was marked percutaneously with two needles proximal and two needles distal to the lesion. The needles were placed in the coronal plane immediately deep to the nerve and in the sagittal plane immediately medial to it. With a skin marker, the path of the sural nerve from the proximal to the distal repair was represented. In the contralateral limb, the sural nerve was not identified by ultrasound before surgical repair of the Achilles tendon (control group) (Figure 2).

Percutaneous repair of Achilles tendon injuries was performed using the Ma and Griffith technique. In the ultrasound group, the suture was performed posterior and medial to the representation of the identified trajectory of the sural nerve in order to avoid injuring it.

Elements and materials

- Minor surgery set
- Ti-cron™ 5-0 suture
- Nylon 3-0 skin suture

Figure 1. Section level of the Achilles tendon.

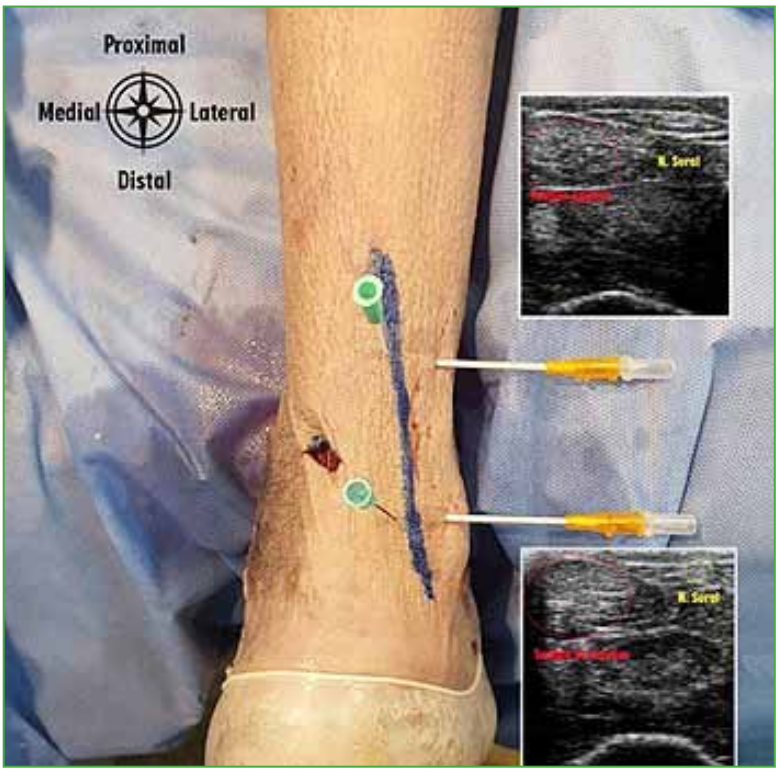

Figure 2. Ultrasound triangulation, distal and proximal to the lesion.

Surgical technique

Corpse in ventral decubitus position. Six 0.5 cm incisions (3 lateral, 3 medial) are made, four in the proximal end and two in the distal end, identified by direct manual palpation. The first surgical action involves the passage of the first needle through the proximal approaches (from medial to lateral). Both needles are crossed to exit through the second contralateral orifice. The subcutaneous tissue between the middle and distal orifices is dissected with a fluted probe. The distal end is grasped with the medial needle, introduced through the medial distal orifice and extracted through the lateral distal orifice, the suture knot is made at the level of the second lateral orifice while suture tension is controlled, placing the ankle in moderate equinus position. The approaches are sutured.

At the end of the procedure, a median posterior longitudinal approach is performed in the distal third of the leg and the planes are dissected until the sural nerve and the Achilles tendon are identified (Figure 3).

Figure 3. Sural nerve (X) and lesser saphenous vein (*).

The presence of injury to the sural nerve is evaluated, either by direct injury or by entrapment with the sutures.

In the ultrasound group, it is recorded whether the needle landmarks of the sural nerve were properly placed in relation to it.

This entire procedure was carried out by third-year resident doctors of Orthopedics and Traumatology, with no experience in the use of ultrasound and without the assistance of specialists in diagnostic imaging.

RESULTS

In the ultrasound group, no sural nerve lesions were identified. In the control group, two sural nerve injuries were detected, one due to suture entrapment and the other due to direct puncture with the needle ($p = 0.6$ calculated with chi-square) (Table, Figure 4).

Table. Results

	Control group	Ultrasound group	P
Total pieces	6	6	
Sural nerve injuries	2	0	P = 0.6

Figure 4. Sural nerve entrapment with percutaneous suture.

In all cases, the identification of the sural nerve by ultrasound was correct (Figure 5).

Figure 5. Ultrasound landmarks (needles) and subsequent dissection, checking the proper positioning of the needles and their relationship with the sural nerve.

DISCUSSION

Achilles tendon rupture is one of the most frequent tendon injuries of the lower limbs, mainly in young men.[13] The incidence of this condition has increased in recent times in an intrinsic relationship with the increase in sports activity at older ages and the prevalence of obesity.[14] The Achilles tendon is the longest and strongest in the body.[15] It has a highly vascularized paratenon. The blood supply to the proximal portion comes from the posterior tibial artery, and the supply to the distal portion comes from the fibular artery. The middle portion (2-6 cm from its distal insertion) is the most prone to rupture, as it is an area with relative hypovascularization.[16] The Achilles tendon is closely related to the sural nerve. It is a sensory nerve of the lower limb that innervates the posterolateral region of the leg. It is characterized by a great anatomical variability, which makes it difficult to correctly predict its location in order to avoid injuring it during minimally invasive or percutaneous surgeries for Achilles tendon repair.[8]

Treatment of acute Achilles tendon tears can be both conservative and surgical. The choice between therapeutic options is currently controversial, since the options achieve similar outcomes, but with different complications. Conservative treatment causes a higher retear rate than surgical options.[17] In our institution, minimally invasive techniques are used in injuries with less than 15 days of evolution, and open techniques in injuries that exceed this time.

Surgical repair techniques for the Achilles tendon seem more reliable to the specialist, due to the holding strength of the suture and the lower risk of retear. They can be classified into open, minimally invasive, and percutaneous techniques.[18] Open surgical techniques can cause wound-related complications and skin adhesions, among them, the most frequent are infection, necrosis and dehiscence.[19,20]

The benefit of percutaneous techniques is to avoid wound-related complications, but the main complication described is an injury to the sural nerve due to its entrapment when suturing. Klein reports a 13% risk of sural nerve injury; Haji, 10.5%; and Majewski, 18%.[21,22]

Minimally invasive techniques decrease the risk of sural nerve entrapment, but can lead to puncture injury when passing the needles.[7]

Ultrasound is an easily accessible study that allows the location of the sural nerve and its satellite vein, the lesser saphenous. The challenge, in these cases, is to obtain an adequate interpretation of the images to identify these structures, particularly for an orthopedic surgeon not accustomed to ultrasound techniques.[23] It allows observing the precise location of the sural nerve and its intimate anatomical relationship with the Achilles tendon, minimizing the risk of injury when inserting the needle.[24]

Yongliang et al. used ultrasound assistance in minimally invasive techniques to avoid sural nerve injury. In their study, they did not report injuries to this nerve.10

In this study, we were able to correctly identify the sural nerve and thus avoid injuring it. In the control group (without ultrasound), the incidence of injury was 33.3%.

We believe that ultrasound assistance to identify the path of the sural nerve before surgery allows us to reduce the incidence of complications related to its injury and thus reintroduce percutaneous surgical techniques as a fast, simple, and safe treatment method.

The main limitation of this study is that the difference between the control group and the ultrasound group is not statistically significant due to the low number of pieces used.

CONCLUSIONS

Ultrasound guidance in the percutaneous treatment of Achilles tendon injuries is an effective and reliable method to prevent sural nerve injuries. No imaging specialist was required during the procedure, making it possible for orthopedic surgeons to use. By reducing the rate of complications, ultrasound would allow the percutaneous technique to be revalued.

Despite the limitation regarding the low number of cadaveric pieces used, the promising results obtained allow us to conclude that this study lays the foundations for adapting the technique that was implemented in cadaveric material during surgery.

Conflict of interest: The authors declare no conflicts of interest.

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