Neglected rupture of achilles tendon. Free masive allograft for reconstruction. Ten years follow-up

Rotura inveterada del tendon de Aquiles. Aloinjerto masivo para su reconstrucción. Seguimiento a diez años

Mariano Núñez-Samper[1], Guillermo Parra Sanchez[1], Eldis Lao Duran[1]

Keywords:
Achilles tendon/abnormalities; Allograft; Free allograft for reconstruction

Descriptores:
Tendón de Aquiles/anormalidades; Roturas inveteradas; Transplante tendinoso criopreservado

ABSTRACT

Introduction: A neglected rupture or an inveterate Achilles tendon, with severe substance loss of the tendon itself requires specific surgical treatment in order to supply vascularization to the substance loss and in order to re-establish tendon functionality. The inveterate ruptures are characterized by the difficulty of achieving an end-to-end apposition of the tendon ends with plantar flexion of the foot during surgical reconstruction. (Abraham-Pankovich, Christiensen etc...). **Objective:** The Achilles tendon allograft has been used for reconstruction of neglected Achilles tendon rupture without sacrificing other autologous tendons. The use for reconstruction has been reported, but mostly limited to case report, by Nellas, Yuen and Nicholas, Lepow and Green. All the authors reported favorable outcomes after surgery because they corrected these defects satisfactorily and it allows recovering the 3 rockers of the step. **Methods***:* The cryopreserved Achilles tendon allograft with attached bone (osteotendinous) was thawed and rehydrated in sterile normal saline solution for 30 minutes prior to insertion. During this process a quadrangular cavity of the same size as the bone block graft was carved in the posterior tuberosity of the calcaneus. Once the bone graft was hosted in the posterior tuberosity, the tendon portion was extended with 90° traction of the foot, suturing it to the calf muscles, so that it would maintain the tension of the implanted tendon. This was anchored press-fit into the carved out cavity and checked to see that it fit perfectly so as to avoid the use of osteosynthesis.This procedure has been used satisfactorily by us in two cases. **Results***:* They have been highly favourable in the revising 10 years after surgery. The scales AOFAS (ankle scale) and OXFORD follow in the same range as the ones carried out the first year of follow-up. In case study 1, the AOFAS Clinical Rating System improved from 69 to 95 points one year after surgery and the muscle strength (OXFORD scale of 0-5) increased from 0 to 4. In case study 2, the AOFAS rating improved from 75 to 95 points and the muscle strength increased from 1 to 4. **Conclusions:** The use of this free allograft procedure has been recommended when significant segmental defect is encountered, about 10 cm when fascia advancement or tendon transfer is not able to provide sufficient bridging between the tendon ends.

Therapeutic study: Level III.

[1] Orthopaedic Surgery Service, Virgen del Mar Hospital, Madrid, Spain.

Corresponding author:
M. Núñez-Samper M.D. Ph.D.
Virgen del Mar Hospital
c/ Honduras, 14 - 28016 Madrid, Spain
Phone: (+34) 913539500
Cell Phone: (+34) 667776050
Fax: (+34) 91 3451 01 3
E-mail: mnusamp1@nunezsamper.com
parrasanchezguillermo@gmail.com
drlaoduran@yahoo.es

Conflict os interest:
None of the authors received funding in relation to this study.

Received on:
Sept 28, 2018

Accepted on:
Jan 2, 2019

RESUMEN

Introducción: Las rupturas crónicas o inveteradas del tendón de Aquiles, con pérdida de substancia grave, requieren un tratamiento quirúrgico muy específico que supla la solución de continuidad existente y recupere la funcionalidad del tendón y del sistema Calcáneo-Aquileo-Plantar. Las plastias tipo Abraham-Pankovich y Christiensen sólo reemplazan esta pérdida hasta 6 u 8 centímetros. **Objetivo:** La necrosis de los extremos del tendón obliga a resecar más tejido durante la cirugía, aumentando así el tamaño de la falla, por lo que se hace imposible cerrar el defecto con las técnicas anteriormente citadas. El injerto permite cerrar el *"gap"* de forma satisfactoria y recuperar la longitud del tendón. Autores como Nellas, Yuen y Nicholas reportan buenos resultados utilizando este procedimiento en casos limitados. **Métodos:** Dos pacientes de 58 y 67 años con grave rotura crónica evolucionada en el tendón de Aquiles en los que este procedimiento ha sido utilizado con resultado altamente favorable. El transplante osteotendinoso masivo criopreservado de tendón de Aquiles realizado mediante la técnica que describimos, consiste en resecar toda la zona necrótica de los extremos, tallar una cavidad en la tuberosidad del calcáneo para el anclaje óseo y posteriormente adaptar toda la plastia tendinosa a los restos musculo-tendinosos y a las partes blandas vecinas, con la tensión necesaria que requiera el injerto, permitiendo así recuperar la longitud del tendón y su funcionalidad. **Resultados:** En la última revisión realizada, a los 10 años de la implantación, los resultados de las escalas AOFAS (escala para tobillo) y OXFORD (para la potencia muscular) han sido los mismos que los obtenidos en la primera revisión al año de la cirugía, no habiendo sufrido ninguna modificación desfavorable en este espacio de tiempo. Los pacientes actualmente hacen una vida normal.

Estudio terapéutico: Nível III.

INTRODUCTION

The failure rate in the primary treatment of a ruptured Achilles tendon ranges from 4-8%. Re-ruptures are more frequent (5-6%) in orthopedic treatments with percutaneous sutures than those of surgical procedures.[1]

There is a higher incidence of necrosis, infection and tendinosis of the ends of the tendon in surgical reconstruction using end-to-end suture. This is due to the damage of the vascularization of the peritenon during surgery (2%) and, as is often the case, this conditions the onset of substance loss of up to 3 or 4 centimeters in size.[2]

The long standing tendinosis with micro-ruptures and/or successive surgical treatments results in a progressive elongation of the gap, which determines the subsequent dysfunction.[3-5]

These small substance losses (Kuwada I-II) or failures can be treated with plasty reconstruction techniques such as Lindholm, Bosworth, etc... serious problem arises when the gap size is from 6 centimeters on, (Kuwada III-IV)[3] and there is a need to surgically resection a wide area up to the healthy tissue for its reconstruction.

In these situations the materials available for augmentation can be categorized into autologous, synthetic or allograft techniques.[6-8]

Different procedures with distant or local autologous tendon transfers have been described in order to reinforce or reconstruct neglected Achilles tendon ruptures. The plastys and local or distant tendon transfer (Flexor Hallucis Longus, Peroneus Brevis, Flexor Digitorum Longus, free Gracilis tendon, fascia graft and the techniques of Abraham-Pancowich (V-Y tendinous flap), Christiensen (turn-down-flap) etc...) and in some instances, reinforcement and augmentation techniques can be coupled with an Acellular Dermal Matrix (graft-jacket) or bio absorbable synthetic graft (Artelon).[8-16] However, these cases do not satisfactorily bridge these serious defects because of the risk of developing problems in vascularization and failure to adequately assess and reinstate the optimal length-tension relationship of the gastrocnemius-soleus complex.

Synthetic materials have also been used for augmentation. The advantage of using synthetic materials is that they avoid sacrificing other active tendons. Besides, the morbidity associated with larger incisions and dissections involved in autologous techniques can be bypassed. However, the use of synthetic materials in an area well-known for tenuous wound healing is a major disadvantage.[15]

The Achilles tendon allografts have been used for reconstruction of neglected Achilles tendon ruptura[6-8,15-17] mainly to reconstruct serious defects without sacrificing other autologous lower extremity tendons with relative technical ease.

Surgical indication of total replacement of the Achilles tendon using a bone and tendon (osteotendinous) is unusual. The allograft acts as a structure that facilitates cell migration, allowing the integration of the graft into the bone and the recovery of the muscle functionality.[5-8]

The following two cases with 10 years of follow-up, guarantee our experience. Before requesting our opinion, both patients had been previously treated elsewhere and encountered many problems in the treatment of their Achilles tendon as reflected by their medical records.

METHODS

Case study 1

Corresponds to a 58-year-old woman who had suffered a subcutaneous rupture of the right Achilles tendon. She had been treated surgically with end-to-end suture which subsequently got infected. As a result, two new interventions, a new end-to-end suture and a Christensen plasty (turn-down flap) were performed but were unsuccessful. After a 18-month post-operative, she was still in pain and presented total functional deficit at take-off in walking.

A clinical evaluation and an image scan were performed (Figure 1-A) which confirmed a loss of

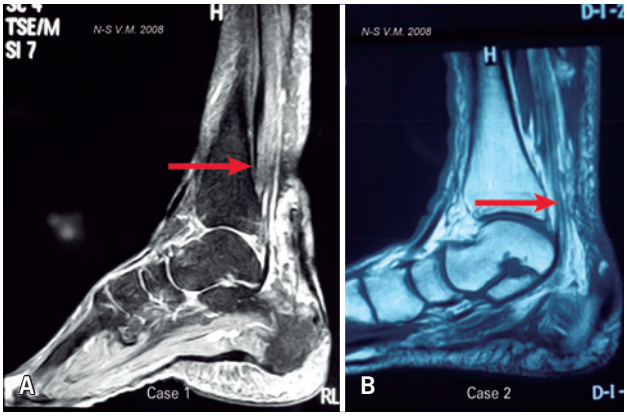

Figure 1. Magnetic resonance imaging, where you can see the loss of substance and tendinous degeneration of the tendon (A case 1 - B case 2)

substance of 8cm and severe degeneration of the tendon ends. Considering the medical record and clinical evaluation (Kuwada IV) the patient *was* considered a good candidate for a cryopreserved allograft.

Case study 2

A 67-year-old male was treated for chronic tendinitis during 6 months with cortisone injections and rehabilitation. While making a minimal effort, the patient suffered an acute rupture to his tendon which was treated using conservative methods and with more cortisone injections for a year.

At the end of the treatment he was still in pain and had absolute difficulty when walking and at take-off.

Clinical evaluation and an image scan confirmed a chronic rupture with a substance loss of 7cm, tendinosis and fibrous tissue replacing the tendon gap (Figure 1 B). Considering the medical record and clinical evaluation (Kuwada IV), the patient was considered a good candidate for a cryopreserved allograft.

Surgical technique

The surgical approach in both cases was performed from the posterior of the leg, from the muscle mass of the calf to the calcaneal plantar face, so as to be able to see the tendon ends and to accurately assess the existing loss of substance (Figure 2 A-B).

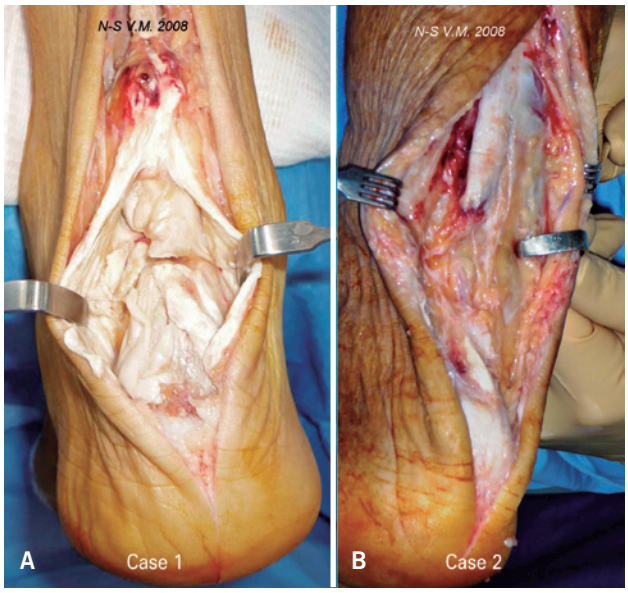

Figure 2. Intra-operative image. Observe the degeneration, necrotic and avascular tissue making it non-viable for its direct reconstruction (A case 1 - B case 2)

The pathological anatomy of the injury needs that all the necrotic avascular tissue was excised up to the point where the healthy vascularized tissue was reached (Figure 3 A-B).

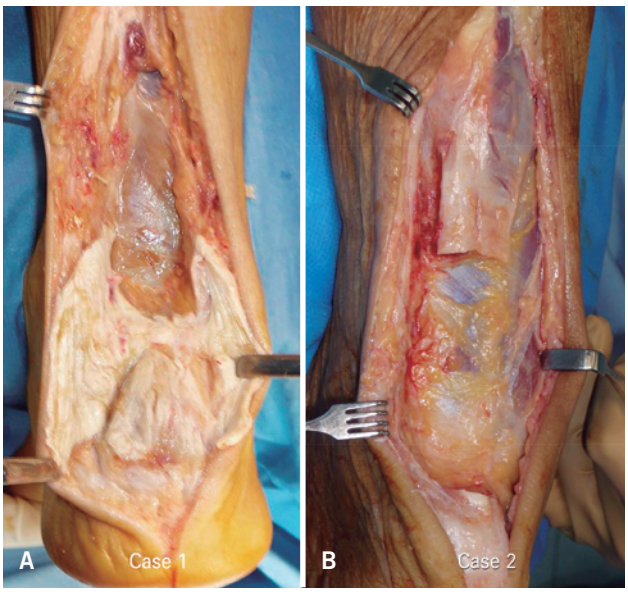

Figure 3. Total removal of the tendon remains up to the healthy tissue (A - B)

The cryopreserved Achilles tendon allograft with attached bone is prepared for insertion, thawed and rehydrated in sterile normal saline solution for 30 minutes prior to insertion (Figure 4 A-B). During this process a quadrangular cavity of the same size as the bone block graft was carved in the posterior tuberosity of the calcaneus (Figure 5 A-B).

Figure 4. Bone and tendon graft ready for transplanting (A - B)

Figure 5. Preparation and carving of the recess in the calcaneus/heel to host the bone graft. (A case 1 - B case 2)

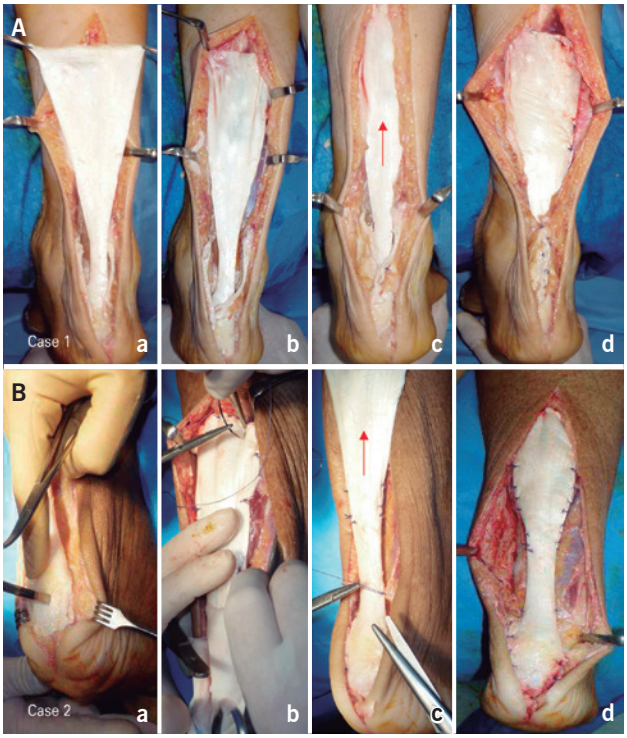

Figure 6. (A case 1 - B case 2). (a) Grafting anchored and expanded to give the required tension. (b) Adaptation to calf muscle mass. (c) Verification of the tension. (d) Closing of sheaths and skin. Final examination

This was anchored press-fit into the carved out cavity and checked to see that it fit perfectly so as to avoid the use of osteosynthesis.

Once the bone graft was hosted in the posterior tuberosity, the tendon portion was extended with 90° traction of the foot, suturing it to the calf muscles, so that it would maintain the tension of the implanted tendon (Figure 6 A-B).

The final tension and the areas of contact with the muscles were carefully checked. Next, the surgical wound was closed with a drainage in place. The wound healed satisfactorily.

RESULTS

The two patients were operated with a difference of 6 months, so the same protocol was followed. During the post-surgery, a cast was used for 8 weeks. At the end of the period, the patients presented an ankle range of motion of 20°, without pain and their Thompson sign was negative. A slight plantar flexion was observed when the movement was performed.

In both cases the relief of the tendon was visible and since there was absence of pain a rehabilitation program was started.

At the end of the 1st eight weeks of rehabilitation the patient was able to move around using crutches. For the next 2 months, as the patients increased in strength and the tendon healed, the patients were able to gradually bear more weight on the treated leg. After 4 months patients were allowed to start using normal shoes while gradually using the crutches for longer walks until they were no longer needed. At the end of this period, there was take-off in the foot, full joint mobility with 40 ° of active movement but the patients still had difficulty when walking on tiptoes.

The rehabilitation lasted until maximum functional recovery was reached, one year after the surgery.

Both patients had clinical evaluations before surgery and a year after for follow up. According to the Clinical Rating System - AOFAS ankle scale, their muscular capacity was also assessed according to the OXFORD scale (0-5) in order to determine their muscular strength.

In case study 1, the AOFAS Clinical Rating System improved from 69 to 95 points one year after surgery and the muscle strength (OXFORD scale of 0-5) increased from 0 to 4. In case study 2, the AOFAS rating improved from 75 to 95 points and the muscle strength increased from 1 to 4.

The slight loss of points in the assessment was due to the patient's inability to do a single heel rise on the affected foot. However, it could be noted that they could stand on tip toe with both feet simultaneously. Both patients healed well after surgery. They could both walk without assistance and perform the movement of the 3 rockers normally (Figure 7 A-B).

The two patients have confirmed a high level of satisfaction with the outcome of the surgery and in their daily activities.

Ten years later (2018), they were requested for review. All the explorations, clinical, functional and radiological and the magnetic resonance scan offered better results than those one year after surgery (Figure 8 A-B).

Figure 7. (A Case1). Clinical and functional appearance ten years after the transplant. (B Case 2). Graft integrated with functional calf muscle activity in equine position. Walking correct, unassisted. Observe the relief of the gastrocnemius muscle tension during take-off

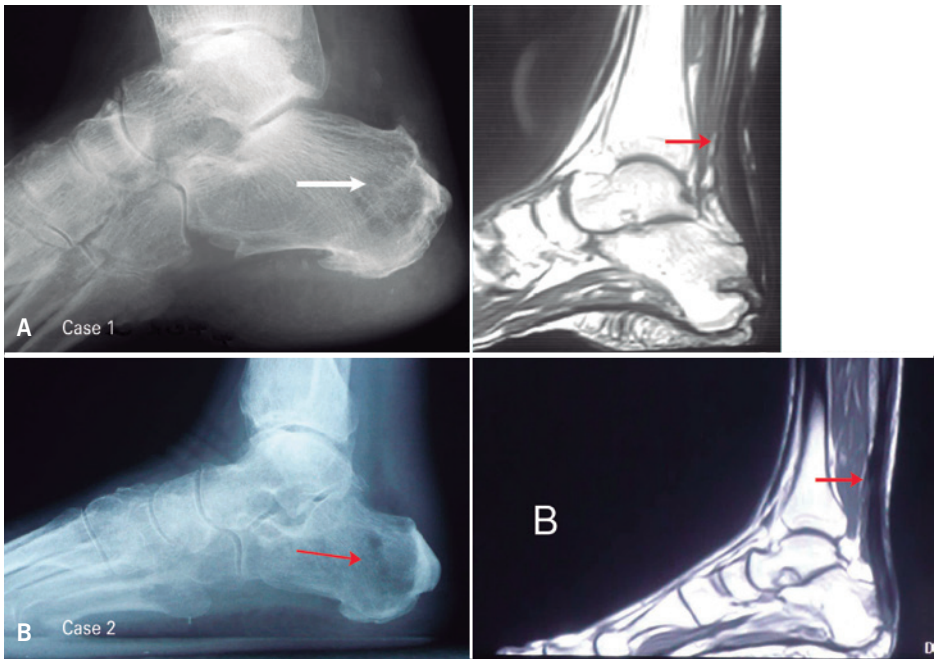

Figure 8. Radiographic Imaging and magnetic resonance with full integration of bone grafting in the calcaneus ten years after transplant (A-B). Both cases

DISCUSSION

Long-standing injuries of 6 centimeters or more are unusual and require more aggressive treatment in order to repair the loss of anatomical and functional substance.

There are no series in the literature about the Achilles allograft tendon transplant. The publications are isolated clinical cases: Nellas et al. (1996),[7] Yuen et al. (2000),[8] Haraguchi et al. (2005),[15] Lepow (2006),[9] Fernandez Torres et al. (2012),[17] Lee et al. (2012)[18] and Cienfuegos et al. (2012)[19] presented good clinical and functional results one year after the transplant, none of them mention any signs or symptoms of rejection or graft intolerance in their communications. In both cases we presented, the anatomical and functional recovery was complete and ten years after the transplant the functions of walking and take off were performed naturally without assistance but with some limitation for walking on tip-toe on one foot.

Anchoring the bone block graft by press-fit offers the advantage of not having to use interference or metallic screws[17] which could interfere with its complete osteointegration in the tuberosity of the calcaneus. As a result fractures of the block are prevented and also the surgical extraction of osteosynthesis at a later time.

With respect to the integration of the graft it has the capacity to replace the original structure with an appropriate mechanical movement. For this reason it is recommended that the grafts come from young donors.

Even though fibroblasts are destroyed, since the graft is cryopreserved it does not alter its morphology and its mechanical movement remains intact. Once implanted, the initial vascular response occurs immediately and continues for 2 or 3 days. After an initial period of vasoconstriction, a dilation of the surrounding vessels is produced, which is enhanced if the contact of the graft with the gastrocnemius is very broad, allowing for a proper adaptation, peritendinous neovascularization and its tolerance.[20]

The allograft serves as a basic structure for remodeling and once the maturation process is complete, histological studies [20] have shown similar cellular composition to a native tendon. However the correlation of this process with the return to normal function has yet to be established.

It should be noted that full integration of the graft may exceed one year.

In our experience and in accordance with Yuen et al.,[8] Lepow[9] and Lee et al.,[18] in these severe and longstanding cases, it is deemed necessary to transplant the Achilles tendon along with the cryopreserved bone graft.

This surgical procedure ensures the length, tension and the functionality of the gastrocnemius-soleus complex. Therefore we recommended it for patients with neglected ruptures in which end-to-end anastomosis is impossible.

CONCLUSION

The failure of primary surgery or poorly indicated conservative treatments can lead to tendinopathies and necrosis of the ends of the Achilles tendon. This would progressively encourage the occurrence of cavities and non-contractile fibrous tissue (degenerative cystic tendinosis). In more advanced stages could even lead to the production of a gap by loss of substance sometimes reaching 6-10cm by the contraction of the gastrocnemius. This situation makes repairing with plasty or common tendon transfers complex and difficult.

The use of an allograft allows bridging of a large tendon defect with an adequate graft, avoidance of donor site morbidity, and relative ease of surgical technique.

REFERENCES

1. Dalton G. Achilles tendon rupture. Foot Ankle Clin. 1996;(1): 225-36.
2. Coughlin MJ. Schon LC. Disorders of tendons In: Coughlin MJ, Mann RA, Saltzman CL, editors. Surgery of the foot and ankle. Philadelphia: Mosby; 2007. Chapter 22.
3. Kuwada G.T. Classification of tendon Achilles rupture With consideration of surgical repair techniques. J Foot Surg.1990; 29 (4):361-5.
4. Myerson MS. Disorders of the Achilles tendon. In: Reconstructive foot and ankle surgery. 2nd ed. Philadelphia: Saunders; 2010. p.331.
5. Nuñez-Samper M, Llanos Alcazar LF, Viladot R. Surgery of Achilles tendon. In: Surgical techniques in surgery of the foot. Netherlands: Elsevier; 2007. Chapter 16.
6. Ebert AM. Treatment of chronic Achilles tendon. In: Nunley JA. Editor. The Achilles tendon: treatment and rehabilitation. New York: Springer; 2009. Chapter 20.
7. Nellas ZJ, Loder BG, Wertheimer SJ. Reconstruction of an Achilles tendon defect utilizing an Achilles tendon allograft. J Foot Ankle Surg. 1996;35(2):144-8.
8. Yuen J, Nicholas R. Reconstruction of a total Achilles tendon and soft-tissue defect utilizing an Achilles Allograft combined with a rectus muscle free flap. J Plast Reconstr Surg. 2000; 107(7):1807-11.
9. Lepow GM. Reconstruction of a neglected tendon allograft. A case report. Foot Ankle Surg. 2006; 4(5):351-5.
10. Mahajan RH, Dalal RB. Flexor hallucis longus tendon transfer for reconstruction of chronically ruptured Achilles tendons. J Orthop Surg (Hong Kong). 2009;17(2):194-8.

11. Tay D, Lin HA, Tan BS, Chong KW, Rikhraj IS. Chronic Achilles tendon rupture treated with two turndown flaps and flexor hallucis longus augmentation - two-year clinical outcome. Ann Acad Med Singapore. 2010;39(1):58-60.
12. Maffulli N, Leadbetter WB. Free gracilis tendon graft in neglected tears of the achilles tendon. Clin J Sport Med. 2005;15(2):56-61.
13. Maffulli N, Longo UG, Gougoulias N, Denaro V. Ipsilateral free semitendinosus tendon graft transfer for reconstruction of chronic tears of the Achilles tendon. BMC Musculoskelet Disord. 2008;9(1):100.
14. Ozaki J, Fujiki J, Sugimoto K, Tamai S, Masuhara K. Reconstruction of neglected Achilles tendon rupture with Marlex mesh. Clin Orthop Relat Res. 1989; 238:204-8.
15. Haraguchi N, Burman EM, Myerson MS. Reconstruction of chronic Achilles tendon disorders with Achilles tendon allograft. Tech Foot Ankle Surg. 2005;4(5):154-9.
16. Shoaib A, Mishra V. Surgical repair of symptomatic chronic achilles tendon rupture using synthetic graft augmentation. Foot Ankle Surg. 2017;23(3):179-82.
17. Fernandez Torres JJ, Salas Martinez JM. Treatment techniques of chronic rupture and re-rupture of the Achilles tendon. Rev Soc Andaluza Trauma Ortop. 2012;29(1/2):48-58.
18. Lee J. Schubert JM. Surgical treatment of the neglected Achilles tendon rupture. Cretnik A, editor. Achilles tendon. Croatia: Intech Open; 2012. Chapter 7. p.115-44.
19. Cienfuegos A, Holgado MI, Díaz del Río JM, González Herranz J, Lara Bullón J. Chronic Achilles rupture reconstructed with Achilles tendon allograft: a case report. J Foot Ankle Surg. 2013;52(1):95-8.
20. Alvarez Lozano E, Ripalda JM, Forriol F. Repair and integration of the grafts in orthopedic surgery. Rev Mex Ortop Traumatol. 2002;16(3):173-80.