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Research Article

MRI Evaluation of Calf Hematoma: Frequency of Plantaris Tendon *versus* Medial Gastrocnemius Injury as the Causative Etiology

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Abstract

The clinical syndrome of "tennis leg" is often associated with a calf hematoma and was originally ascribed to a ruptured plantaris tendon. Recent publications have demonstrated a much higher association of myotendinous injuries of the Medial Head of the Gastrocnemius (MHG), with infrequent injuries to the plantaris, in the setting of calf hematoma. Nevertheless, a purported association between plantaris tendon rupture and calf hematoma persists in some literature and clinical discussions.

Hypothesis/Purpose: The purpose of our study is to evaluate whether a hematoma or fluid collection between the soleus and MHG muscles after trauma may be caused by an isolated plantaris tendon tear.

Study Design: Cross-sectional study.

Methods: IRB approval was obtained for this retrospective review. An institutional radiology database search for MRI examinations of the calf performed over a ten year period returned 710 MRI examinations, 67 of which demonstrated an interfascial hematoma, fluid collection or edema between the MHG and soleus muscles. Each MRI was scrutinized by two fellowship trained musculoskeletal radiologists for integrity of the plantaris, gastrocnemius, and soleus myotendinous structures and intervening fascia. Discrepancies were resolved by consensus.

Results: 62 of the 67 cases demonstrated a visible plantaris tendon and hematoma, fluid collection, or edema interposed between the soleus and MHG muscles. The plantaris was not visible and was presumed to be congenitally absent in five cases. Of the remaining 62 cases, the MHG was abnormal in 62/62 (100%) cases and the plantaris tendon was abnormal in 3/62 (4.8%) cases. Isolated injury to the MHG was observed in 59/62 (95.2%) cases; isolated injury to the plantaris tendon was not observed in any cases (0%).

Conclusion: Our results demonstrate no association between a hematoma, fluid collection, or edema between the soleus and MHG muscles and a plantaris tendon tear. In concert with previous studies, our results support gastrocnemius injuries as the causative etiology of a calf hematoma in this location following acute trauma.

Clinical Relevance: A hematoma interposed between the soleus and MHG muscles following acute trauma is not associated with plantaris tendon tears; this historical association should be abandoned.

What is known about this subject: Medial head gastrocnemius muscle injury is more common than plantaris tendon injuries in cases of "tennis leg."

What this study adds to existing knowledge: A hematoma between the soleus and MHG muscles following trauma is not attributable to isolated plantaris tendon injury. In cases of tennis leg, even when the plantaris tendon is injured, a hematoma between the soleus and MHG muscles is attributable to concurrent gastrocnemius injury.

Introduction

"Lawn tennis leg" was originally described in 1883 as a syndrome in which acute calf pain followed a sports related injury and was initially associated with plantaris tendon rupture [1]. The plantaris originates from the lateral supracondylar femoral ridge, just superior to the origin of the Lateral Head of the Gastrocnemius (LHG), and passes posterior to the knee joint, immediately deep to the gastrocnemius muscles, before coursing medially upon its decent into the lower leg (Figure 1). The proximal muscular portion of plantaris ranges from 7 to 13 cm in length and the long thin tendon has a mean diameter of 3.4 mm (range, 1.5-5 mm) [2]. The plantaris tendon, sometimes referred to as the "fool's nerve" having been incorrectly identified, typically inserts along the medial aspect of the Achilles tendon although some variability in its course and insertion has been described [3,4,5]. Anatomic studies have reported congenital absence of the plantaris in7-20% of the population [6,2].

The plantaris is an accessory plantar flexor of the calf and is closely related to the gastrocnemius muscles in the superficial posterior compartment of the lower leg. The plantaris tendon has recently

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been associated with mid Achilles tendinosis although this relationship is not clear and the plantaris tendon often remains intact even in the setting of a ruptured Achilles tendon [2,4]. Isolated plantaris tendon tears can occur, although numerous recent publications almost exclusively implicate myotendinous injuries of the MHG, occurring at a rate of 66.7%, over a ruptured plantaris tendon, occurring at a rate of 1.4%, as the causative etiology of tennis leg [6,7,8].

We are unaware of a study specifically evaluating the vascularity of plantaris tendon, but previous studies have demonstrated a relative hypovascularity of tendons compared to the rich blood supply of skeletal muscle fibers [9,10]. It follows, then, that muscular injuries rather than tendinous injuries would be a more likely cause of a hematoma in patients presenting with "tennis leg." In fact, previous reports associate myotendinous injuries of the MHG with a hematoma or fluid collection interposed between MHG and soleus muscles [11,2] while previous studies of isolated plantaris tendon tears demonstrate no confirmed association of a hematoma or fluid collection between the soleus and MHG muscles [12,5]. Only one small study suggested an association between plantaris injuries and a hematoma between the MHG and soleus muscles, however the cases in this study involved muscular, not tendinous, injuries of the plantaris and in one of the two representative cases there was also a strain of the MHG [2].

To our knowledge no study has directly evaluated the frequency of isolated plantaris tendon tears in patients with a hematoma of fluid collection between the soleus and MHG muscles on MRI. The purpose of our study is to evaluate whether a hematoma or fluid collection in this location following trauma may be caused by an isolated plantaris tendon tear.

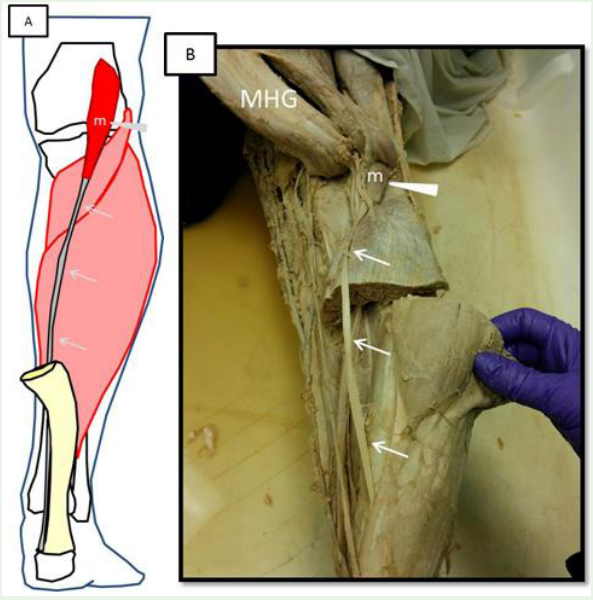

Figure 1: Diagram (A) and cadaveric specimen (B) demonstrating proximal muscle belly (m, arrowhead) and thin distal tendon of the plantaris (arrows). Proximally, the tendon originates at the lateral supracondylar ridge, has a short muscle belly and a long, thin tendon which courses deep to the MHG (reflected in cadaveric image, B) to insert at the medial aspect of the Achilles tendon.

Materials and Methods

After obtaining Internal Review Board approval, an institutional radiology database search was performed to identify MRI examinations of the lower leg in patients with a reported history of calf injury performed between January 1, 2005 and December 31, 2015. The search included any of the following specific terms or phrases: "hematoma," "plantaris," "medial gastrocnemius," "edema," "tear," and "fluid collection." Informed consent was waived in this retrospective imaging review.

A total of 710 examinations were identified and evaluated for the presence of an interfascial hematoma, fluid collection or edema between the soleus and MHG muscles. 633 of these examinations were excluded due to the absence of any of these findings or because of an alternative diagnosis, such as dissection or rupture of a Baker's cyst or a potential neoplasm. An additional 10 studies were excluded because a hematoma or fluid collection was present but not located in the described location for inclusion.

A total of 67 cases demonstrated a hematoma, fluid collection or edema between the soleus and MHG muscles. Of these, a hematoma was present in 47 cases and some combination of fluid and/or edema was present in an additional 20 cases.

The plantaris tendon was not visualized at any point along its expected course in 5 of these 67 cases (7.5%), in keeping with a reported rate of congenital absence in 7-20% of the population [6,2]. These five cases were excluded from additional analysis.

Each of the remaining 62 cases was scrutinized by two fellowship trained musculoskeletal radiologists (13 years post graduate experience and 12 years post graduate experience) in consensus. All of the MRI examinations were performed on either a 1.5 or 3.0 T GE Magnet (GE Healthcare, Waukesha, WI) and included T1 and Short-Tau Inversion Recovery (STIR) or fat suppressed T2 weighted imaging of the calf in the axial plane and in the sagittal and/or coronal planes. Post contrast images were present for a small number of these cases, typically performed to confirm fluid and exclude solid, enhancing lesions. For each case, the plantaris, gastrocnemius and soleus myotendinous structures and their intervening fascia were evaluated, along with the signal characteristic of the fascia and adjacent soleus and MHG muscles.

For the purposes of our study, we defined interfascial edema as ill-defined T2 hyperintensity without significant T1 signal abnormality without mass effect extending along the fascial planes between the soleus and MHG muscles, interfascial fluid as a more circumscribed band-like area of T2 hyperintensity with corresponding to T1 hypointensity (compared to skeletal muscle) without mass effect extending along the fascial plane between the soleus and MHG muscles and an interfascial hematoma as a crescent shaped mass-like collection containing either signal characteristics of methemoglobin (T1 shortening that does not suppress on chemically selective fat suppressed sequences) or hemosiderin (T2* effects) [13,14].

The plantaris tendon was considered normal if it was discretely visualized and appropriately positioned, continuous from the proximal myotendinous junction to its insertion, demonstrated homogenous hypointense signal on both T1 and fat-suppressed T2 or STIR images, and measured less than 5 mm in maximal transverse

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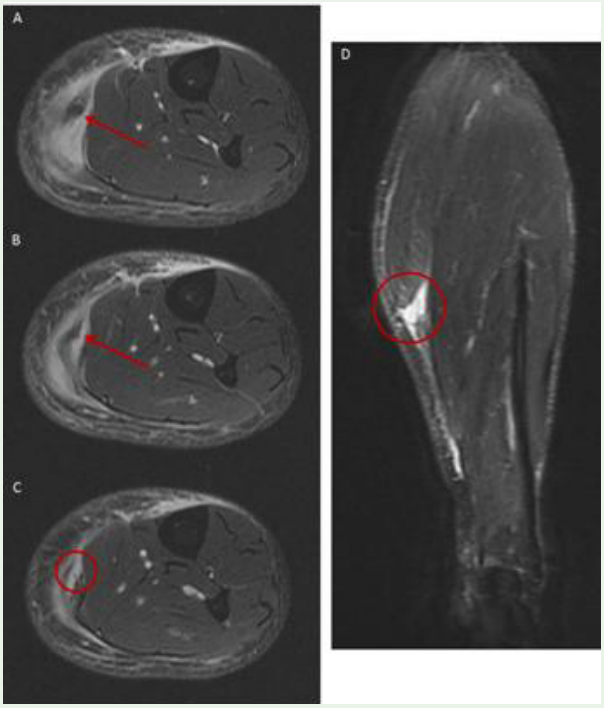

Figure 2: Plantaris tendon tear adjacent to a full thickness tear of the MHG. Contiguous axial inversion recovery images (A-C) demonstrate tapering of the tendon in the midcalf (arrows) before becoming discontinuous (circle). The full thickness tear of the MHG at its distal myotendinous junction is well imaged in the coronal plane (D, circle).

diameter, as defined by Santos, et al [3]. A focal disruption of the tendon, with visualization of fibers both proximally and distally, was defined as a tear. Alteration in normal signal characteristics or maximum diameter of the tendon equal or greater than 6 mm were reported as thickened and remodeled, respectively, based upon previous reports of normal tendon thickness [3].

Given there ported congenital absence of the plantaris tendon, complete non-visualization was not considered a tear [6,2]. In distinction to a congenitally absent tendon, we assumed that a torn tendon, even if not visualized segmentally, would be visible at some point along its course [6]. Based upon this, direct visualization of a discontinuous tendon was established as the criterion for tear.

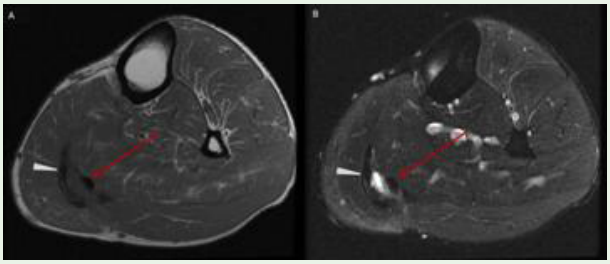

Figure 3: Axial T1 weighted (A) and axial inversion recovery (B) images of the mid calf demonstrating a thickened plantaris tendon (arrow) with a small adjacent hematoma (B, outlined in interrupted lines) and an irregularly thickened and scared MHG myotendinous junction (arrowhead). Additional imaging findings in this patient confirmed an acute on chronic MHG injury.

Results

The results are summarized in Chart 1 and Table 1. Of the 62 cases in which the plantaris tendon was present and there was a hematoma, fluid collection or edema between the soleus and MHG muscles, the MHG muscle was abnormal in all cases (100%) and the plantaris tendon was abnormal in 3 cases (4.8%). In the three cases in which the plantaris tendon was abnormal, there was 1 case (1.6%) of full thickness tear with disruption of the entirety of its fibers (Figure 2) and 2 cases (3.2%) of a thickened and remodeled but otherwise intact tendon (Figure 3). In 59/62 cases (95.2%), the plantaris tendon was normal and an isolated injury to the MHG muscle was observed (Figure 4). An isolated plantaris tendon tear was not observed in any of the 62 cases (0%).

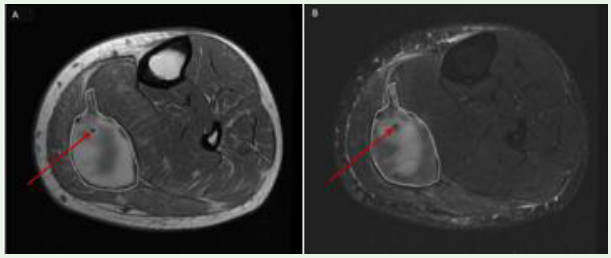

Figure 4: Axial T1 weighted (A) and inversion recovery (B) images of the calf demonstrating the presence of an intact, normal appearing plantaris tendon (arrow) deep to a hematoma (outlined in interrupted lines) associated with a MHG injury.

Table 1: Summary of results from original 710 patients with calf injury. 643 were excluded on the basis of no hematoma/fluid collection or a hematoma/fluid collection in the wrong location. Of the 67 patients remaining, 5 additional patients were excluded as there was no visible plantaris tendon. of the 62 remaining, all of them (100%) demonstrated an abnormality of the Medial Head Gastrocnemius (MHG) and only three of them (4.8%) demonstrated an abnormality of the plantaris tendon. No patients demonstrated an isolated plantaris tendon abnormality.

MRI Exams reviewed in patients with calf injury (n=710)				
Excluded subjects	643			
No hematoma or fluid collection	633			
Hematoma or fluid in wrong location	10			
Included subjects	67	Hematoma/fluid/edema with visualized plantaris	62	
Hematoma in region of plantaris	47	MHG abnormality	62	100%
Fluid and/or edema in region of plantaris	20	plantaris tendon torn	1	1.60%
		plantaris tendon thickened/remodeled	2	3.20%
Plantaris not visualized at any point	5			

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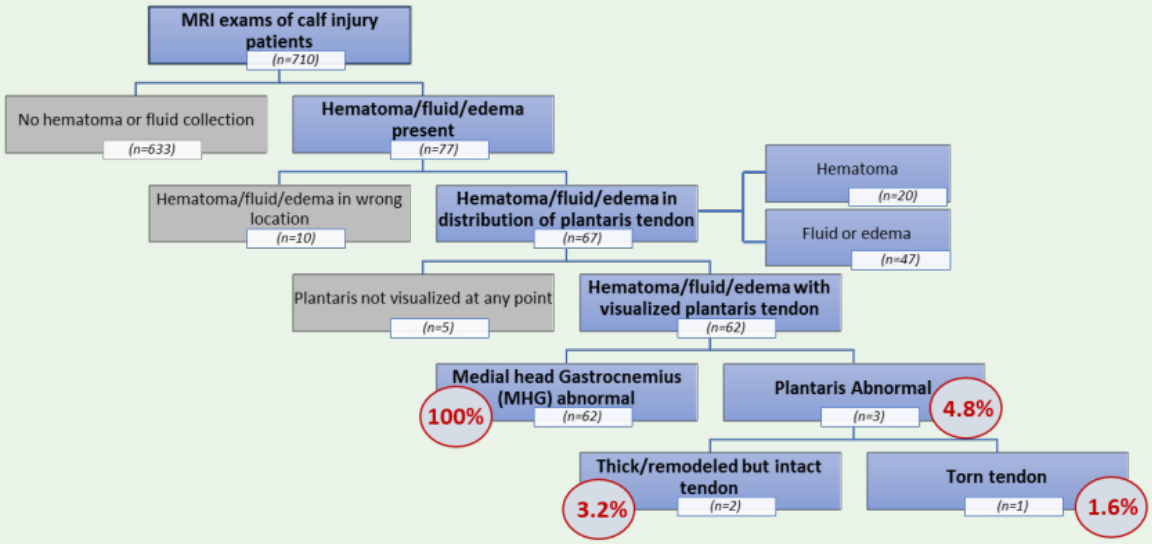

Chart 1: Flow chart illustrating the number of patients from our original 710 MRI studies with hematoma/fluid/edema in the distribution of the plantaris tendon. Of the 62 patients with included in the final analysis, all 62 of them (100%) demonstrated an abnormality of the Medial Head Gastrocnemius (MHG) with 3 of them also demonstrating an abnormal plantaris tendon. There were no isolated plantaris tendon abnormalities in our study.

Figure 5: Axial T1 weighted (A) and inversion recovery (B) images of the mid calf demonstrating an intact plantaris tendon (arrows) surrounded by a small volume of interfascial edema in the fascial plane between the soleus (S) and MHG muscles (M). A strain of the central fibers of the lateral gastrocnemius (B, circle) was the primary injury in this patient.

All of the cases demonstrated an injury of the MHG (100%), including those in which the plantaris tendon was abnormal, with the point of injury located either at the distal MHG myotendinous junction or its myofascial interface with the soleus. In the case of the full thickness plantaris tendon tear, there was visualization of a concurrent, full thickness tear of the MHG at the same level (Figure 2). Interestingly, one case with a hematoma extending between the soleus and MHG muscles demonstrated a lateral gastrocnemius myotendinous injury (Figure 5) to a greater degree than that seen medially.

Discussion

Although myotendinous injuries meeting clinical criteria for the "tennis leg" are typically managed clinically with conservative measures, it is important to note that approximately 10% of patients presenting with "tennis leg" may have a DVT [6,7,15,10]. Given the urgency related to prompt diagnosis and treatment of DVTs, initial imaging of patients presenting with acute onset calf pain should be focused on ensuring vascular patency. In patients where vascular patency is confirmed and/or further evaluation of myotendinous injury is desired, diagnostic musculoskeletal ultrasound or MRI may be performed to evaluate for the severity of secondary findings such as a hematoma [7].

In the setting of a hematoma or fluid collection between the soleus and MHG muscles on MRI, informal interviews with medical students and residents in our health care system indicate persistence of an association with plantaris tendon tears. This appears to emanate largely from anatomy and early ultrasound courses or rotation. Indeed, the recollections of the authors from their own early medical training further support informal teaching of the same association. These teachings may ultimately linger from the original supposition of such a diagnosis in the early description of the "tennis leg" syndrome.

Given the very low published incidence of plantaris tendon injuries in general, the far greater likelihood of MHG lesions and a lack of a confirmed association between plantaris tendon tears and a significant calf hematoma between the soleus and MHG muscles, it is interesting to us that plantaris tendon tears continue to be suspected when such a hematoma or fluid collection is present in calf injury patients. Upon review of the originally published reports for the 67 MRI examinations initially included in this study, we found 7 in which the final diagnosis of plantaris tendon tear was rendered based upon a hematoma or fluid collection between soleus and MHG muscles, despite the visualization of a plantaris tendon which was normal in size and signal intensity in our retrospective review. Likewise, a recently published case report of plantaris tendon rupture also relies strongly on the secondary finding of a hematoma to make the diagnosis; large field of view CT angiographic images, performed to exclude DVT, demonstrated a fluid collection between the soleus and MHG muscles, but did not provide direct visualization or report an assessment of the tendon itself [16-21].

In an attempt to decrease variations in interpretation during our study, we established clear and objective criteria for defining hematoma, fluid, edema and tears and adhered to these internal

definitions. Still, there are several limitations to our study. Since this was a retrospective review, we do not have clinical information regarding the time interval between injury or onset of calf pain and the MRI examination and we do not have clinical follow-up to establish type, location or severity of pain or timeline of symptom resolution. This clinical information may have been specifically helpful in the two cases of a thickened/remodeled plantaris tendon to determine whether previous injury or underlying tendinosis contributed to prolonged clinical symptoms. Another limitation of our study is the absence of a "gold standard" for diagnosing plantaris tendon tears, as there was no surgical confirmation in any of our cases.

Despite these limitations, our results demonstrate no association between a hematoma or fluid collection between the soleus and MHG muscles and an isolated plantaris tendon injury and supports previous knowledge implicating medial gastrocnemius injury as the primary cause of tennis leg. In summary, the diagnosis of plantaris tendon tears on MRI should be rendered with caution, based upon direct visualization as opposed to secondary findings alone. Furthermore, even in the rare instance in which the plantaris tendon is injured in the setting of acute trauma, the presence of a hematoma between the soleus and MHG muscles should be attributed to gastrocnemius, not plantaris, injury.

References

1. Powell RW. Lawn tennis leg. Lancet. 1883; 2: 44.
2. Hamilton W, Klostermeier T, Lim EV, Moulton JS. Surgically Documented Rupture of the Plantaris Muscle: A Case Report and Literature Review. Foot & Ankle International. 1997; 18: 522-523.
3. Santos MAD, Bertelli JA, Kechele PR, Duarte H. Anatomical study of the plantaris tendon: reliability as a tendo-osseous graft. Surgical and Radiologic Anatomy. 2008; 31: 59-61.
4. Spang C, Alfredson H, Docking SI, Masci L, Andersson G. The plantaris tendon: a narrative review focusing on anatomical features and clinical importance. The Bone & Joint Journal. 2016; 98: 1312-1319.
5. Sterkenburg MNV, Kerkhoffs GMMJ, Kleipool RP, Dijk CNV. The plantaris tendon and a potential role in mid-portion Achilles tendinopathy: an observational anatomical study. Journal of Anatomy. 2011; 218: 336-341.
6. Bianchi S, Sailly M, Molini L. Isolated tear of the plantaris tendon: ultrasound and MRI appearance. Skeletal Radiol. 2011; 40: 891-895.
7. Delgado GJ, Chung CB, Lektrakul N, et al. Tennis Leg: Clinical US Study of 141 Patients and Anatomic Investigation of Four Cadavers with MR Imaging and US. Radiology. 2002; 224; 112-119.
8. Lopez GJ, Hoffman RS, Davenport M. Plantaris Rupture: A Mimic of Deep Venous Thrombosis. The Journal of Emergency Medicine. 2011; 40: e27-e30.
9. Magnusson SP, Hansen P, Kjaer M. Tendon properties in relation to muscular activity and physical training. Scandinavian Journal of Medicine and Science in Sports. 2003; 13: 211-223.
10. Shields CL, Redix L, Brewster CE. Acute Tears of the Medial Head of the Gastrocnemius. Foot & Ankle International. 1985; 5: 186-190.
11. Bencardino JT, Rosenberg ZS, Brown RR, Hassankhani A, Lustrin ES, Beltran J. Traumatic Musculotendinous Injuries of the Knee: Diagnosis with MR Imaging. RadioGraphics. 2000; 20.
12. Allard JC, Bancroft J, Porter G. Imaging of plantaris muscle rupture. Clinical Imaging. 1992; 16: 55-58.
13. Bush CH. The magnetic resonance imaging of musculoskeletal hemorrhage. Skeletal Radiology. 2000; 29: 1-9.
14. Pakter RL, Fishman EK, Zerhouni EA. Calf hematoma ? computed tomographic and magnetic resonance findings. Skeletal Radiology. 1987; 16: 393-396.
15. Millar AP. Strains of the posterior calf musculature ("tennis leg"). The American Journal of Sports Medicine. 1979; 7: 172-174.
16. Rohilla S, Jain N, Yadav R. Plantaris rupture: why is it important? Case Reports. 2013; 2013.
17. Arner O, Lindholm A. What is Tennis Leg? Acta Chir Scandinav. 1958; 116: 73-75.
18. Bianchi S, Martinoli C, Abdelwahab IF, Derchi LE, Damiani S. Sonographic evaluation of tears of the gastrocnemius medial head ("tennis leg"). Journal of Ultrasound in Medicine. 1998; 17: 157-162.
19. Hamilton W, Klostermeier T, Lim EV, Moulton JS. Surgically Documented Rupture of the Plantaris Muscle: A Case Report and Literature Review. Foot & Ankle International. 1997; 18: 522-523.
20. Miller WA. Rupture of the musculotendinous juncture of the medial head of the gastrocnemius muscle. The American Journal of Sports Medicine. 1977; 5: 191-193.
21. Takasugi H, Akahori O, Nishihara K, Tada K. Three-Dimensional Architecture of Blood Vessels Of Tendons Demonstrated by Corrosion Casts. Hand. 1978; 10: 9-15.

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