

TENDINOPATHY OF THE ANTERIOR COMPARTMENT OF THE ANKLE

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ABSTRACT

Objective: To carry out a retrospective analysis on the etiopathogenesis, diagnosis and therapeutic options in cases of tendinopathy of the anterior compartment of the ankle. *Method:* 13 patients underwent surgery between September 1998 and February 2009; ten men and three women. The right side was involved in twelve patients and the left in one. The mean age was 35 years (range 15-67). The etiology was traumatic in eight patients and degenerative (non-traumatic) in five. The mean time elapsed between diagnosis and treatment was 19 months (range 1 - 60) and the mean length of follow-up was 34 months (range 4 - 127). The diagnosis was made through anamnesis and clinical examination. Magnetic resonance imaging was performed on nine patients, for staging and planning. The surgical treatment

was personalized in each case (synovectomy, resection of the muscle belly, consolidation with the adjacent tendon, and free grafting of the semitendinosus tendon). The following scales were used to evaluate the results: 1) subjective satisfaction scale, 2) AOFAS and 3) Maryland. *Results:* In relation to the subjective satisfaction scale, 12 patients were satisfied and one was dissatisfied. The mean AOFAS score was 80 points, and the mean Maryland scale was 86 points. *Conclusion:* Surgical treatment is effective for restoring function. The surgical techniques need to be personalized. The option of free grafting of the semitendinosus tendon is effective for gaps larger than five centimeters.

Keywords – Anterior compartment syndrome; Tendinopathy; Orthopedic surgery; Tendon transfer

INTRODUCTION

The anterior compartment of the ankle delimits a tunnel such that its floor corresponds to the anterior face of the metaphysis of the tibia and its roof (also inelastic) is formed by the expansion of the anterior retinacular ligament and its corresponding upper and lower bundles. The tendons of the anterior tibial muscle, long extensor muscle of the hallux and long extensor muscle of the toes pass through this segment in their respective synovial sheaths, along with the vasculonervous bundle. Pressure increases inside the tunnel may result from tenosynovitis, tearing, anatomical variations, capsule expansion, anterior marginal osteophytes of the tibia, etc. The deep fibular nerve may be compromised and cause pain and dysfunction.

The diagnosis of tendon rupture is confirmed by the pain and by weakness in extending the ankle and toes⁽¹⁾.

Magnetic resonance imaging has been used in a complementary manner to recognize the possible lesions and their staging. In cases of rupture, the image identifies the distance between the two stumps and the intrinsic degree of tendon stretching (overstretching), which are useful pieces of information for therapeutic planning. Even though rare, occurrences of tendinopathy in this compartment may be underestimated or may be difficult to diagnose when presenting few symptoms. Late diagnosis should be differentiated from other findings such as arthrosynovial cysts, tumor syndromes of the anterior part of the ankle and compressions of the deep fibular nerve⁽²⁾.

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We declare that there is no conflict of interests in this article

The therapeutic possibilities are restricted to the symptoms and functional incapacities, without taking into consideration age, sex, level of activity, comorbidities or delays in the diagnosis. For properly staged complete ruptures, surgical treatment is several authors' preferred method^(1,3,4). However, Markarian *et al*⁽⁵⁾, Burman (1934) and Moskowitz (1971) *apud* Kashyap and Prince⁽²⁾ reported good results from conservative treatment of tendinopathy and affirmed that nonsurgical treatment could be a good alternative for elderly patients with low functional demands.

The purpose of the present study was to describe the arsenal of surgical tactics used for treating tendinopathy of the anterior compartment. The surgical techniques used were tendon debridement, resection of the anomalous muscle belly and consolidation, along with free grafting of the semitendinosus tendon in cases of gaps greater than five centimeters.

OBJECTIVE

To retrospectively analyze the etiopathogenesis, diagnosis and treatment options in cases of tendinopathy of the anterior compartment of the knee.

SAMPLE AND METHODS

Between September 1998 and February 2009, 14 patients were diagnosed with tendinopathy of the anterior compartment of the ankle. Surgical treatment was indicated for 13 patients and there was one case of conservative treatment due to partial injury of the extensor tendon of the toes. In this study, the inclusion criterion limited the sample to the patients who underwent operations.

The sample therefore consisted of 10 male patients and three female patients. The right side was affected in 12 cases and the left was affected in one case. The patients' mean age was 35 years (range 15-67).

The etiology was traumatic in eight patients, and the others were considered to be non-traumatic origin: indications of degenerative in two cases and inflammatory processes in three cases.

The mean time that elapsed between making the diagnosis and instituting the treatment was 19 months (range 1-60) and the mean length of follow-up was 34 months (range 4-127).

For both the acute and the chronic cases of rupture, the diagnosis was made through the history and clinical examination. Among the chronic cases, a trio of signs

was investigated: 1) nodulation, corresponding to hypertrophy of the proximal stump of the injured tendon; 2) loss of outline of the tendons under the extensor retinaculum; and 3) vicariance of the complete tendons⁽¹⁾ (Figure 1).



Figure 1 – Clinical signs: A) Frontal appearance – loss of relief on the path of the anterior tibial tendon; B) Lateral appearance – vicariance of the undamaged tendons.

Magnetic resonance was performed on nine patients for staging of the lesion and surgical planning (Figure 2).

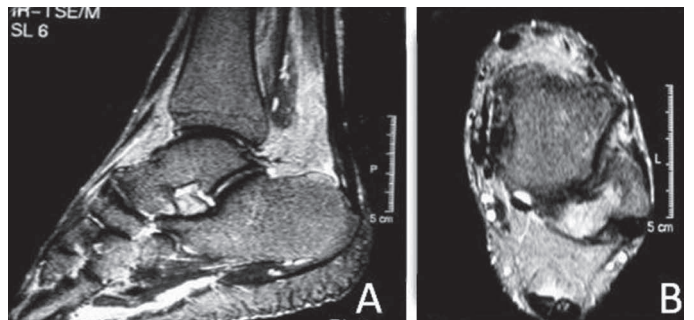


Figure 2 – Magnetic resonance image: A) Sagittal projection: tenosynovitis of the long extensor tendon of the toes; B) Axial projection: inflammatory process around the extensor tendon of the toes.

The distribution of the etiopathogenesis in the five non-traumatic cases was as follows: 1) one case of villous-nodular synovitis and low positioning of the muscle belly in the anterior tibial tendons and long extensors of the toes; 2) one case of chronic tenosynovitis of the long extensors of the toes; 3) one case of accessory muscle of the anterior tibial tendon; and 4) two cases of degenerative rupture of the anterior tibial tendon.

Among the patients without ruptures (2, 3 and 5), the common factors were female gender, similar age range (young adult) and practices of strenuous physical activities. The physical examinations on these patients showed that pain was the symptom present in the anterior compartment, and that it radiated outwards to the

dorsal region of the foot along the path corresponding to the deep fibular nerve, as shown by Tinel's sign. The functional incapacity was a consequence of the inflammatory process and anatomical variations, which acted as compression factors due to increased content within an inelastic space.

The non-traumatic cases (6 and 7) were male patients over the age of 60 years who presented spontaneous ruptures of the anterior tibial tendon while walking. The clinical examinations showed the characteristic trio of changes to the outline, vicariance of the adjacent complete tendons and nodulation. The etiopathogenesis was attributed to a nonspecific degenerative factor.

In the trauma group, there was reference to cutting and bruising wounds. Functional impotence regarding dorsiflexion of the ankle or toes was the sign present. In case 13, there was loss of substance (all the skin and segments of the anterior tibial tendon and long extensor tendon of the hallux).

The topographic impairment of the affected tendons consisted of the following:

- a) Three isolated ruptures of the anterior tibial tendon;
- b) Two isolated complete ruptures of the long extensor tendon of the toes;
- c) Two ruptures of the anterior tibial tendon in association with the long extensor tendon of the toes; and
- d) One complete rupture of the anterior tibial tendon in association with partial injury of the long extensor tendons of the hallux and toes.

TREATMENT

In the non-traumatic group, without rupture, after lack of success with conservative treatment, surgical exploration was indicated. Among the individuals who presented ruptures of degenerative cause, one patient voluntarily postponed the initial surgical indication until he felt the need for it, and the other waited for a 30-day period with plaster-cast immobilization.

Delays in the operation, among the trauma cases, occurred because of a variety of factors, such as delay in achieving a precise diagnosis, patient negligence and late start of the symptoms.

In patient 13, the surgery was delayed because of the condition of the soft tissue. Tendon grafts and a microvascular flap were needed in order to cover the skin, concomitantly with the tendon repair.

The surgical tactic used in case 2 was resection of the belly of the anterior tibial muscle and release of the deep fibular nerve. In case 3, the decompressive surgery consisted of release of the deep fibular nerve, resection of muscle belly and synovectomy (intra-articular tumor ablation) (Figures 3, 4 and 5).

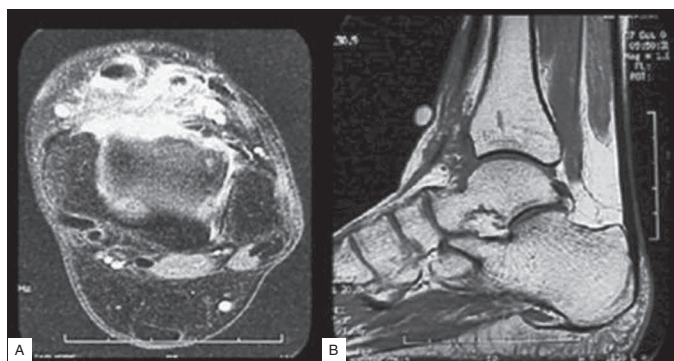


Figure 3 – Magnetic resonance image: A) In the axial plane; B) In the sagittal plane, showing low muscle belly and intra-articular tumor.

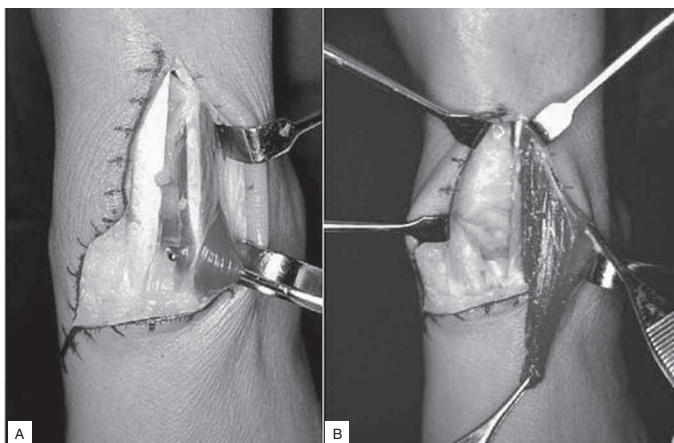


Figure 4 – A) Low positioning of the muscle belly; B) Resection of the anomalous muscle.

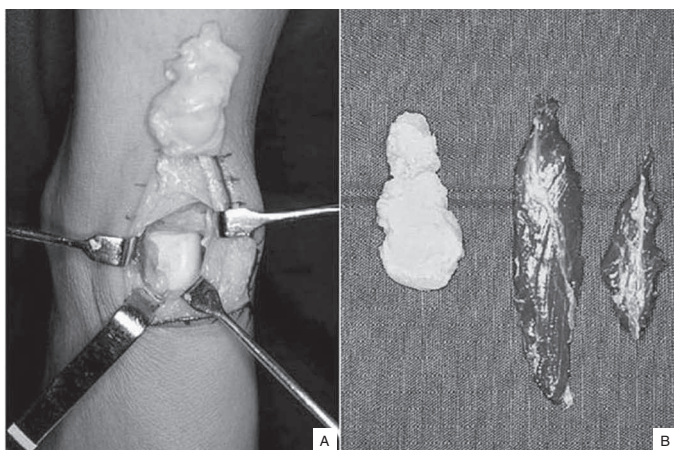


Figure 5 – A) Opening of the joint capsule and resection of the villous-nodular tumor; B) Specimens removed.

In case 5, resection of the tendon sheath and synovectomy of the long extensor of the toes was performed.

In all the cases of rupture due to cutting wounds or degeneration, reconstruction of the tendons was performed through consolidation with the adjacent tendon (cases 1, 4, 6, 8 and 9) or through free grafting of the semitendinosus (cases 7, 10, 11, 12 and 13). In these cases, the gap between the tendon stumps after debridement was greater than five centimeters.

The surgical technique for free grafting of the semitendinosus tendon consisted of the following:

1. Identification and removal of the semitendinosus tendon of the ipsilateral knee (Figure 6A).
2. Preparation of the graft (Figure 6B).
3. Oblique anteromedial incision, starting six centimeters proximally to the joint line and heading obliquely as far as the talonavicular joint, over the path of the anterior tibial tendon (Figure 6C).
4. Opening of the retinacula (Figure 6D).
5. Debridement and preparation of the tendon stumps (Figure 6E).
6. Tendinoplasty with free grafting to join together the stumps and tubularization (Figure 6F).
7. Closure of the retinacula (Figure 6G).
8. Immobilization in dorsiflexion.

To evaluate the results, three scales were used: subjective satisfaction grading, AOFAS and Maryland.

Table 1 presents the general analysis of this study.

RESULTS

In relation to the subjective satisfaction grading scale (presence or absence of pain and satisfactory or unsatisfactory functional result), 12 patients were satisfied and one was dissatisfied. The latter case presented dehiscence of the skin and recurrence of the rupture, thereby indicating the need for a new surgery. However, the patient refused to undergo this.

Patient 13 presented muscle weakness in the reconstructed anterior tibial tendon, because of the short follow-up and adherence of soft tissues. However, because of the previous severity of the condition and expectations of functional deficit, this patient felt satisfied with the result.

The mean score on the AOFAS scale after the operation was 80 points, with a range from 51 to 90 points.

The mean score on the Maryland scale was 86 points, with a range from 62 to 95 points.

Table 2 correlates the results obtained with the intraoperative findings.

DISCUSSION

In this retrospective study, the 13 patients presented formed a small case series. Nonetheless, this was a significant sample in the light of the sizes of other authors' samples. Kausch and Rutt⁽⁴⁾ reviewed 33 cases compiled from the current literature. Most of the studies consisted of case series, and the largest was by Bernstein *apud* Velan and Hendel⁽⁶⁾, citing 24 cases. Results from surgical treatment on ruptures of the anterior tibial tendon were presented by Markarian *et al*⁽⁵⁾, among a series of 16 patients, and likewise by Sammarco *et al*⁽⁷⁾, among a sample of 19 patients.

The ages among the present series of patients with tendinopathy of the anterior compartment, of various etiologies and on different tendons, ranged from 19 to 67 years.

Taking into consideration only the degenerative factor, Pattern and Pun⁽⁸⁾ reported in their review of the literature that the cases were predominantly among individuals in their sixth and seventh decades of life, with rupture of the anterior tibial tendon. Our sample showed that 18% of the patients fitted into this age range. Ouzonian and Anderson⁽¹⁾ and Markarian *et al*⁽⁵⁾ considered that age was a decisive factor in selecting patients for either conservative or surgical treatment. In the present sample, surgical treatment was chosen for the different age groups.

In the present study, like in previous reports, cases among males were more prevalent^(1,6,9,10).

Chronic tendinopathy of the anterior compartment of the ankle results from different etiologies. The most prevalent etiopathogenesis for the tendon ruptures in the present series was traumatic, consisting of laceration due to cutting and bruising wounds. Rimoldi *et al*⁽³⁾ reported cases of traumatic rupture due to sudden isotonic contraction or tendon stretching due to excessive plantar flexion. The disorders of non-traumatic origin considered in this sample resulted in chronic tendinopathy through a degenerative or inflammatory process of various etiologies: rubbing, repeated movements, synovial disease, anatomical variation (elongated or accessory muscle belly), etc. Clinical investigations on systemic diseases such as diabetes, hyperparathyroidism, liver disease, rheumatic disease, gouty tophus, etc., along with the use of corticoid therapy, have been recommended since these conditions have been found in other series with impairment of the tendons of the anterior compartment^(5,6,10,11).

The common denominator of the spontaneous rupture of the anterior tibial tendon in two cases was weakening due to a degenerative process (antecedents of tendinopathy) (cases 6 and 7).

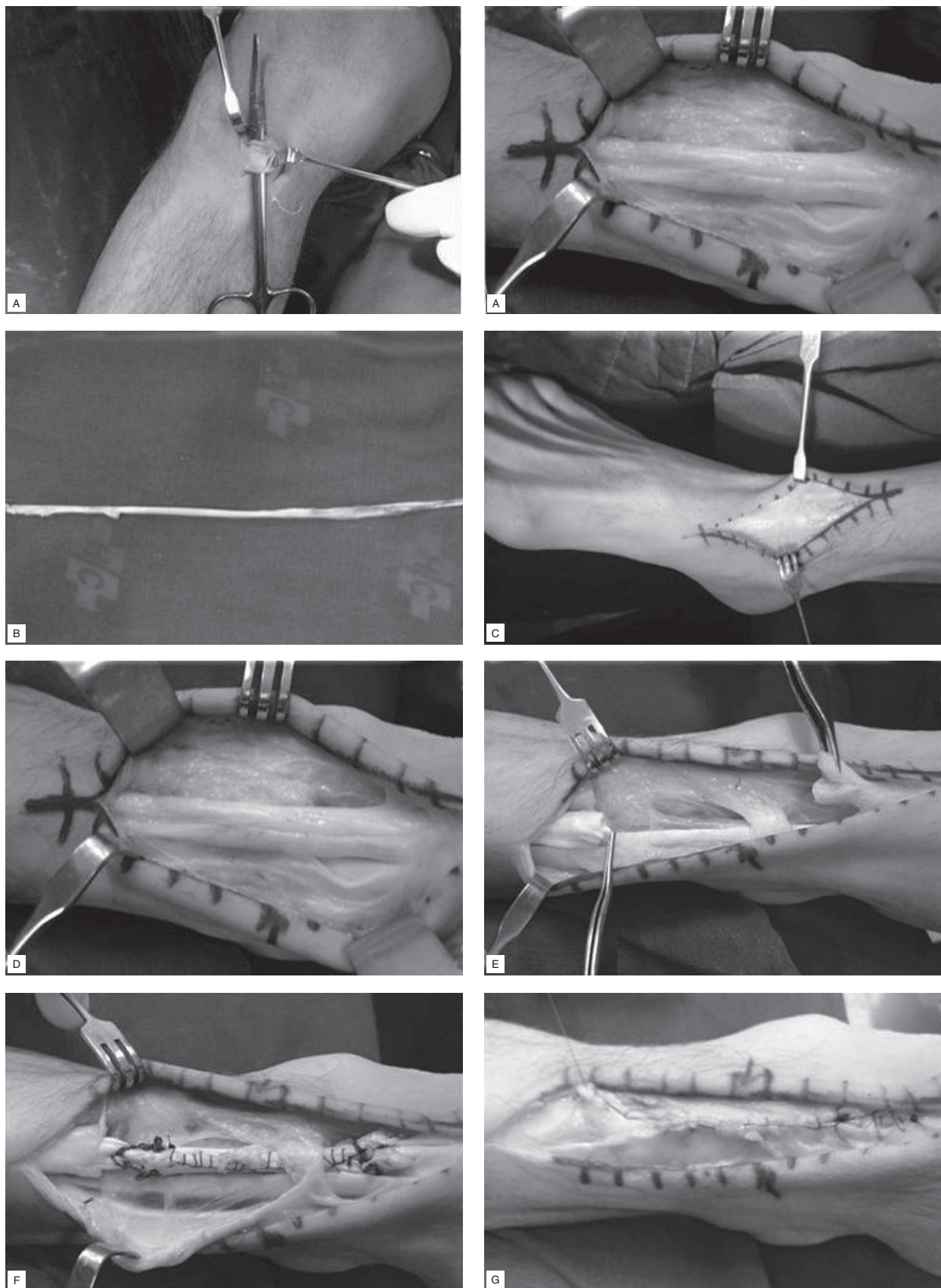


Figure 6 **A** – Identification of the semitendinosus tendon. **B** – Preparation of graft. **C** – Oblique anteromedial incision. **D** – Opening of the retinaculum. **E** – Debridement and preparation of the tendon stumps. **F** – Tendinoplasty with free grafting to join the stumps together, with tubularization. **Figure 6G** – Closure of the retinaculum.

Table 1 – Epidemiology, etiopathogenesis, etiology, signs and symptoms, antecedents, physical examinations, complementary examinations and time elapsed from diagnosis

No.	Age	Sex	Side	Etiopathogenesis	Etiology	Signs and symptoms	Antecedents	Physical examinations	Complementary examinations	Time elapsed from diagnosis
1	15	M	D	T	CBW	CL PF-AT		CR F FI CG		48
2	28	F	E	NT	AV VNS	PAIN IF	Running athlete	CS CV PAIN TINEL	MRI	36
3	22	F	D	NT	AV	CV PAIN	Soccer player	CV PAIN TINEL	MRI	24
4	42	M	D	T	CBW	CL PF-AT		CR F FI CG		60
5	19	F	D	NT	CTS	CV CL CR PAIN	Gymnast	PAIN FI TINEL	MRI	12
6	67	M	D	NT	DEG	CL PAIN IF		PAIN FI CG	MRI	03
7	61	M	D	NT	DEG	CL PAIN IF		CR PAIN F CG	MRI	02
8	26	M	D	T	CBW	CS CL PF-LET 2°,3°,4°,5°	SI	PAIN FI TINEL	MRI	05
9	26	M	D	T	CBW	CL PF-AT LET LEH	SI	CR F FI CG		07
10	47	M	D	T	CBW	CL PF-AT		CR F FI CG	MRI	07
11	37	M	D	T	CBW	CS CL PF-LET 2°,3°,4°,5°		PAIN FI TINEL	MRI	11
12	19	M	D	T	CBW	CL PF-AT LEH		CR FI CG TINEL	MRI	01
13	28	M	D	T	CBW	PF-AT LET LEH		CR FI LS		01

1) CR – change of relief; 2) CS – change of sensitivity; 3) CV – change of volume; 4) CL – claudication; 5) CR – crepitation; 6) LET – long extensor of the toes; 7) LEH – long extensor of the hallux; 8) F – failure; 9) CBW – cutting-bruising wound; 10) FI – functional impotence; 11) SI – superficial infection; 12) CG – calcaneal gait; 13) NT – non-traumatic; 14) CP – childhood paralysis; 15) MRI – magnetic resonance; 16) VNS – villous-nodular synovitis; 17) PF – loss of strength; 18) LS – loss of substance; 19) CTS – chronic tenosynovitis; 20) T – traumatic; 21) AT – anterior tibial; 22) AV – anatomical variation

Table 2 – Intraoperative findings and final results

No.	Treatment	Finding	Follow-up (months)	Objective result	Subjective result
1	CON LEH JTS	TAP F 2cm FBR AT	127	S	S
2	RN MBR SY	DFC AV AT LEH	79	S	S
3	RN MBR	DFC AV AT	67	S	S
4	CON LEH	F 4cm AT	31	S	S
5	SY	TSR TN LET	31	S	S
6	CON LEH	F 4cm AT	31	S	S
7	FG	F 8cm AT	15	S	S
8	RN CON LEH	F 3cm LET FBR TSR	15	S	S
9	CON LEH	F 4cm AT	13	U	U
10	FG	F 6cm AT	12	S	S
11	FG	F 6cm LET	12	S	S
12	FG	F 7cm AT	10	S	S
13	FG	F 8cm AT, LEH	04	S	S

1) TAP – tapering; 2) DFC – deep fibular compression; 3) FG – free grafting; 4) LET – long extensor of the toes; 5) LEH – long extensor of the hallux; 6) TSR – thickening of superior retinaculum; 7) F – failure; 8) PT – physiotherapy; 9) FBR – fibrosis; 10) I – unsatisfactory; 11) RN – release of nerve; 12) MBR – muscle belly resection; 13) S – satisfactory; 14) SY – synovectomy; 15) CON – consolidation; 16) AT – anterior tibial; 17) TN – tenosynovitis; 18) JTS – Jones tenosuspension; 19) AV – anatomical variation

The clinical signs that showed the tendon ruptures were the following: 1) changes in gait (drop foot due to deficit of the anterior tibial tendon and painful claudication); 2) loss of completeness found through palpation of the tendons; 3) change in the relief of the anterior compartment; and 4) weakness in the dorsiflexion test against resistance of the foot or toes.

According to Ouzoniam and Andreson⁽¹⁾, the time that elapses between the injury and its diagnosis is

greater in cases of non-traumatic etiopathogenesis, since these patients generally do not have complaints of pain and the functional incapacity is insignificant because of the low demand for activity. In the two cases of degenerative rupture in the present series, early diagnoses were made, but the patients voluntarily delayed the indication of surgery until a time when there was both loss of function and pain complaints.

Cases 1 and 4, which were cases of traumatic rupture, were in young patients who despite immediate diagnosis, were only treated later on when there was interest in improvement of function.

With regard to antecedents, no systemic disease was identified. The etiopathogenesis in cases 2, 3 and 5 was related to anatomical variation (low muscle belly), presence of an intra-articular tumor (villous-nodular synovitis) and intense physical activity. The presence of Tinel's sign was explained through the compressive effect of increased content in the anterior compartment, above the deep fibular nerve.

The routine for imaging examinations included initial radiography, which showed soft-tissue edema⁽²⁾, marginal osteophytes and other bone anomalies⁽³⁾. We considered magnetic resonance imaging to be the gold standard, since this enabled the diagnosis, with staging and measurement of the distance between the stumps. Echography has also been useful in situations in which magnetic resonance was impossible. Aboukrat⁽¹²⁾ proposed tenoscanography for diagnostic confirmation of tendinopa-

thy, and this was the only reference to this technique that we found. According to Peetrons⁽¹³⁾, ultrasonography was sufficient because of its specificity and sensitivity.

Ouzonian and Anderson⁽¹⁾ and Frigg *et al*⁽¹⁰⁾ used magnetic resonance not as a diagnostic method but as a verification resource, in order to identify the characteristics of the lesion, the details of the location and the distance between the stumps. This imaging resource was used on nine patients and contributed towards choosing the access route and the surgical technique, and in diagnosing the anatomical variations.

Among active patients with traumatic or degenerative etiology, with complete rupture, there is a tendency in the literature for the surgical treatment to be selectable.

When the rupture is diagnosed early, end-end anastomosis of the stumps can be performed. For chronic lesions, when direct suturing is not possible, "V-Y" advancement, consolidation or free grafting can be performed. "V-Y" advancement is not indicated for tendons of the anterior compartment because of the small diameter, which would result in technical difficulty. Consolidation has become a feasible and effective resource, and this has been used on adjacent tendons such as the long extensor of the hallux, long extensor of the toes and anterior tibial tendons, when the distance between the stumps has not exceeded 4 cm.

The grafts may be autogenous or autologous. In the present series, only autogenous grafts were used, because we did not have a tissue bank available, but this might become an option in the future. Free grafting was used when distances greater than 5 cm between the stumps made it impracticable to perform end-end suturing or consolidation.

The semitendinosus tendon was chosen for the cases of free grafting because of its similar thickness and resistance characteristics. Moreover, its size is convenient and it is easy to obtain. Use of the semitendinosus tendon has become established for knee ligament reconstructions because of its low morbidity and low interference with flexor strength. The principle of not unbalancing the action of the

extrinsic musculature of the foot and ankle was maintained, since we did not use transfers that would change this dynamic. The suturing of the free graft to the tendon stumps was done at the maximum tension possible. The ankle was immobilized in dorsiflexion at 95° and the toes at 30°. Integration of the free graft was achieved in all cases.

The rupture site most commonly found by Pattern and Pun⁽⁸⁾ was 0.5 to 3 cm proximally to the insertion of the anterior tibial tendon. The mean location found in the present study was 5 cm from this reference point, with a range from 2 to 8 cm.

The time that elapsed between diagnosis and treatment was long (mean of 19 months), independent of whether the case was traumatic or degenerative, for a variety of reasons. Low functional demand, low intensity of pain and adaptation to walking with a drop foot (compensated through the use of an orthosis) may be explanations for why it took so long for these individuals to seek treatment.

The results from this series indicate that surgical treatment was efficient for reestablishing function and for pain relief. 92% of these individuals successfully returned to their pre-injury activities.

Surgical treatment was also seen to be necessary in cases of tendinopathy of the anterior compartment, whether of traumatic origin or not, when the aim was to reestablish functional capacity.

CONCLUSION

- 1 – Surgical treatment is effective for functional recovery.
- 2 – Several techniques should be used to attend to the spectrum of severity of tendon ruptures and deal with the possible differential diagnoses of chronic tendinopathy of the anterior compartment of the ankle.
- 3 – The choice of free grafting of the semitendinosus tendon is efficient for gaps of more than five centimeters and, in the same manner, consolidation is efficient at shorter distance between the stumps.

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