OUTCOME OF SURGICAL TREATMENT OF MEDIAL TIBIAL STRESS SYNDROME

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Background: Medial tibial stress syndrome is a common chronic sports injury characterized by exercise-induced pain along the posteromedial border of the tibia. The reported outcomes of surgical treatment of this condition have varied.

Methods: Of seventy-eight patients who underwent surgery for medial tibial stress syndrome, forty-six (thirty-one men and fifteen women) returned for follow-up. The outcomes of the surgery were determined by comparing preoperative and postoperative pain levels as indicated on a visual analog pain scale and ascertaining the ability of the athletes to return to presymptom levels of exercise.

Results: The mean duration of postoperative follow-up was thirty months (range, six to sixty-three months). Surgery significantly reduced pain levels ($p < 0.001$) by an average of 72% as indicated on the visual analog pain scale. An excellent result was achieved in 35% of the limbs; a good result, in 34%; a fair result, in 22%; and a poor result, in 9%. Despite the success with regard to pain reduction, for a variety of reasons only nineteen (41%) of the athletes fully returned to their presymptom sports activity.

Conclusions: Surgery can significantly reduce the pain associated with medial tibial stress syndrome. Despite this reduction in pain, athletes should be counseled that a full uninhibited return to sports is not always achieved.

Level of Evidence: Therapeutic study, Level IV (case series [no, or historical, control group]). See Instructions to Authors for a complete description of levels of evidence.

Exercise-induced pain is one of the most common overuse sports injuries of the lower limb[1,2]. It has many causes (Table I), with the three most frequent being tibial stress fracture, chronic compartment syndrome, and medial tibial stress syndrome. Of all the conditions causing exercise-induced leg pain, medial tibial stress syndrome is by far the most common and is sometimes referred to as *true shin splints*. Medial tibial stress syndrome is defined as a symptom complex in athletes who experience exercise-induced pain along the distal posteromedial aspect of the tibia[3]. In two large epidemiological surveys, medial tibial stress syndrome accounted for 13.1% of more than 1800 injuries seen in runners and 22% of 385 injuries seen in aerobic dancers[4,5].

In medial tibial stress syndrome, the pain is in the middle-to-distal third of the posteromedial border of the tibia. It is increased by exercise and may last for several hours after the individual ceases exercise. Discomfort the following day is not uncommon, particularly in severe cases[6,7]. Diagnosis of the condition is based primarily on the clinical history, the location of the pain, and palpation of the medial tibial border, which is tender. Magnetic resonance imaging or bone scintigraphy may aid in the diagnosis, particularly when the clinical history and the findings of the examination are nonspecific[8,9].

Numerous causative factors have been mentioned by various authors and include poor sports technique, improper warm-up, increasing the level of training too quickly, overuse of muscles, playing on uneven terrain, training on hard surfaces, skeletal malalignment, muscle imbalance, and inflexibility of the calf muscles[10-13]. The most common skeletal malalignment is excessive pronation of the foot. Inflexibility of the soleus muscle has been mentioned as a possible etiology on the basis of anatomical studies that demonstrated the site of pain to be at the attachment of the distal-medial part of the soleus muscle and the crural fascia[14,15]. More recent evidence suggests that medial tibial stress syndrome is most likely caused by a bone stress reaction[16-19].

Treatment recommendations have varied among authors, but all have recommended a period of rest. Other conservative modalities include application of ice in the acute stage, cast immobilization, ultrasound, taping, steroid injections, nonsteroidal anti-inflammatory medication, orthoses, shoe modifications, stretching exercises, and a gradual return to sports activity[6,7,11,20-26]. If conservative treatment fails, which it rarely

TABLE I Causes of Exercise-Induced Pain in the Leg

	Diagnosis
Osseous	Medial tibial stress syndrome, stress fracture
Muscle	Strain or tear, tendinopathy, muscle hernia
Nerve	Saphenous or superficial peroneal nerve entrapment, radiculopathy
Fascial	Chronic compartment syndrome, interosseous membrane strain or tear
Vascular	Popliteal arterial entrapment, arterial endofibrosis, effort-induced deep-vein thrombosis

does according to most authors[6,18,20-23], then surgical intervention may be warranted. Studies have varied with regard to both surgical technique and outcomes. The reported success of surgical treatment has ranged from 29% to 86%[6,11]. However, the ability to analyze some of the published surgical results is limited because several studies were based on only a few cases and therefore represent only anecdotal evidence[3,6,27], some had a very short or unspecified postoperative follow-up period[11,28], and others did not identify the method of determining or classifying surgical outcomes or comment on the presence of postoperative complications[2,3,29]. Perhaps more importantly, several authors did not specify whether the athlete was able to fully return to sports activity.

Materials and Methods

All patients with a diagnosis of medial tibial stress syndrome were asked to record their pain level on a visual analog scale, and their presymptom level of sports activity was noted. The patients who eventually underwent surgery were contacted postoperatively and were asked to participate in the study. The study had a repeated-measures design in which preoperative and postoperative visual analog pain scales were used to determine the surgical outcome. Exercise levels before the onset of the medial tibial stress syndrome were compared with postoperative levels to determine the success of the surgical intervention. These two assessment methods were chosen because the desire to reduce pain and to return to sports activity were the reasons that the patients underwent surgery.

The vast majority of patients presenting to the Orthopaedic Sports Medicine Clinic with medial tibial stress syndrome have had symptoms for at least six months and have tried several forms of conservative treatment without success. They therefore represented the minority of individuals with medial tibial stress syndrome in whom conservative treatment had failed.

All of the patients had preoperative studies of intracompartmental pressure while exercising to exclude the presence of chronic deep posterior compartment syndrome. All patients with this condition were excluded regardless of whether they had medial tibial stress syndrome. All of the patients also underwent bone scintigraphy to determine whether they had a stress fracture or medial tibial stress syndrome. Patients with a stress fracture were treated appropriately and were not included in this study.

The diagnosis of medial tibial stress syndrome was confirmed on the basis of several factors.

History of pain: The diagnosis was indicated by pain that was induced by exercise, although the athlete was able to continue to exercise, and that persisted for a minimum of two hours following the exercise. There was no history of paresthesias.

Location: The pain was identified by the athlete as occurring along the posteromedial border of the tibia. The pain was always in the distal or middle third and was rarely in the proximal third of the leg.

Palpation: Palpation of the posteromedial border of the tibia elicited areas of discomfort usually confined to the middle or distal third of the bone.

Bone-scanning: Bone scintigraphy, in the third phase, that was positive for the diagnosis demonstrated a linear vertical uptake in the posterior tibial cortex on the lateral view (Fig. 1). Because bone scintigraphy can produce false-negative results for medial tibial stress syndrome but not for stress

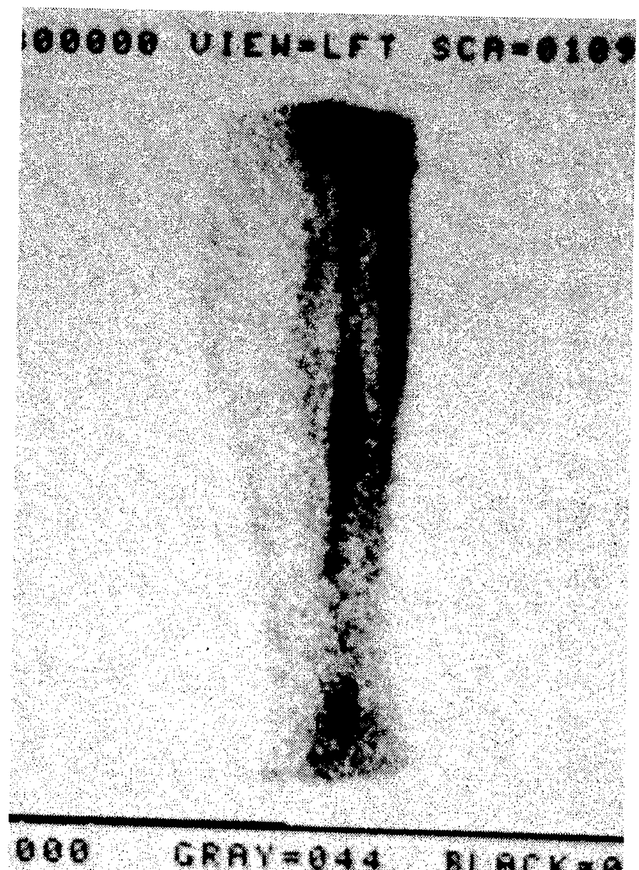

Fig. 1
Positive bone scan for medial tibial stress syndrome identified by diffuse linear uptake along the posterior cortex of the middle third of the tibia. In contrast, scans of stress fractures usually demonstrate a focal ovoid uptake.

fracture[16,30,31], patients with a negative bone scan were still considered to have medial tibial stress syndrome as long as the scan was negative for stress fracture and the other three factors were present.

To be enrolled in the study, a patient had to be more than eighteen years old at the time of surgery, had to have a diagnosis of medial tibial stress syndrome, had to have been followed for a minimum of six months postoperatively, and could not have any neurological condition affecting the lower limb, a previous fracture of the lower limb, a previous operation on the lower limb other than for medial tibial stress syndrome, or any other sports injury that might inhibit sports activity.

Surgical Technique

Surgery was performed only after conservative treatment had failed for a minimum of twelve months. Patients had often undergone conservative treatment prior to referral, and all were advised to rest for a minimum of six weeks. Those with obvious excessive pronation of the foot were fitted with a foot orthosis. Periosteal corticosteroid injections were tried initially but were discontinued as they failed to alleviate symptoms.

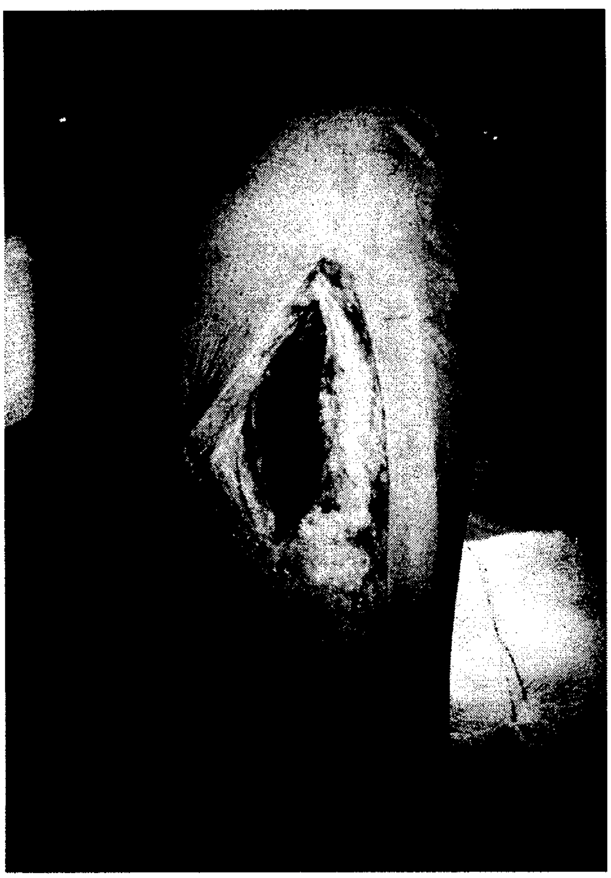

Fig. 2
Partial division of the deep posterior compartment fascia. The division is extended to the distal margin of the incision to ensure release of the soleus bridge.

TABLE II Main Sports Activity at the Time of Onset of the Medial Tibial Stress Syndrome

Main Sports Activity/ Main Exercise Surface	No. of Patients
Running/road	9
Running/grass	2
Running/treadmill	2
Soccer/grass	8
Aerobics/wood	3
Aerobics/concrete	2
Squash/hardwood	2
Cricket/grass	6
Hockey/Astroturf	3
Netball/concrete	2
Rugby/grass	2
Athletics/track	2
Occupation*/grass and road	3

*These three patients attributed the symptoms to their occupation rather than to a sports activity.

All surgical procedures were performed by one of us (M.J.A.). Surgery is performed with the patient under general anesthesia, the affected leg or legs exsanguinated, and a tourniquet applied to the thigh. A longitudinal linear incision is made along the middle and distal thirds of the inner tibial border. The greater saphenous vein and saphenous nerve are retracted, exposing the deep posterior compartment fascia that inserts along the posteromedial border of the tibia.

The fascia is then divided at the fascia-bone interface, thus effecting a deep posterior compartment fasciotomy (Fig. 2). The most distal part of the fascia is thicker and stronger as it passes distally to form the flexor retinaculum. This part of the fascia, proximal to the retinaculum, is often termed the *soleus bridge* and its release has been discussed as an important factor in achieving a successful outcome[6,14].

A strip of periosteum approximately 2 cm wide is then removed from along the inner tibial border. This is achieved by incising the fascia at the inner tibial border and cauterizing the periosteum approximately 2 cm anteriorly from the inner tibial border. The periosteum is then removed by means of a periosteal elevator, and the exposed surface of the tibia is scored with an osteotome (Fig. 3). A drain is laid alongside the medial tibial border, the wound is closed with subcuticular Vicryl sutures, and a wool and crepe bandage is applied.

The drain is removed between twenty-four and forty-eight hours after the operation, and the patient then begins walking with the aid of crutches. Patients are routinely allowed to go home at this point. The bandages are kept on for two weeks, and the patient stops using crutches within two

TABLE III Postoperative Reduction in Pain and Return to Sports Activity by Athletes with Medial Tibial Stress Syndrome

Surgical Outcome (% Pain Reduction)	No. of Limbs	No. of Athletes Able to Fully Return to Sports Activity
Poor (≤40%)	8 (9%)	0
Fair (41%-60%)	19 (22%)	2
Good (61%-80%)	30 (34%)	8
Excellent (81%-100%)	31 (35%)	9

weeks. Normal walking is then permitted, but no sports activity is allowed for six weeks, after which time the athletes are allowed to swim and ride a bicycle. At three months, they are allowed to resume running with a graduated increase in intensity and distance. Return to full activity may take between six and twelve months.

Medical records were reviewed to identify early postoperative complications such as hematoma and infection. The long-term postoperative evaluation involved measurement of pain levels with use of a visual analog pain scale and completion of a questionnaire. Patients were asked about tenderness along the tibial border, persistent postoperative swelling, and any abnormal sensation or numbness close to the surgical site. The physical assessment involved testing for tenderness along the posteromedial tibial border and altered nerve sensation in the area.

Fig. 3
Excision of the periosteum, now reflected and lying distally in the wound.

Current sports activities were also determined and were compared with presymptom levels of exercise. This involved recording the type or types of weight-bearing sports that were played, the hours of exercise per week, and the exercise surface used.

Surgical outcome was determined by comparing the presymptom and postoperative pain and activity levels. Statistical analysis of the pain levels was performed with a two-tailed t test. The percentage of reduction in pain was classified as poor (≤40%), fair (41% to 60%), good (61% to 80%), or excellent (81% to 100%)[32]. The number of athletes in each group who were able to return to their presymptom level of sports activity was also determined.

Results

Forty-six (59%) of the seventy-eight patients who underwent surgical treatment of medial tibial stress syndrome were available for postoperative follow-up. Of the thirty-two patients lost to follow-up, twenty-three had moved and no forwarding address was available and nine were unable to return for follow-up. There were thirty-one men and fifteen women in the study population. The medial tibial stress syndrome was bilateral in forty-two patients and was unilateral in four. All symptomatic limbs had been operated on, so there was surgical outcome data for eighty-eight limbs. The mean age of the patients at the time of surgery was 28.2 years (range, eighteen to fifty-six years). The mean duration of postoperative follow-up (and standard deviation) was 30 ± 11.5 months (range, six to sixty-three months).

The main sports activities that were being performed when the symptoms developed are shown in Table II. The three most common were running, soccer, and cricket. Three of the patients did not play any sports but identified their occupation as the cause of the condition. Two of those patients made milk deliveries, and the third was a postal worker. Their occupations involved walking more than 80 mi (129 km) each week and they associated the pain with that component of their jobs.

At the time of the onset of symptoms, the athletes were engaging in an average of 8.76 hours of sports activity weekly, with a minimum of three hours per week (a squash player) and a maximum of twenty-five hours per week (an aerobics instructor). All of these athletes, with the exception of the

TABLE IV Postoperative Complications

Postoperative Complication	No. of Limbs
Infection	1
Hematoma	2
Localized paresthesias	21
Localized numbness	10
Tibial stress fracture	1

squash player, were engaging in at least six hours of sports activity each week. The preoperative pain levels ranged from 3 to 10, and averaged 7.5 ± 1.7, on the visual analog scale. At an average of thirty months after the surgery, the mean postoperative pain level was 2.2 ± 1.8, which represented a mean reduction in pain of 71.6% (range, –20% to 100%). One patient had an increase in pain, from 5 to 6 on the visual analog scale, and all others had a reduction in pain. Surgical intervention significantly reduced the pain in these patients with medial tibial stress syndrome ($p < 0.001$).

Table III presents the numbers of limbs with each surgical outcome, as the results of surgery in patients with bilateral involvement can differ between limbs. The number of athletes who were able to fully return to their presymptom level of sports activity is also given for each surgical outcome group. The majority (69%) of the patients had either a good or an excellent result. However, only nineteen (41%) of the forty-six patients returned to their presymptom level of sports activity. The inability of the athletes to fully return to their previous levels of sports activity was multifactorial and included symptoms that had not fully resolved (ten patients), lack of time (eight), fear that the symptoms would recur (seven), and a change in occupation (two of the three nonathletes). The patients who did not return to their presymptom level of sports activity because of a lack of time often had been university students at the time of the surgery but were working full time when they were interviewed postoperatively. Many stated that they did not have sufficient time to exercise at their previous level despite being pain-free.

The postoperative complications are shown in Table IV. Although local sensation had not been tested preoperatively, it was assumed that localized paresthesias and numbness at the time of follow-up had probably resulted from the surgical incision. The altered sensation may reverse with time[11], although it was still present in some of our patients several years after surgery. One athlete failed to follow the postoperative rehabilitation protocol, returned to nearly full sports activities within two weeks, and sustained a tibial stress fracture six weeks after surgery.

Discussion

The number of patients lost to follow-up was disappointing but not surprising. A large number of the patients were students at a local physical education college at the time of treatment and had moved by the time of the study. Because the response rate was only 59%, the results of the study must be interpreted with some caution.

There was a significant decrease in symptoms following surgical intervention ($p < 0.001$). We believe that this is the largest study of the results of surgery for medial tibial stress syndrome to date, involving eighty-eight procedures in forty-six patients. Four previous studies of surgical outcomes involved only two[3], four[27], five[6], and nine[29] patients, making meaningful comparison with those studies difficult. The five other surgical series that we identified[2,7,11,28,33] involved a total of 125 cases and some comparisons with those results are possible. Our results are comparable with those of Jarvinnen et al.[2], who reported an excellent result in 41% of their patients, a good result in 37%, a fair result in 15%, and a poor result in 7%. In our series, the result was excellent in 35% of the limbs, good in 34%, fair in 22%, and poor in 9%. Unfortunately, Jarvinnen et al. did not specify the basis on which they categorized their results or how many of their thirty-four patients were able to fully return to sports activity. The results achieved in our study are better than those reported in the two other large studies[7,33].

Puranen[28] operated on eleven patients and stated that the pain disappeared in all of them after the surgery. The time at which this was determined postoperatively was not specified. Also, the author did not report whether the patients returned to their previous activity levels.

Detmer[11] reported the results of surgery in eighteen patients who had been followed for a mean of six months postoperatively. Fourteen patients had a complete resolution of symptoms and were able to fully return to sports activities. Another three had substantial improvement, and the remaining patient had no improvement. The better results seen in this study may have been due to a slightly different surgical technique, in which periosteal cauterization was performed in addition to the fasciotomies. The purpose of the cauterization was not stated but was justified on the basis of the fact that the same procedure was used with success in horses with a similar condition ("buck shins"). Additional studies of this technical modification with a longer follow-up period are needed.

The return of an athlete to full sports activity depends on many factors. In one study[7], many of the twenty-three athletes who had improvement after surgery but did not return to their previous activity level did not identify the medial tibial stress syndrome as the reason that they did not return to that level. Eight of the ten athletes who did return to full sports activity were at the elite or professional level, at which the motivation to return is likely to be greater. Many of those who were unable to return to a full level identified a lack of time as the reason. This factor was also mentioned in the present study. Eight of the patients in our study were undergraduate students at the time of the surgery but had left the university and started full-time employment during the follow-up period. They therefore had less leisure time for sports activity. Two of the patients who identified their occupation as the cause of the symptoms did not return to their jobs despite a 100% resolution of the symptoms. Ten patients did not return to full sports activity because of pain. Four of those patients had a difference in the results between limbs and thus could not return despite substantial improvement on one side. These results indicate that athletes should be counseled, before surgery, that they may not be able to fully return to their previous sports level. As Abramowitz et al.[6] concluded: "It may be unwise for athletes who undergo surgery to expect complete relief and a full uninhibited return to preoperative activity levels."

Postoperative complications are mentioned in only three of the published series. Detmer[11] commented that some of his eighteen surgically treated patients had transient saphenous nerve paresthesias and minor anesthetic areas, and Jarvinnen et al.[2] reported similar findings. Neither gave specific numbers, so it is not possible to compare their results with those in the present series, in which thirty-one limbs had paresthesias or localized numbness. Detmer thought that these symptoms would decrease with time but did not document a reduction in symptoms. The results in our series suggest that these symptoms do not decrease with time and are permanent rather than the transient neurapraxia that Detmer believed them to be. Because of the frequency of this complication, patients should be warned that it may occur.

Persistent tenderness along the tibial border was reported only by Holen et al.[7], in twelve of their thirty-two patients. Three of those patients eventually reported a complete resolution of symptoms. Similar findings were seen in the current study. Of the twenty-three patients who had tenderness along the tibial border, five eventually were completely asymptomatic and had returned to full sports activity. It is unknown whether the persistent tenderness is due to the surgical intervention, as the location of the tenderness was the same as that before the surgery. The fact that patients were able to fully return to previous sports levels even with tenderness along the tibial border suggests that its presence in the diagnosis of medial tibial stress syndrome may not be as important as previously thought.

The results of this study demonstrated that surgical intervention significantly reduces preoperative pain in medial tibial stress syndrome, by >70%. Despite this success, surgery frequently does not enable athletes to return to their presymptom exercise level. A number of athletes identified a lack of time or a concern that the symptoms might return as the reasons for not fully returning to their previous sports activities. It is therefore important that athletes are properly counseled, prior to undergoing surgery, that a full, uninhibited return to sports may not be possible. ■

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