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# Tibial stress syndrome in athletes

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Twenty cases of tibial stress syndrome characterized by severe pain, periosteal induration and tenderness over the medial border of the low mid shaft of tibia are presented in well conditioned athletes undergoing heavy training. Average age of the group was 17.45 years. Middle distance runners were the most common. An increase in the circumference of the affected leg at the level of periosteal induration averaged 0.92 cm. Atrophy at the level of maximal muscle mass of the anterior tibial group and gastrocnemius on the affected side was an average of 1.46 cm. decrease in circumference. Radiological evidence of stress fracture was present in 5 of these athletes.

An etiological theory is presented based on cyclic training stress inducing a local muscle fatigue in the lower leg. This causes a loss of shock absorbing function and structural stress to bone creating a painful periostitis reaction. Resultant disuse muscular atrophy furthers the loss of shock absorption and the cycle is reinforced.

A treatment regimen of modified training and isometric muscle rehabilitation is outlined which is designed to remove stress from the tibia and improve muscular strength and endurance to the anterior tibial and gastrocnemius group. Average recovery time was 4.83 weeks.

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Current training methods in sport expose the athlete to higher and higher levels of stress and subsequent injury is all too common. The athlete who presents with gradually increasing pain in the lower leg, following repetitive running or jumping offers a challenge in proper diagnosis and adequate treatment. Slocum[1] has probed this challenging differential diagnosis and Devas[2] has commented that one of the most disabling conditions presenting in this manner is a stress fracture of the tibia. Traditionally this diagnosis is dependent on the radiological findings that Wilson and Katz[3] describe as a combination of a fracture line, focal sclerosis of bone with endosteal callus or periosteal reaction with external callus. The dependence on radiological findings in the description of stress fracture can be confusing since the clinical symptoms can develop without or in advance of any X-ray changes. Cahill[4] suggests withholding specific treatment until X-ray changes occur. This may well prolong disability a considerable period of time. Adding to the confusion is Hobbs'[5] opinion that no reliable method of treatment is available except rest.

The tibial stress syndrome which will be described in this paper represents a clinical continuim with radiological proof of stress fracture common only as an occurrence in the advanced state. By de-emphasis of X-ray findings and expansion of the early signs and symptoms, it is hoped proper management can be instituted before the process advances to an end state of radiological proof of stress fracturing.

## CLINICAL SERIES

This material was collected over a ten year period by a physician in family practice with a special interest in sports medicine.

### The Athletes

These athletes were generally in year round heavy training for their sport. The average age was just over seventeen years. Distance runners were the most prevelant group to be affected. See table I.

### Symptoms

Symptoms began with mild to moderate discomfort over the lower shaft of the tibia after activity. In the early phase, rest overnight often relieved symptoms. With continued repetitive activity of running or jumping, pain became more prominent and long lasting. After some weeks, the pain persisted from day to day and often a gallop in running or limp in walking would develop. The athlete who jumps in volleyball or basketball adapts by using the unaffected limb for lift off and landing. Ultimately the severity of the pain prevents further activity. See table II.

### Signs

On examination of these athletes, all showed localized periosteal induration and tenderness. Only four athletes had bilateral induration while the remaining sixteen showed equal distribution right and left. See Table III. The lower third of the tibia was the most common site of periosteal induration. The circumference of the leg at this level was 0.92 centimeters greater than the unaffected limb. See table IV.

**TABLE I Athlete's Description**

| | n = 20 |
|---|---|
| **Age** | |
| Average | 17.45 Years |
| Range | 13 to 24 Years |
| **Sex** | |
| Male | 12 |
| Female | 8 |
| Sport | |
| Athletics | |
| Sprints | 4 |
| Jumps | 3 |
| Distances | 10 |
| Volleyball | 2 |
| Basketball | 1 |
| Total | 20 |

**TABLE II Symptoms**

1. Severe PAIN over medial border of the low mid shaft of the TIBIA
2. Progressively associated with repetitive STRENUOUS physical ACTIVITY
3. Pain INCREASES after STRESS overload
4. Pain DECREASES with REST from sport
5. Ultimately GAIT ABNORMALITY develops

**TABLE III Site and Location of Periosteal Induration**

| | |
|---|---|
| Site n = 20 | |
| Lower third tibia | 13 |
| Middle third tibia | 7 |
| Location n = 20 | |
| Unilateral | |
| Right tibia | 8 |
| Left tibia | 8 |
| Bilateral | 4 |

Atrophy in the muscles of plantar and dorsal flexion were shown by a decrease of 1.46 centimeters in circumference at the level of maximal mass of the anterior tibial and gastrocnemius groups when compared to the unaffected side. See table V. Most of these athletes showed a marked impairment of one legged hopping on the affected side due to both pain and weakness. See table VI.

In spite of these severe symptoms and signs, only 5 athletes from this group of twenty athletes showed any radiological evidence of stress fracture at the time of presentation. See Table VII.

### ETIOLOGICAL THEORY

The role of muscle strength and endurance in shock absorption in regards to athletic injuries has been recently acknowledged in the work of Gelehrter[6] and of Nirschl[7]. Gelehrter describes the protective role of the muscles to the skeleton in the same way the rigging stabilizes a ship's mast. Nirschl linked the lack of power in the extensors of the forearm with the etiology of tennis elbow. Radin[8] feels effective muscle action in runners protects bones by their shock absorption function. In other words, a considerable part of the forces created by movement is dissipated in the musculature.

It would seem that the athlete exposed to gradually progressive resistance training adapts to the new levels of stress by increasing the inherent strength of his boney framework while improving the strength and endurance of the muscle support systems. Matefi[9] has stated that control of the foot in running or jumping requires a balanced synergistic or antagonistic interplay of the various muscles. The delicate balance and adaptive ability may be disrupted by overloading of the training stress. Too much stress in running or jumping activities may cause the muscular system to fatigue and loose its efficiency in shock absorption. That portion of the biomechanical force which was once dissipated in absorptive muscular action is transmitted to bone. Continued physical activity at this point leads to structural stress to bone with resultant periostitis and pain from bone overload. Periosteal pain leads to involuntary rest of the muscle system and disuse atrophy follows with cyclic reinforcement of a loss of shock absorption function. Further stress overload deepens the cyclic effect and ultimately stress fracturing can result. See table VIII.

**TABLE IV Periosteal Induration Measurement**

Circumference of Leg Measured in Centimeters at Level of Induration
n = 5

| Subject | Affected Leg | Non-affected Leg | Difference |
|---|---|---|---|
| B.D. | 24.1 | 22.8 | 1.3 |
| C.B. | 28.9 | 27.9 | 1.0 |
| C.Q. | 23.5 | 22.2 | 1.3 |
| R.J. | 20.0 | 19.4 | 0.6 |
| T.B. | 23.2 | 22.8 | 0.4 |

Average Difference +0.92 cm on Affected Leg

**TABLE V Plantar and Dorsiflexion Muscle System Atrophy Measurement**

Circumference of Leg Measured in Centimeters at Level of Maximal Mass of Anterior Tibial and Gastrocnemius Muscle Groups
n = 6

| Subject | Affected Leg | Non-affected Leg | Difference |
|---|---|---|---|
| C.B. | 33.2 | 36.5 | 3.3 |
| T.L.J. | 34.5 | 35.5 | 1.0 |
| A.Ba. | 36.3 | 37.2 | 0.9 |
| T.B. | 33.6 | 34.3 | 0.7 |
| D.D. | 40.0 | 41.5 | 1.5 |
| M.S. | 33.0 | 34.5 | 1.5 |

Average Difference +1.46 on Non-affected Leg

**TABLE VI Signs**

1. Markedly tender PERIOSTEAL INDURATION on the medial tibial surface usually in the lower third.
2. ATROPHY of the plantar and dorsiflexion MUSCLE SYSTEMS.
3. IMPAIRED jumping performance on affected limb.
4. Often NORMAL X-rays at time of clinical presentation.

### Treatment Plan

Traditional treatment of tibial stress fractures have emphasized the concept of rest and avoidance of stress. Too often after a four to six week layoff, original symptoms and signs return when the athlete resumes training. Examination of the etiological framework of the tibial stress syndrome would suggest that equal importance be given to regaining muscular strength and endurance through specific rehabilitative attention.

Twelve of the athletes in this series of twenty were treated in the following manner.

### Phase I

The initial aim is to control pain and reduce the periosteal swelling. Crutches for a few days are indicated where there is substantial limping or pain with walking. Rest from the athlete's specific sport is started immediately and continued for two to three weeks. Anti-inflammatory drugs such as phenylbutazone can assist in the reduction of induration. Dosage was 100 to 200 milligrams given four times a day for a maximum of four days.

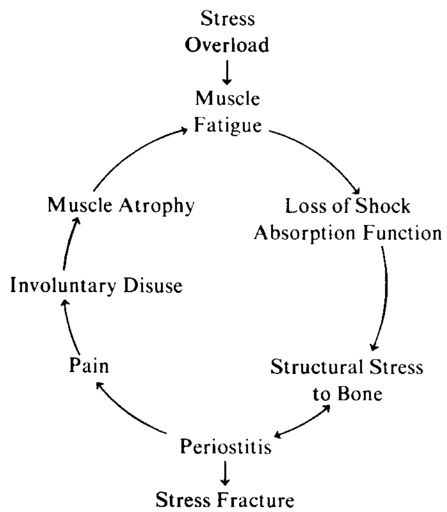
### Phase II

After four to six days of treatment when pain and swelling are controlled, rehabilitative measures both specific and general can be instituted. The first step of specific muscle rehabilitation must allow progressive resistance training without bearing. This is achieved by institution of isometric training

**TABLE VII Radiological Examination**

| | n = 20 |
|---|---|
| Normal | 15 |
| Stress fracture | 5 |

**TABLE VIII Etiological Theory**




stimulating the muscles of dorsal and plantar flexion. Resistance is supplied by a partner or by the opposite limb and the foot is dorsal flexed and plantar flexed. A six second contraction is repeated six times on the first day adding one repetition per day to a maximum of 18 repetitions per day.

The second step of specific muscle rehabilitation can be instituted after ten to twelve days of isometric work. Dorsal and plantar flexion as a isotonic exercise with a progressively loaded weight shoe is used initially. Three sets of twenty repetitions are done in one or three sessions daily starting at approximately one kilogram resistance and ending when five to six kilograms are accomplished. This is followed by weight bearing exercise. The forefoot is dorsiflexed by a 5.0 centimeter block of wood and the plantar flexion is repeated slowly against the resistance of body weight with this toe raising maneuver. After stress load to allow dynamic adaption. The athlete should be advised to choose footwear which has maximal shock absorption potential. It should be noted that general cardiovascular training can be introduced after the first three to four days of treatment. This can be achieved with swimming or by use of a stationary bicycle for the first ten to fourteen days. The bicycle should be pedalled by the unaffected limb only. See table IX.

## RESULTS

The twelve athletes who were treated by this method resumed full training in their sport in an average of 4.83 weeks after the initiation of treatment. See table X.

## CONCLUSION

Recognition of the tibial stress syndrome as a prologue to the end state of a stress fracture may allow the sports physician to institute rehabilitative measures in the early

**TABLE IX Treatment Outline**

*Phase I*

1. Removal of stress
   a. Crutches
   b. Rest
2. Anti-inflammatory medication

*Phase II*

1. Specific muscle rehabilitation
   a. Isometric
   b. Isotonic
2. General cardiovascular training
3. Gradual re-introduction of specific sport

**TABLE X Treatment Results**

| | Duration in weeks from the Initiation of Treatment of Resumption of Full Time Training in the Specific Sport |
|---|---|
| T.J. | 4 |
| P.L.* | 8 |
| C.Q. | 7 |
| R.J. | 4 |
| B.S. | 5 |
| D.D. | 3 |
| L.R. | 3 |
| A.Bo. | 6 |
| M.S. | 4 |
| A.Ba.* | 4 |
| G.L. | 6 |
| T.B. | 3 |

Average duration 4.83 weeks

* Radiological evidence of stress fracture.

phases of this process and avoid lengthy periods of disability.

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