International Journal of Physiology, Exercise and Physical Education
www.physicaleducationjournals.com
Online ISSN: 2664-7257; Print ISSN: 2664-7249; Impact Factor: RJIF 5.22
Received: 05-05-2020; Accepted: 20-05-2020; Published: 06-06-2020
Volume 2; Issue 1; 2020; Page No. 04-09

A practical physiotherapy treatment and rehabilitation guide for the athlete with tibial stress fracture

Asma Islam
Department of Physiotherapy, Bangladesh Health Professions Institute-Affiliated to the University of Dhaka, Dhaka, Bangladesh

Abstract
Introduction: Stress fracture is considered as an overuse mechanism where the partial or complete fracture occurs caused by an abnormal repeated loading exerted through a bone. It is common among physically active people, track and field athletes, dancers, and military persons. Tibial stress fracture comprises the most common among the other stress fracture. Conservative treatment is the usual way to manage stress fracture but, in some cases, surgical intervention may require. Although Physiotherapy management is an important area for the treatment and Rehabilitation of stress fracture often it is difficult for the Novice physiotherapist to apply the evidence-based treatment. Therefore the study was aimed to formulate a simple treatment guide, especially for novice physiotherapists.
Method: Five good quality scholarly articles and two established treatment guidelines were used to formulate the guideline. An electronic search strategy was performed through Google, Google Scholar, Pedro, and Pub Med. The guideline was devised with simplicity so that it can easily be understood and applied by sports Physiotherapists.
Conclusion: Diverse Physiotherapy treatment programs for the same condition impose a strong demand in the creation of standard treatment guidelines in order to standardize the management. Expert clinicians in different organizations can play a very important role in this regard.

Keywords: physiotherapy, athlete, tibial stress fracture

1. Introduction

A stress fracture is considered as an overuse mechanism where the partial or complete fracture occurs caused by an abnormal repeated loading exerted through a bone which cannot be withstood by it. It is common among physically active people, track and field athletes, dancers, and military persons (Bennell, Matheson, Meeuwisse & Brukner, 1999) [1]. It comprises 1%-20% of all sports injuries. 80% of stress fracture takes place at the lower limb. The Common sites are the tibia (23.6%), tarsal navicular (17.6%), metatarsals (16.2%), femur (6.6%), and pelvis (1.6%) (Kahanov, Eberman, Games, Wasik, 2015) [14]. As the tibial stress fracture comprises the most common among the other stress fracture, it is needed to be explained better as often its clinical presentation can merge to other similar conditions. The onset of a stress fracture is gradual. A typical tibial stress fracture will initially confuse as "shin splints" where the pain is felt along the midline of the tibia. The pain usually starts over a large area along the shin bone and is mainly noticed after a hard training session, race, or after a long difficult workout (Fullem, 2000) [13]. A cross-sectional study by Crossley, Bennell, Wrigley, and Oakes (1999) [7] found that bone geometry such as the smaller bones in relation to body size in the male runner is one of the risk factors for the development of tibial stress fracture. Another study by Bennel *et al*. (1996) found female track and field athlete who has already lower bone density, history of menstrual disturbance, less mass in the lower limb, leg length discrepancy, and lower-fat diet are prone to develop stress fracture. A study by Milgrom *et al*. (1996) [12] explored that the narrowest part at the distal quarter of the tibia is more prone to develop stress fracture as it is the low area moments of inertia. This study concludes that the bone's bending strength as measured by the area moment of inertia helps determine the risk to stress fracture. Biomechanical cause such as excess vertical and anterior-posterior dynamic loading of the tibia is associated with Tibial stress fracture (Milner, Ferber, Pollard, Hamill & Davis, 2006) [16]. Current Sports Medicine Report by Denay (2017) listed a couple of risk factors which are further classified as extrinsic and intrinsic. The extrinsic factors are Intensive training regimen, improper footwear, hard training surface, type of sport such as running more than swimming, Low calcium or vitamin D, muscle fatigue. The intrinsic factors are low bone density, female sex, previous history of a stress fracture, hormonal imbalance (late menarche, amenorrhea), BMI less than 19, eating disorder, metabolic disorder (thyroid dysfunction). A retrospective case-control analysis by Taunton *et al*. (2002) [20] also found female sex (54%), low BMI as risk factors for the development of tibial stress fracture. Conservative treatment is the usual way to manage stress fracture but, in some cases, surgical intervention may require. The usual conservative managements are rest, education, preventive care, analgesics, icing, serial radiograph, physiotherapy modalities, and exercise (Sterling, Edelstein, Calvo, Webbll, 1992). There are several Physiotherapeutic interventions that are effective in the treatment and rehabilitation of tibial stress fracture. After analyzing several scholarly articles a treatment guide was formulated which accumulated evidence-based physiotherapy management aiming to guide Physiotherapist especially novice physiotherapists in the treatment and rehabilitation following a tibial stress fracture.

2. Material and Methods

An electronic search strategy was executed through Google, Google Scholar, Pedro, and Pub Med. The keywords such as

"Physiotherapy AND Tibial Stress fracture", "Physiotherapy guideline AND tibial stress fracture", "Tibial Stress fracture Management", "Stress fracture", "Tibial stress fracture" were used for the search. The guideline was devised with simplicity so that it can easily be understood and applied by sports Physiotherapists. Five good quality articles and two established treatment guidelines were used to formulate the new guideline. The selected articles were analyzed carefully and were presented in simple language with the tabulated format. A five weeks treatment program was designed. Besides, the synopsis of the article also was presented in the result section.

3. Result

To synchronize with the objectives several scholarly articles were studied. For the treatment guideline synopsis of five scholarly articles and two treatment protocols for tibial stress fracture by Coyner, K. J. (nd) and Bolthouse, Hunt, Mandrachia, Monarski, and Lee (2015) [4] were followed.

3.1 Study summery

A study titled The Effect of a Pneumatic Leg Brace on Return to Play in Athletes with Tibial Stress Fractures by Swenson *et al*. (1997) [21], Published at the American Journal of Sports Medicine was conducted with 18 participants who were the competitive and recreational sports person. The prospective RCT was aimed to find out the effectiveness of Pneumatic leg braces in the time of return to full activity after a tibial stress fracture. The control group gets to rest and the usual care; the experimental group got pneumonic leg brace with the usual care. After 12 weeks the brace group was able to perform light activities within 7 days where the control group needed 21 days. Additionally, the brace group returned to full activity within 21+/- 2 days, and the control group took 77+/-7 days. Therefore, the study concluded that pneumonic brace is effective for tibial stress fracture athletes in early return to the sports with pain-free unrestricted full activity.

Another study by Ekenman *et al*. (2002) [12]. Titled "The Role of Biomechanical Shoe Orthoses in Tibial Stress Fracture Prevention" was published at the American Journal of Sports Medicine. It was aimed to find out the effectiveness of custom biomechanical shoe orthosis in the prevention of tibial stress fracture during walking and running. The participants were assessed during treadmill walking 5km/ hour and running 2 km running in 13 km/hour with running shoes with or without the orthosis**.** The study found that soft or semi-rigid insole in boots/shoes reduces tibial compression and tension strain rate. Therefore, the study suggested using soft insole in the boot during training sessions especially walking session to prevent tibial stress fracture.

A systematic review by Rome, Handoll and Ashford (2005) [22] on Intervention for preventing and treating stress fracture and stress reactions of bone of the lower limbs in young adult was conducted aiming to find out the intervention for a lower limb stress fracture on prevention and management.16 randomized and quasi-experimental study were revised. The study concluded that shock-absorbing insole in footwear may reduce the incidence of a stress fracture. The study also recommended using Pneumatic bracing during the rehabilitation stage.

A case series was conducted by Batt, Kemp, and Kerslake (2001) [6] titled "Delayed union stress fractures of the anterior tibia: conservative management" was published at the British Journal of Sports medicine. It was aimed to find out whether conservative management is effective or not in treating delayed union stress fractures of the anterior mid tibia. Three players, one was a male marathon runner, and the rest of the two were female professional ballet dancer and net ballplayer with delayed union of tibial stress fracture were included in this study. The patient was instructed to use pneumonic leg brace with anterior pad continuously for 13-28 weeks during Activities of Daily living and to move around when they didn't have any pain on walking. They were also suggested to cease ballistic activity but were encouraged to continue non-impact aerobic exercises which consist of dancing, yoga, swimming, martial arts (judo, karate), static cycling, etc to provide cardiovascular conditioning rather jumping, jogging or calisthenics. Depending upon radiological evidence of healing they instructed to continue the bracing intermittently for 0-13 weeks while exercising. The result showed that all the players returned to the former level of activities without the symptoms within 12 months. Therefore, the study suggested using pneumatic lower leg brace combined with modified activity and rest to reduce the need for surgery and return to a normal level of activity for the athlete with delayed union tibial stress fracture.

A Review by Brand, Brindle, Nyland, Caborn, & Johnson (1999) titled Does pulsed low-intensity ultrasound allow an early return to normal activities when treating stress fractures? A review of one tarsal navicular and eight tibial stress fractures." Was conducted aiming to find out the efficacy of daily use of Pulsed low-intensity ultrasound for lower limb stress fracture. Eight participants with a tibial stress fracture and one tarsal navicular fracture participated in this study. They assessed pain using the VAS scale; the functional performance was also measured. They received LIUS for 20minutes, 5times/week, 4 weeks with the usual functional activities. After 4 weeks the study found that Low-intensity ultrasound is effective in pain relief and early return to vigorous activity after a posterior medial stress fracture.

3.2 The Treatment guide

Rehabilitation usually starts after a certain period of immobilization -Non weight bearing until walking pain-free (4-6 weeks).

- To start the program, one should not claim any pain unless it is from muscle soreness.
- Progression of the exercise will depend on pain (should not provoke pain).
- The painkiller must be avoided as it can mask the problem.
- If any pain is felt during this program stop immediately and inform your therapist or physician.
- All the exercises such as stretches, weights, therapeutic exercises should be performed bilaterally (Bolthouse *et al*. 2015) [4].

Prevention (According to Beck, 1998)

Modification of weight-bearing training

- Find the history of the previous injury and need to make sure that it was properly managed.
- Correct lower limb mal-alignment through strength training or orthotic support.
- Correct running technique if it is not proper.
- Maximize Triceps Surae muscle (Calf muscle) flexibility and strength.

- Wearing of light and activity-specific shoe which provides enough shock absorption and replace it accordingly.
- Training on a different surface such as level asphalt, synthetic track, grass, sand, and uneven ground.
- Dietary calcium intake (at least 1000 mg/day).
- Female athletes should monitor and maintain normal circulating levels of estrogen. Here menstrual dysfunction can be a warning sign.

When already injured should not do:

- Excessively stretch the gastronomies and soleus muscles
- leg muscle strengthening exercises
- High-intensity activities
- Training on unusually soft /hard/uneven surfaces

Table 1: Week 1

Days	Exercise/Interventions
Day 1	-Discuss the whole exercise Regime with the participant. -Warm-up -5-10 minutes by a stationary bike. (Cinelli, 2013). -Treadmill walking 7.5 minutes. 45% unweighted (a training device for simultaneous control of unweighting, posture and balance on a treadmill) -Bodyweight squat 3 sets, 10 repetitions. -Single repetition Static Stretching exercises of leg and thigh muscles15 to 30 seconds each (Shirer & Gossal, 2015). -Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks (Brand, Brindle, Nyland, Caborn, & Johnson, 1999) -Use Pneumatic Leg Brace (continuous) (Batt, Kemp, and Kerslake, 2001) [6]. -The soft custom-made insole can be provided in boot/shoe every time of exercise (Ekenman *et al*. 2002) [12].
Day 2	-Warm-up -5 -10 minutes by a stationary bike. (Cinelli, 2013). -Single repetition Static Stretching exercises of leg and thigh muscles 15 to 30 seconds each (Shirer & Gossal, 2015). - Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks (Brand, Brindle, Nyland, Caborn, & Johnson, 1999). -Bodyweight squat 3 sets, 10 repetitions. -Low weight 40-50% of 1 repetition maximum, resistance training, Use Machine / free weight. /Resistance band exercise.
Day 3	-Warm-up -5 -10 minutes by a stationary bike/jogging /fast walking using Pneumatic leg brace and shoe insole modification -Single repetition Static Stretching exercises of leg and thigh muscles 15 to 30 seconds each (Shirer & Gossal, 2015). - Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks. - Bodyweight squat 3 sets, 10 repetitions. -Treadmill running: 7.5 min, 40% un-weighted.
Day 4	-warm-up -5 -10 minutes by a stationary bike -Stretching exercise of leg and thigh muscles. 5-10 minutes. -Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks. - Bodyweight squat 3 sets, 10 repetitions. - Low weight 50% of 1 repetition maximum, resistance training, Use Machine, or free weight. Resistance band exercise. -Treadmill running: 7.5 min, 40% un-weighted,
Day 5	-Warm-up -5 -10 minutes by a stationary bike. - Stretching exercise of leg and thigh muscles. 5-10 minutes. - Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks. -Bodyweight squat 3 sets, 10 repetitions. -Low weight 50% of 1 repetition maximum, resistance training, Use Resistance band exercise. -Treadmill running: 7.5 min 35% un-weighted,
Day 6	- Warm-up -5 -10 minutes by a stationary bike. (Cinelli, 2013). -Stretching exercise of leg and thigh muscles. 5-10 minutes. -Pulsed Low-Intensity Ultrasound for 20 minutes daily for 5 sessions /week, 4 weeks. -Bodyweight squat 3 sets, 10 repetitions. -Low weight 60% of 1 repetition maximum, resistance training, Use Machine, or free weight. Resistance band exercise. -Hydrotherapy in pool 30 minutes (walking, moving the legs, flutter kick swimming (need to be careful so that not kick on the wall with the injured leg)
Day 7	Free day (no exercise)

Table 2: Week 2

Days	Exercise/Interventions
Day 1	-Warm up (same as before) -Treadmill running: 15min, 30% un-weighted -Body weight squat 3 sets, 10 repetitions. -Continue stretch. -Continue the Pulsed low-intensity Ultrasound. -Resistance training with 60% of 1 repetition maximum

	-Hydrotherapy in pool 30 minutes (walking, moving the legs, flutter kick swimming (need to be careful so that not kick on the wall with the injured leg)
Day 2	-Same as Day 1 except treadmill running.
Day 3	-Day 2 exercises and additionally -Treadmill running: 15 min, 25% unweighted
Day 4	-All previous exercises and electrotherapy. -Hydrotherapy 30 minutes. -Resistance training 70% of 1 repetition maximum
Day 5	-Repeat day 4 program
Day 6	-Repeat Day 5 and -Resistance training, 80% of 1 repetition maximum. -Treadmill running: 15 min, 20% unweighted
Day 7	Free day (no exercise)

Table 3: week 3

Days	Exercise/Interventions
Day 1	-Continue previous and additionally Treadmill running: 15min 15% unweighted -Bodyweight squats 3x15.
Day 2	-Same as Day 1 except treadmill running.
Day 3	-Day 2 exercises and additionally Treadmill running: 15min 0% Unweighted Bodyweight squats 3x20.
Day 4	-Free day (no exercise)
Day 5	-Repeat day 3 program additionally -Run on treadmill at 0% for 15 minutes
Day 6	-Free day (no exercise)
Day 7	Free day (no exercise)

Table 4: Week 4

Days	Exercise/Interventions
Day 1	-Continue previous and additionally Jog 300 yards → run 100 yards→jog 300 yards→ run 100 yards, →jog 300 yards→ run 100 yards→ jog 300 →Yards→ run 100 yards→ jog 300 yards→ Jog total 10 minutes. -Need to take intervals according to need.
Day 2	-Continue previous and additionally -Jog 400 yards→run 400 yards, →jog 400 yards→ run 400 yards. -Swimming for 20 minutes -Need to take intervals according to need.
Day 3	-Jog. 10 minutes, Jog 50 yards at 50 % speed →75% speed →and finally 100% speed -Need to take intervals according to need.
Day 4	-Run 100 yards, 6 times, take 45 seconds rest between each 100 yards. -Bike for 20 minutes -Squats 3x8 (with dumbbells).
Day 5	-10-minute jog. 40 yards, 18 times, 20 seconds rest after each 40 yards.
Day 6	-Run 50 yards 20 times, 20 seconds rest after each 50 yards. Bike 30 minutes.
Day 7	-Free day (no exercise)

Table 5: Week 5

Days	Exercise/Interventions
Day 1	-Running on Grass - 2 miles.
Day 2	-2 Speed work: Run 75 yards' x 15 (30 second rest after each 75 yards), -Quadriceps and Hamstring curl 3x8 -squats 3x8 with dumbles.
Day 3	-Grass running: Up to 2.5 miles.
Day 4	-Day 3 plus Jog 20 yards, sprint 20 yards, jog 20-yard sprint 20 yards x15 with 30 seconds rest,
Day 5	-Grass running: Up to 3 miles.
Day 6	- Grass running: Up to 3 miles.
Day 7	-Free day

Note/ It is very important to start Agility drills if the sports demand the agility at week 5. Some common agility exercises are. Carioca, side shuffle line jumps, forward/backward/ side/side walking and running, triangular cone drill, Ladder drill, Zigzag drill, Wave drill, line jump, box jump, plant and cut drill etc., 3 days /week.

4. Discussion

According to a report on Drug and Therapeutics Committee Training Course Session 10. Standard Treatment Guidelines Participants' Guide by USAID, WHO, and MSH (2007), "Standard treatment guideline is a systematically developed statement designed to assist practitioners and patients in making decisions about appropriate health care for specific clinical circumstances". Therefore, it is very important to have a guideline for every health professional. The standard treatment guideline is an ancient concept where the traditional healers used to develop a certain guideline of treatment and convey those in a generation to generation. In modern world Doctors, nurses, pharmacists, community health workers, and other health care providers of United States, Europe, Latin America, Asia, Africa, and the Western Pacific are using it to improvise treatment by applying the best available treatment, reduce confusion in different available treatment for the same condition, reduce the unnesseray exposure to treatment, reduce cost and to maximize the adherence with the treatment. A study by Kruger (2013) [23] found that adherence to standard treatment guidelines, training of health care staff in the implementation of the guideline, and monitoring significantly improve the outcome of hospitalized children suffering from Lower respiratory tract infection and malaria. In the area of Physiotherapy, the modern world also using standard treatment guidelines for a different condition. Some criteria should be considered while creating a guideline such as evidence-based, circumstance based, simple, credible, applicable, appropriate, accurate, cost-effective, time-effective, dynamic (regularly updated). Worldwide the diverse Physiotherapy treatment program for the same condition imposes a strong demand in the creation of standard treatment guidelines to standardize the management. It is also important to incorporate the above-mentioned criteria. The expert clinician in the different organizations can play a very important role in this regard so that the Novice can have a guide of standard management. It is also important to translate the information among all Physiotherapy practitioners by Journal Publication, Formal training, Seminar, Conference, emailing. Professional Regulatory Body can also play a very important role.

5. Conclusion

The study was conducted aiming to find out the scientific information regarding tibial stress fracture among athletes at home and abroad. It was also conducted to find out the evidence-based management and finally to create a treatment guideline through a synopsis of 5 different scholarly articles and an established treatment guideline. The guideline was formulated with simplicity so that it can easily be understood and applied by sports Physiotherapists.

6. References

1. Bennell K, Matheson G, Meeuwisse W, Brukner P. Risk factors for stress fractures. Sports medicine. 1991; 28(2):91-122.
2. Bennell KL, Malcolm SA, Thomas SA, Reid SJ, Brukner PD, Ebeling PR, *et al*. Risk factors for stress fractures in track and field athletes: a twelve-month prospective study. The American journal of sports medicine. 1996; 24(6):810-8.
3. Beck BR. Tibial stress injuries. Sports Medicine. 1998; 26(4):265-79.
4. Bolthouse E, Hunt A, Mandrachia K, Monarski L, Lee K. Return to Running After a Tibial Stress Fracture: A Suggested Protocol. Orthopaedic Practice. 2015; 27:37-45.
5. Brand Jr JC, Brindle T, Nyland J, Caborn DN, Johnson DL. Does pulsed low intensity ultrasound allow early return to normal activities when treating stress fractures?: A review of one tarsal navicular and eight tibial stress fractures. The Iowa orthopaedic journal, 1999, 19:26.
6. Batt ME, Kemp S, Kerslake R. Delayed union stress fractures of the anterior tibia: conservative management. British journal of sports medicine. 2001; 35(1):74-7.
7. Crossley K, Bennell KL, Wrigley T, Oakes BW. Ground reaction forces, bone characteristics, and tibial stress fracture in male runners. Medicine and Science in Sports and Exercise. 1999; 31(8):1088-93.
8. Coyner KJ. (nd). Femoral/Tibial Stress Fracture Protocol. UCONN Musculoskeletal Institute. Retrieved on 21 October, 2018. from www.drcoyner.com/pdf/tibial-and-femoral-stress-fx-protocol.pdf
9. Cinelli M. The Importance of Warming Up Before Activity, 2013. Retrieved on 18th November, 2018 from http://www.bostonherald.com/entertainment/health_fitness/mr_fit/2013/05/the_importance_of_warming_up_before_activity
10. Denay KL. Stress fractures. Current Sports Medicine Reports. 2017; 16(1):7-8.
11. Drug and Therapeutics Committee Training Course Session 10. Standard Treatment Guidelines Participants' Guide by USAID, WHO and MSH, 2007. Retrieved on 4th January, 2019 from http://apps.who.int/medicinedocs/en/m/abstract/Js22115en/
12. Ekenman I, Milgrom C, Finestone A, Begin M, Olin C, Arndt T, Burr D, *et al*. The role of biomechanical shoe orthoses in tibial stress fracture prevention. The American journal of sports medicine. 2002; 30(6):866-70.
13. Fullem B. A Stress fracture. How to sidestep and manage this frustrating injury? Retrieve on October 3, 2018. From https://www.runnersworld.com/advanced/a20800688/a-stress-fracture-prime.
14. Kahanov L, Eberman LE, Games KE, Wasik M. Diagnosis, treatment, and rehabilitation of stress fractures in the lower extremity in runners. Open access journal of sports medicine, 2015, 6:87.
15. Milgrom C, Gildadi A, Simkin A, Rand N, Kedem R, Kashtan H, *et al*. The area moment of inertia of the tibia: A

16. risk factor for stress fractures. Journal of Biomechanics. 1989; 22:1243-1248.
17. Milner CE, Ferber R, Pollard CD, Hamill JO, Davis IS. Biomechanical factors associated with tibial stress fracture in female runners. Medicine and science in sports and exercise. 2006; 38(2):323.
18. Rahman N, Yasmin S. BKSP Journal of Sports Science, 2015, 1(14)
19. Sterling JC, Edelstein DW, Calvo RD, Webb R. Stress fractures in the athlete. Sports Medicine. 1992; 14(5):336-46.
20. Shrier I, Gossal K. Myths and truths of stretching: individualized recommendations for healthy muscles. The physician and sportsmedicine. 2000; 28(8):57-63.
21. Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD, *et al*. A retrospective case-control analysis of 2002 running injuries. British journal of sports medicine. 2002; 36(2):95-101.
22. Swenson JR, DeHaven KE, Sebastianelli WJ, Hanks G, Kalenak A, Lynch JM, *et al*. The effect of a pneumatic leg brace on return to play in athletes with tibial stress fractures. The American Journal of Sports Medicine. 1997; 25(3):322-8.
23. Rome K, Handoll HHG, Ashford RL. Interventions for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults. Cochrane Database of Systematic Reviews, 2005. Issue 2. Art. No.: CD000450. DOI: 10.1002/14651858.CD000450.pub2.
24. Kruger M. The importance of standard treatment guidelines in pediatric practice in Africa. Public health action. 2013; 3(2):94.