Descriptive analysis of selected alignment factors of the lower extremity in relation to lower extremity trauma in athletic training
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A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Physical Education
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Abstract:
A study was conducted to investigate the relationships between lower extremity alignments and the shin splint syndrome in female athletes. Selected measures describing the alignment of the lower extremities of thirty-two women athletes were taken. Data recorded were classified into: Group 1 - a no shin splint group; Group 2 - a cur- rent moderate shin splint group; Group 3 - a current severe shin splint group; Group 4 - a previous shin splint group; and Group 5 - a current shin splint group. Data were analyzed through the use of an analysis of variance, a Duncan's test, and a step-wise regression.

The analysis of variance found that there were significant alignment differences ($p < .05$) between subjects who had no shin splints, subjects who had shin splints previously, and subjects who currently had shin splints.

The Duncan's test indicated the variables which were significantly different ($p < .05$) between each of the above mentioned groups. Ten of the fifteen measures varied significantly between the no shin splint group and the current shin splint group and between the no shin splint group and the previous shin splint group. Eleven of the fifteen measures varied significantly between the previous shin splint group and the current shin splint group.

The step-wise regression indicated that six of the fifteen measures taken could be used to predict the occurrence of the shin splint syndrome. The six predictive factors included: the degree of external rotation of the femur with the hip extended, the degree of dorsiflexion of the ankle with the knee both flexed and extended, the degree of inversion at the subtalar joint, the frontal plane position of the tibia/subtalar joint static, and the position of the calcaneus in relationship to the floor/subtalar joint static.

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Date September 20, 1976

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ABSTRACT

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Chapter 1

INTRODUCTION

Shin splints have directly afflicted athletes and hence have been a concern of coaches, trainers, and doctors for many years. Consequently, much attention has been given to the shin splint syndrome. The occurrence of the syndrome is erratic, i.e., it may only affect one of two athletes even though both are of similar condition and follow equally stressful training programs. Likewise, the treatment of the shin splint syndrome is erratic, and what alleviates the pain for one individual may have no effect upon another person's pain even though both persons are diagnosed as having the same ailment.

Recently, some podiatrists and medical doctors have proposed that orthotics, or shoe inlays, be used to treat the shin splint syndrome (12). This proposal is based on the hypothesis that the alignment of the lower extremity and/or a lack of flexibility of the hamstring muscle group may be the causative agents of the syndrome. Although, to the author's knowledge, there has been no research that supports this hypothesis, such treatments, i.e., use of orthotics, have been used (22:111). In one case a male high school basketball player was enabled, through the use of orthotics, to play an entire basketball game. Without the use of the shoe inlays, the athlete was limited to less than one full quarter of play by the syndrome (12).

The following study was done in an attempt to discover whether or not certain alignments of the lower leg and/or the flexibility of certain muscle groups are related to the occurrence of shin splints. Determining whether or not these relationships are significant would lend support or opposition to the treatment of shin splints through the method of realigning the lower extremity.

Statement of the Problem

The general purposes of this investigation were to determine whether or not specific populations could be described according to selected lower extremity measures and to determine the relative importance of the selected measures of the lower extremity to the relative severity of the shin splint syndrome, and which of these measures, if any, could best be used to predict the occurrence of the syndrome. Specifically, the investigator attempted:

1. to determine whether the alignment of the lower extremity, as defined by fifteen selected measures, varied between persons who never had shin splints, persons who had shin splints previously, and persons who currently had shin splints.

2. to determine which of the selected measures, if any, varied significantly between the three groups described.

3. to determine which of the selected measures, if any, could best be used to predict the occurrence of the shin splint syndrome.

Selected measures used included the ranges of inversion and eversion of the subtalar joint, dorsiflexion of the ankle with the knee both flexed and extended, external and internal rotation of the femur with the hip both flexed and extended, flexibility of the hamstring muscle group, and the positions of the forefoot in relationship to the rearfoot with the subtalar joint neutral, frontal plane of the tibia with the subtalar joint in static stance and neutral position, calcaneus in relationship to the floor with the subtalar joint in static stance and neutral position, and the malleoli with the subtalar joint in static stance position.

Hypotheses

Null Hypotheses. It was hypothesized that there would be no significant difference in the lower extremity alignment as described by the selected measures between persons who never had shin splints, persons who had shin splints previously, and persons who currently had shin splints, i.e., these specific populations could not be independently described according to the alignment of the lower extremity. Furthermore, it was hypothesized that there would be no significant correlation between the occurrence or non-occurrence of the shin splint syndrome and any of the measures used to describe the lower extremity

alignment, i.e., none of the measures used to describe lower extremity alignment could be used to predict the occurrence of the shin splint syndrome.

Alternate. It was hypothesized that there would be a significant difference in the alignment of the lower extremity, as described by the fifteen measures, between persons who never had shin splints, persons who had shin splints previously, and persons who currently had shin splints, i.e., these three specific populations could be independently described according to the alignment of their lower extremities. In addition, it was hypothesized that there would be a significant correlation between each of the selected measures and the occurrence or non-occurrence of the shin splint syndrome. Hence, it would be possible to predict the occurrence of the shin splint syndrome using the fifteen measures.

The hypotheses would be individually accepted at the .05 level of significance.

Definition of Terms

The following terms, unless otherwise noted, were used in the study as they were defined by Root (15).

Abduction. Abduction is any action in which the distal aspect of the foot, or a part of the foot, moves away from the body's midline.

Axis of rotation is in the frontal and sagittal planes and motion occurs in a transverse plane.

Adduction. Adduction is any action in which the distal aspect of the foot, or a part of the foot, moves toward the body's midline. Axis of rotation is in the frontal and sagittal planes and motion occurs in a transverse plane.

Dorsiflexion. Dorsiflexion is any action in which the distal aspect of the foot, or a part of the foot, moves toward the tibia. Rotation is around the frontal and transverse axis and motion occurs in a sagittal plane.

Eversion. Eversion is any action in which the distal aspect of the foot, or a part of the foot, tilts away from the body's midline. Axis of rotation is in the sagittal and transverse planes and the motion occurs in the frontal plane.

Inversion. Inversion is any action in which the distal aspect of the foot, or a part of the foot, tilts toward the body's midline. Axis of rotation is in the sagittal and transverse planes and motion occurs in the frontal plane.

Neutral position of the subtalar joint. The neutral position of the subtalar joint is that point at which the foot is neither

pronated nor supinated. From this position, the calcaneus will invert twice as many degrees as it will evert.

Plantarflexion. Plantarflexion is any action in which the distal aspect of the foot, or a part of the foot, moves away from the tibia. Rotation is around the frontal and transverse axis and motion occurs in the sagittal plane.

Pronation. Pronation is simultaneous action of the foot in the directions of abduction, eversion, and dorsiflexion. Axis of rotation runs from the posterior lateral and plantar surface of the foot to the anterior, medial, and dorsal surface, and allows motion in three planes simultaneously.

Shin splints. Shin splints is the condition diagnosed by the symptoms of tenderness to the touch and pain in the lower leg along the anterior medial side of the tibia with resultant discomfort (5).

Subtalar joint. The subtalar joint is the contact point between the calcaneus and the talus.

Supination. Supination is simultaneous action of the foot in the direction of adduction, inversion, and plantarflexion. Axis or rotation runs from the posterior lateral, and plantar surface of the foot to the anterior, medial, and dorsal surface and allows motion in three planes simultaneously.

Valgus. A valgus position of the foot is an inverted structural position of the foot or a part of the foot.

Varus. A varus position of the foot is an everted structural position of the foot or a part of the foot.

Delimitations

Only those measures previously mentioned were taken for the study. The investigation of the shin splint syndrome dealt with the syndrome as it occurs only on the anterior medial aspect of the tibia in female athletes.

Limitations

Each subject was evaluated at a random time during the day, and evaluations were done during the weeks of April 5-9, and April 12-16, 1976.

No control was placed on the type of shoe the subjects wore during workouts, the type of surface on which the workouts were done, or the type of activity engaged in by the subjects. Also, no attempt was made to measure the amount of physical activity the subjects engaged in daily.

All subjects were active in that each was competing on a varsity level in either track, basketball, volleyball, or gymnastics.

The researcher attempted to eliminate those persons who had suffered or who were currently suffering from sprained ankles, knee injuries, hip problems, and other injuries of the lower extremity. It was felt that such injuries would bias the data collected.

Chapter 2

REVIEW OF RELATED LITERATURE

Definition of Shin Splints

The term shin splint, although commonly used by trainers, physicians, coaches, and athletes, is often used without being specifically defined. In essence, the term shin splint is a "waste basket" term and is used in reference to many different conditions. Considerable argument arises when an attempt to define the term is made. One fact generally agreed upon, however, is that the condition is unique to the lower leg. Conditions frequently referred to as shin splints include:

1. Strains of the tibialis anterior or the tibialis posterior.
2. Tearing of the interosseous membrane between the tibia and the fibula.
3. Irritation of the periosteum due to tendons pulling away from it.
4. Inflammation of the tendons or the dorsiflexors of the foot (28:68-69).

Generally it is agreed that shin splints are an irritation or inflammation of or along the interosseous membrane. The membrane acts as an elastic buffer zone between the fibula and the tibia, helps stabilize the two bones, and serves as an attachment for both anterior and posterior muscle groups. The anterior muscles are the foot

flexors and are responsible for dorsiflexion, raising and lowering the toes, controlling the arch, and inverting the foot, as well as aiding in plantarflexion in an eccentric manner. Posterior muscles are the foot extensors and are responsible for plantarflexion, everting the foot, pronation, and helping to control dorsiflexion in an eccentric manner.

For purposes of the study, shin splints were defined as a condition diagnosed by the symptoms of tenderness to the touch and pain in the lower leg along the anterior-medial aspect of the tibia with resultant discomfort (5). By definition, the shin splint syndrome was limited to the anterior medial side of the tibia. No differentiation was made between persons complaining and being diagnosed as having the syndrome in the distal 1/3 of the lower leg and persons complaining and being diagnosed as having the syndrome in the proximal 1/3 of the leg.

Symptoms of Shin Splints

It is generally accepted that the following symptoms are prime indicators that the condition of shin splints is present.

1. Dull, achy, cramplike pain is felt in the lower leg, along the tibial crest--the shin.
2. Pain will increase with running, and/or dorsiflexion and/or plantarflexion.

3. Pain will subside with rest.

4. The shin is tender to the touch (5).

Biomechanics of Running and Walking

Before considering causative factors or enhancing agents of the shin splint syndrome, the functioning of the lower extremity during running or walking activities should be understood. Shin splints, after all, do occur when the lower extremity is placed in a stressful situation (running, walking, jumping, etc.) and are symptomatically treated by resting the lower extremity.

Walking or running activity of the lower extremity may be broken down into two basic phases--a stance phase and a swing phase. The stance phase is further divided into three stages, these being the contact stage, the mid-stance stage, and the propulsive or toe-off stage. The contact or heel strike stage of stance is the pronatory portion of the gait where the leg and thigh are still internally rotating. Foot-strike may occur with the weight on the ball of the foot, the entire foot, or the heel of the foot depending upon the running techniques, the demands for speed and the type of movement required (17:359). During the mid-stance stage of gait, the subtalar joint should be in neutral position, the mid-tarsal joint should be fully pronated, and the foot should be moving out of pronation and into supination (12). Near the end of the mid-stance stage, the foot acutely dorsiflexes,

thus readying itself for propulsion (17:359). Upon supination, the foot becomes more stable and more powerful. During the propulsive stage of stance, the leg externally rotates, the foot fully supinates, thus becoming the rigid lever needed at toe-off (12). The swing phase of gait sees the leg internally rotating and preparing for heel contact (12).

Many difficulties may be encountered if the proper mechanics of walking and/or running are not observed and most of the difficulties encountered when the proper biomechanics of walking/running are not observed deal with pronation. According to Subotnick (23:15), "a pronated foot at toe-off has a tendency to adversely affect the ankle, knee and/or leg and results in many overuse symptoms."

Anytime the lower extremity and its actions are discussed, the concept of the lower extremity being a linked system must be taken into consideration, since, in a linked system, what occurs in one part of such a system will cause changes in the other parts of that same system. Because the lower extremity is such a system, the effect of the subtalar joint is one of a torque converter, i.e., movement in one direction by the tibia will bring about movement in the opposite direction by the calcaneus due to the action of the subtalar joint (12).

Causes of Shin Splints

The etiology of shin splints is unknown. In attempting to determine the cause of shin splints, many factors must be considered. Speculations advanced as to the cause of shin splints include faulty posture alignment, fallen arches, muscle fatigue, overuse stress, body chemical imbalance, or a lack of proper reciprocal muscle coordination between the anterior and posterior aspects of the leg (6:255).

Running on a hard surface, or switching to a hard surface after running on a soft surface are often spoken of as causative agents of shin splints. Klafs and Arnheim (6) believe that strenuous work on a hard surface will bring about the shin splint syndrome.

Some authors (1:24-25; 16:29-39; 28:68-69) believe that when muscle groups of the lower leg lack strength and/or flexibility, shin splints will result.

More recently, improper foot alignment has been proposed as a cause of shin splints (4:55-60; 14:28-36; 21:1-8; 22:104-113). Cerney (2) believes that whenever the problem of shin splints is considered, the foot must also be considered. He cautions us to, "Remember that as the foundation goes, so goes the building,--and in ALL cases of shin splints a foot problem is present concurrently (2:91). Sheehan (21:6) states that the foot is an architectural marvel, but that improper alignment or balance of its parts may lead to shin splints.

For persons promoting this theory, the concept of structural balance is very important.

Treatments of Shin Splints

The care and prevention of shin splints varies from case to case, and there is much controversy when various types of treatment are discussed. In dealing with shin splints, one actually deals with the symptoms and not the cause since the cause is unknown. Regardless of the type of treatment employed, there is agreement that one can not run shin splints out, and that full recovery from the affliction requires time. Many treatments for shin splints have been proposed and utilized with each claiming some degree of success. Treatments usually include rest, heat, and strapping. Aspirin, friction massage, ice massage, stretching exercises, and felt pads may also be used. Preventive measures usually call for stretching and strengthening of the muscles of the lower leg, and strapping of the longitudinal arch of the foot prior to games and practices (1:24-25; 3:111-139; 6:255-256; 7:73-74; 8:171-173; 10:536-539; 11:42-50; 13:83-90).

Recently the use of orthotics for both prevention and treatment of shin splints has been proposed (2:91-96; 16:29-39; 20:85-89; 24:31-35; 26:75-79). This proposal is based on the premise that if the foot functions within established guidelines, many athletic injuries to the lower extremity can be decreased. Such guidelines

state what range of motion is normal at the various joints in the lower extremity and thus allows for the most efficient functioning of the foot. The following values are accepted as biophysical criteria for normalcy.

1. In the static tibial stance position, the distal 1/3 of the leg is vertical. However, a variance of 2° varum or 2° valgum is acceptable provided the subtalar joint is normal (15:34,131).
2. In a relaxed calcaneal stance position, ideally the subtalar joint rests in its neutral position, i.e., the calcaneus is perpendicular to the ground and parallel to the distal 1/3 of the leg. However, a variance of 2° inversion to 2° eversion of the calcaneus is acceptable in persons age seven years to adult (15:34,131). At the subtalar joint there should be twice as much inversion as there is eversion (12).
3. A line bisecting the posterior surface of the calcaneus will be vertical (15:34,131).
4. The plantar forefoot lies perpendicular to the line bisecting the posterior surface of the calcaneus, i.e., at the midtarsal joint, zero degrees of varus and zero degrees of valgus should be reported (15:34,131; 12).

5. At the ankle joint, a minimum of 10° of dorsiflexion is necessary for normal locomotion (15:34,131).
6. External malleolar torsion of 13-18° is considered normal for persons age six years to adult (15:130).
7. At the hip joint there should never be more internal rotation than external rotation. Usually there is twice as much external rotation as there is internal rotation, but even a ratio of 1:1 is acceptable (12). The minimum total range of motion necessary for normal locomotion is 15-20° (15:131).
8. The hamstring muscle group must not be more than 20° flexed from the vertical position when the subject is lying on her back with the hip flexed at 90° (12).

Chapter 3

METHODS AND PROCEDURES

Instrumentation

A manual biometer developed by Phillips (12) was used to collect data for the study (see Figures 1-6).

The biometer consisted of a number of protractor-like devices and was capable of measuring body positions and/or segmental movements in terms of degrees. The instrument could be broken apart so that various protractors within the instrument could be used to take the various measurements. Figure 6, although not truly a part of the biometer, was used to establish the plane position of the forefoot in relationship to the rearfoot and so was required during the examination.

Face validity of the instrument was accepted.

Data Collection Techniques

Pictorial descriptions of the measures taken to describe the alignment of the lower extremity are illustrated in Figures 7-26. A detailed description of the methods used to collect the data may be obtained from the author.