Tibial Stress Fractures and Associated Diseases in Military Recruits

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ABSTRACT

Introduction: Tibial stress fractures are a very common condition in military recruits. Our objective is to demonstrate that stress fractures are associated with other diseases. **Materials and Methods:** 42 stress fractures in 34 patients were retrospectively evaluated. Every patient had recently joined the Argentine Army and consulted for painful symptoms in the tibia. A clinical and scintigraphic diagnosis of stress fracture was made. Patient data, associated diseases, and risk factors were documented. Inclusion criteria: recent incorporation, same training, age between 16 and 23 years. Trauma, simulators, tumoral pathology, and cases with negative scintigraphy were excluded. **Results:** We studied 42 stress fractures in 34 patients, 14 were men and 20 were women. The average age was 20 years. There were no significant differences in the number of injuries regarding the affected limb. 64.7% had associated diseases, 73% in women and 27 % in men. Among the women with stress fractures, 80% had associated diseases, compared to 43% for men. Different diseases were found with lower limb varus and valgus imbalances. Varus was the most associated with fractures. **Conclusions:** A high rate of associated diseases was found in patients with tibial stress fractures with a predominance of lower limb varus imbalances. Associated diseases were more likely to be found in women with stress fractures than in men.

Keywords: Stress fractures; associated pathology; tibia; recruits.

Level of Evidence: IV

Fracturas de tibia por estrés y enfermedades asociadas en reclutas

RESUMEN

Introducción: Las fracturas de tibia por estrés son un cuadro muy frecuente en el personal militar recién incorporado. Nuestro objetivo fue demostrar que existe una asociación entre fracturas por estrés y otras enfermedades. **Materiales y Métodos:** Se evaluaron retrospectivamente 42 fracturas por estrés en 34 pacientes, entre noviembre de 2012 y septiembre de 2014. Todos se habían incorporado recientemente al Ejército Argentino y consultaron por cuadros dolorosos en la tibia. Se realizó el diagnóstico clínico y centellográfico de fractura por estrés. Se documentaron datos filiatorios, cuadros asociados y factores de riesgo. Los criterios de inclusión fueron: reciente incorporación, mismo entrenamiento, edad 16-23 años. Se excluyó a pacientes con traumatismos, cuadro tumoral o centellograma negativo, y a los simuladores. **Resultados:** Se evaluaron 42 fracturas por estrés en 34 pacientes (14 hombres y 20 mujeres). La edad promedio era de 20 años. No hubo diferencias significativas en el número de lesiones respecto al miembro afectado. El 64,7% tenía enfermedades asociadas (mujeres 73%, hombres 27%). El 80% de las mujeres y el 43% de los varones tenían un cuadro asociado. Se hallaron diversos cuadros con desejes de miembros inferiores en varo y en valgo, los primeros fueron los que más se asociaron con fracturas. **Conclusiones:** La tasa de asociación con enfermedades en los miembros inferiores fue alta, con predominio de los desejes en varo. Las mujeres con fracturas por estrés tenían más cuadros asociados que los hombres.

Palabras clave: Fracturas por estrés; enfermedad asociada; tibia; reclutas.

Nivel de Evidencia: IV

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How to cite this article: Coria HE, Fedun Rodríguez E, García D, Masaragian H, Mizdraji L, Perin F, Rega L, Sartorelli D, Veizaga Velasco J. Tibial Stress Fractures and Associated Diseases in Military Recruits. *Rev Asoc Argent Ortop Traumatol* 2024;89(2):143-149. https://doi.org/10.15417/issn.1852-7434.2024.89.2.1868

INTRODUCTION

In the military setting, tibial stress fractures are a frequent entity and have a high incidence in newly recruited personnel[1] subjected to intense training and psychophysical demands. The aim of this study was to demonstrate that patients with stress fractures have associated diseases.

MATERIALS AND METHODS

A total of 42 stress fractures in 34 patients were retrospectively evaluated between November 2012 and September 2014. All of them were recent Argentine Army NCO Academy cadets with up to a year of service who sought treatment for medial tibial pain. Stress fractures were diagnosed clinically and by scintigraphy. An Excel spreadsheet was created with all of the personal data, including age, gender, laterality, associated conditions, sleep deprivation, irregular menstrual cycles, body mass index (BMI), appropriate or inappropriate footwear, terrain on which they ran, and type of training. Shoes that were hard, non-cushioned, flat or broken were defined as inappropriate.

Palpatory discomfort in the anterointernal region of the tibial diaphysis in various patterns, such as vertical, focused on or transverse, was utilized to raise clinical suspicion.

The incidence of associated diseases was compared with that of recruits without fractures. The sample was ethnically heterogeneous.

The inclusion criteria were a maximum of one year of service in the Force, the completion of the same training, and an age range of 16 to 23 years old.

Those who reported any form of trauma, as well as those suspected of simulation, tumor disease, or negative scintigraphy for stress fractures, were excluded.

RESULTS

The 42 stress fractures studied corresponded to 34 patients (14 men and 20 women), with an average age of 20 years. Eight were bilateral stress fractures. Twenty injuries were right and twenty-two were left.

There were no significant differences in the number of injuries with respect to the affected limb.

Of the patients with stress fractures, 64.7% had an associated disease (16 women and 6 men). 80% of women and 43% of men with stress fractures had a concomitant condition.

The diseases associated with stress fractures were, in order of frequency: cavovarus foot (7 cases), pes planovalgus (5 cases), rearfoot varus (1 case), plantar fasciitis (1 case), tibia vara (1 case), tibia vara associated with extreme thinness and facial malformations (1 case), cavovarus foot associated with tibia vara (1 case), cavovarus foot with genu valgum and short stature (1 case), external tibial torsion (1 case), short stature (1 case), hindfoot valgus (1 case) and pes cavus plus brachymetatarsia (1 case) (Figure 1).

Fourteen patients had cavovarus feet and sixteen had varus deformities in the lower limbs (Figure 2).

BMI was normal in 60% of the cases and low in 30%. 29% wore inappropriate footwear.

Only one patient reported irregular menstrual cycles since joining the Army.

The clinical findings were characterized by referred pain in the anterointernal aspect of the tibial diaphysis, which manifested in different patterns on palpation, whether vertical, centered or not on the medial border of the tibia, transverse, combined, or localized, the latter referred to as “fingertip”. All had slender legs with moderate muscle mass.

Initial radiographic findings were positive in only two patients with periosteal reactions, while scintigraphy was positive in all cases.

In the control group, without stress fractures, no associated diseases were detected.

DISCUSSION

Stress fractures are defined as fractures resulting from repetitive and sustained stress over time that exceeds the physiological capacity for adaptation and bone remodeling.[1] They are a known entity with several statistics that are difficult to compare since they allude to the patients’ military training but do not clarify what it entails or provide key parameters such as frequency and intensity. There is also no consensus regarding treatment.

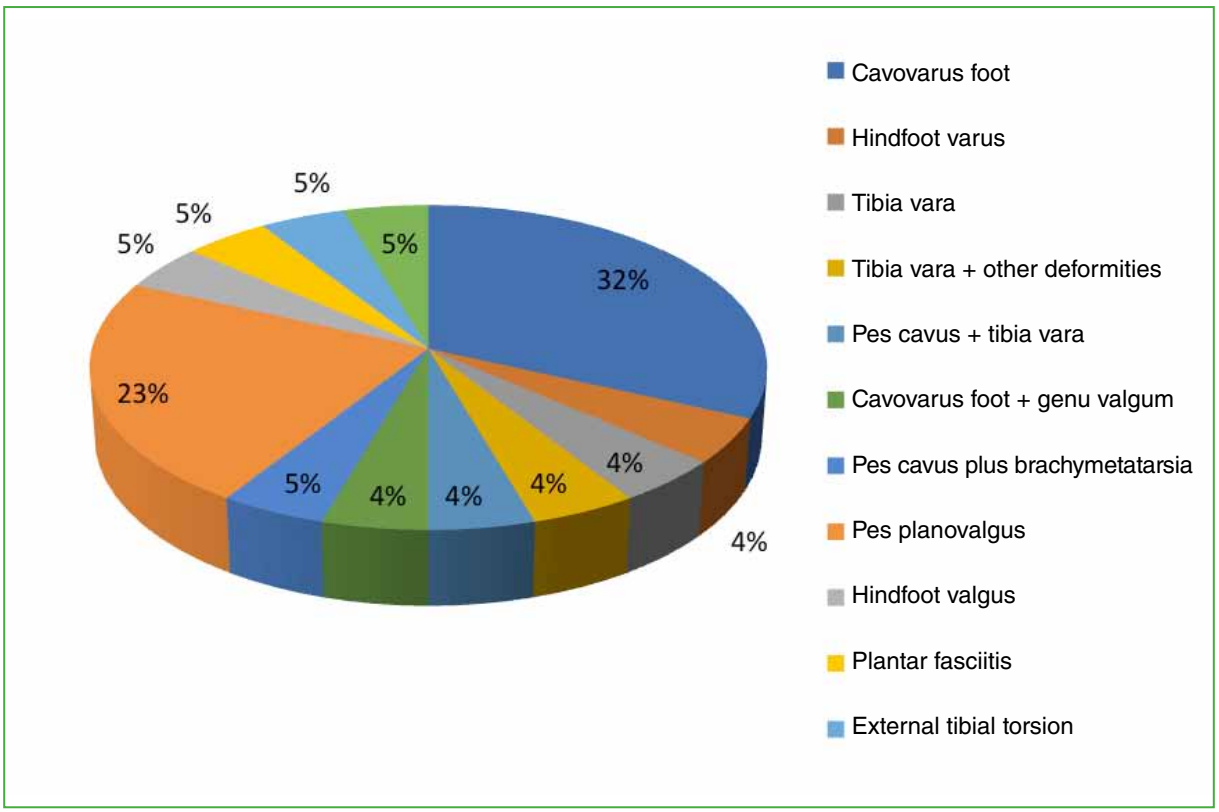

Figure 1. Associated diseases.

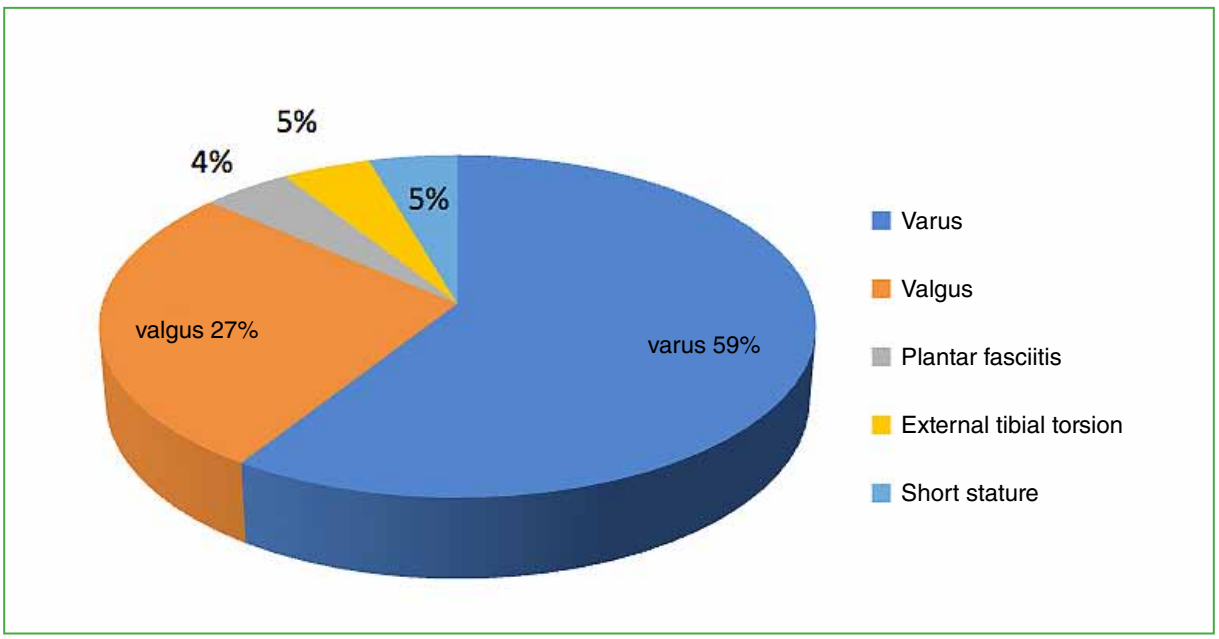

Figure 2. Associated diseases, grouped according to whether they present varus or valgus misalignment, or other components.

According to Devas, there are two types: compression and distraction;[2] however, we must distinguish between stress microfracture and macrofracture.

The clinical presentation is characterized by pain focused on the anterointernal aspect of the tibia,[3] but it may not be clear and it is necessary to know the epidemiology and risk factors of the patient in order not to confuse this condition with others with a similar presentation, such as periostitis and chronic compartment syndrome, which are the main differential diagnoses.[4]

Regarding epidemiology, all authors point out a predominance in recruits, a term that includes personnel recently incorporated into the Armed Forces, who begin a period of military instruction, with intense training and psychophysical demands. The reported incidence of stress fractures in this risk group is 31% (80% in the tibia) and 60% of concomitant asymptomatic contralateral asymptomatic fractures.[5]

There is a clear prevalence of the female sex (2:1),[6] and the findings of our series coincide with this data. This condition is more frequent in military women than in civilians,[6] the prevalence is higher and they suffer a more severe condition, with the same training as men, even in military units with low physical demands.[7]

Regardless of sex, the incidence is higher in patients with thinner tibial cortices[8] or low muscle mass,[8,9] the latter was a generalized finding in our sample.

Regarding ethnicity, in studies conducted in the American and Israeli armies, the incidence was higher in white patients.[10,11] In our series, this comparison was not possible given the ethnic heterogeneity of the sample.

One problem in comparing the results of the studies is that they all refer to military training without detailing it.

Associated diseases is not addressed as a main topic by any published study, but as one of the risk factors,[1] which are multiple and can be classified according to:

- Type of training: they can be found in both civilian and military settings, with the latter being the most relevant predictor.

- Patient characteristics: among the characteristics predisposing to stress fractures, female sex, as already mentioned, is a very important risk factor reported in the literature, which is consistent with the findings of our study. It may be aggravated in women with hormonal disorders and irregular cycles, but there is no evidence that hormonal treatment improves the condition.[6] The triad of eating disorders, menstrual alterations and low bone density is an important predictor of stress fractures in women, increasing the risk by 30-50%.[12] In our series, we were unable to identify patients with disorders of this type, only one reported irregular cycles.

- Dietary factors: in military recruits, the diet is not always sufficient to meet the high metabolic requirements, it is usually rich in carbohydrates and fats, and low in protein.[13] It has been published that low vitamin D intake is a risk factor in the military[13] and civilian populations.[14] Because our research was retrospective, we were unable to conduct hormonal testing or assess the participants' food intake throughout the study period.

- Technical aspects of running: although the technique used for running is beyond the scope of our study, we believe it is important to mention that several authors have evaluated the incidence of technical issues in running and reported that the gait or running pattern is a modifiable risk factor. Those who impact with the heel during running have a higher risk than those who impact with the forefoot.[15]

Not having trained or played sports prior to joining the Force would not raise the likelihood of stress fracture;[16] however, abrupt onset, intensity, and lack of progression might. The remaining risk factors are hard flat footwear without cushioning, such as flat-soled shoes and sneakers, a finding in 29% of patients.

- Associated pathologies: although there is a significant amount of published research on stress fractures in recruits, we were unable to find any studies that focused on associated conditions as the primary topic. In our series, the percentage of patients with stress fractures and associated disease in the lower limbs was high (64.7%), especially in the lower limbs with varus misalignments (Figure 2).

Short stature, progressive weight loss during training and decreased tibial mineral mass in such patients constitute other risk factors.[17] Low muscle mass in the lower limbs was a frequent finding in our series.

Yagi et al.[18] conducted a prospective study in runners, and identified high BMI in women and increased internal rotation of the hip as risk factors. In our series, the impact of high BMI on the incidence of this disease could not be evaluated, because all had a normal or low BMI. Nunns et al.[19] evaluated a large series of Royal Marines, and identified four risk factors predictive of stress fractures, such as lower BMI, smaller bimalleolar width, greater peak heel pressure, and a lower range of tibial rotation during running, but they did not refer to conditions such as those found in our series.

The same is true of many other studies conducted on military personnel, possibly due to the exclusion of personnel with orthopedic conditions.

Hetstroni et al.[20] described foot supination and the protective role of pronation in gait, without mentioning varus as a risk factor; they also indicated that valgus during running is protective against stress fractures.

Other authors, such as Hadid et al.[21] observed that a slender tibia and muscle fatigue in the legs generated greater pressure on the anteromedial cortex of the tibia.

Imaging studies

Radiographs are negative in the early stages, thus if a stress fracture is suspected, scintigraphy or magnetic resonance imaging should be sought to visualize edema in the periosteum, bone, and even fracture lines.[6,22]

Several authors report that the best diagnostic method is Tc-99m scintigraphy,[6,23] a highly sensitive study, but which does not allow the exact site of the fracture to be observed.

Milgrom et al. suggested that, even with positive radiographs, a scintigraphy should be performed, because it may reveal asymptomatic fractures,[5] as was observed in our series.

Among the strengths of our study, we can mention the strict selection and study of the sample and the association of the disease with other comorbidities and not only the running technique or the type of footwear or terrain.

Weaknesses include the retrospective nature of the study, which prevented evaluations of running technique, food intake, and hormone levels.

CONCLUSIONS

Stress fractures are more common in the military population than in the civilian population.

New recruits are more likely to sustain stress fractures.

In the sample studied, a high rate of association with lower limb diseases was found, with a predominance of varus disorders over other conditions.

The rate of associated disease was higher in the female population with stress fractures than in the male population.

We believe that the physical examination of patients with suspected stress fractures should include screening for associated conditions and evaluating therapeutic measures to prevent recurrence.

Conflict of interest: None of the authors have any conflict of interest.

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