Stress fracture and nuclear medicine*

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ABSTRACT

The authors present a case of stress fracture detected by nuclear medicine and describe a brief literature review of the methods of image in the diagnosis and pursuing of this pathology.

Key words: Scintigraphy. Diagnosis. Stress fracture.

INTRODUCTION

Unlike it seems, bone tissue is a structure that presents continuous metabolic activity, whose stability is a result of the balance between lysis and reposition, task performed by osteoclasts and osteoblasts, respectively. Lately, above all in the last two decades, the human being, concerned of maintaining the physical fitness, has practiced sports activities, submitting their skeleton to overloads that sometimes exceed the bone physical-histological strength, according to the modality performed.

The deeper knowledge on the human body physiology has allowed, among other findings, the improved investigation of the causes that may lead to the bone fatigue, regardless its chronological evolution.

The bone structure while submitted to exertions within its capacity to support them, undergoes elastic deformation, recovering its histological configuration as soon as the solicitation stops. However, when these solicitations exceed its regular strength, the elastic deformation is replaced by the plastic deformation; in other words, there is no return to the previous situation and, in case the requirements remain, microfractures occur, thus prevailing the bone reabsorption. In this stage of the stress fracture evolution, a physiological alteration occurs without apparent anatomical involvement[1,2].

The pursuing of the "sportive" requirements, after microfracture initial installing, ends up by leading to a open fracture, this time associated with anatomic modifications of the bone structure. Thus, one may say that the setting up of the stress fracture starts with a physiological alteration; when the cause of this alteration remains, the situation ends up with an anatomic modification[1,2].

The imaging diagnosis techniques, that presented remarkable evolution in these last 25 years, are divided into anatomic and functional procedures, in which the nuclear medicine (NM) and the magnetic resonance (MR) stand out as functional methods, and the other radiological procedures, in which the NM technique is also included, stand out as anatomical methods. The functional-physiological information provided by the NM technique may be considered as wider, reason why this diagnosis technique may present some prevalence on the MR technique at the first stage of the stress fracture investigation[3].

The present work emphasizes the importance of the Nuclear Medicine as a low-cost and easy-to-perform method for the stress fracture diagnosis.

OBJECTIVE

The technology advances on the health area have made many diagnosis procedures available for physicians in general. This case report has as objective to illustrate the choice that the Nuclear Medicine offers to the traumato-orthopedist to investigate bone pain, with no radiological translation, in the athlete patient.

CASE REPORT

Man, 27 years old, Caucasian, marathon runner preparing for competition, who has been running 60 km a week, presented pain at the anterior region of the right leg. The athlete quit physical activities five days after the beginning of the pain situation and searched for medical orientation, when the radiological evaluation was requested. The radiography performed seemed to be normal (image not demonstrated). Due to differences between the clinics the patient mentioned and the radiological findings, the physician requested a three-phase bone scintigraphy, that was performed three days after.

Scintigraphic findings

The scintigraphic images demonstrated slightly increased blood flow towards the right leg (figure 1), with area of higher tracer accumulation at the distal third of the right leg in the phase of vascular balance (figure 2). Finally, in the late phase images, one observes a tracer hyper fixation focal area of moderate intensity at the cortical of the right tibia distal third (figure 3). These findings are in agreement with the stress fracture diagnosis.

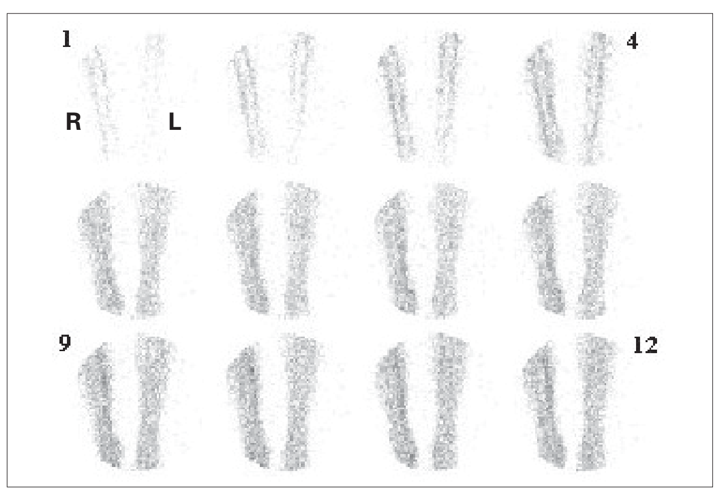

Fig. 1 – Blood flow of lower limbs (distal). Asymmetry with vascular support increased for MID is observed.

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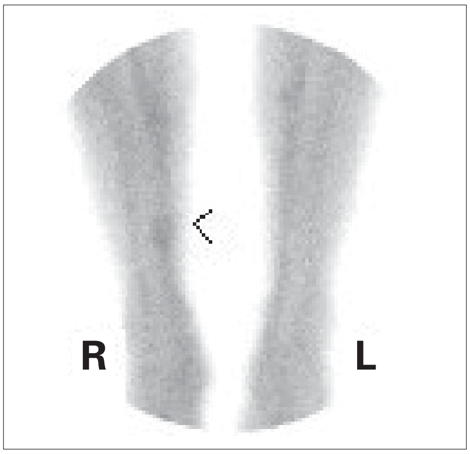

Fig. 2 *– Radiotracer tissular equilibrium phase, where increased concentration area is observed in the medial border of the right tibia (arrow)*

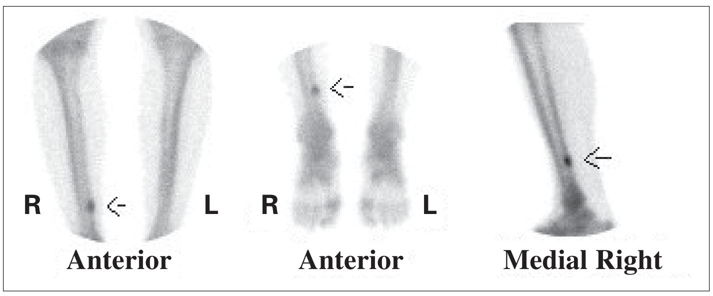

Fig. 3 *– Late images of tibias, where $MDP\text{-}^{99m}Tc$ focal hyper concentration is observed in the medial border of the right tibia, in agreement with the presence of stress fracture*

DISCUSSION

For the athlete, pain in competition level is a common symptom that may be due to several pathologies. The correct and early recognition of this condition through imaging diagnosis methods is vital to select the correct therapeutic procedure to be adopted.

In the simple radiography (X-ray), the stress fracture appears as a radiolucent fracture line, focal sclerosis due to the formation of endosteum callosity, periosteal reaction or as an external callosity[5]. It is a low-cost and easy-to-perform examination; however, it is necessary that changes on the bone density occur in order for the typical stress fracture signals be emphasized. For this reason, around 80% of the stress fractures are not evident with this complementary method in the initial phase[4], and the sensibility increases up to 50% between one and three weeks.

Fredericson *et al.*[7] proposed a classification system for stress injuries based on MR findings, whose alterations of stress fracture are based on periosteal edema, bone medulla edema and fracture line.

In the scintigraphic exam, the stress fracture is usually presented with increased blood flow (from three to four weeks after the beginning of the pain), increase on the tracer concentration at the phase of vascular balance (from six to eight weeks), and focal hyperactivity in the late images, returning to normality between three and six months[8]. Zwas *et al.* proposed a classification of stress fractures, according to the scintigraphic abnormalities, being the most used currently (table 1)[5].

The bone scintigraphy presents high diagnostic sensibility for stress fracture, once it detects the initial phase of the pathology (> 95% of positives in < 24h), when alterations on the bone remodeling are observed[6], reason why it goes before the radiological diagnosis in 7 to 14 days[5], even though with lower specificity when compared with the X-ray[6].

Up to 40% of patients are non-symptomatic and the most common site of stress fracture is the tibia, where it tends to be multifocal in 87% of patients[5], being mostly observed in military and marathon runners (table 2). Stress fracture in the femoral colon, superiorly close to the great trochanter, is more frequent in the elderly and it occurs asymptomatically; however, it must not be ignored due to its high morbidity. For this reason, a more aggressive treatment is indicated in order to avoid development into colon fracture itself. When the location is inferior, close to the small trochanter, site in which the treatment may be more conservative, this type of fracture is more common among young patients[9].

TABLE 1
Stress fractures classification

Classification	Findings
I	Small, focal and well-defined lesion with intermediate increase on the cortical activity.
II	Focal, well-defined lesion presenting higher than I degree, extended with moderate increase on the activity confined to the bone cortex.
III	Large, focal, spindle-shaped lesion presenting high activity involving the cortical and less than half of the bone medulla.
IV	Large and extended lesion presenting intense activity at the cortical-medullary region involving more than half of the bone diameter.
V	Lesion involves 100% of the transcortical-medullary region, being considered as a full stress fracture.

TABLE 2
Main sites of stress fracture in athletes

Patients/Sports	Sites
Marathon runners	distal third of the fibula distal third of the tibia 2nd and 3rd metatarsi
Ballet dancers	fibula medial third of the tibia
Military	proximal and distal third of the tibia 2nd and 3rd metatarsi
Acrobats	fibula
Golf players Tennis players	ribs
Weight lifting Dart throwing	humerus
Fighting	calcaneus
Elderly	sacrum proximal third of the tibia
Children	proximal third of the tibia

McBryde[10] studied 1,000 consecutive stress fracture cases in runners and observed that 20% occurred in metatarsus, and the 2nd and 3rd were involved in 90%.

The main pathologies involved in the differential diagnosis are the periostitis, especially Shin Splint, the Ribbing Disease (Multiple Diaphyseal Sclerosis), the osteonecrosis, the hidden fractures, the insufficiency fractures, the bone tumors and the bone trauma[6,11]. The importance of the MR at the beginning of the investigation lies on its capacity of distinguishing between fracture and other types of lesions, for example, tumors, infection or soft tissue traumatism[3].

On the other hand, one cannot deny that the clinical history, associated to the patient's symptomatic situation, many times allows rejecting some possibilities, if not all, to raise the stress fracture pre-exam probability.

CONCLUSION

The stress fracture is a relatively frequent pathology among poorly conditioned physically athletes or who exercise excessively, whose main symptom is the pain. The lesion site will depend on the activity exercised by the patient. The imaging methods are vital for the diagnosis of this pathology as discussed in the present work, where the precocity and the sensibility of the nuclear medicine are emphasized.

According to the authors of this study and to the above considerations, one may say that considering the complaint frequency and the clinical situation with high probability for stress fracture, the bone scintigraphy is the selected examination, although one may also admit that when some difficulty is observed with regard to the differential diagnosis between this type of lesion and lesions of different origin, the magnetic resonance technique is also a good choice.

It is important to emphasize that the evaluation of the clinical history and the pain complaint, despite all medical technology advancements, still remain the best tools for the diagnostic explanation of many diseases.

All the authors declared there is not any potential conflict of interests regarding this article.

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