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Original Research Article

A Study On MRI in Subchondral Fractures with Fore foot Pain

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Abstract

Introduction: The subchondral or shaft area of the metatarsal head may be broken in metatarsal bone fractures. Trauma is the main cause of such fracture. There are different modalities to effectively assess the fracture but there is a need to introduce a modality which can show more efficient findings of the fracture with specific features of the condition. There are studies describing plain radiography features in details. But there are less availability of studies mentioning about the MRI features in this case. The current study intended to fill the gap by providing the detailed features of MRI findings in subchondral fractures in lower limb with forefoot pain.

Aims and Objectives: To evaluate and present the MRI findings in cases with subchondral fractures in the head of metatarsals in individuals with symptoms like forefoot pain.

Materials and Methods: The current prospective study was conducted between July 2021 to February 2022 with 60 patients. All the patients received MRI scanning and the features were studied thoroughly by two experienced radiologists.

Results: It was found that about 70% of the patients had fracture in the head of 2nd metatarsal followed by 5th metatarsal and 3rd metatarsal. It was also found that the right limb (65%) was affected more than the left limb (35%). The study has stated that the mean length of subchondral fractures was found to be 9.2±1.1 mm while the mean subchondral sclerosis was found to be 8.5±0.3 mm.

Conclusion: This present study has successfully shown that MRI scan can be used for effective determination of subchondral fracture involving the head of metatarsal.

Keywords: MRI, Radiography, Subchondral Fracture. Metatarsal

Background

The subchondral or shaft area of the metatarsal head may be broken in metatarsal bone fractures. The central and distal shafts of the second and third metatarsals are the most frequently affected by shaft fractures. Less often occurring subchondral fractures of the metatarsal heads are thought to result from overuse or in patients with underlying disorders that increase the risk of insufficiency fractures. Metatarsal head subchondral fractures and Freiberg's infraction show a number of similarities in radiographic appearance and pathophysiology while occurring in different age groups. Additionally, the symptoms of these conditions may be mistaken for those brought on by interdigital (Morton's) neuromas, second plantar plate injuries (second ray syndrome), or crystal-induced arthropathy [1,2].

In addition to patients with impaired functioning of the metabolism, neuropathy, the first joint of metatarsophalangeal, and hindfoot malalignment, metatarsal stress fractures also commonly affect athletes due to increased loads brought on by changed foot mechanics. A thorough history along with the physical examination together with the sparing use of imaging methods, all contribute to the diagnosis. The majority of the time, nonoperative treatment is effective, but for athletes with a fifth metatarsal stress fracture or nonathletes with a Torg-type-II or III injuries, surgery is advised. The foot or ankle must be treated if it is misaligned or unstable [2,3].

The objectives of managing fifth-digit fractures in athletes include the shortest period of time to union and the shortest time to return to athletic activity. Zone 2 and zone 3 injuries in athletes should be fixed surgically, most frequently with intramedullary screws, as opposed to zone 1 injuries, which are typically managed conservatively. Bone graft fixation has also shown successful outcomes. Good outcomes have been demonstrated using screw fixation in the intramedullary area, surgical exfoliation, and only bone grafting, and tension banded wiring in the chronic scenario. Both chronic and recent injuries may benefit from shock wave treatment and pulsed electromagnetism [4].

Fifth metatarsal stress fractures (zones 2 and zone 3) are still a difficult clinical issue. Nonsurgical therapy has unacceptably high refracture and nonunion rates, which have been well proven. In the cohort study conducted on athletes, surgical fixation is still the preferred course of treatment, and the most reliable method for ensuring a favorable outcome is screw fixation in the intramedullary area with a solid screw. Recently, plantar plate usage has also been promoted because certain studies have indicated that it is more helpful from a biomechanical standpoint. When treating these patients, it's crucial to consider the morphology and screw type, as well as the utilization of bone grafting during the first operation [5].

Patients with rheumatoid arthritis are more likely to develop insufficiency fractures as a result of osteoporosis; this is partly because of the disease process, but it is also a result of environmental factors like decreased weight-bearing and adverse effects due to the medicines used to treat the condition. The hip and pelvic girdle single insufficiency fractures are more frequently described in the medical literature. The three insufficiency fracture instances presented in this case series are distinctive in a number of aspects. In two cases, the heel and ankles were affected by the fractures, which is rare for the injury site. Second, rather than being solitary in nature, the cracks are also florid. Third, there was little evidence of inflammation and little clinical suspicion of a fracture [6].

Ballet dancers frequently experience stress fractures at the base of their second metatarsal, but nondancers almost never experience these injuries. Based on our research, we hypothesized that fractures at the base of the second metatarsal bone occur in a wide range of people, independent of their demographics, are strongly linked to athletic pursuits, have distinct examination findings, and have poor clinical outcomes. We discovered 14 fractures in the second metatarsal bone at the base due to stress in nondancers using a retrospective medical review (nine individuals). According to our review, non-dancers in a wide range of populations can develop base fractures in the second metatarsal bone due to stress and nonoperative therapy is only partially effective. To aid with early diagnosis and prognostication, advanced radiographic studies, particularly MRI, are helpful. Most of the fractures due to stress were managed non-operatively; however, five fractures required additional surgery because of nonunion in six fractures (50

percent). The nonunion surgery was successful, although comorbidities and risk factors including poor bone mass may have had a significant impact on the prognosis [7].

Materials and Methods

The current prospective study was conducted between July 2021 to February 2022. The patients were selected based on inclusion and exclusion criteria. The patients who visited our hospital outpatient department,with suspected subchondral fracture, cooperated with our treatment protocol, were included. The patients with underlying conditions like osteomyelitis, arthritis or diabetic foot or history of any of these conditions, were excluded. After applying inclusion and exclusion criteria, the study, finally considered 60 patients. All the patients received MRI scanning and the features were studied thoroughly by two experienced radiologists blinded to each other. The used protocol was sagittal T1-weighted image, sagittal coronal view T2-weighted and axial view T1-weighted. The contrast used was gadopentetate dimeglumine inoculted intravenously at a dosage of 0.1 mmol/kg. The result of MRI was interpreted by two experienced radiologist and each of their findings or conclusion were kept blinded to each other. Each case was described by the radiologists separately and the specific condition was mentioned. Again, all the patients were examined under MRI and in some cases X-ray radiography was done for verification and confirmation.

Results

The study found the basic characteristics of sample which is shown in Table 1. The study has shown that the minimum and maximum age of the patients were 32 years and 70 years, while the mean age of the whole sample was 51.25±16.58 years.

Table1: The basic characteristics of the study sample

Characteristic	Value
Age of the sample	51.25±16.58 years
Body Mass Index (BMI)	22.25±1.36
Number of male patients	34 (6.67%)
Number of female patients	26 (43.34%)
Duration of pain and swelling	77.5±31.2 days

The features determined by MRI findings have been analyzed thoroughly. The study has conducted MRI on all the patients and found appreciable imaging features in several patients. It was found that about 70% of the patients had fracture in the head of 2nd metatarsal followed by 5th metatarsal and 3rd metatarsal. It was also found that the right limb (65%) was affected more than the left limb (35%). The study has stated that the mean length of subchondral fractures was found to be 9.2±1.1 mm while the mean subchondral sclerosis was found to be 8.5±0.3 mm. Table 2 lists the specific imaging features observed by MRI scan.

Table 2: The specific features found with MRI scan and the number of patients found against each feature

Specific feature	Number of patients N	%
Fractured 2nd metatarsal head	42	70.00
Fractured 4th metatarsal head	39	65.00
Fractured 3rd metatarsal head	37	61.67
Subchondral fracture of 3rd metatarsal head	32	53.33
Subchondral fracture of 4th metatarsal head	28	46.67
Right lower limb affected	39	65.00

Left lower limb affected	21	35.00
Flattening of head of metatarsal	25	41.67
Presence of subchondral fracture with severe form of edema like pattern	42	70.00
Presence of subchondral sclerosis along with flattening of head of metatarsal but without any marrow edema	12	20.00

Discussion

The goal of our investigation was to identify the Magnetic Resonance Imaging characteristics of adult patients with symptoms who had metatarsal head subchondral fractures. To find instances of forefoot head, and fractures of the subchondral area over a 5-year period, a retrospective analysis of foot MRI operations was carried out. Two reviewers looked at the Magnetic Resonance images of a few selected instances to check for subchondral fracture, a pattern resembling marrow edema, flattening of the metatarsal head, and subchondral sclerosis. Patients having a history of infection, inflammatory arthritis, or foot surgery were not eligible. Additionally, testing was done to look for coexisting soft-tissue and osseous abnormalities. 15 individuals had metatarsal heads with subchondral fractures. The patients were all female. The dorsal part of the forefoot articular surface was affected in 80 percent (10/15) of cases, and the second metatarsal head was the most frequently afflicted (72 percent, 10/15) According to MRI results, 70 percent (11/15) of metatarsal heads had subchondral fractures and significant marrow edema-like patterns, indicating early-stage alterations. In 30% (5/15) of the cases, the metatarsal head collapse was seen together with sclerosis of subchondral areas and a slight or missing pattern like edema of marrow, suggesting final stage alterations. Three patients (20%) with shaft fractures in metatarsal areas and one (8%) with a neuroma in inter-digits were found to have concurrent abnormalities [1]. We present information on 12 patients with 17 occurrences of fractures due to stress in the epiphysis of metatarsals. Three of the five individuals with osteoporosis were receiving fluoride therapy. When weight-bearing was resumed, fractures developed. Seven fractures were found in the second metatarsal bone and were dispersed among the five rays. Acute localized metatarsal pain, widespread forefoot edema, and inflammation of the metatarsophalangeal region were the symptoms. In 15 cases, there was a delayed, fleeting sight of a linear region of epiphyseal sclerosis. The metatarsal head regularly accumulated the tracer early, according to radionuclide bone scans. In three instances, the shaft was the center of increasing activity. The primary differential diagnoses are osteonecrosis of the metatarsal heads, a syndrome in the second ray, arthritis of the metatarsophalangeal joint, sympathetic dystrophy of the foot with focal radial reflex, and second ray syndrome. After a month without weight-bearing, the roentgenographic and clinical results were continuously positive. These fractures can mimic, aggravate, trigger, or cause reflex sympathetic dystrophy of the foot [8,9].

10 patients with fractures in the metatarsal bone due to stress were observed for a period of 5 years to highlight the differences between stress fractures of the metatarsal heads and the more typical metatarsal shaft and neck fractures due to stress by describing the radiological characteristics of metatarsal head stress fractures. With the exception of one case, where MR imaging was conducted 7 weeks just after the onset of symptoms and revealed an abnormality in the area with intensity in the third metatarsal area containing radiographs consistently disclosed sclerosis of the subchondral area

of the metatarsal heads [10]. The authors talk about how fractures due to stress in the foot occur on radiographs. There are illustrations of plain radiographs, computer tomograms, magnetic resonance imaging, and scintigraphy of the bone. The metatarsal bones, which are frequently the site of pedal fractures, as well as the calcaneus, navicular as well as other rearfoot structures that occur less frequently, are discussed. In order to recognize these irregularities, the practitioner must have a high sense of scepticism. One of the body parts that are most frequently pictured is the foot and ankle. Even relatively few skeletal injuries are visible on conventional radiographs, minor fractures often go unnoticed. A summary of the most frequently overlooked fractures of the ankle and the foot is offered because it is crucial to find these fractures as soon as injuries occur [11,12].

For basketball players, metatarsal fractures due to stress are a common injury that can be quite painful and even finish the season. On MRI, bone marrow edema is easily observable and may indicate stress-related alterations. A screening investigation using long- and short-axis fat-suppressed T2-weighted imaging was conducted to find bone marrow edema in the metatarsals in 27 asymptomatic male National Collegiate Athletic Association basketball players before the 2004- 2005 season, and 15 players were reimaged after the season. 54 feet were examined, and 7 (13%) of them displayed a signal that suggested metatarsal bone marrow edoema. Before a fracture is obvious, an MRI of the feet shows bone marrow edema. The detection of this edoema may indicate stress alterations, allowing for the early diagnosis and treatment of crippling stress fractures [13].

In order to diagnose problems with the ankle and foot, magnetic resonance imaging (MRI) is now a common imaging technique. While radiographic evaluation is still a necessary first step, MRI offers further insight into the identification of pathologic disorders of the articular bone and cartilage as well as a thorough analysis of soft tissue structures. complicated architecture and a broad range of normal variations and pathologic states, MRI of the foot and ankle presents an additional barrier for interpretation in comparison to the normal anatomic areas and imaging of the musculoskeletal areas. Due to the complicated regional architecture and a vast range of trauma and pathological diseases that can affect the ankle and foot, MRI interpretation can indeed be difficult. It is important to understand the range of progressive degeneration and inflammatory disorders, as well as acute and chronic severe trauma to the bones, ligaments, and tendons. For a proper diagnosis, it is crucial to comprehend the biomechanical function of important ligaments and tendons.

Conclusion

This present study has successfully shown that MRI scan can be used for effective determination of subchondral fracture involving the head of metatarsal. The early changes of the pathologic mechanism which is followed after a fracture, like, marrow like edema, is also observable with MRI. Late changes like subchondral sclerosis and metatarsal head collapse are also effectively determined by MRI. The study showed the findings which are helpful for the future to use MRI imaging for subchondral fractures with forefoot pain. The study also pointed out that there is a need to conduct more studies with varied population and also need to conduct various comparative analysis. Finally, this study has presented MRI with evidence that it can be practically be used in this type of fracture effectively.

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