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Role of Magnetic Resonance Imaging in Evaluation of Hip and Groin Sports-related Injuries

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Magnetic Resonance Imaging (MRI) proved to be highly accurate imaging modality allows clear differentiation of the normal anatomic features of the hip. In addition to that it allows clear differentiation of the individual component of the normal joint from one another. The purpose of this work was to diagnose sports-related injuries of hip and groin using MR imaging with different sequences.
Methods: This prospective study was carried out on59 athletic subjects presented clinically with different hip or groin joint complaints, both sexes within adult age. All patients were subjected to clinical examination, imaging (conventional radiography of both hips were performed mostly in antero-posterior and lateral views to detect fractures, dislocations, bony lesions or soft tissue swelling), MRI examinations and image analysis.
Results: There was significant difference between MRI type of injuries and different age groups of studied sportive patient. MRI show lesion in 59 cases in comparison to X-ray which has less sensitivity as 46 case has negative results show lesions in MRI.
Conclusions: MRI of the hip has established to be the gold standard for the diagnosis of sports-related hip and groin injuries in the setting of negative radiographs, also it can determine early signs of stress fracture before it appear in X-ray. so, more details about different lesions can be obtained from MRI and This help in accurate diagnosis, rapid treatment of different athlete lesions and determine time plane of returning to the sport by follow up imaging.

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Keywords: Magnetic resonance imaging; evaluation of hip and groin; sports- related injuries.

1. INTRODUCTION

Groin is the region between the abdomen and the legs, groin and hip pain in Athletes is one of the most diffecult clinical entities to diagnose and treat in sports medicine. This is due to the amount of differential diagnoses and the complexity of the groin and hip region's anatomy, where many structures interact [1].

The understanding, assessment, and management of hip and groin pain in athletes have improved significantly over the last decade. In the past, the assessment of hip pain and groin injuries were limited to obvious disorders. The progress have improved awareness of the complexities of groin and hip athletic injuries, as well as the biomechanical basis for recent hip abnormalities [2].

Magnetic Resonance Imaging (MRI) proved to be highly accurate imaging modality allows clear differentiation of the normal anatomic features of the hip. In addition to that it allows clear differentiation of the individual component of the normal joint from one another. As MRI allows identification of the muscles, bone marrow, cortex, fascia, vessels and nerves with high contrast between them. Although MRI has no ionizing radiation and thus no biological hazards have been identified [3].

Radiology is play a critical role in guiding the monitoring of athletic injuries. It is essential to understand the benefits and drawbacks of imaging modalities as it helps in accurate and timely diagnosis.

MRI is the best evaluation technique for the different injuries, Despite the fact that the initial evaluation with conventional radiography and the use of other imaging techniques as ultrasonography (US), computed tomography, and bone scintigraphy may be helpful or preferred in certain cases [4].

Because the hips are major weight-bearing joints, athletes depend on them to perform well in their respective sports activities. Hip pain is a frequent complaint among athletes as a result of acute and chronic injuries affecting the hip.

Recent progress in imaging approaches aid radiologists in their understanding of hip anatomy, biomechanics, and pathologic conditions, thereby assisting our orthopaedic surgeon colleagues in the early management of these cases [4].

The purpose of this study was to diagnose sports-related injuries of hip and groin using MR imaging with different sequences.

2. PATIENTS AND METHODS

This was aprospective study that carried out on 59 athletic cases presented clinically with different hip or groin joint complaints, both sexes within adult age.

Exclusion criteria: Participants who hadn't sport injury, history of hip trauma, hip joint malignancy, contraindicated to MRI, with metal implants, such as hip replacements, vascular clips, or foreign bodies and those who suffer from severe claustrophobia may be unable to tolerate an MRI scan, although more open scanners are now available, and medical sedation (which is not needed in our study) is avilable of making the test more bearable.

2.1 All Patients were Subjected to

Full history taking, clinical examination, imaging (conventional radiography of both hips were performed mostly in antero-posterior and lateral views to detect fractures, dislocations, bony lesions or soft tissue swelling), MRI examinations and image analysis.

2.2 MRI Protocols

Both hips were examined for suspected bilateral deformities using the body coil with a wide field of view to determine the extent of the lesions and to enable for comparison between the normal and abnormal sides. The thickness of the slices was adjusted to be between 4 and 8mm, and thinner slices were used when additional detail was needed. Scout observe of the hip: In all cases, a coronal TI weighted image was taken to aid in the localization of subsequent slices of various planes and to delineate the anatomy. A repetition time (TR) < 800 msec, an echo time (TE) < 30 msec, a slice thickness of 4-8 mm, FOV= 30-40 cm. Coronal and Axial T1 weighted spin echo images: A repetition time (TR) < 800 msec, an echo time (TE) < 30 msec, a slice thickness of 4-8 mm, FOV= 30-40 cm. Sagittal, axial and coronal T2 weighted spin echo images:

repetition time (TR) >2000 msec, an echo time (TE) > 60 msec, a slice thickness of 4-8 mm, FOV= 30-40 cm. Coronal and axial STIR (short time inversion recovery) weighted images: A repetition time (TR) > 2000 msec, an echo time (TE) > 30 msec, a slice thickness of 4-8 mm, FOV= 30-40 cm.

2.3 Image Analysis

Interpretation was done regarding assessment of the followings: hip joint alignment on both sides to determine femoral head acetabular articulation and exclude femoral head dislocation. Femoral heads regarding size, shape and the signal intensity. Femoral head marrow signal intensity was estimated in both T1 & T2WIS and graded as normal, increased or decreased judged relative to the contralateral femoral head. The joint space for presence or absence of joint effusion and is graded into mild, moderate and severe as in labrum tear. The pelvic bones and the upper femur, for exclusion of any bone fractures, edema and abnormal shape and assess the signal intensity of the bone marrow and evaluate any abnormal signal in all pulse sequences. The periarticular soft tissues for any abnormal signal or any abnormal swelling. The surrounding muscles and intra pelvic soft tissue structures for the presence of any abnormal signal for exclusion of muscle tear, contusion or strain.

2.4 Statistical Method

The data were arranged, tabulated and statistically analyzed by SPSS software (Statistical Package for the Social Sciences, version 21, SPSS Inc. Chicago, IL, USA). The range, mean, and standard deviation were calculated for quantitative data. For qualitative data, which characterize a categorical set of data by the frequency, percentage, or proportion of each category, the Chi-square test was used to compare two groups and more. Significance was accepted at $p<0.05$ for explanation of results of tests of significance.

3. RESULTS

Table 1 showed patient characteristics of the studied patients.

Table 2 showed MRI types of injuries found in 59 studied sportive patients.

Table 1. Age, sex and affected side of the studied patients who play sports and presented with persistent or recurrent hip or groin pain (n=59)

Variables		The studied patients (n=59)
Sex	**Female**	25(42.4%)
	Male	34(57.6%)
Age years	14-18	9(15.3%)
	>18-25	16(27.1%)
	>25-45	22(37.3%)
	>45-65	12(20.3%)
	Range	14-65
	Mean±SD	31.37±13.40
	Median	30.00
Side affected	Right	32(54.2%)
	Left	21(35.6%)
	Right & left	6(10.2%)

Data are represented by mean± SD or number (%)

Table 2. MRI types of injuries found in 59 studied sportive patients

MRI types of injuries	The studied patients (n=59)
Bone injuries	14(23.7%)
Joint injuries	6(10.2%)
Muscle injuries	36(61.0%)
Bone and muscle injuries	1(1.7%)
Joint and muscle injuries	2(3.4%)

Data are represented by number (%)

Table 3. Relation between MRI type of injuries and different age groups of studied sportive patients (n=59)

MRI types of injuries found in studied patients	Age years of the studied patients (n=59)				χ^2	P
	14-18 (n=9)	>18-25 (n=16)	>25-45 (n=22)	>45-65 (n=12)	35.984	0.0001*
Bone injuries	6(66.7%)	6(37.5%)	0(0%)	2(16.7%)		
Bone and muscle injuries	1(11.1%)	0(0%)	0(0%)	0(0%)		
Joint injuries	0(0%)	0(0%)	6(27.3%)	0(0%)		
Muscle injuries	2(22.2%)	10(62.5%)	14(63.6%)	10(83.3%)		
Joint and muscle injuries	0(0%)	0(0%)	2(9.1%)	0(0%)		

**: Statistically significant at p ≤ 0.05, Data are represented by number (%)*

Table 4. Final detailed diagnosis of lesions by MRI of the studied patients who play sports and presented with persistent or recurrent hip or groin pain (n=59) and Relation between final MRI finding and X-ray finding in 59 sportive patients with painful hip

Final MRI finding in investigated patients	The incidence (n=62)	
bone injuries:	**(n=15)**	
Anterior inferior iliac spine avulsion	6(40.0%)	
Femoral neck stress fracture	4(26.7%)	
Greater trochantric fracture	2(13.3%)	
Anterior superior iliac spine avulsion	1(6.7%)	
Thigh splint (Adductor insertion Avulsion)	2(13.3%)	
Joint injuries:	**(n=8)**	
Femero - acetabular impingment	2(25.0%)	
Labrum tear	6(75.0%)	
Muscle injuries:	**(n=39)**	
Greater trochanter syndrome	12(30.8%)	
Muscle contusion	2(5.1%)	
Snapping hip syndrome	2(5.1%)	
athletic publagia	12(30.8%)	
Strain	11(28.2%)	
Final MRI finding in investigated patients	**Patient do X –ray n=59**	
	Positive X- ray n=13	**Negative X-ray n=46**
Anterior inferior iliac spine avulsion	5	1
Femoral neck stress fracture	1	3
Greater trochantric fracture	2	0
Anterior superior iliac spine avulsion with muscle strain	1	0
Thigh splint (Adductor insertion Avulsion)	2	0
Femero - acetabular impingment	1	1
Labrum tear	0	4
Labrum tear with muscle strain	0	2
Greater trochanter syndrome	0	12
Muscle contusion	0	2
Snapping hip syndrome	0	2
Athletic publagia	0	12
Muscle Strain	1	7

Data are represented by number (%), MRI: Magnetic Resonance Imaging

Table 5. MRI signs in different sequences in investigated sportive patient with painful hip

MRI	T1 weighted image	T2weighted image	STIR image	No. of cases
Bone marrow edema	Hypo intense	Hyper intense	Hyper intense	25
Fracture line	Hypo intense	Hypo intense Surrounded by high signal	Hypo intense Surrounded by high signal	11
Muscle strain	Hypo intense	Hyper intense	Hyper intense	23
Grade 1: edema	Hypo intense	Hyper intense with partial retracted	Hyper intense with partial retracted	3
Grade 2: partial tear	Hypo intense	fiber	fiber	16
Grade3: complete tear		Hyper intense with complete retracted muscle	Hyper intense with complete retracted muscle	4
Tendnosis	Hypo intense	Hyper intense	Hyper intense	14
Intermuscular hemorrage	Hypo intense	Hyper intense	Hyper intense	7
Labrum tear	Non- specific labrum hypo intense in T1	Hyper intense area within hypointense labrum	Hyper intense area within hypointense labrum	6
Joint effusion	Hypo intense	Hyper intense	Hyper intense	11

There was significant difference between MRI type of injuries and different age groups of studied sportive patient. Table 3.

Table 4 showed final detailed diagnosis of lesions by MRI of the studied patients who play sports and presented with persistent or recurrent hip or groin pain and relation between final MRI finding and X-ray finding in 59 sportive patients with painful hip (n=59).

Table 5 show MRI signs in different sequences in investigated sportive patient with painful hip.

MRI show lesion in 59 cases in comparison to X-ray which has less sensitivity as 46 case has negative results show lesions in MRI These data are shown in Fig. 1.

Male contact athletes aged 32y and had direct kick in hip, he presented with pain extending to thigh and increase with movement Fig. 2.

Male football player aged 32y and had sudden onset of hip and groin pain during heavy exercise for 3 days Fig. 3.

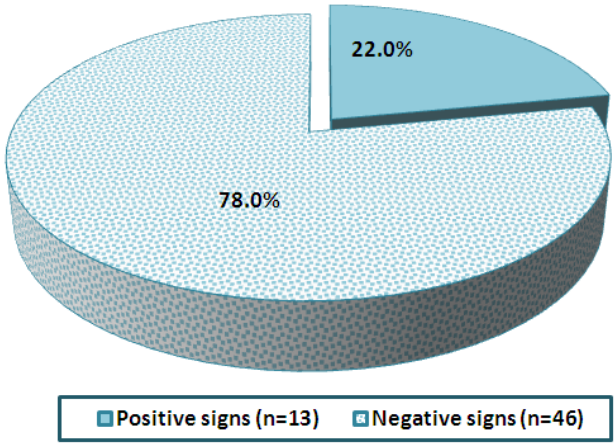


Fig. 1. X-ray finding among the studied sportive patients who presented with persistent or recurrent hip or groin pain (n=59)

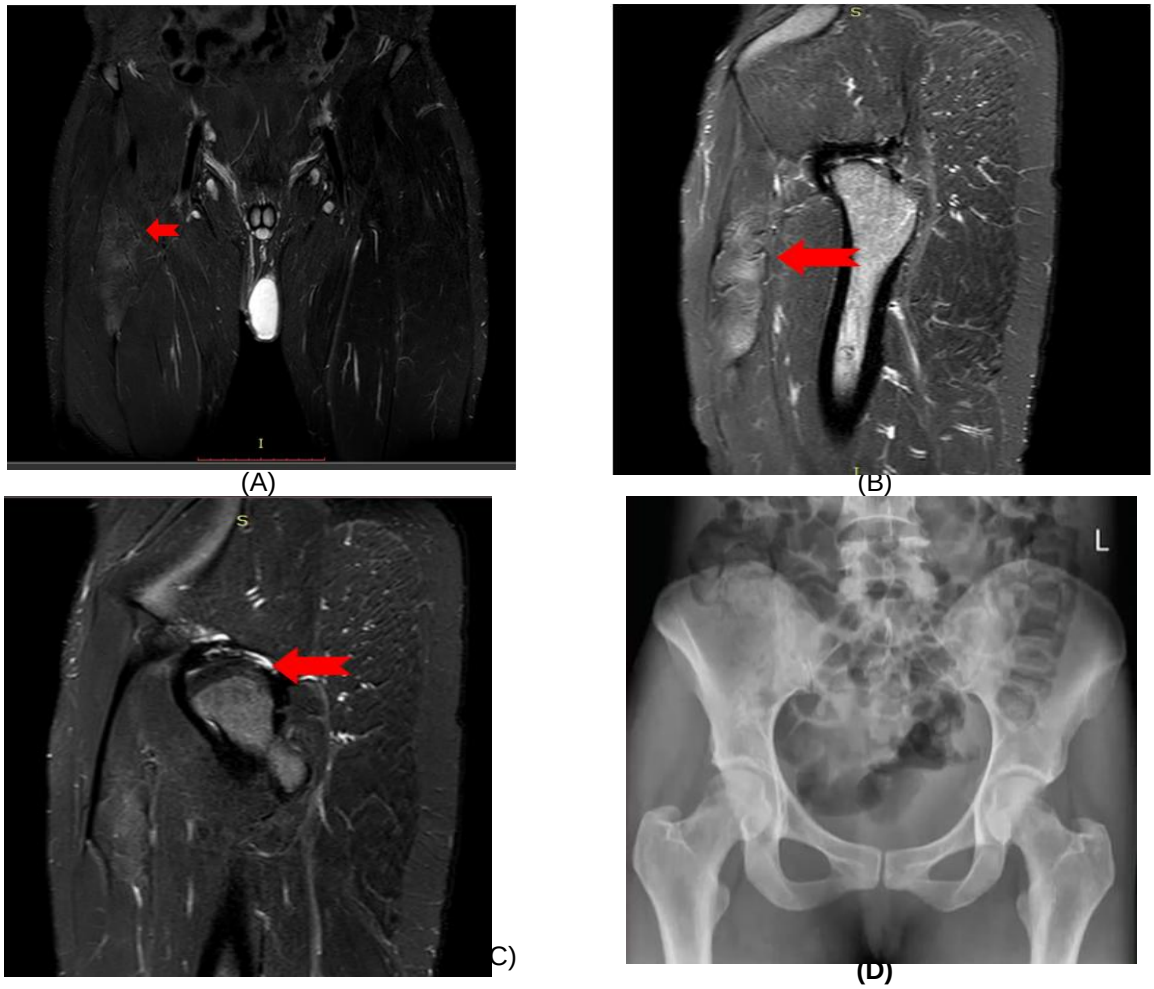
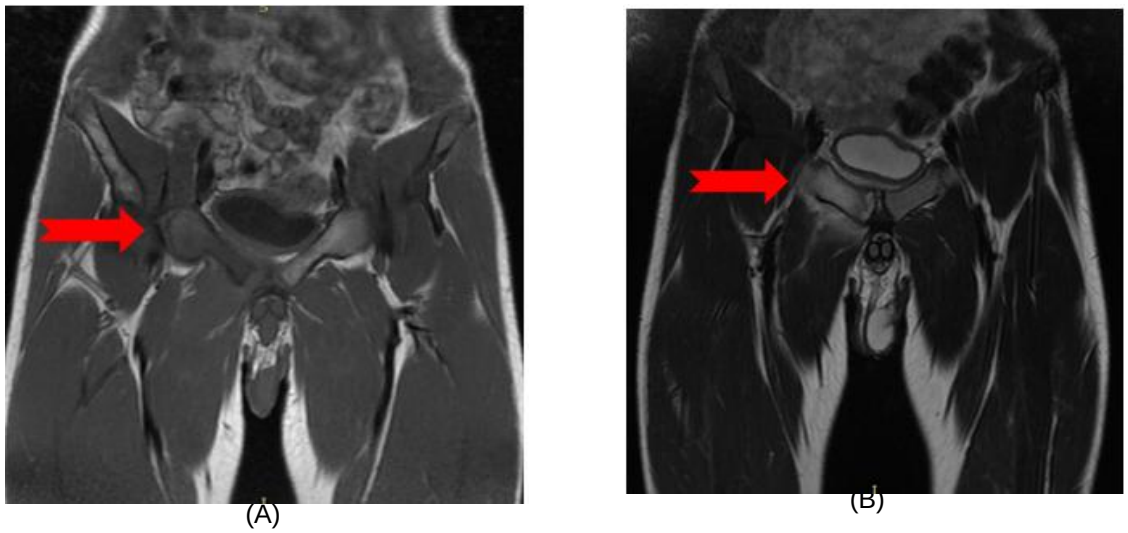
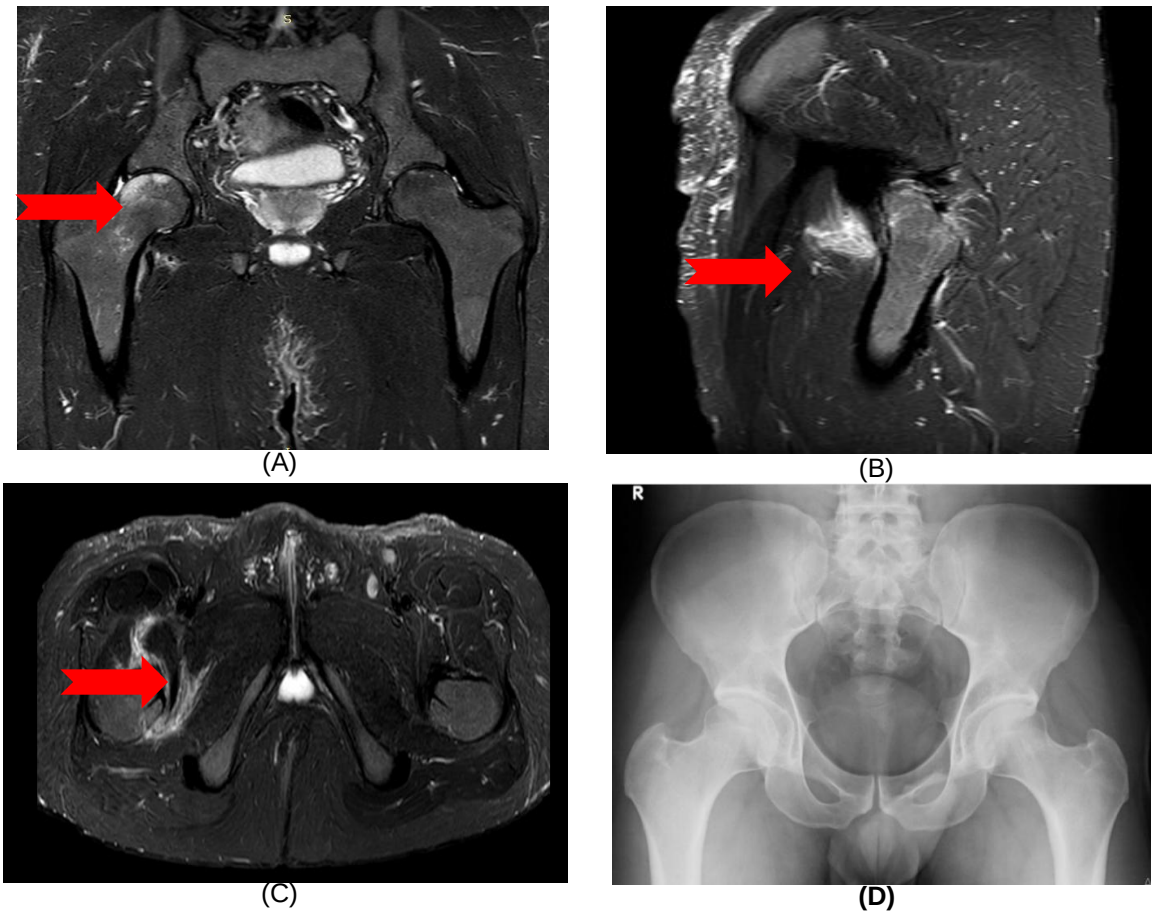


Fig. 2. (A) coronal image show the right rectus femoris muscle shows abnormal signal intensity of its proximal third, displaying high signal at the T2 & STIR WIs, with minimal peri-fascial collection. pictures suggest of grade II muscle strain of the right rectus femoris muscle. (B) sagittal STIR image on right hip shows high signal in rectus femoris muscle strain grade II. (C) sagittal STIR image shows high signal at superior lateral joint space represent labrum tear. (D) x ray on pelvis show normal finding



(C) (D)

Fig. 3. (A, B) and (C) coronal T1 FSE, coronal T2 and axial STIR show low signal intensity in right pupic ramus in an image and high signal in b. there is high signal in right adductor muscles mainly adductor magnus seen in image. (D) x ray on pelvis show normal finding



(A) (B)

(C) **(D)**

Fig. 4. (A) coronal STIR image, the right femoral head shows an ill-defined area of abnormal signal intensity involving the sub-cortical region, displaying high signal with overlying cortical irregularity and Minimal amount of joint effusion is noted represent femur head contusion. (B and C) sagittal and axial STIR image show right vastus intermedius muscle display areas of high signal grade II muscle strain. (D) x ray on pelvis shows normal finding

Male football player aged 21y complain of sudden onset of hip pain since 4 days accidentally occurred by direct contact with knee of another player.

4. DISCUSSION

Hip and groin pain is an usual complaint among all ages of athletes and has been estimated to account for 5% to 6% of all types of sports injuries. Hip and groin pain are frequently caused by a combination of factors, including bony and soft tissue abnormalities that can occur intra- or extra-articularly in both acute and chronic situations of overuse [5].

In this study according to MRI types of injuries there are 62 lesions in 59 patients, 14 patients showed bone injuries (23.7 %), 6 patients with joint injuries (10.2%) and 36 patients with muscle injuries (61%), Some of patient had multiple injuries 1 patient had bone and muscle injuries (1.7%) and 2 patient had joint and muscle injuries (3.4%). This result showed that muscular injuries which represent extra-articular injuries is the most common lesion in 39 patients (66.1%) .

This agree with Chan et al. [6] who had study showed that the majority of the injuries were mild to moderate and the most frequently occurring ones were abrasion (37%), contusion (21%), cramp (20%), sprains (9%), and strains (7%). All represent 94% and mostly include muscles and only 8% had severe injuries include other types like fractures.

Comparison between MRI types of injuries and different age groups showed that out of 47 patients within age group 14 - 45 ys (n=12 patients,25.5 %) had bone injuries , (n=26 patients, 55.3 %) had muscle injuries, (n=6 patients, 12.8%) had joint injuries, (n=2 patients , 4.3%) of them had joint and muscle injuries and (n=1 patient, 2.1%) of them had bone and muscle injuries the most prevalent lesions were muscle injuries.

Out of 12 patients within age group > 45-65 ys (n=2 patients, 16.7 %) had bone injuries and (n=10 patients , 83.3 %) had muscle injury and also this showed that the most prevalent lesions were muscle injuries.

In our study, we noticed that: Muscle injuries is the most common lesion represent 39 of 59 patients (66.1%) with this lesions and this showed that strain represent 59% of muscular injuries and 39% of all injuries so it was the commonest lesion within athlete group.

This agree with Kumaravel et al. [7] who had MRI study on American football player at the high school level and at the collegiate level and found that the large proportion of all American football injuries are muscular. Strains of muscle represent 12–24% of all high school injuries [and approximately 20% of all collegiate practice injuries. Approximately half of all muscle strains occur in the thigh. The hamstrings, hip flexors, and quadriceps were the most frequently injured muscles during the New York Giants training camp, in decreasing order of incidence.

Bone injuries had higher incidence in age group 14-18 with total cases 7cases out of 9 patients in this group (77.8%) and in Final detailed diagnosis of lesions by MRI the most common lesion in bone category was AIIS .

This agree with Yeager et al. [8] who had study on Pelvic Avulsion Injuries in the Adolescent Athlete that showed high rate of this type of injuries within old adolescent boys. in review of 228 pediatric pelvic avulsion fractures, It was established that 49% were AIIS avulsions and that the most frequently occurring mechanism was running (39 %).

8 patients had joint injuries found in 59 studied sportive patients most lesions were labrum tear 6 cases represent 10.2% of total cases. This not agree with Narvani et al. [9] who had published a report on the prevalence of acetabular labrum tears in athletes suffering from groin pain and showed that in four out of eighteen athletes (22%) had acetabular labrum tear and this difference in result due to use higher modality MR arthrography that more sensitive than MRI in labrum tear detection.

In our study, MRI finding in 59 investigated patients ; 15 patient with bone lesions show AIIS avulsion in 6 cases 40%, stress neck fracture in 4 case 26.7 %, greater trochanteric fracture in 2 case 13.3 %, ASIS avulsion in 1 case 6.7 % and Thigh splint (Adductor insertion Avulsion) in 2 case 13.3%. as most bone lesion include fracture or avulsion we find that conventional radiograph positive in all cases except 4 cases : 1case showed non- healed AIIS avulsion fracture show non-healed fracture line in T1 weighted image and 3 cases of early signs of stress fracture showed grade 1 to 2 edoema of the bone marrow

with hyper intense signal in T2 weighted image and STIR image.

8 patient had joint lesions showed labrum tear in 6 case 75% and FAI in 2 case 25 % all patient has MRI signs and negative conventional radiograph except 1case of FAI which had positive X-ray signs.

39 patient had muscular lesions showed Greater trochanter syndrome in 12 cases 30.8%, Muscle contusion in 2 case 5.1%, Snapping hip syndrome in 2case 5.1%, Strain of athletic publagia in 12 cases 30.8% and Strain in 11 cases 28.2%. all had negative X-ray except 1case showed soft tissue shadow by X-ray and complete muscular tear with hematoma in MRI.

In our study, out of 59 patient with MRI lesions only 13 patients (22%) had positive sign in conventional radiograph include; bone lesion 11 of 13 (84.6%) case with fractures,1 of 13 (7.7%) case in joint lesions had FAI and 1 of 13 (7.7%) case in muscle lesion had complete tear and hematoma in MRI and only showed soft tissue shadow in X-ray this result confirm low sensitivity of X-ray in different soft tissue injuries.

This agree with Mourad et al. [10] who showed that X-ray is rapid technique but It is insensitive to soft tissue changes and has limited sensitivity to bony changes.

The limitations of our study were The limited numbers of athletes from each sport separately as every type is known for different types of injury, also wide range of age groups due to random choice of sport type making each group number small and not very accurate results, in addition to that high cost of MRI.

5. CONCLUSIONS

In the absence of negative radiographs, MRI of the hip has established itself as the gold standard for diagnosing sports-related hip and groin injuries, also it can determine early signs of stress fracture before it appear in X-ray. so, more details about different lesions can be obtained from MRI and This help in accurate diagnosis, rapid treatment of different athlete lesions and determine time plane of returning to the sport by follow up imaging.

CONSENT AND ETHICAL APPROVAL

The study was done after approval from the Ethical Committee Tanta University Hospitals. All patients provided informed consent.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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