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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(4): 2472-2477. **OPEN ACCESS**

Diagnosis of Anterior Cruciate Ligament Injuries using Magnetic Resonance Imaging in Taif, Saudi Arabia

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The most common subversive knee injuries seen in hospitals are anterior cruciate ligament (ACL) injuries. Magnetic resonance imaging (MRI) is the tool used to diagnose ACL injuries with regard to the type of ACL tear and associated pathologies. The study aimed to assess MRI accuracy in detecting ACL injuries, estimate the prevalence of ACL tears and correlate the type of ACL with gender in Taif. A retrospective study was conducted in two Taif hospitals (King AbdulAziz Specialist hospital And Alhada Armed Force in 2018). One hundred and forty patients selected as suspected cases of ACL tear were referred for MRI of the knee. Utilizing the patients' data from the Picture Archiving and Communication System (PACS) program; all the reviewed patients underwent 1.5T MRI scanning. The analyses for the data were performed using the Statistical Package for the Social Sciences (SPSS). ACL injuries were detected in 115 patients out of 140 with an overall sensitivity and specificity of MRI of 95.83% and 92.59%, respectively. The prevalence of ACL tear was 85.2% for males and 14.8% for females. The most commonly affected age group was 21–40 years. The incidence of complete ACL tear was higher in men than in women (45.2 vs 1.7%, respectively), whereas partial tears occurred more frequently in females (13% vs. 40%). However, the correlation between the type of injury and gender was not significant. MRI can accurately diagnose ACL injuries. ACL tears in this study were more prevalent in males than in females.

Keywords: ACL injury, ACL tear, MRI

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are considered one of the commonest sport- and non-sport-related knee injuries (Hewett et al. 2013). They are often accompanied by other injuries such as meniscal tears, chondral lesions, and long-term risk of early onset post- osteoarthritis caused by trauma (Levine et al. 2013, Chu et al. 2011, Quatman et al. 2011). Accurate diagnosis of ACL injuries improves the treatment strategies, avoids unnecessary surgical interventions, and prevents unwanted complications. Most studies have focused on sport-related ACL injuries. Little attention has been given to ACL lesions in the general community. Furthermore, most studies have shown that females have a higher incidence rate of ACL injuries than males (Crawford et al. 2007). Magnetic resonance imaging (MRI) is the tool for evaluating and diagnosing ACL injuries with regard to the type of ACL tear and associated pathologies (Crawford et al. 2007, Fritz, 2003, Kam et al. 2010, Boden et al.2000, Ireland, 2002).

Historically, arthroscopy was the standard diagnostic tool for meniscal and ACL injuries. However, because arthroscopy is an invasive surgical procedure, it has been replaced by MRI, which is non-invasive and less expensive. The sensitivity of MRI for ACL tears may exceed 90% (Winters and Tregonning, 2005). MRI is accepted by both physicians and patients and can assist 'in differential diagnosis of knee conditions with the same clinical presentations as in meniscal tears and osteochondral injuries (Crawford et al. 2007, Huang et al. 2002)**.**

Two types of ACL injuries are detected using MRI: complete and partial tears. The usefulness of MRI has been previously studied worldwide (Brandser et al. 1996, Hong et al. 2003, DeFranco and Bach, 2009, Tjoumakaris et al. 2011, Duthon et al. 2006, Rose and Gold, 1996, Siddiqui et al. 2013, Orlando Junior et al. 2015). In the Arab region, studies concerning the role, accuracy, specificity, sensitivity, and impact of MRI on ACL injuries are lacking. There are discrepancies in previous studies regarding the accuracy of MRI in diagnosing ACL injuries and the agreement of findings with clinical examination. In addition, there are differences in the prevalence rate of ACL lesions between the genders and among different age groups. Lastly, there are indeterminate conclusions about the type of ACL injury in relation to gender.

Therefore, this study aimed to examine the accuracy of MRI in diagnosing ACL injuries in Taif, establish the prevalence of ACL tears among males and females of different age groups, and determine the type of ACL injury in relation to gender. The significance of this research was to improve the diagnostic accuracy of ACL injury to help in identifying appropriate treatment strategies. In addition, identifying the gender-related prevalence and types of injuries the aim was to help in proposing appropriate protective measures against ACL injuries.

In Taif, Saudi Arabia, as far as the authors know, no study has been conducted to assess the accuracy and role of MRI in detecting ACL injuries. Thus, this is the first in Taif to study the accuracy and role of MRI in detecting ACL injuries.

MATERIALS AND METHODS

This retrospective study was conducted at King AbdulAziz Specialist Hospital and Alhada Armed Forces Hospital in Taif from January to April 2018. Ethical approval was received from the Institutional Review Board (IRB) of the Armed Forces Hospitals in the Taif region. The study included data from 140 patients, 113 males (aged 15–70 years), and 27 females (aged 17–68 years). Patients were selected as suspected cases of ACL tear, based on the history and clinical examination, and were then referred for MRI of the knee. Patients' data were reviewed from the Picture Archiving and Communication System (PACS) program and a table was created with the following information: demographic information (patient's serial number, age, and gender), the presence of an ACL tear, ACL type, side, and cause of the ACL injury. The patient age groups were categorized into ≤20 years, between 21 and 40 years, between 41 and 60 years, and lastly between 61 to 80 years old. All the reviewed patients underwent 1.5T MRI scanning with the protocols presented in Table 1.

Statistical analysis

The data were revised, coded, entered, tabulated and the analyses for were performed using the Statistical Package for the Social Sciences (SPSS). Results were considered statistically significant when the *p*-values were less than 0.05.

Table 1: MRI protocols used to scan patients at 1.5T

Sequence	Parameter	Axial	Sagittal	Coronal
T_2-FS	Repetition time (*TR*)ms	3000	2500	2500
	Time to echo *(TE)*ms	100	70	70
	Slice thickness (mm)	3	3	3
T_1	(*TR*)ms	---	500	450
	*(TE)*ms	---	20	15
	Slice thickness(mm)	---	3	3
PD-FS	(*TR*)ms	2400	3000	---
	*(TE)*ms	16	45	---
	Slice thickness (mm)	3	3	---

RESULTS

After reviewing the suspected cases of ACL lesions that underwent MRI, ACL injuries were detected in 115 patients, and 25 patients had normal MRI scans. The overall sensitivity and specificity of MRI in detecting ACL injuries was 95.83% and 92.59%, respectively, as shown in Table 2.

Table 2: MRI sensitivity and specificity in detecting ACL injuries in suspected cases

Frequency	%
115	**82.1**
25	**17.9**
140	**100**
Sensitivity = 95.83% Specificity = 92.59%	

The prevalence of ACL lesions was calculated mong males and females and the results showed that males were significantly affected more than females (Table 3).

Table 3: Prevalence of ACL injuries by gender

Gender	N	%
Male	98	85.2
Female	17	14.8
Total	115	100.0
***P*-value**	0.0001	

The ACL tears by age group are shown in Table 4. The age group of 21–41 years was most affected in both males and females (69% and 47%, respectively), followed by the 41–60 age group (16% in males and 23% in females). The age group of 61–80 was less affected by ACL injury (around 5% males and 12% females) (Table 4; Figure 1).

Table 4: ACL injuries by age group

Age group	Male		Female	
	Frequency	%	Frequency	%
≤ 20	10	10	3	18
21–40	67	69	7	47
41–60	16	16	5	23
61–80	5	5	2	12

Finally, the relationship between the type of ACL injury (complete and partial ACL tears) and gender was examined. Almost 53% of the male patients had a complete tear, compared to only about 2% of their female counterparts (Table 5). On the other hand, partial tears were more frequently seen in the females (~88%), compared to about 46% in males. However, there was no significant relationship between the type of ACL tear (complete or partial) and gender (*p*-value = 0.48 in males and *p*-value = 0.65 in females) (Figure 2).

Table 5: Type of ACL tear by gender

			Type		Total
			Complete tear	Partia tear	
Gender	Male	N	52	46	98
		% within gender	53.1	46.9	100.0
		% of total	45.2	40.0	85.2
	Female	N	2	15	17
		% within gender	11.8	88.2	100.0
		% of total	1.7	13.0	14.8
Total		N	54	61	115
		% of total	47.0	53.0	100.0

DISCUSSION

The aim of the research study was to assess the accuracy and impact of MRI in the identification of ACL injuries. In addition, the authors assessed the prevalence of ACL injuries in males and females and the distribution of injuries among different age groups and examined the correlation between the types of ACL tear and gender. Our findings showed that, of the suspected patients with ACL tear who underwent

MRI of the knee, 82% had an ACL injury, whereas only 18% did not show an ACL tear. This indicates that MRI is highly accurate in diagnosing ACL injuries and shows a high agreement with clinical examination. These results agreed with the findings from previous studies that showed the high sensitivity and specificity of MRI in detecting ACL tears (Wong et al. 2017, Fritz, 2003)**.** MRI is considered the most appropriate non-invasive imaging technique, and to avoid risks from surgery it remains the first option for the physician to diagnose ACL injury after the clinical examination has been performed and before therapeutic arthroscopy in most patients. MRI is advantageous when looking at soft tissue as they present high contrast with good spatial resolution. In addition, it allows multi-parameter assessment of morphological changes in ACL injuries.

Regarding the prevalence of ACL injuries, males were significantly more affected than females. Complete ACL tears were more frequent in males, while partial tears occurred more often in females, although these results were not significant. Our results agreed with a recent study conducted in Makkah city, Saudi Arabia, which found that males were more affected than females by 84.8% (Alzahrani M, 2017). A possible reason that males are more affected than females is that lifestyle and sport practice for men in the Arab world are different, as they participate in sports such as football and basketball. In addition, car driving is another factor as it makes males more prone to accidents. Taif is considered a military zone and the Taif terrain is high-altitude. Therefore, ACL injuries are high as they are associated with military activities such as parachuting, and jumping from airplanes, balloons, and helicopters. The geography of Taif and its military area, with males exclusively in this field, make males more prone to ACL injuries.

However, our results differed from previous studies from western countries (Bryan et al. 2004, Elvenes et al. 2000, Challen et al. 2007, Lamar et al. 2005, Lopiano, 2000), which showed that females are more prone to ACL tears. These studies suggested that the increased popularity of women's professional sports has increased the likelihood of ACL injury. In addition, they proposed that females were found to have smaller ACL and narrower femoral notches than males, which make them at increased risk for ACL injury. As yet, there is no consensus on the role of the ACL size and the femoral notch in ACL injury.

In the current study, 115 patients with a history of knee injuries were evaluated. The age range 21–40 years was mostly affected by ACL injuries. This finding reflects this age group's higher physical activity; therefore, this age group is more likely to suffer knee injuries. This conclusion was supported by a study conducted in 2010 by Avcu et al. (Avcu et al. 2010), which demonstrated that age is highly correlated with knee pathologies.

CONCLUSION

MRI is an accurate and non-invasive modality for the assessment of ACL injuries in patients presenting with signs and symptoms of ACL tear. In this study, the prevalence of ACL tears was higher in males than females in Taif. No significant correlation was found between the type of injury and gender. Findings from this study may help in identifying ACL injuries using MRI and proposing appropriate protective measures against ACL lesions for both males and females.

Limitations

This study's small sample size limited the accuracy and specificity of the results but gave acceptable percentage of them. In addition, the hospitals from which we collected the data acquired the MRI images with slightly different pulse sequences, which may have caused certain features of ACL tears to not be clearly defined and thus have different diagnostic accuracy. In additions, some cases did not have an isolated ACL tear, yet there were associated lesions, such as meniscal rupture. Lastly, we did not compare the MRI findings and reports with the gold standard arthroscopy.

Recommendations and future directions

Similar studies should be conducted with a larger sample size, and the MRI findings should be validated with the gold standard arthroscopy. The inclusion and exclusion criteria should be well defined and restricted to isolated tears only. In addition, using 3T MRI would add higher resolution and detailed features of ACL tears,

which would facilitate the differentiation between partial and complete ACL tears.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

We acknowledge all of our colleagues and radiographers in the Radiology Departments in Taif hospitals- King Abdul Aziz Specialist Hospital and Alhada Armed Forces hospital- who assisted us and provided us with all the information we needed during the study period.

AUTHOR CONTRIBUTIONS

NLF designed and performleed the research project, analyze the data and wrote the manuscript. HO and SA helped in the data analysis and revision of the manuscript. AA, AS, TM and ES did the data collection and helped in drafting the work. All authors read and approved the final version.

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