Original article

Compare the Magnetic Resonance Imaging (MRI) and conventional radiography in diagnosis of distal radius injury before skeletal maturity

Seyyed Mehran Razavipour[1], Roohollah Abdi[2], Mehran Fazli[3*], Saeed Ghorbani[2]

1- Assistant Professor, Department of orthopedics, Imam Khomeini Hospital, Mazandaran University of medical science, Sari, Iran

2- Department of Radiology, Mazandaran University of medical science, Imam-Khomeini Hospital, Sari, Iran

3- General Practitioner in Imam Khomeini Hospital of Esfarayen, Esfarayen Faculty of Medical Sciences, Esfarayen, Iran

Corresponding author: Mehran Fazli Email: mehran222@gmail.com

Abstract

Objective: Physeal injuries in childhood may produce irreversible damage to the growing cells, resulting in growth disturbance. The aim of this study is compare conventional radiography and magnetic resonance imaging (MRI) in the assessment of distal radius epiphyseal and physeal injury.

Methods: 31 cases with distal radius trauma were examined with conventional radiography and MRI. One blinded experienced radiologists and one blinded experienced specialist in orthopedics separately evaluated the results.

Results: The main age of our patient was 11.74±2.98 years. The results of MRI showed 90.32% injury in all patients whiles conventional radiography showed 64.51% injuries (P=0.014). In survey the physeal injury by conventional radiography we have 6 Salter–Harris II fractures. Meanwhile, the MRI showed 9 physeal injuries that included 6 Salter–Harris II fracture and 3 other fracture with physeal injury (all of them had distal radius microfracture with mild physeal injury) (P>0.05). In patients that conventional radiography showed they were normally, MRI showed 4 Bone Bruising and 4 microfracture. The other results were similar. The sensitivity, specificity, Positive predictive value, negative predictive value and total accuracy of conventional radiography in diagnosis of physeal injury were 66.6%, 100%, 100%, 88%, 90.32%.

Conclusion: our study showed MRI and conventional radiography had almost similar power to diagnosis growth plate injuries in distal radius trauma. When we considering high cost of MRI, it's seems that conventional radiography was beneficial than MRI to use in distal radius injury.

Keywords: *Magnetic Resonance Imaging, Physis, Radius Fractures, Radiography*

.

Introduction

Physeal and epiphysis are two areas that responsible for skeletal growth. Cartilaginous structures of these areas provide bone formation and Elongation (1). Several pathologic conditions can effect on premature skeletal of young patients and induce complication such as growth disturbance, shortening of the extremities, bony bridge formation, and angular deformities (2). The primary reason for physeal trauma in children is acute traumatic conditions which in most cases it causes fractures. Other conditions which have an effect on physeal are repetitive stress traumas, infections, metabolic diseases, thermal damage, and radiation (3). Distal radius injury and physeal distal tibia injury, respectively, are the first and second most common cause of growth palate injuries (4). Physeal distal injury can sometimes cause growth disturbance of physeal and following that it can cause disturbance in bony bridge formation which lead to angular deformity or length discrepancy of the legs (5). These permanent traumas can be caused due to the trauma itself or the inadequate treatment. Different mechanisms were recognized for the growth plate injury as a result of trauma which are related to the injury type and the injury occurrence after growth plate trauma (4). As mentioned before, long bone growth abnormalities in children usually occur as a result of trauma or it is possible for it to occur as a result of physis, epiphysis or the metaphysis ischemia (5). Radiography provide logical evaluation of the epiphysis fractures and it is considered as a primary method for evaluating the condition of patients (6), but we should consider the fact that other methods of imaging will be needed based on their privileges. As an example, CT scan is an appropriate method for evaluating if joint surfaces are aligned and it is adequate for diagnosing bony bridge, whereas MRI has some other kinds of privileges, such as diagnosing covert fractures and better understanding the extent of fracture, it also has the privilege of depicting associated disorders such as ligamentous lesions (5). MRI imaging has been very helpful for growth abnormalities and this kind of imaging accurately depict growth cartilaginous plate pathology and epiphysis; it also could be used for young children who are at high risk of growth disorders (5, 7). It is worthy to notify that MRI cannot accurately depict cortical lesions (8). Therefore, based on these information and the lack of studies for comparing advantages and disadvantages of utilizing conventional radiography as the standard method (6) and MRI, we conducted this study to compare the MRI and conventional radiography in diagnosis of distal radius injury in growth age.

Methods

The nature of this survey is of a diagnostic study. This study was carried out at orthopedic section of Imam's hospital in Sari city (Mazandaran province, Iran).. According to the related statistic formula and by considering 0.05% error, and 80% power, about 30 patients (9) with age between 7 to 16 years old were selected for this study; the patients, who are assumed to have distal radius injury, were selected based on the results of clinical examination. After patients gave their approval and agreed to take part in the study, their demographic information was recorded and they were examined by a specialist. In order to evaluate the radiography of patients 3 planes were chosen: lateral, posteroanterior, and oblique (10). MRI was performed in 1.5 Tesla by using a 3 inch wraparound coil. The imaging Protocol consists of a short tau inversion recovery (STIR) sequence (TR/TE, 3912/60; inversion time, 150 msec; acquisition time, 4 min 18 sec), T1-weighted spin-echo sequences (TR/TE, 500/20; acquisition time, 4 min 51 sec) in the coronal and axial planes, and a T2-weighted turbo spin-echo sequence (TR/TE, 3500/96; acquisition time 4 min 6 sec) in the axial plane. The view field was arranged between 10 to 12 centimeters (11, 12). These assessments were performed exactly after the physical examination and the patients' consent. Then, the results of these assessments were observed by an expert radiologist and orthopedic specialist, and it was recorded in each patient's data forms.

Data analysis

The difference in percentages (quality variables) was analyzed by the chi-square test. Mean difference was estimated by student's t-test and the data analysis was performed by SPSS version 16 software, statistically, P value<0.05 was considered meaningful.

Result

The number of patients who were examined in this study was 31, 18 of them were boys (58.1%). Mean age of patients was 11.74 ± 2.98 years (median=12). In this study, conventional radiography on the patients showed 11 normal cases, 6 Salter–Harris II fractures and 5 distal radius metaphysis torus fractures. Further information about other cases is available in table 1

Table 1.Radiographic finding in conventional radiography and MRI

Radiography reports	Conventional	MRI
Normal	11 (35.5%)	3
Salter-Harris type II	6 (19.4%)	6
Metaphysis torus fractures of distal radius	5 (16.1%)	5 (16.1%)
Metaphysis fracture of distal radius	4 (12.9%)	4 (12.9%)
Distal radius microfracture	0	4 (12.9%)
Bone bruising	0	4 (12.9%)
Metaphysis fracture of distal radius and ulna	2 (6.5%)	2 (6.5%)
Torus fracture of distal radius and ulna	2 (6.5%)	2 (6.5%)
Radial styloid fracture	1 (3.2%)	1

MRI on these patients showed 3 normal cases, 6 Salter–Harris II fractures and 5 distal radius metaphysis torus fractures, 4 distal radius metaphysis fractures, 4 distal radius microfractures, and 4 distal radius bone bruising. Further information about other cases is available in table 1. In addition, in 2 of the patients with distal radius torus fracture and one patient with distal radius microfracture, distal radius bone bruising was also observed.

In this survey, in 90.32% of patients, MRI showed injury and fracture very clearly. While, conventional radiography was able to show the fracture only in 64.51% of patients (P=0.014).

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and the overall accuracy of conventional radiography on based of MRI in diagnosing distal radius injuries were 71.42%, 100%, 100%, 27.27% and 74.19%, respectively (table 2).

Table 2. Diagnostic power of conventional radiography on base of MRI in distal radius injury

Distal radius injury	Sensitivity	specificity	PPV	NPV	OA
Overall injury	71.42%	100%	100%	27.27%	74.19%
Physial injury	66.66%	100%	100%	88%	90.32%

PPV; Positive Predictive Value, NPV; Negative Predictive Value, OA; Overall Accuracy

MRI showed physeal injuries in 9 patients (29%). Among these 9 patients, 6 of them had Salter–Harris II fractures (Figure 1). Among the other 3 remained patients, all of them had distal radius microfracture with mild physeal injury. The first 6 lesions (19.35%) were observed in both MRI and conventional radiography, but the other 3 patients only observed by MRI (P=0>0.05).

The sensitivity, specificity, PPV, NPV and the overall accuracy of conventional radiography to diagnosing growth plate injuries in distal radius were 66.6%, 100%, 100%, 88% and 90.32%, respectively (table 2).

Figure 1. Salter-Harris type II fracture of distal radus. Frontal radiogragh (A), T1W (B),T2W (C), T2 Fat Sat (D) MRI images.

Discussion

Physeal and epiphyseal injury of developing long bones is one of the most common traumatic events in children which is associated with many growth abnormalities. The reason for this is that ligamentous structures and joint capsule are 2 or 5 time stronger than cartilage and therefore, physis and epiphysis are the areas which are most susceptible to injury (11, 13). If the diagnosis is delayed or the treatment is not appropriate, it could lead to premature closure of the physis. The result of this event would be angular deformity or shortening of the extremities (11). Determining the fracture pattern and diagnosing physis conflict is possible according to fracture line in the conventional radiography. But, conventional radiography has so much limitation for determining the degree of physis injuries, treatment planning and the final prognosis. However, it has been proven that MRI can depict cartilage abnormalities in rabbit and human (11, 14). Therefore, this study was designed to assess the diagnostic power of MRI and the conventional radiography (which is used routinely) to diagnosis of distal radius injury before skeletal puberty age.

In this survey, MRI in 90.32% of patients showed injury and fracture very clearly. While, conventional radiography was able to show the injury and fracture only in 64.51% of patients, a significant statistical difference was observed between these two means in diagnosing lesions. Griffith et.al conducted study on patients who had elbow injury, ranging from 2 to 12 years old. In their study, radiography and MRI was able to identify the fracture in 52% and 74% of patients, respectively (15).

The result of conventional radiography on patients in this study were somehow similar to the results of their MRI; conventional radiography showed 6 Salter–Harris II fractures. While the results of MRI showed that three other patients, who had physeal injury too; the conventional radiography was not able to diagnose the physeal injury in these three patients. However, no statically significant difference was observed between MRI and conventional radiography to show phuseal injury. In the study of Shi et al. about 5 of the patients had physeal injury which all of them were belonged to the Salter – Harris classification. In their study both MRI and conventional radiography depicted 2 Salter-Harris II fractures and 3 Salter-Harris IV fracture. Also in Griffith 3 patients had physeal injury which 2 of them had Salter-Harris I fracture and one of them had Salter-Harris II fracture (15).

In this study 4 of the patients had distal radius microfracture and 4 of them had distal radius bone bruising. The important fact is that, conventional radiography was not able to diagnose the existence of microfractures and bone bruising. As mentioned before, MRI revealed that 4 of the patients (12.9%) had bone bruising, while in Zimmemann et al. study it was announced to be 50% (16).

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and the overall accuracy of conventional radiography based on MRI in diagnosing distal radius injuries with conventional radiography showed the following results: sensitivity 71.42%, specificity 100%, PPV 100%, NPV 27.27% and overall accuracy 74.19%.

I our study sensitivity of conventional radiography was lower than Welling et al. study. In their study, sensitivity of conventional radiography for diagnosing distal radius fracture reported to be 100% (10). It should be mentioned that in their study sensitivity was measured based on CT. There exist no other study about the sensitivity and specificity of conventional radiography for distal radius injuries. However, there exist some reports about the sensitivity and specificity of conventional radiography for elbow Scaphoid area. According to these reports conventional radiography for the elbow area was as following: sensitivity 71%, specificity 56%, PPV 57%, NPV 93%; conventional radiography for Scaphoid area: sensitivity 70%, specificity 90% (15, 17). In addition, for other kinds of fractures (except Scaphoid area), Jørgsholm et al. declared that conventional radiography in tenderness of distal radius and wrist, has shown 60% of sensitivity (17).

In Griffith et al. sensitivity, specificity, PPV, NPV of conventional radiography for diagnosing physeal of elbow area were reported 33%, 100%, 96%, and 100% respectively (15). Except of sensitivity, other results of their study was comparable with this present study.

Conclusion: Our study showed MRI and conventional radiography had almost similar power to diagnosis growth plate injuries in distal radius trauma. When we considering high cost of MRI, it's seems conventional radiography was beneficial than MRI to use in distal radius trauma.

Acknowledgements

We are grateful from emergency department team of Imam Khomeini and Bo-Ali Sina Hospital of Mazandaran University of medical sciences for their helping to collecting patients.

Conflict of interest

The Authors declare that there are no conflicts of interest

References

1. Rauch F. Bone growth in length and width: the Yin and Yang of bone stability. Journal of Musculoskeletal and Neuronal Interactions. 2005;5(3):194.
2. Laor T, Jaramillo D. MR Imaging Insights into Skeletal Maturation: What Is Normal? 1. Radiology. 2009;250(1):28-38.
3. Yanaguizawa M, Taberner GS, Aihara AY, Yamaguchi CK, Guimarães MC, Rosenfeld A, et al. Imaging of growth plate injuries. Radiologia Brasileira. 2008;41(3):199-204.
4. Schurz M, Binder H, Platzer P, Schulz M, Hajdu S, Vécsei V. Physeal injuries of the distal

tibia: long-term results in 376 patients. International orthopaedics. 2010;34(4):547-52.
5. Ecklund K, Jaramillo D. IMAGING OF GROWTH DISTRUBANCE IN CHILDREN. Radiologic clinics of North America. 2001;39(4):823-41.
6. Renner JB. Conventional radiography in musculoskeletal imaging. Radiologic Clinics of North America. 2009;47(3):357-72.
7. White PG, Mah JY, Friedman L. Magnetic resonance imaging in acute physeal injuries. Skeletal radiology. 1994;23(8):627-31.
8. Mack MG, Keim S, Balzer JO, Schwarz W, Hochmuth K, Windolf J, et al. Clinical impact of MRI in acute wrist fractures. European radiology. 2003;13(3):612-7.
9. Carey J, Spence L, Blickman H, Eustace S. MRI of pediatric growth plate injury: correlation with plain film radiographs and clinical outcome. Skeletal radiology. 1998;27(5):250-5.
10. Welling RD, Jacobson JA, Jamadar DA, Chong S, Caoili EM, Jebson PJ. MDCT and radiography of wrist fractures: radiographic sensitivity and fracture patterns. American Journal of Roentgenology. 2008;190(1):10-6.
11. Shi D-P, Zhu S-C, Li Y, Zheng J. Epiphyseal and physeal injury: comparison of conventional radiography and magnetic resonance imaging. Clinical imaging. 2009;33(5):379-83.
12. Steinborn M, Schürmann M, Staebler A, Wizgall I, Pellengahr C, Heuck A, et al. MR imaging of ulnocarpal impaction after fracture of the distal radius. American Journal of Roentgenology. 2003;181(1):195-8.
13. Carter S, Aldridge M, Fitzgerald R, Davies A. Stress changes of the wrist in adolescent gymnasts. The British journal of radiology. 1988;61(722):109-12.
14. Jaramillo D, Laor T, Zaleske DJ. Indirect trauma to the growth plate: results of MR imaging after epiphyseal and metaphyseal injury in rabbits. Radiology. 1993;187(1):171-8.
15. Griffith JF, Roebuck DJ, Cheng JC, Chan YL, Rainer TH, Ng BK, et al. Acute elbow trauma in children: spectrum of injury revealed by MR imaging not apparent on radiographs. American Journal of Roentgenology. 2001;176(1):53-60.
16. Zimmermann R, Rudisch A, Fritz D, Gschwentner M, Arora R. [MR imaging for the evaluation of accompanying injuries in cases of distal forearm fractures in children and adolescents]. Handchirurgie, Mikrochirurgie, plastische Chirurgie: Organ der Deutschsprachigen Arbeitsgemeinschaft fur Handchirurgie: Organ der Deutschsprachigen Arbeitsgemeinschaft fur Mikrochirurgie der Peripheren Nerven und Gefasse: Organ der V. 2007;39(1):60-7.
17. Jørgsholm P, Thomsen NO, Besjakov J, Abrahamsson S-O, Björkman A. The benefit of magnetic resonance imaging for patients with posttraumatic radial wrist tenderness. The Journal of hand surgery. 2013;38(1):29-33.