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ABOUT COVER

Editorial board member of *World Journal of Clinical Cases*, Dr. Li is a Professor at the Nanjing University Medical School in Nanjing, China. Having received his Bachelor's degree from Xuzhou Medical College in 1997, Dr. Li undertook his postgraduate training first at Nanjing Medical University, receiving his Master's degree in 2004, and then at Fudan University, receiving his PhD in 2007. He advanced to Chief Physician in the Department of Anesthesiology at The Affiliated Hospital of Nanjing University Medical School in 2017 and has held the position since. His ongoing research interests involve ultrasound (transthoracic echo and transesophageal echo) in clinical anesthesia and ultrasound-guided limb and trunk nerve block in postoperative pain management. (L-Editor: Filipodia)

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Retrospective Study

Comparison between computed tomography and magnetic resonance imaging in clinical diagnosis and treatment of tibial platform fractures

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Abstract

BACKGROUND

Tibial plateau fracture is one of the common fracture types. It occurs mainly in teenagers and is usually caused by a fall. After the occurrence of fracture, knee swelling, pain, limited activity, *etc.* greatly affect the patient's exercise habits and lifestyle. X-ray, computed tomography (CT) and magnetic resonance imaging (MRI) were used in this examination. X-rays are relatively new and easy to operate. However, there are some errors in the observation of fracture collapse and fracture displacement. In recent years, CT and MRI have been actively used to diagnose various types of clinical fractures. They have more diagnostic power than X-ray film. However, some scholars believe that CT is also prone to errors in clinical application. The volume effect leads to missed diagnosis and misdiagnosis in some cases, while the multidirection scanning of MRI technology can effectively overcome the shortcomings of CT. To facilitate the selection of clinical examination regimens, this study further observed the diagnostic ability of these two regimens in the diagnosis of tibial plateau fractures.

AIM

To explore the value of nuclear MRI and CT in the clinical diagnosis of tibial plateau fractures.

METHODS

A total of 120 patients with tibial plateau fractures admitted from September 2017 to August 2019 were included. All patients were examined by nuclear MRI and CT scanning. The results were sent to senior physicians in our hospital to complete the diagnosis.

RESULTS

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Nuclear magnetic resonance showed the same effects as CT in four aspects: fracture displacement, bone defect, fracture site and fracture comminution. There was no significant difference in the score data ($P > 0.05$). Nuclear magnetic resonance and CT tended to be consistent in the B3, C2 and C3 fracture diagnosis coincidence rate, combined injury detection rate and fracture detection rate. The diagnostic coincidence rate of type B1, B2 and C1 fractures and the accuracy rate of overall fracture classification indicated that the MRI technique was significantly better than that of CT ($P > 0.05$).

CONCLUSION

MRI and CT have good diagnostic typing in the diagnosis of tibial plateau fractures, but MRI is more accurate and may be preferred.

Key Words: Nuclear magnetic resonance technology; Tibial plateau fracture; Diagnostic compliance; Comparative study; Fracture classification; Diagnostic compliance

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Core Tip: This study observed the diagnostic efficacy of computed tomography and magnetic resonance imaging examination schemes in the diagnosis of tibial plateau fractures.

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INTRODUCTION

Fracture refers to a complete or incomplete break in the bone caused by an external force or a violent shock, such as a fall from a great height or a car accident, or pathological changes, such as bone metastases or myeloma^[1]. As one of the common fracture types, tibial plateau fractures mainly occur in adolescents, usually due to falling from a great height. After fractures occur, knee joint swelling and pain, restricted movement, *etc.* significantly impact patients' exercise and lifestyle^[2,3].

The structure of tibial plateau fractures is relatively simple compared to hip fractures and spinal fractures. However, because the fracture site is at the joint, accurate imaging diagnosis in clinical diagnosis and treatment can yield information on the patient's fracture type and whether it will be associated with injuries in the follow-up treatment plan. Has an essential guiding role in the formulation^[4-7]. X-ray examinations that have been commonly used in fracture diagnosis because of their weak fracture display ability can provide less diagnostic evidence and have gradually failed to meet the clinical needs of patients in practice.

Computed tomography (CT) and magnetic resonance imaging (MRI) have been actively used in the diagnosis of various types of clinical fractures in recent years. They have higher diagnostic efficacy than X-ray films. However, some scholars believe that CT is also prone to errors in clinical applications. The volume effect leads to missed diagnoses and misdiagnoses of some cases, and the multidirectional scanning of MRI technology can effectively overcome the shortcomings of CT. To facilitate the selection of clinical examination schemes, this study used a comparative research approach to further observe the diagnostic efficacy of these two examination schemes in the diagnosis of tibial plateau fractures.

MATERIALS AND METHODS

One hundred twenty patients with tibial plateau fractures admitted from September 2017 to August 2019. All patients met the guidelines for diagnosis and treatment of orthopedic diseases. For the study population, the sex ratio was 68:52 male to female,

and the patients were aged 21-57 years, averaging 35.6 ± 4.4 years. The causes of fracture were as follows: 49 cases of falling from a great height, 34 cases of car accidents, 25 cases of collision with heavy objects and 12 other cases. The AO types were as follows: 26 cases of B1, 21 cases of B2, 14 cases of B3, 27 cases of C1, 22 cases of fracture and 10 cases of C3.

Selection criteria

The following inclusion criteria were used: No history of congenital malformation of the tibia; fracture of the tibial plateau; no organic lesions of the heart, liver, kidney or other vital organs; no history of prosthesis implantation or ligament implantation; no compliance; no severe schizophrenia or cognitive dysfunction; and no knowledge of all the contents of this study.

Exclusion criteria

The exclusion criteria were as follows: Other types of fractures; other critical diseases, such as septicemia and respiratory failure; open fracture or need for emergency surgery; and imperfect clinical information.

Methodology

All 120 patients underwent MRI and CT scans as follows.

CT

A 64-row 128-slice Light Speed spiral CT (General Electric Company, United States) with a voltage of 120 kV, tube current of 200 mA and layer thickness control of 5 scans was used. Patients took a supine position to ensure that the center of the focal length could be aligned to the proximal tibia from far to near to complete the scan using workstation software analysis. Multiplane reconstruction was performed after the completion of the diagnosis by two senior physicians in the hospital.

MRI

Scanning was performed using a Signa Excite HD 1.5 T MRI system (General Electric Company, United States). The patient took a supine position for cross-section positioning, and sagittal, axial and coronal scans were performed. The parameters were set as follows: Coronal position: Time of repetition 2000 ms, layer thickness 4.0 mm, pitch 0.4 mm, time of echo 75 ms and field of view 19.0; sagittal position: Time of repetition 2000 ms, time of echo 72 ms, pitch 0.5 mm, layer thickness 4.0 mm and field of view 20.0; and axial position: Time of repetition 2000 ms, time of echo 140 ms, pitch 0.4 mm, pitch 4.0 mm and field of view 18.0. After completing the scan, the imaging data was sent to two senior physicians in the hospital for diagnosis.

Outcomes: According to the final surgical pathology results, the coincidence rate and the whole classification accuracy of the two imaging methods in the AO classification were counted, and the fracture detection and the combined injury detection were calculated and compared. Evaluation of the two examinations showed the effects of fracture comminution, bone defect, fracture site and fracture displacement. These four aspects of observation were measured as follows: 2 points for a clear product; 1 point for a fuzzy product; and 0 points for no product. Higher scores represent a better effect.

Statistical analysis

Statistic Package for Social Science statistical software was used for statistical analysis of the data. Independent sample *t*-test was used for continuous data, χ^2 test was used for frequency data (%), and data between groups were compared. $P < 0.05$ indicated that the difference between the two groups was statistically significant.

RESULTS

Comparison of diagnostic coincidence rates between the two methods in AO types of fractures.

Based on the results of surgical cases, there was no significant difference in the coincidence rate of B3, C2 and C3 fracture diagnosis between the two methods ($P > 0.05$). The coincidence rate of B1, B2 and C1 fracture diagnosis was significantly higher for MRI than for CT ($P < 0.05$) (Table 1).

Table 1 Comparison of conformity rates among types of diagnosis, *n* (%)

AO classification	Surgical pathology, case	NMR, <i>n</i> = 120	CT, <i>n</i> = 120	χ^2	<i>P</i> value
B1	33	33 (100.00)	27 (81.82)	19.998	0.001
B2	16	16 (100.00)	13 (81.25)	20.690	0.001
B3	10	8 (80.00)	7 (70.00)	2.672	0.102
C1	32	31 (96.88)	26 (81.25)	12.542	0.001
C2	20	18 (90.00)	17 (85.00)	1.143	0.285
C3	9	9 (100.00)	9 (100.00)	0.001	1.001

CT: Computed tomography; NMR: Nuclear magnetic resonance.

Comparison of the two inspection methods

There was no significant difference between MRI and CT in the bone defect, fracture site, fracture displacement or comminution ($P > 0.05$) (Table 2).

Comparison of the detection rate of fracture, the detection rate of combined injury and the accuracy of fracture classification between the two examination schemes

As shown in Table 3, there was no significant difference in the detection rate of fractures and the detection rate of combined injuries between MRI and CT ($P > 0.05$). However, the accuracy of fracture analysis was significantly higher, and the difference was statistically significant ($P < 0.05$).

DISCUSSION

As an essential tissue responsible for human movement, support and protection, bones can support human labor and movement under normal conditions, but fractures can occur after excessive external stress or pathological decreases in bone density. Fractures greatly influence the function of the site and need to be promptly treated^[8]. The tibial plateau plays an important role in the movement of the knee joint, and it is easy to break under the action of external forces. Because of its complex anatomical structure, it is crucial to accurately grasp whether the patient has other injuries and the specific fracture classification before clinical treatment^[9]. According to an epidemiological analysis, the urban population is increasing with the number of vehicles, machinery and equipment. The incidence of accidents, such as mechanical accidents and falling from a great height, is rising, and the incidence of fractures of the tibial plateau are increasing year by year. In view of the significant influence of fractures on patients' daily lives, clinical diagnosis and treatment-related research is highly valued^[10].

X-ray, CT and MRI were used in the current examination. X-ray is easy to operate and is the preferred method for diagnosing tibial plateau fracture. However, there are some errors in the observation of fracture collapse and fracture displacement. The general error is 2-3 mm, so it is only suitable for fracture screening^[11]. According to clinical research, fractures generally occupy a three-dimensional space, and only two-dimensional plane observation has some limitations and cannot provide an accurate and reliable diagnostic basis for patients with compression, comminution and other fractures^[12]. As a product of modern medical development, spiral CT can adequately compensate for the limitation of two-dimensional plane observation. CT scanning has the advantages of being less time consuming and having a wide range and high resolution in practical application. It can also help physicians accurately observe the collapse of the bone platform in patients through reconstruction technology and has good display effects on other injuries, fracture fragments, *etc.* However, missed diagnoses and misdiagnoses with CT examination may also be due to the scan level and volume effects^[13].

MRI, as a new imaging technique, can perform multidirectional and multisequence scanning in the examination of tibial plateau fractures. It can effectively observe injuries of the articular cartilage and meniscus by watching the change in the signal of a knee joint injury^[14]. According to a clinical study, complicated tibial plateau fractures with increased intra-articular density (*i.e.* a fluid-liquid plane demonstrating the

Table 2 Comparison of the two inspection methods

Display effect, points	NMR, n = 120	CT, n = 120	t	P value
Bone loss	1.53 (0.31)	1.49 (0.33)	0.968	0.334
Fracture site	1.61 (0.24)	1.59 (0.25)	0.632	0.528
Fracture displacement	1.12 (0.29)	1.09 (0.26)	0.844	0.400
Fracture comminution	1.31 (0.31)	1.28 (0.33)	0.726	0.469

CT: Computed tomography; NMR: Nuclear magnetic resonance.

Table 3 Comparison of the detection rate of fracture, the detection rate of compound injury and the accuracy of fracture classification, n (%)

Items, total = 120, combined injury = 108	NMR	CT	χ^2	P value
Fracture detection rate	116 (96.67)	108 (90.00)	3.576	0.059
Fracture classification accuracy	115 (95.83)	99 (82.50)	9.196	0.002
Combined injury detection rate	105 (97.22)	103 (95.37)	0.480	0.489

CT: Computed tomography; NMR: Nuclear magnetic resonance.

clinical need of nuclear magnetic resonance examination), knee injury, bone marrow cavity and torn periosteum tissue with fat and blood exudates in the joint in some patients can directly reflect the degree of knee injury^[15]. Based on the principle of chemical imaging, MRI is more sensitive to changes in water molecules, and its soft tissue resolution and display efficiency are better than those of CT.

According to some studies, the fracture line in patients with tibial plateau fractures on MRI generally has an irregular T₁WI low signal, T₂WI high signal and T₁WI better display^[16]. The multidirectional tomography system with MRI can prevent the overlapping interference of a noncollapse site, which is better than the traditional X-ray. Bone contusion is a common complication of perfracture bone, which is characterized by a diffuse, nonlinear signal abnormality in cancellous bone, no definite fracture line, a low signal T₁WI sequence, a high signal T₂WI and a precise short-TI inversion recovery sequence; bone contusion cannot adequately be diagnosed with conventional CT, and X-ray MRI has a unique advantage in this respect.

The fracture of tibial articular cartilage is also a common complication in tibial plateau fractures. The thickness and continuity of the tibial articular cartilage surface can be clearly shown in MRI scans in T₁WI and T₂WI, both with a high signal. The short-TI inversion recovery sequence showed the best effects; however, MRI showed slight thickening of the cartilage surface and a significant increase in the sign of patients with tibial articular cartilage injury^[17]. The meniscus of the knee joint belongs to a fibrous cartilage plate, and its water content is low. Under normal conditions, MRI scans show that its edge is smooth, and T₂WI and T₁WI show a weak internal signal. When patients had a meniscus injury, there was a striped or speckled high signal inside the meniscus. Generally, the T₁WI sequence showed the best results. The clinical diagnosis can refer to the degree and scope of the signs to assess the severity of injury in patients. When changes have been through the upper and lower edge of the meniscus, it is suggested that arthroscopic treatment should be provided^[18]. In the treatment of patients with this type of meniscus injury, it is of great guiding value to determine whether to perform broken meniscus resection or lower meniscus angioplasty. The fracture of a joint is also one of the common complications of tibial plateau fractures. The signal intensity of a normal knee ligament is low on MRI scan; only when the ligament has been damaged and internal exudation occurs. T₁WI and T₂WI can have an elevated signal. T₂WI showed the best results: A rough edge, thickening and other signs^[19]. According to the relevant statistics, the incidence of joint capsule/articular cavity effusion at the time of fracture of the tibial plateau can reach 90%. MRI is effective in clinical diagnosis, and a low T₁WI signal and high T₂WI signal in the joint capsule/articular cavity can be seen in the MRI scan^[20].

There was no significant difference between the two methods in fracture comminution and displacement, and there was no significant difference in the

detection rate of whole fracture and the coincidence rate of diagnosis of type B3, C2 and C3 fractures, which indicated that CT and nuclear magnetic resonance techniques had sound diagnostic effects in the clinical diagnosis of patients with tibial plateau fractures. Neither group had apparent noticeable difference in the detection rate of the combined injury. In theory, the effectiveness of MRI in a partial combined injury examination was better than that of CT. The diagnostic coincidence rate and fracture classification accuracy of MRI for type B1, B2 and C1 fractures were significantly higher than those of CT in fracture classification according to Xue Hong-Qiang. The clinical value of MRI and CT in the diagnosis of tibial plateau fractures was observed in a study. The results showed that MRI classified fractures more accurately than CT, but there was no significant difference in the evaluation of other effects and the fracture detection rate.

CONCLUSION

Overall, MRI and CT have certain diagnostic efficacy in the diagnosis of tibial plateau fractures, but MRI has higher typing ability and may be selected first.

ARTICLE HIGHLIGHTS

Research background

Tibial plateau fracture is one of the most common fracture types, mainly occurring in adolescents. After fracture occurs, knee joint swelling, pain and limited activity impact the patient's exercise habits and lifestyle. The incidence of accidents, such as mechanical accidents and falling from a great height, is increasing, and the incidence of fractures of the tibial plateau are increasing year by year. In view of the great influence of fractures on patients' daily lives, clinical diagnosis and treatment-related research is highly valued. X-ray, computed tomography (CT) and magnetic resonance imaging (MRI) can be used for diagnosis. According to clinical research, fractures generally occupy a three-dimensional space, and only two-dimensional plane observation has some limitations and cannot provide an accurate and reliable diagnostic basis for patients with compression, comminution and other fractures. CT and MRI have been actively used in the diagnosis of various types of clinical fractures in recent years. They have higher diagnostic efficacy than X-ray films. However, some scholars believe that CT is also prone to errors in clinical applications. The volume effect leads to missed diagnoses and misdiagnoses of some cases, and the multidirectional scanning of MRI technology can effectively overcome the shortcomings of CT.

Research motivation

In clinical diagnosis and treatment, accurate imaging diagnosis can provide information about the type of fracture and whether it is associated with injury in subsequent treatment plans. It plays an important guiding role in the formulation. In order to facilitate the selection of clinical examination protocols, this study adopted the method of comparative study to further observe the diagnostic effect of the two examination protocols on tibial plateau fracture.

Research objectives

Our study aimed to investigate the value of MRI and CT in the clinical diagnosis of tibial plateau fractures. Through a retrospective analysis of 120 patients with tibial plateau fracture, we compared the two methods to provide a better current examination in the diagnosis and treatment of tibial plateau fractures.

Research methods

Statistical analysis was performed with the Statistic Package for Social Science software package. Continuous data with a normal distribution were analyzed with an independent sample *t* test, and frequency data (%) were analyzed using χ^2 test. $P < 0.05$ represented a statistically significant difference in the comparison of data between the groups.

- 10.1302/0301-620X.97B1.34195]
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