COMPUTED TOMOGRAPHY (CT) IMAGE IN REPAIRING TENDON INJURY IN ATHLETES

IMAGENS DE TOMOGRAFIA COMPUTADORIZADA (TC) NO TRATAMENTO DE LESÕES DO TENDÃO EM ATLETAS

IMÁGENES DE TOMOGRAFÍA COMPUTARIZADA (TC) EN EL TRATAMIENTO DE LESIONES DEL TENDÓN EN ATLETAS

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ABSTRACT

Introduction: endon injury can usually be divided into the following types: fracture, dislocation, compression, bone insert, tendon injury, among which dislocation and compression are more common. Objective: To evaluate the application value of Computed Tomography (CT) image in tendon display. Methods: CT scan of the hands and feet was performed in our hospital for suspected tendon lesions. The CT and MRI data of 61 patients with tendon injury were retrospectively analyzed, and the diagnostic efficiency of CT and MRI were compared and analyzed. Results: The diagnostic accuracy of 61 patients was 89.71% (61/68). Except for chronic tendon injury (12/19), the diagnostic accuracy of other lesions was 100%. The sensitivity of CT and MRI in the diagnosis of hand tendon injury was 94.7% and 90.7%, the specificity was 99.3% and 98.6%, and the coincidence rate was 97.7% and 96.3%. Conclusions: CT images are accurate in localization and characterization of tendon injury, with high sensitivity and specificity, and can provide accurate anatomical basis for surgery. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: AchillesTendons; Damage Assessment; Diagnostic Imaging.

RESUMO

Introdução: Lesões do tendão geralmente podem ser divididos em: fratura, luxação, compressão e inserção óssea. A luxação e compressão são as mais comuns. Objetivo: Avaliar o valor de aplicação de imagens de Tomografia Computadorizada (TC) em manifestações do tendão. Métodos: Imagens por TC de mãos e pés foram feitas em nosso hospital para verificar suspeitas de lesões do tendão. Os dados de imagens por TC e IRM de 61 pacientes com lesões nos tendões foram analisados retroativamente. A eficiência das imagens de TC e de IRM foi comparada e analisada. Resultados: A precisão diagnóstica dos 61 pacientes foi de 89,71% (61/68). Com exceção da lesão de tendão crônica (12/19), a precisão diagnóstica de outras lesões foi de 100%. A sensibilidade de imagens por TC e IRM no diagnóstico de lesões de tendão da mão foi de 94,7% e 90,7% respectivamente. A especificidade foi de 99,3% e 98,6%, enquanto a taxa de coincidência foi de 97,7% e 96,3%, respectivamente. Conclusões: Imagens por TC são precisas na localização e caracterização de lesões de tendão e apresentam alta sensibilidade especificidade, fornecendo uma base anatômica precisa para cirurgia. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descriptores: *Tendão do Calcâneo; Avaliação de Danos; Diagnóstico por imagem.*

RESUMEN

Introducción: Lesiones del tendón generalmente pueden dividirse en: fractura, luxación, compresión e inserción ósea. Luxación y compresión son las más comunes. Objetivo: Evaluar el valor de aplicación de imágenes de Tomografía Computarizada (TC) en manifestaciones del tendón. Métodos: Imágenes por TC de manos y pies se hicieron en nuestro hospital para verificar sospechas de lesiones del tendón. Se analizó retroactivamente los datos de imágenes por TC e IRM. Se comparó y analizó la eficiencia de las imágenes de TC y de IRM. Resultados: La precisión diagnóstica de los 61 pacientes fue de 89,71% (61/68). A excepción de la lesión de tendón crónica (12/19), la precisión diagnóstica de otras lesiones fue de 100%. La sensibilidad de imágenes por TC e IRM en el diagnóstico de lesiones de tendón de la mano fue de 94,7% y 90,7%, respectivamente. La especificidad fue de 99,3% y 98,6%, mientras la tasa de coincidencia fue de 97,7% y 96,3%, respectivamente. Conclusiones: Imágenes por TC son precisas en la ubicación y caracterización de lesiones de tendón y presentan alta sensibilidad y especificidad, brindando una base anatómica precisa para la cirugía. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Tendón de Calcáneo; Evaluación de Daños; Diagnóstico por Imagem.*

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INTRODUCTION

Tendon injuries can usually be divided into the following types: Fracture, dislocation, compression, bone insert, tendon injury, among which dislocation and compression are common. There are many reports on the treatment of ankle tendon injuries in China, but there are few studies on ankle tendon injuries using multi-slice spiral CT. There are related reports abroad, one of the reasons is that the value of CT is ignored due to the more application of MRI. At present, there are three commonly used methods for tendon detection: ultrasound, MRI and CT. Ultrasound technology is greatly affected by the site of tendon injury, soft tissue swelling around the tendon and the condition of clot at the broken end, and the rate of missed diagnosis is high. In addition,

ultrasound examination is greatly affected by the skill level of the operator and the scanning method.[1] Conventional transplanting for tendon display is not good, its specificity and positive rate is not high, so the application of transplanting in this field is greatly limited. Wideblow meteorite has a high tissue resolution, through multi-parameter imaging, can be different water content of tissue lesions and their relationship clearly displayed, especially suitable for the observation of tendon and other soft tissue, has become a commonly used imaging means of tendon examination; But the different tendon shape is different, the Angle of walking, the plane is changeable, the brew hit the meteorite is difficult to completely accurately display. CT images can be reconstructed by a variety of post-processing methods. By achieving isotropic image quality, the tendon can be observed from multiple planes and angles, which overcomes the disadvantages of ultrasound, conventional transplanting and wideblow. CT imaging is clear, the scanning speed is fast, and there is no need to change the patient's position during the examination, which provides a new platform for tendon display.[2,3]

Hand and foot tendon is superficial and powerful, and its injury is very common in clinical practice. In the past, the diagnosis of tendon injury was mainly based on clinical manifestations, MRI examination and even surgical exploration, but all of them were unsatisfactory. How to display the anatomical structure and injury of tendon conveniently, quickly, clearly and intuitively has always been the goal of imaging. As a new examination technique, CT has been widely used in the examination of soft tissue lesions with its unique energy spectrum scanning mode, and has a broad prospect in clinical application. This study aims to explore the preliminary application of CT in hand and foot tendon injury, so as to provide objective basis for clinical diagnosis and treatment in an early, timely and accurate manner.[4]

METHOD

Materials and methods

From October 2019 to April 2020, 61 patients, 43 males and 18 females, aged from 3 to 68 years old, with an average age of 33.4 years old, came to our hospital for energy spectrum CT scan of hand and foot due to clinically suspected tendonopathy. There were 35 cases of hand, 26 cases of foot, 39 cases of hand and 29 cases of foot. The main clinical manifestations of the patients included chronic and recurrent hand and foot pain, swelling and discomfort, limitation of movement, trauma, reexamination after tendon anastomosis, congenital deformity, fracture and so on. This examination has been detailed to all patients and their consent, cooperation and support have been obtained.

CT examination technique

1. Scanning conditions

CT scanning machine, energy spectrum scanning mode. Scan layer thickness 5.0mm, interval 5.0mm, scanning mode: Helicalfull0.6 s GSI-18, tube voltage: 140kV / 80kV, tube current: 640mA, pitch: 0.531:1, bed speed: 10.62mm/r, collimation: 20.0mm. The average volume CT dose index was 45.97mGy.

2. Position of client

Foot scan: client is in supine position with legs straight and feet in rest position. Hand scan: 28 subjects were supine, arms straight up, hands back against the bed, as straight as possible; 7 subjects were in prone position due to discomfort in supine position, with arms extended and raised, palms leaning on the bed surface as straight as possible. Scanning range: The hands included the wrist and the feet included the ankle. When necessary, the forearm and leg were scanned. Bilateral contrast scanning was performed in all subjects.

3. Image post-processing

After the mixed energy image with a thickness of 5.0mm was reconstructed into a single energy image with a thickness of 0.625mm, the tendon and surrounding muscles were taken as the area of interest under the GSIVIEW view, and the energy spectrum analysis software was used to analyze the results, select a series of images (Figure 1) with the best contraston-noise ratio (CNR), and transmitted to AW4.4, and integrated application of volumerendering (VR), multiplane reformation (MPR), curvedplanarreformation (CPR) and other image post-processing functions was made. Adjust the window width and window position to achieve the best display effect of the target tendon. Observed and recorded the course, insertion point, shape and surrounding tissue of the tendon. It is supervised and reviewed by two experienced radiologists above the attending level, and the diagnosis is made independently without the knowledge of each other. When two people disagree with each other, work together to solve the problem through consultation.

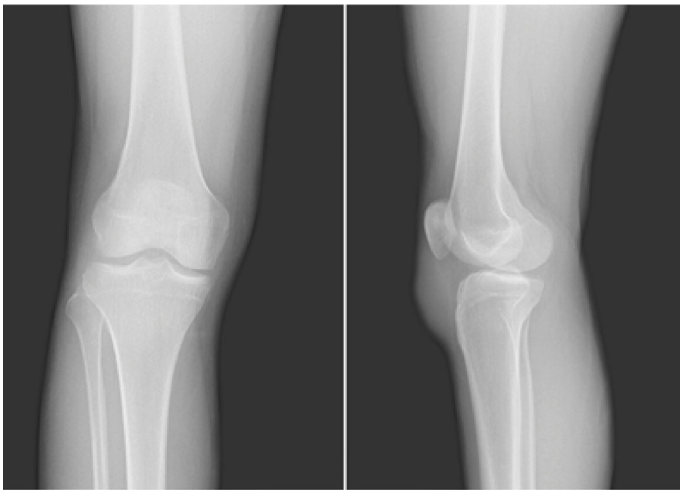

Figure 1. Avulsion fracture.

RESULTS

Displaying ability of CT and MRI on tendon anatomy

CT showed the shape, course, insertion point of the tendon itself and the relationship between the tendon and surrounding soft tissues with clear images. Through VR, MPR, CPR and other image recombination methods, multi-plane and multi-angle imaging can be performed, it can intuitively display the whole course of tendon movement on one level, which can provide three-dimensional distance, Angle measurement and accurate anatomical relationship for clinical use. However, it is difficult for CT to display thin tendons, especially extensor tendons in zone I. Due to its small thickness, it is not easy to distinguish from hyperplastic tissue and scar tissue, and the sensitivity and accuracy of diagnosis are poor. MRI can clearly display tendons, surrounding tissues, blood vessels and ligaments with more abundant image information. However, the image obtained by MRI is a two-dimensional image of a single plane. The positioning accuracy of thin-layer 3D-DESS is not as good as that of CT in observing the continuous movement of tendons and the three-dimensional relationship between tendons and bones and muscles. In general, CT and MRI can provide important diagnostic and therapeutic basis for clinic. 2 display and detection of hand tendon and surrounding tissue lesions 12 lesions were missed by CT, including thickening in 1 case, compression in 1 case, adhesion in 3 cases, degeneration in 2 cases and tendon sheath lesions in 5 cases. MRI missed 7 lesions, including 2 cases of thickening, 1 case of missing, 2 cases of compression, 2 cases of tendon sheath lesions. CT is better than MRI in observing thickening and compression, and less sensitive than MRI in density/signal changes and surrounding tendon sheath. (Table 1)

Table 1. CT and MRI in the detection of different properties of tendonopathy.

Check the method	Number of lesions detected						
	Enlargement	Missing	Compression	The fracture	Adhesion	Transgender	The sheath lesion
CT	13	2	11	3	16	3	23
MRI	12	1	10	3	16	3	22

MRI was used to diagnose 68 lesions with a sensitivity of 90.7% (68/75), while CT was used to diagnose 71 lesions with a sensitivity of 94.7% (71/75). Among 140 normal tendons in 10 patients (14 in each hand) in the control group, 2 were misdiagnosed by CT, with a specificity of 98.6% (138/140), and 1 was misdiagnosed by MRI, with a specificity of 99.3% (139/140). In terms of sensitivity and specificity, CT group was the highest, followed by MRI (Table 2). There was no statistical significance in the detection rate of tendon lesions between the two methods ($x^2 = 4.75$, $p > 0.0$ Table 3). In conclusion, the two examination methods are effective in the diagnosis of hand tendon lesions, and the CT group has the best diagnostic efficiency.

Table 2. Comparison of CT and MRI in the diagnosis of tendonopathy.

Check the method	Diseased tendon group		Normal tendon group	
	Lesions	Normal	Lesions	Normal
CT	71	4	1	139
MRI	68	7	1	139

Table 3. Comparison of detection rates between the two methods.

Check the method	Check out the	Did not check out	A combined	Detection rate (%)
CT	71	4	75	94.7
MRI	68	7	75	90.7
A combined	139	11	150	92.7

DISCUSSION

Tendon injury and general examination

Tendon injuries can be divided into open injuries and closed injuries. Open injuries are easy to be diagnosed according to symptoms, signs and doctors' experience, and can be treated in a timely and effective manner. If there is no suspected fracture, they can generally be treated without CT examination. Therefore, the majority of patients in this group were reexamined after tendon surgery to observe the reduction of tendon edema, adhesion and healing.[5] The diagnosis of closed injury is mainly based on the patient's clinical manifestations, MRI, ultrasound examination and even surgical exploration. With the improvement of CT (MSCT), its soft tissue resolution has been increasing, but the tendon display is still weak, so the conventional CT in the diagnosis of tendon lesions is limited. MRI has been widely applied in the tendon, ligament damage, high resolution, is considered to be check the tendon of the gold standard, but small lesions and its application in emergency for bone is restricted, the high cost of inspection, scanning time is long, some trauma patients can not be a long time, the group cases, 12 cases by cannot insist for a long time not to give up MR images.[6] Patients with metal foreign body in body, implanted pacemaker and claustrophobia also become contraindication of this examination. Moreover, the Angle of tendon movement is changeable, and it is difficult to display the whole process in the same plane. So far, there are few reports on three-dimensional display of tendon and ligament. Ultrasound examination is convenient, quick, low cost, easy to be accepted by patients, and can be dynamically observed. In recent years, high-frequency ultrasound has been applied more and more widely in tendon lesions, and some studies believe that ultrasound can be used as the preferred imaging examination method for tendon injuries, however, the diagnostic criteria are not easy to master, and the diagnostic accuracy depends too much on personal technical experience, and false positive results will be obtained for patients with simple tendonitis. Surgical exploration is difficult for patients to accept due to high cost, large investment and large trauma.[7-8]

CT and MRI findings of tendon injury

Tendon injury is clinically divided into 3 degrees: I degree refers to traction injury or chronic injury. MRI lacks specific imaging findings. There is no obvious abnormal change in tendon morphology and continuity, and the density may be reduced. CT can more sensitively detect the tear of the tiny fiber bundles in the tendon, showing edema and localized bleeding.[9] Healing well, no sequela. II degree injury is incomplete tear, mainly manifested as continuous existence of tendon, or local discontinuity, thinning and relaxation, decreased MRI density, combined with acute hemorrhage, increased density of the broken end and surrounding space can be seen; CT showed slightly higher localized T1 signals, smooth edges or rough surfaces on part of the plane, and localized retraction in cases with larger tear range. For example, different forms of bleeding signals could be seen at the junction of tendons and muscles, which was the unique manifestation of II degree injury. II Conservative treatment of a degree of injury can often restore the range of muscle extension and flexion, but may also result in long-term functional impairment. III degree is complete fracture, and there is no significant difference between CT and MRI in the lesion. The results showed that the tendon continuity was interrupted, the broken end curled and twinned, and the surrounding space was blurred. The embedded surrounding torn tissue was seen. The density of the tendon was reduced on MRI, and the tendon and the surrounding space showed extensive hemoceles and exudation signals on CT. II ~ Moderate tendon injury is usually accompanied by bone contusion and cartilage contusion. III Degree injury must be repaired surgically, otherwise the function of the site will be lost and the prognosis will be poor. It is of great significance to correctly distinguish the degree of tendon injury for clinical treatment and prognosis.[10]

CONCLUSION

CT scan is quick and has strong post-processing function. It can not only show the signs of fracture, but also observe the tendonopathy, and find the lesions of bone, joint and surrounding soft tissue. Unique MARS technology reduces high density artifacts. It can also evaluate the abnormal changes of tendon dislocation, tendon entrapment, bone insert, complete tendon rupture and so on. It is a valuable examination method.

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