Pathology-based CT Imaging Performance Contrast Study of Osteosarcoma and Chondrosarcoma

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Abstract: This paper aims to compare the CT imaging features of osteosarcoma and chondrosarcoma based on pathology evidence. 27 patients with osteosarcoma or chondrosarcoma confirmed by surgical pathology in our hospital from October 2018 to February 2023 were retrospectively selected. Among them, 15 cases of osteosarcoma and 12 cases of chondrosarcoma underwent conventional CT scanning. The CT findings and diagnostic efficacy of each measurement parameter of the two types of patients were compared. Compared with osteosarcoma, the incidence of chondrosarcoma was significantly increased (P<0.05). Of the 15 cases of osteosarcoma, 9 cases (60.00%) developed in the long tubular bone. Of the 12 cases of chondrosarcoma, 7 cases (58.33%) occurred in axial bone, and the difference between them was significant (P<0.05). The appearance of periosteal reactions, Codman's triangle, and radial bone needles indicates a higher incidence of osteosarcoma, while the appearance of type IV calcium density shadow indicates a higher incidence of chondrosarcoma.

Keywords: Osteosarcoma; Chondrosarcoma; CT; Imaging Findings

1. Introduction

Primary osteosarcoma often occurs at the epiphyseal end of the long shaft, causing clinical manifestations such as swelling, pain, and limited mobility in the affected area, which seriously affects the patient's life, health, and quality of life [1-3]. The treatment plans for primary osteosarcoma vary due to differences in pathological classification. Therefore, accurate and effective early diagnosis of osteosarcoma is of great significance for the treatment of the disease [4]. Chondrosarcoma is a malignant bone tumor with an incidence rate second only to osteosarcoma, which originates from chondrocytes or mesenchymal cells differentiated into cartilage. In clinical pathology, chondrosarcoma can be classified into two types based on cell heterogeneity, differentiation, and degree of invasion: low grade and medium to high grade [5]. The pathological grading of chondrosarcoma varies, and the treatment methods also vary, which can have a certain impact on the prognosis of patients. Currently, the diagnosis of the above two types of tumors is mainly determined through a comprehensive approach combining clinical, imaging, and pathological methods. The common non-invasive diagnostic methods for osteosarcoma and chondrosarcoma include CT, X-ray, MRI, etc. These imaging techniques play an important role in the clinical diagnosis, treatment, and prognosis of these two types of tumors [6,7].

As the most common primary malignant bone tumors in clinical practice [8], CT manifestations of osteosarcoma and chondrosarcoma overlap in certain aspects. And it is difficult to distinguish [9]. This study conducted CT scans on 27 patients with pathologically confirmed osteosarcoma and chondrosarcoma, and compared and analyzed the CT imaging manifestations of the two types of tumors, in order to explore the diagnostic value of CT for osteosarcoma and chondrosarcoma.

2. Methods

2.1 Subjects

Based on the inclusion and exclusion criteria, a total data of 27 patients with osteosarcoma or chondrosarcoma confirmed by surgical pathology in our hospital from October 2018 to February 2023 were retrospectively selected. Among them, there were 15 cases of osteosarcoma and 12 cases of chondrosarcoma. The onset age of osteosarcoma is 7-73 years old, with an average of 45.23 years old. The male to female ratio is 1.52:1; The onset age of chondrosarcoma is 14-82 years old, with an average age of 50.46 years. The male to female ratio is 1.38:1. Main clinical manifestations: All patients present with local pain, swelling, and accompanied by motor dysfunction. CT examinations were performed for all the patients, and the follow-up data were analyzed and summarized. The study was approved by the Medical Ethical Committee of Shaanxi Provincial People's Hospital.

Inclusion criteria: (1) Complete clinical data; (2) Confirmed by surgical pathology; (3) No mental or cognitive impairment.

Exclusion criteria: (1) Incomplete clinical data; (2) Merge with other malignant tumors or severe organ lesions; (3) Having mental and cognitive impairments.

2.2 CT Examination

A routine scan was performed on patients using the Toshiba Medical Systems 2nd-generation 640 slice volumetric CT scanner (Aquilion ONE), with a scanning range of lesions and adjacent joints, cross-sectional scans, and necessary coronal and sagittal reconstructions. Adopting SYNGO VIA post-processing workstation to further analyze. Scanning parameters: tube voltage 80-100 kV; Tube current 150-200 mA, scanning field of view FOV-M, collimation 640 layers × 0.5 mm, with a tube speed of 0.275 revolutions per second.

2.3 Observation Parameters

(1) CT manifestations of osteosarcoma and chondrosarcoma (signs, age of onset, location and surrounding degree of long tubular bone and soft tissue mass, tumor parenchyma and muscle $\triangle T/\triangle M$, periosteal reaction, Codman's triangle, radial bone needle, calcium density classification); (2) Comparison of diagnostic performance of various measurement indicators.

2.4 Statistical Method

The SPSS 23.0 software (SPSS, US) was utilized to perform statistical analysis. The age of onset was tested using the Manm-Whitney U rank sum test, and the ratio of tumor parenchyma to muscle CT values was $\Delta T/\Delta M$, using t-test. The site of onset, periosteal response, Codman's triangle, and radial bone needles are used χ^2 Inspection. $P<0.05$ indicates a significant difference.

3. Results

3.1 CT manifestations of Osteosarcoma and Chondrosarcoma

3.1.1 Observation of signs (classification of calcium like density shadows)

Type I: Calcium density shadows in the medullary cavity appear as dense patches, with a large number of bone trabeculae present, which are not clearly displayed; Type II: Within the soft tissue mass in the extraosseous area, the calcium density shadow appears as a cloud like or cotton like appearance, with lower density and blurred boundaries compared to the cortical bone; Type III: Within the soft tissue mass in the extraosseous area, the calcium density shadow appears patchy, with a density close to the bone cortex and clear boundaries; Type IV: The calcium density shadow appears arched and circular (Figure 1); Type V: The calcium density shadow presents as a thick bone mass, similar to mature bone tissue, and can be found to be surrounded by complete or incomplete cortex.

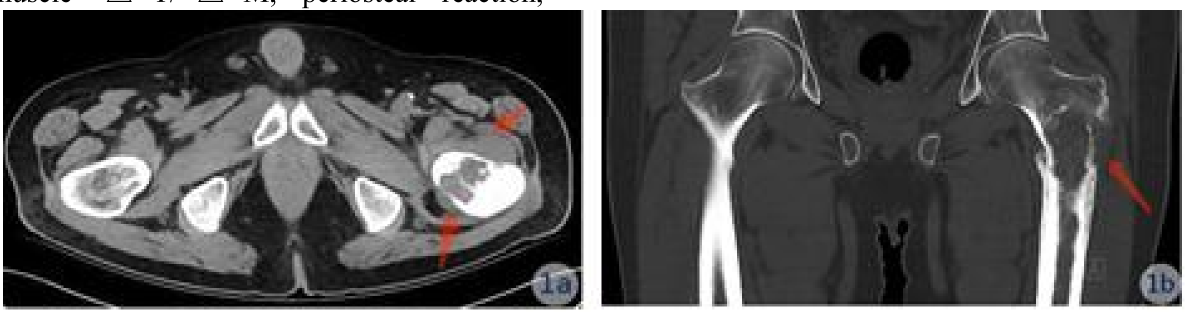

Figure 1. The Calcium Density Shadow Appears Arched and Circular

3.1.2 Age of onset, location, and surroundings

Compared with osteosarcoma, the incidence rate of chondrosarcoma was significantly higher ($P<0.05$). Among the 15 cases of osteosarcoma, 9 cases (60.00%) occurred in the long tubular bone. Among the 12 cases of chondrosarcoma, 7 cases (58.33%) occurred in the axial bone, and the difference between the two was significant (*P*<0.05). In addition, there were 7 cases of osteosarcoma and 2 cases of chondrosarcoma, and the circumferential degree of the long tubular bone soft tissue mass in the horizontal axis was greater than 1/2, with a significant difference between the two (*P*<0.05).

3.1.3 Tumor and muscle: △T/△M

The CT value range of osteosarcoma parenchyma is 31.24~81.05 HU, with an average of (49.36 ± 8.92) HU; The Δ T/Δ M values of tumor parenchyma and muscle ranged from 0.61 to 1.63, with an average of (0.91 ± 0.18). The CT value range of chondrosarcoma parenchyma is 9.32~49.58 HU, with an average of (31.05 ± 11.47) HU. The △ T/△ M value of tumor parenchyma and muscle is 0.42~0.99 HU, with an average of (0.61 ± 0.19). The t-value of △ T/△ M between osteosarcoma and chondrosarcoma is 6.13, and the difference between the two is significant (*P*<0.05).

3.1.4 Periosteal reaction, Codman triangle, radial bone needle

15 patients with osteosarcoma all experienced periosteal reactions, including 9 cases (60.00%) with Codman's triangle and 5 cases (33.33%) with radiating bone needles, as shown in Figure 2; Among the 12 patients with chondrosarcoma, 8 cases (66.67%) showed periosteal reactions, 3 cases (25.00%) showed Codman's triangle, and 1 case (8.33%) showed radial bone needles. The difference between the two is significant (*P*<0.05), as shown in Table 1.

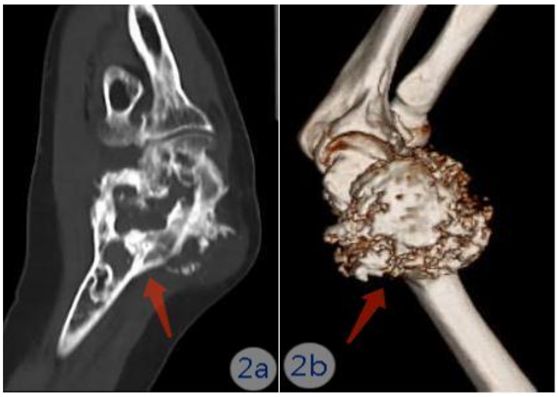

Figure 2. Osteosarcoma of the Lower Segment of the Right Humerus. 2a: CT Scan Shows Bone Destruction in the Lower Segment of the Right Humerus with Tumor Bone and Soft Tissue Shadows; 2b: VR Image Display of Lesions and Surrounding Tumor.

Table 1. Comparison of Periosteal Response, Codman's Triangle, and Radial Bone Needles between Osteosarcoma and Chondrosarcoma (%)

	Periosteal response		Codman's triangle		Radial bone needles	
	Positive	Negative	Positive	Negative	Positive	Negative
Osteosarcoma(n=15)	15(100.00)	0(0.00)	9(60.00)	6(40.00)	5(33.33)	10(66.67)
chondrosarcoma(n=12)	8(66.67)	4(33.33)	3(25.00)	9(75.00)	1(8.33)	11(91.67)
χ^2	5.032		8.125		7.036	
P	0.041		0.015		0.014	

3.1.5 Classification of calcium density shadow

There was a statistically significant difference in the morphology of type I and type IV calcium density shadows, while there was no statistically significant difference in type II, III, and V calcium density shadows, as shown in Table 2.

3.2 Comparison of Diagnostic Efficacy of Various Measurement Indicators

The sensitivity and specificity of periosteal reaction, periosteal reaction, and radial bone needle are shown in Table 3.

Table 2. Comparison of Calcium Density Shadow Morphology between Osteosarcoma and Chondrosarcoma (%)

	Type I		Type II		Type III		Type IV		Type V	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Osteosarcoma (n=15)	10 (66.67)	5 (33.33)	7 (46.67)	8 (53.33)	3 (20.00)	12 (80.00)	2 (13.33)	13 (86.67)	2 (13.33)	13 (86.67)
Chondrosarcoma (n=12)	1 (8.33)	11 (91.67)	3 (25.00)	9 (75.00)	4 (33.33)	8 (66.67)	6 (50.00)	6 (50.00)	5 (41.67)	7 (58.33)
χ^2	18.476		3.014		3.985		7.125		0.603	
P	0.013		0.092		0.046		0.027		0.458	

Table 3. Comparison of Diagnostic Efficacy of Various Measurement Indicators

	Periosteal response	Codman's triangle	Radial bone needles	Calcium density shadow morphology type I	Calcium density shadow morphology type IV	Surrounding degree of long bone soft tissue mass >1/2
Sensitivity	0.698	0.854	0.882	0.902	0.325	0.943
Specificity	0.601	0.543	0.519	0.715	0.214	0.378

4. Discussion

Osteosarcoma is mainly composed of osteoblasts, tumor like bone tissue, and cartilage with different degrees of differentiation. The common age range for the onset of osteosarcoma is 10-20 years old, with less than 1/10 of patients aged 60 and above. There is a significant difference in the incidence of osteosarcoma between the two groups of people [10,11]. Primary chondrosarcoma of the bone often occurs in the pelvic and other flat bone areas, while when it occurs in the long bone, the femur and tibia are more common [12]. Chondrosarcoma is mainly composed of cartilage of different degrees of differentiation, accompanied by mucinous degeneration, calcification, and ossification. Due to the overlapping composition of osteosarcoma and chondrosarcoma, the two poorly differentiated types of tumors lack representativeness in CT imaging. There are significant differences in the treatment methods between osteosarcoma and chondrosarcoma, therefore accurate preoperative diagnosis can help delay the survival and prognosis of patients [13,14].

The results of this study showed that compared with chondrosarcoma, the age of onset of osteosarcoma was significantly reduced ($P<0.05$). Osteosarcoma often occurs in long tubular bones, while chondrosarcoma often occurs in the axial bone. There was no significant difference in the incidence rate of the two tumors in terms of gender. The above research conclusions are in good agreement with relevant foreign research results [15-17]. Osteosarcoma and chondrosarcoma both exhibit imaging features such as bone destruction, soft tissue mass formation, and calcium like density shadows. The bone destruction of both is mainly characterized by osteolytic and phagocytic changes, with some affected cortical areas exhibiting expansive changes [18-20]. Due to the high moisture content in cartilage, the density of chondrosarcoma masses is also relatively small. In this study, the ratio of tumor parenchyma to muscle CT values ($\triangle T/\triangle M$) was calculated using muscle as a reference. The results showed that the average ratio of osteosarcoma was (0.89 ± 0.23), and the average ratio of chondrosarcoma was (0.59 ± 0.32), which can be used as one of the reference indicators for differential diagnosis. The morphological classification results of calcium like density shadows show that osteosarcoma is mainly characterized by type I calcium like density shadows, while chondrosarcoma is mainly characterized by type IV calcium like density shadows. The difference in calcium like density between these two subtypes is significant in osteosarcoma and chondrosarcoma. Among them, Type I has the highest diagnostic efficiency, while Type IV has the lowest diagnostic efficiency. In addition, there were significant differences ($P<0.05$) in the measurement parameters of periosteal response, Codman's triangle, radial bone needle, and long tubular soft tissue mass surround degree>1/2 between the two types of tumors.

5. Conclusions

The appearance of periosteal reactions, Codman's triangle, and radial bone needles indicates a higher incidence of osteosarcoma, while the appearance of type IV calcium density shadow indicates a higher incidence of chondrosarcoma.

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Competing interests: The authors have declared that no competing interests exist.

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