Computed Tomography Imaging Study of a Diffuse Tenosynovial Giant Cell Tumour in the Temporomandibular Joint

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Objective: *To provide diagnostic and therapeutic references by analysing clinical features and CT imaging data of diffuse tenosynovial giant cell tumours (D-TSGCT) in the temporomandibular joint (TMJ).*

Methods: *Patients who were diagnosed with a D-TSGCT in the TMJ through histopathological examination and underwent surgical treatment at Peking University Stomatological Hospital from April 2013 to October 2022 were included in the present study. The study retrospectively analysed and summarised patients' clinical and radiological features, the latter including osseous erosion, invasion of surrounding tissues and imaging characteristics.*

Results: *This study included 31 patients with a D-TSGCT in the TMJ (16 men, 15 women; median age 46 years). All patients underwent surgical treatment, with 51.6% receiving postoperative supplementary radiotherapy. The recurrence rate was 19.4% over a 3- to 12-year follow-up period. Imaging revealed extra-articular extension in 83.9% of cases, and 93.5% of cases showed bone involvement (condyle 48.4%, glenoid fossa 77.4%). Other features included articular eminence destruction (67.7%), ill-defined masses with calcification (51.6%), marginal enhancement (26.9%) and periosteal reaction (9.7%).*

Conclusion: *The imaging features showed that D-TSGCT in the TMJ is an aggressive and expansive neoplasm with significant bone invasion. The recurrence patterns further support its intermediate-type biological behaviour. Computed tomography images play a critical role in diagnosis, treatment planning and prognosis assessment.*

Keywords: *bone destruction, computed tomography, diffuse tenosynovial giant cell tumour, recurrence, temporomandibular joint*

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Diffuse tenosynovial giant cell tumours (D-TSGCTs) are locally aggressive tumours that arise from the synovium of joints, bursae and tendon sheaths and show synovial differentiation. In 1941, Jaffe et al[1] first named this condition "pigmented villonodular synovitis (PVNS)", characterising it as a non-neoplastic, inflammatory disease. By the 1990s, genetic studies revealed that its development typically involved chromosomal abnormalities, leading more scholars to regard D-TSGCTs as a neoplastic disorder. In 2013, the World Health Organization classification of soft tissue and bone tumours unified these conditions under the term "diffuse tenosynovial giant cell tumors",[2] then the 2020 fifth edition classification explicitly recommended using this term to designate the disease.[3] The incidence of D-TSGCTs is estimated to be around four cases per 1 million people per year, occurring most frequently in the knee (75%), hip (15%), ankle, elbow and shoulder, and less frequently in the temporomandibular joint (TMJ). D-TSGCTs usually occur in patients between the ages of 30 to 50 years, and are more prevalent in women.[4,5]

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The main symptoms of D-TSGCTs include joint pain or swelling with limited mobility.[5] Computed tomography (CT) scans typically reveal poorly defined soft tissue masses, often accompanied by bone destruction.[6] Histopathologically, they present with mixed cellular components and hemosiderin deposition.[5] Surgery is the primary treatment, but recurrence is frequently observed in large joints, accounting for around 40% to 60% of cases.[7]

Since tumours in the TMJ have rarely been reported, this study retrospectively analysed 31 cases of D-TSGCTs in the TMJ, summarising their clinical and imaging features to provide diagnostic and therapeutic insights for clinicians.

Materials and methods

Subjects

Between April 2013 and October 2022, 38 patients were diagnosed with TMJ D-TSGCT and underwent surgical treatment at Peking University School of Stomatology. The diagnosis of D-TSGCT was established postoperatively according to histopathological examinations. Of the 38 patients, 34 had undergone preoperative spiral CT scans at the present authors' hospital. Four patients with CT scans taken at other hospitals were not included in the study. After excluding three cases with concurrent D-TSGCT and other tumour types in TMJ, a final cohort of 31 cases that met the histopathological diagnostic criteria for D-TSGCT was included in the present study. The study was approved by the Ethics Committee of Peking University School of Stomatology (approval no PKUSSIRB-202384004).

Imaging studies

All 31 patients underwent preoperative maxillofacial CT scans at Peking University School of Stomatology. From 2013 to 2015, scans were taken using a GE Brightspeed CT scanner (GE HealthCare Technologies, Chicago, IL, USA), and from 2016 to 2022, a GE Optima CT scanner (GE HealthCare Technologies) was employed. The scanning parameters were voltage 120 to 140 kV, current ≥ 200 mA, slice thickness 1.25 mm and interval 1.25 mm. Standard imaging protocols consisted of axial scans of the maxillofacial region with reconstructed coronal and sagittal images.

The radiological parameters assessed included tumour location and extent of involvement, presence of condylar or skull base osseous destruction, degree of surrounding soft tissue infiltration and characteristic enhancement patterns including marginal enhancement or periosteal reaction.

Among the 31 patients, 20 patients in the present series also underwent MRI examinations, but due to the different parameters from different hospitals, the overall analysis of the MRI results were not included in this study.

Images were evaluated by a senior radiologist and two practitioners with over 2 years of clinical experience.

Statistical analysis

The patients were divided into skull base destruction group and non-skull base destruction group. A Fisher exact test was used to compare recurrence rates between 2 groups due to the small sample size (N < 40).

Results

Clinical data

The study included 31 patients with TMJ D-TSGCT, comprising 16 men (51.6%) and 15 women (48.4%) with an age range of 24 to 62 years (median 46 years). Demographic information and CT features are summarised in Table 1. The affected side distribution showed left TMJ involvement in 11 cases (35.5%) and right TMJ involvement in 20 cases (64.5%). All patients underwent surgical resection under general anaesthesia. The surgical approach aimed to completely remove the tumour while protecting important structures such as the dura and internal carotid artery and considering joint function. Intraoperative navigation was utilised in 10 cases to optimise precision. For cases involving skull base invasion where the tumour showed adherence to the dura, complete resection was often challenging, and 16 patients (51.6%) received supplementary postoperative radiotherapy. All patients underwent histopathological examinations postoperatively and conformed to the characteristics of D-TSGCT (Fig 1). Chondroid metaplasia was observed in some cases. All patients were monitored closely with regular clinical and imaging evaluations every 3 to 6 months in the first 2 years and then once a year thereafter. Over the follow-up period ranging from 3 to 12 years, six patients (19.4%) experienced tumour recurrence.

Table 1 Demographic information and CT features of D-TSGCT of the TMJ.

Patient	Age/ sex	Side	Treatments	Recurrence	Bone destruction			Invasion of surrounding tissues			Imaging characteristics		
					Condyle	Skull base	Zygomatic arch	Articular eminence	EAC/ mastoid	Muscle/ parotid	Homogeneity	Margin enhancement	Periosteal reaction
1	54/F	Right	Resection	No	No	No	No	No	No	Yes	No	Yes	No
2	47/F	Left	Resection	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No
3	47/F	Right	Resection	No	No	Yes	No	No	No	Yes	Yes	No	No
4	45/F	Left	Resection	No	Yes	Yes	No	No	No	Yes	No	No	No
5	29/F	Left	Resection	No	Yes	No	No	No	No	No	No	-	No
6	58/M	Right	Resection	No	Yes	Yes	No	Yes	No	Yes	No	No	No
7	46/M	Right	Resection + PORT	No	No	Yes	No	Yes	No	Yes	No	No	No
8	43/M	Right	Resection	No	Yes	Yes	Yes	Yes	No	Yes	No	-	No
9	59/M	Right	Resection	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No
10	33/F	Left	Resection + PORT	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No
11	36/F	Right	Resection	No	No	Yes	No	No	No	Yes	Yes	No	No
12	28/M	Right	Resection + PORT	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No
13	24/M	Left	Resection + PORT	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No
14	49/F	Right	Resection	No	No	No	No	No	No	Yes	Yes	No	No
15	56/M	Right	Resection	No	Yes	Yes	No	Yes	No	Yes	Yes	-	No
16	45/F	Right	Resection + PORT	Yes	No	Yes	No	Yes	No	Yes	No	No	No
17	47/M	Left	Resection + PORT	No	Yes	Yes	No	Yes	Yes	No	Yes	No	No
18	56/F	Right	Resection	Yes	Yes	Yes	No	Yes	No	No	No	-	No
19	28/M	Right	Resection + PORT	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No
20	46/F	Right	Resection	No	Yes	No	No	No	No	Yes	No	-	No
21	55/M	Left	Resection + PORT	No	No	Yes	No	Yes	No	Yes	No	No	No
22	26/M	Right	Resection	No	No	Yes	No	No	No	Yes	Yes	No	Yes
23	34/M	Left	Resection + PORT	No	No	Yes	No	Yes	No	Yes	No	No	No
24	41/F	Left	Resection + PORT	No	No	Yes	No	Yes	Yes	No	Yes	No	No
25	50/M	Right	Resection	No	Yes	No	No	No	No	Yes	Yes	No	No
26	34/M	Left	Resection + PORT	Yes	No	Yes	No	Yes	Yes	No	Yes	No	No
27	31/M	Left	Resection + PORT	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes
28	49/F	Right	Resection + PORT	No	Yes	Yes	No	Yes	No	Yes	Yes	No	No
29	24/M	Right	Resection + PORT	No	Yes	No	No	No	No	Yes	Yes	Yes	No
30	62/F	Right	Resection + PORT	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes
31	48/F	Right	Resection + PORT	No	Yes	Yes	No	Yes	No	Yes	Yes	No	No

EAC, external auditory canal; F, female; M, male; PORT, postoperative radiotherapy.

- indicates that the patient had a plain CT scan (no contrast agent used).

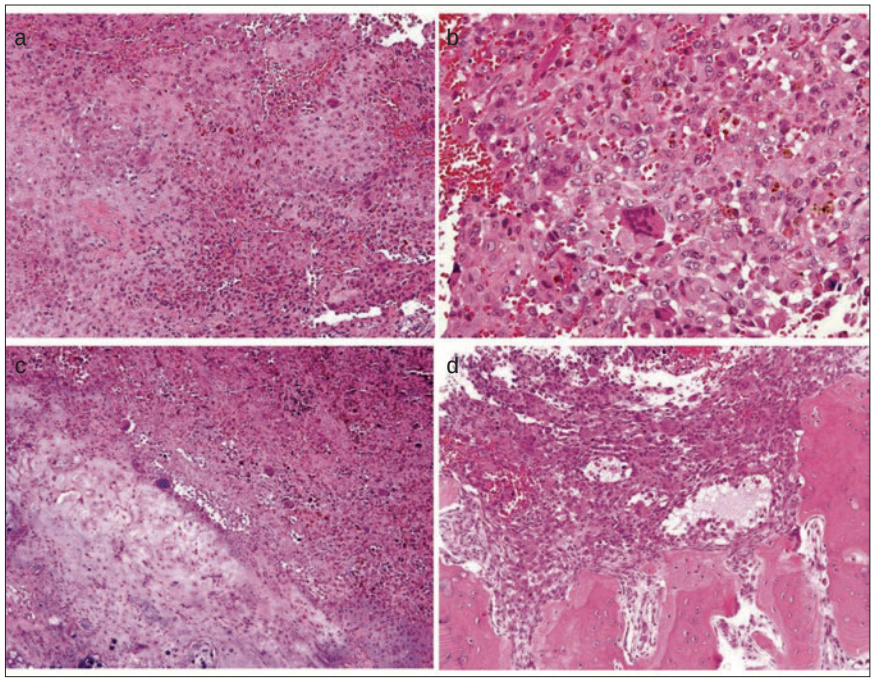

Fig 1a to d Histopathological manifestations of D-TSGCT in the TMJ (HE staining). Mononuclear cells with abundant cytoplasm as round, polygonal or short spindle shapes, interspersed with multinucleated giant cells (a and b). Note the prominent vascularity, hemosiderin deposition and focal areas of old haemorrhage (a scale bar 50 µm, b scale bar 20 µm). Chondroid metaplasia is observed in the lower right field and hemosiderin deposition is observed in the upper (scale bar 100 µm) (c). Aggressive features with tight integration between tumour and normal host bone tissue (scale bar 50 µm) (d).

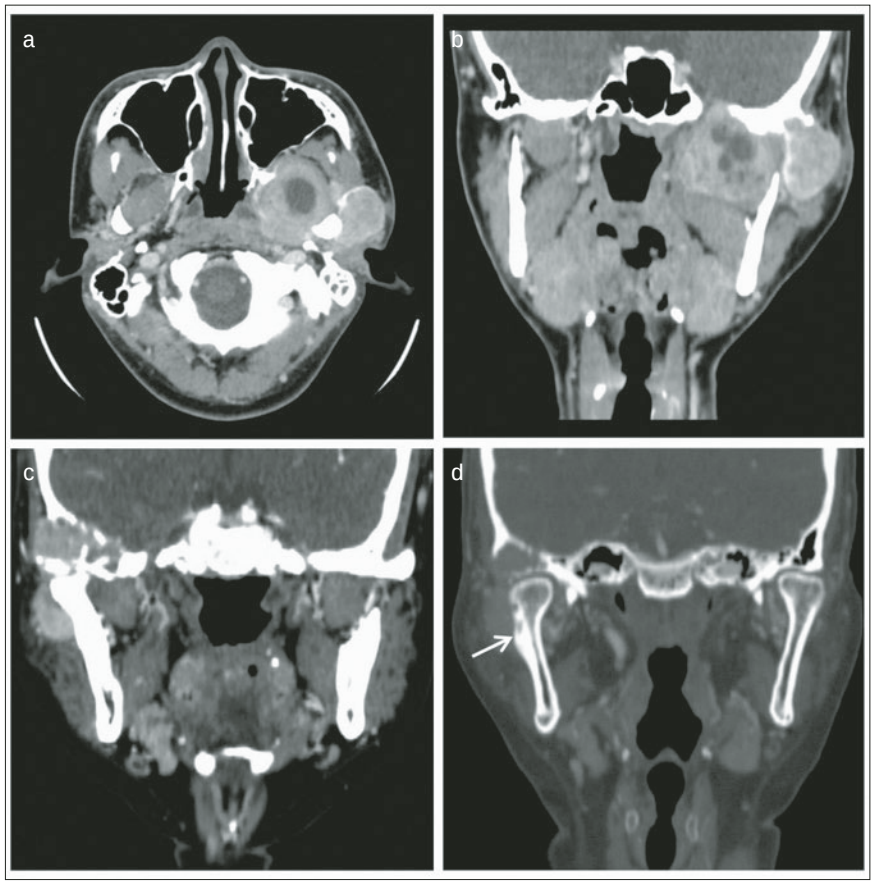

Fig 2a to d CT findings of D-TSGCTs in the TMJ. An ill-defined periarticular mass with marginal enhancement in a left TMJ (a and b). Destruction of the skull base in a right TMJ, and periosteal reaction was seen in the bone window (arrow) (c and d).

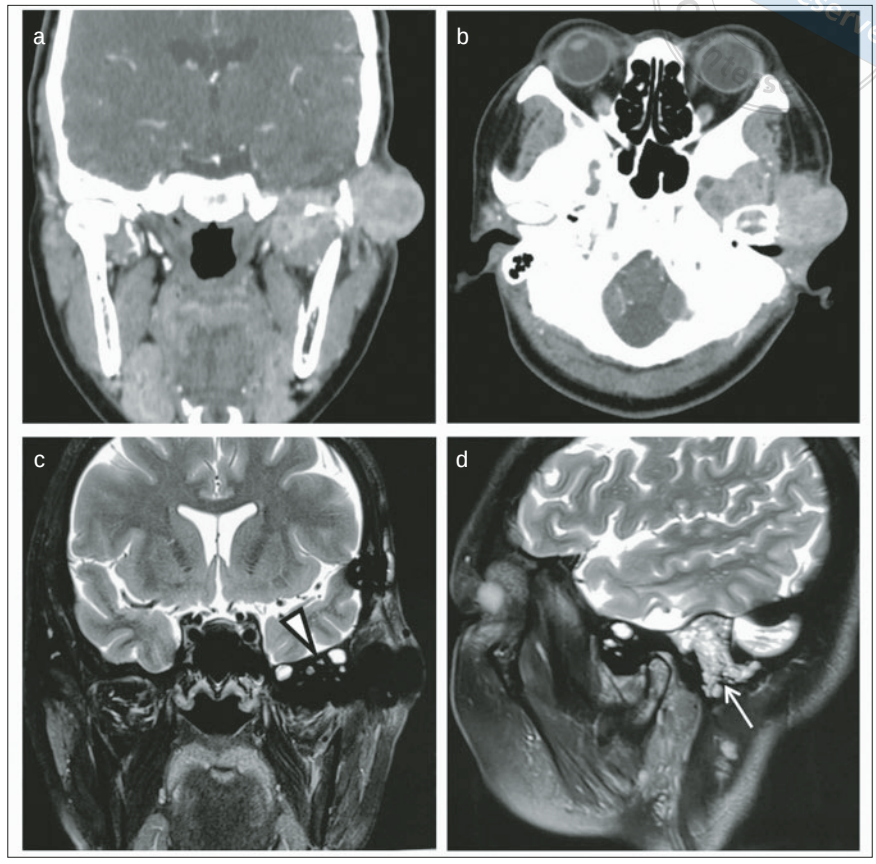

Fig 3a to d A case of D-TSGCT in the left TMJ with tumour invasion into the infratemporal fossa and middle cranial fossa. CT imaging showed the destruction of the skull base (a and b). MRI: the white triangle demonstrates intracranial extension of the mass with dural compression and associated flattening of adjacent cerebral gyri (c). The arrow showed punctate high signal in the mastoid air cells demonstrating mastoiditis (d).

Imaging findings

The imaging analysis included a total of 31 patients from April 2013 to October 2022. All patients underwent spiral CT examinations at the present authors' hospital, and 26 with contrast enhancement. Radiographically, most tumours presented as ill-defined periarticular masses, frequently associated with bony destruction (Fig 2). Bone erosion was observed in 29 patients (93.5%). Bone erosion primarily affected the condyle (48.4%) and glenoid fossa (77.4%), with 35.5% combined involvement. Additional osseous abnormalities included articular eminence destruction (67.7%), zygomatic arch extension (19.4%) and external auditory canal involvement (16.1%). Sixteen cases (51.6%) displayed calcifications. Among the 26 patients who underwent contrast-enhanced CT, 7 (26.9%) exhibited marginal enhancement and 3 (9.7%) demonstrated a periosteal reaction (Fig 2d).

Imaging analysis revealed that 26 patients (83.9%) demonstrated extra-articular extension into adjacent muscles or the parotid, and even into the infratemporal fossa or middle cranial fossa (Fig 3). Further MRI examination demonstrated intracranial extension of the tumour with dural compression in some patients, and MRI also revealed mastoiditis more clearly in the patient with mastoid involvement (Fig 3c and d). Among these patients, 24 had skull base bone disruption. The present authors divided the 31 patients into two groups based on skull base bone disruption on imaging. Recurrence rates showed no significant difference between groups ($P > 0.05$) (Table 2).

Discussion

Bone destruction and invasion of adjacent tissues

In the imaging manifestations of D-TSGCT in the TMJ, bone destruction is a prominent feature.[3] In this series, destruction of the joint's bone (including the condyle and glenoid fossa) was common (29 cases/93.5%). Glenoid fossa destruction (24 cases/77.4%) was more frequent than condylar destruction (15 cases/48.4%), suggesting a predilection for the upper joint space, possibly due to its synovial origin.[8,9] Bone destruction patterns reflect tumour aggressiveness and aid diagnosis in histopathology (Fig 1d).

Table 2 Association between skull base destruction and tumour recurrence: a 2 × 2 contingency table with Fisher exact test results.

		Recurrence		Total
		No	Yes	
Skull base destruction	No	7	0	7
	Yes	18	6	24
Total		25	6	31

N < 40, T = 1, Fisher exact test, $P = 0.573 > 0.05$.

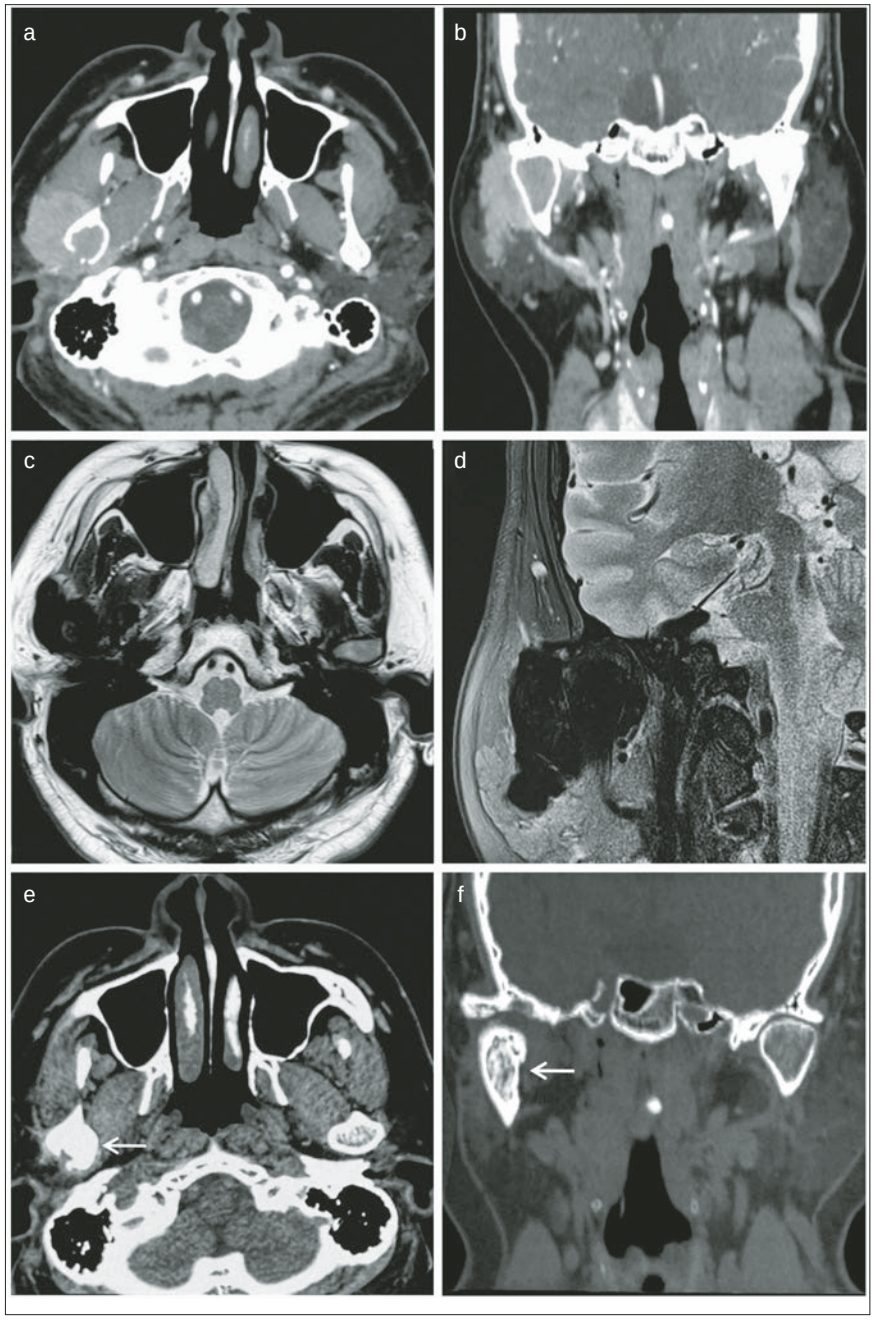

Fig 4a to f A 24-year-old man with D-TSGCT. The tumour invaded the right condyle, adjacent masseter muscle and parotid (this case was histopathologically confirmed as D-TSGCT in Fig 1a). A soft tissue mass was seen in the right joint and parotid area, with an irregular shape and clear boundary on CT. The intensity of enhancement was even. The mass surrounded the right condyle and destroyed the posterior edge of the bone and extended into the condyle (a and b). MRI revealed a mass with low signal intensity in the right joint and parotid area because of haemosiderin deposition **(c and d)**. After a 31-month follow-up, regeneration of trabecular and cortical bone in the condyle was observed on CT as the arrow shows (e and f).

Due to their obvious bone destruction patterns, it is necessary to distinguish D-TSGCT and giant cell tumour of bone (GCTB). GCTB predominantly involves the epiphysis of long bones and rarely occurs in the TMJ. CT imaging shows GCTB as a lytic lesion located in the condyle and the lower articular cavity, whereas D-TSGCT of tenosynovial origin typically appears in the skull base and the upper articular cavity, which is rich in synovial tissue. Although D-TSGCT also contains osteoclast-like multinucleated giant cells histologically (Fig 1a and b), those in GCTB generally have 10 to 20 nuclei (sometimes exceeding 100), which is significantly more than those seen in D-TSGCT.[10]

D-TSGCT frequently extends beyond the TMJ, invading the skull base, infratemporal fossa and even the external auditory canal and mastoid process, which exhibit hearing loss and mastoiditis. In this series, 26 of 31 cases (83.8%) extended into the adjacent muscles or parotid, necessitating differential diagnosis from parotid tumours.

Surgical treatment and postoperative supplementary radiotherapy

Surgical resection is the preferred method in the treatment of D-TSGCT. Researchers have developed appropriate clinical protocols based on its biological manifestations. Liu et al[11] summarised surgical treatment for 22 D-TSGCT cases involving the condyle and skull base, noting its locally aggressive nature despite being benign. Lin et al[12] proposed a grading system for 31 cases invading the temporal bone, emphasising that surgical resection is the preferred treatment method.

According to the 2020 WHO classification of soft tissue and bone tumours,[3] D-TSGCT is categorised as an intermediate-type neoplasm, demonstrating locally aggressive behaviour with significant recurrence potential. Repeated recurrence may predispose to malignant transformation.[13,14]

During surgery, the present authors aimed to completely remove the tumour while protecting important structures such as the dura and internal carotid artery and considering joint function. Even with intraoperative navigation, complete resection was often challenging for tumours with skull base invasion that adhered to the dura. Consequently, 16 patients (51.6%) received supplementary postoperative radiotherapy. Figure 4 shows a case of D-TSGCT in the TMJ with the tumour invading the condyle, adjacent masseter muscle and parotid. The condyle was preserved during surgery, followed by postoperative radiotherapy (40 Gy). After the 31-month follow-up, regeneration of trabecular and cortical bone in the condyle was observed and joint function was preserved (Fig 4e and f).

Given the aggressive nature of D-TSGCT, postoperative adjuvant radiotherapy is recommended in cases demonstrating extensive skull base destruction and adjacent tissue invasion with indistinct tumour margins radiologically, and high-risk cases identified intraoperatively featuring dural adhesion or where complete resection could not be achieved. Moderate-to-low dose radiotherapy has proven effective in these scenarios, significantly improving local control rates and reducing recurrence. Furthermore, in cases with tumour extension into the external auditory canal and mastoid region, radiation therapy has additional benefits in alleviating mastoiditis symptoms.

In the present series, skull base bone destruction was present in 24 patients (77.4%), with 6 exhibiting recurrence (25.0%). No recurrences occurred in the seven cases without skull base bone destruction. A Fisher exact test demonstrated no statistically significant association between skull base destruction and tumour recurrence (P = 0.573; Table 2). The lack of significance may reflect the effect of supplementary radiotherapy in reducing recurrence in the disruption group or the small surgical sample size.

Calcification in D-TSGCT

D-TSGCT with chondroid metaplasia is a rare subset of D-TSGCT but occurs relatively frequently in the TMJ (Fig 1c).[15] In this series of TMJ cases, D-TSGCT contained a high proportion of various kinds of calcification (51.6%), including osseous and cartilaginous calcification, necessitating differentiation from synovial chondromatosis (SC), chondroblastoma and chondrosarcoma. SC shows joint space widening, calcified loose bodies on CT and joint capsule expansion on MRI. D-TSGCT and SC may also occur simultaneously.[16,17] Chondroblastoma, common in adolescents, often involves long bone epiphyses, with 4.6% occurring in the temporal bone. CT shows calcification and expansive lobulated osteolytic destruction; MRI shows heterogenous high signal intensity on T1-weighted images, presenting as a heterogeneous lobulated tumour.[18] Additionally, chondrosarcoma in the TMJ region can cause bone destruction of the condyle and glenoid fossa, showing stronger invasiveness on imaging.[19] For cases with similar presentations, histopathological examination is necessary for a definitive diagnosis.

Marginal enhancement and periosteal reaction

Marginal enhancement is a common feature of D-TSGCT on contrast-enhanced CT. Intra-articular D-TSGCT often presents as diffuse synovial thickening, forming multilocular cystic masses.[20] In this series, marginal enhancement was observed in seven patients (26.9%), reflecting the tumour's rich blood supply and active biological behaviour. It is worth noting that periosteal reaction was also observed in three cases (9.7%). Periosteal reaction is the response of the periosteum to bone or periosteal stimulation, and its occurrence usually indicates tumour invasion of bone and inflammatory response.[21] D-TSGCT with periosteal reactions, is typically seen in slowly progressing lesions, which may correspond to its relatively slow clinical progression.

The present study has several limitations that should be acknowledged, such as the small sample size. Although 20 patients had undergone MRI examinations, due to the different parameters from multiple hospitals, the overall results of MRI were not presented in this study. Generally, these cases showed specific decreased signal intensity in both T1- and T2-weighted images, with artefacts from haemosiderin deposition on MRI (Fig 4c and d). MRI demonstrates superior sensitivity in detecting soft tissue neoplasms compared to other imaging modalities, especially in intracranial extension with dural invasion and adjacent tissue (Fig 4c and d).

Conclusion

The imaging features show that D-TSGCT in the TMJ is an aggressive and expansive neoplasm with significant bone invasion. The recurrence patterns further support its intermediate-type biological behaviour. CT imaging plays a critical role in diagnosis, treatment planning and prognosis assessment, particularly in revealing bone destruction and adjacent tissue invasion, which provide essential evidence for clinical decision making.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Dr Zong Han HE contributed to the data curation, methodology design, manuscript draft and editing; Dr Dan Dan WANG contributed to the data curation; Dr Yan Ping ZHAO contributed to the data validation and radiology supervision; Dr Chuan Bin GUO and Dr Juan Hong MENG contributed to the conceptualisation and manuscript revision. All authors read and agreed to the published version of the manuscript.

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