Diseases Manifesting as a Palpable Mass at the Temporomandibular Joints: Focused on its Differential Diagnosis

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Learning objectives

1. To review a normal imaging anatomy and various tumorous or tumor-mimicking conditions involving temporomandibular joint (TMJ) on CT and MRI

2. To identify those imaging findings that may help to reach a specific diagnosis for the underlying disease of TMJ

Background

A variety of miscellaneous disease such as tumor or tumor-mimicking disease can affect the TMJ. But, most of these disease are very rare and majority of radiologist are not familiar with their specific imaging findings. Therefore, it is very difficult to accurately diagnosis the specific disease involving TMJ.

However, imaging pattern or clinical symptoms are somewhat different between diseases involving bony structure and joint space.

Thus, understanding of specific imaging pattern according to the involved structure, and specific CT or MRI findings of various disease can be helpful in the accurate diagnostic approach for radiologists.

Findings and procedure details

NORMAL ANATOMY OF TM JOINT

- See the Figure 1 and Figure 2.

DISEASE INVOLVING TM JOINT

1. Characteristics of Disease involving Bony Structure

- The joint space is relatively preserved on CT and MRI images until late stage of the disease.
• The opposite non-involved bony structure can be normal even though large size of the tumor.
• Symptoms such as pain or functional abnormality can manifest at late stage of disease.

2. Characteristics of Disease involving Joint Space

• The joint space is widened on CT with bone-window setting, and replace with the lesion on MRI in early stage of the disease.
• Either side of bony surfaces of TM joint can be affected at the same time, but mandibular condyle is more frequently involved because joint capsules are attached to the condyle more broadly.
• Symptoms such as pain or functional abnormality are usually presented at the early stage of disease

CATEGORIES OF DISEASE

• See the Figure 3.

DISEASE INVOLVING BONY STRUCTURE

< Osteochondroma >

• Osteochondroma is a cartilage-capped esophytic lesion that arises from the cortes of bone.
• The tumors is found most often on the medial aspect of the mandibular condyle (52%) at the site of attachment of the lateral pterygoid muscle, followed by an anterior location (20%), and rarely in the lateral or superior positions (1%).

Imaging Finding

• On CT, the tumor is seen as a bony outgrowth arising from the condylar neck. CT clearly depicts the continuation of the cortex and medulla of the parent bone with that of the tumor, a feature considered diagnostic of osteochondromas.
• Osteochondroma of the mandibular condyle must be distinguished from unilateral condylar hyperplasia. Condylar hyperplasia is manifested clinically and radiographically as an enlarged condylar process, whereas the osteochondroma usually shows a globular projection extending from the margins of the condylar head with the normal outline of the condylar head being maintained.
• See the Figure 4.
**< Unilateral Condylar Hyperplasia >**

- Condylar hyperplasia is a unilateral condition characterized by generalized enlargement of the condyle, the condylar neck, the ramus and body of the mandible, leading to facial asymmetry. Typically, the condyle shows globular enlargement maintaining its original shape.
- See the Figure 5.

**< Fibrous Dysplasia >**

- FD is a disorder of unknown etiology characterized by slowly progressive replacement of normal bone by dysplastic fibroosseous tissue.
- The skull and facial bones are involved in 10-25% of cases of monostotic FD and in 50% of the polyostotic variety. Involvement of TMJ, however, is relatively rare.
- The bony overgrowth in these areas may deform the TMJ with resulting decreased excursion of the jaw and trismus.

**Imaging Finding**

- Radiologic findings can be grossly divided into three patterns: pagetoid, sclerotic, and cyst-like according to the degree of fibrous tissue present.
- In the temporal bone, FD is almost always of the predominantly sclerotic form, thus the most common CT findings are increase in bone thickness, a homogenous radiodensity, and a loss of the trabecular pattern.
- MR imaging usually shows a low to intermediate signal intensity on all imaging sequences.
- There usually is intense enhancement with contrast.
- See the Figure 6.

**< Giant Cell Tumor (GCT) >**

- GCT, which most commonly occur in the epiphysis of long bones, are benign expansile tumors that are rich in osteoclastic giant cells.
- GCT of the head and neck are very rare, and most data regarding this entity relate to case reports. The most commonly involved sites are the sphenoid and temporal bones.
- Although GCTs are generally considered to be benign neoplasms, they can exhibit locally aggressive and unpredictable behavior.

**Imaging Finding**

- On CT, GCT usually has the nonspecific appearance of a hyperdense, expansile, destructive soft-tissue mass with a surrounding incomplete thin rim of sclerosis. There is no matrix calcification on CT (differential point with chondroblastoma).
• Contrast-enhanced CT scan show heterogenous enhancement with multifocal non-enhancing foci.
• MR images of the GCT show the soft tissue tumor of intermediate signal intensity on T1WI and very low signal intensity on T2WI due to pathological hemosiderin deposition. GCT can contain some cystic components and secondary aneurismal bone cystic change.
• See the Figure 7.

< Eosinophilic Granuloma >

• Eosinophilic granuloma (EG) is the least severe and localized form of all Langerhans cell histiocytosis and possesses the best prognostic result.
• A high index of suspicion is required to diagnose the EG, especially when a young child or even an infant with otitis media or a swelling in the mastoid region that is refractory to medical treatment.
• Temporal bone lesions usually occur in association with multifocal disease and although it is quite uncommon, isolated lesions may occur either in the mastoid or in the entire temporal bone.

**Imaging Finding**

• On CT, eosinophilic granuloma of the skull is typically a lytic lesion without reactive sclerosis and it is diffusely destructive.
• MR imaging are nonspecific, and show hypointense signal on T1WI and hyperintense signal on T2WI. Marked enhancement after gadolinium injection is usually demonstrated.
• Healing lesions show a decrease in signal intensity on T2WI, indicating gradual re-ossification of the osteolytic lesions. This imaging finding can helps in differentiation it from other neoplastic condition and infection.
• See the Figure 8.

< Osteosarcoma >

• Osteosarcoma is a malignant tumor arising from undifferentiated connective tissue of bone, with the greatest predilection for the metaphyses of long bone.
• Osteosarcomas affecting the TMJ are very rare, and related to case reports. All of them were involved mandibular condyle.

**Imaging Finding**

• The radiographic features in the mandible are extremely variable according to its histological subtype, osteolytic, osteoblastic, or mixed, among which osteoblastic is the dominant pattern (46%).
• On CT scan, the lesion showed a soft tissue mass involving mandibular condyle, with lateromedial soft tissue expansion accompanied by bone...
destruction and aggressive periosteal reaction including the characteristic "sunburst" appearance.

- On T1WI, the solid nonmineralized parts of osteosarcoma generally present as areas of low to intermediate signal intensity. On T2WI, the tumor demonstrates a high signal intensity. The foci of tumor-bone formation are imaged as areas of low signal intensity on all imaging sequences.
- See the Figure 9.

< Metastasis >

- Metastases to the TMJ are very rare, and only 54 cases had been reported in the literature.
- The most common primary tumors for mandibular metastasis are the breast, lung, and prostate carcinomas, which have a hematogenous spread. TMJ metastases have the same primary tumors as the metastasis to the mandible, but are even rarer.
- Ø There were 18 cases (43%) where the TMJ metastasis was the first clinical presentation of the neoplastic disease. Therefore, there can be possibilities of misdiagnosis as other primary TMJ disease or osteomyelitis.
- Radiologically, the findings are nonspecific, and usually osteolytic, although metastases from the prostate, breast, and lung may give a sclerotic appearance.
- Because of the nonspecificity of the clinical signs and radiologic findings, the diagnostic approach is complicated and additional diagnostic tools are needed such as biopsy or fine-needle aspiration biopsy.

DISEASE INVOLVING JOINT SPACE

< Chondroblastoma >

- It is a rare, benign, cartilaginous tumor, and is found usually in the epiphysis of long bones in males under the age of 25 years.
- The origin of chondroblastoma located in the TMJ is considered possibly from the cartilage of the condylar process. But the tumor can be originated from the posterior ligament and the meniscus of the TMJ, too.
- Although chondroblastoma is a benign tumor, it always exhibits local aggressive behavior with infiltration and invasion to the soft and hard tissue around.

Imaging Finding

- CT scan shows a well-defined, expansile soft tissue mass with significant osseous destruction of the petrous and squamous portions of the temporal bone and condylar process. Chondroid matrix may also be seen within the mass (differential point with giant cell tumor).
• The appearance of chondroblastoma on MRI is variable but is usually low-to-intermediate intensity on T1 and T2 images. The cystic or fluid-filled area may show areas of hyperintensity on T2 images. There is partial enhancement after contrast injection.
• See the Figure 10. and Figure 11.

< Synovial Chondromatosis >

• Synovial chondromatosis is a rare, benign, tumor-like disorder of the joint characterized by chondrometaplasia of the mesenchymal remnants of the synovial tissue.
• It is characterized by the formation of cartilaginous nodules (loose bodies) in the synovium and inside the articular space. They may also calcify.
• Although it is considered a benign disorder, it has been described as having a potential capability of destroying the middle cranial fossa and invading intracranial structures.

Imaging Finding

• On MRI, there is often significant joint expansion and disc displacement, and there may be multiple areas of low signal intensity that represent calcified loose bodies.
• On CT, these loose bodies are shown as multiple small calcifications scattered throughout the joint capsule.
• See the Figure 12 and Figure 13.

< Pigmented Villonodular Synovitis (PVNS) >

• PVNS is an uncommon proliferative disorder that may affects the synovial membranes of joints. Although any joint can be affected, involvement of the TMJ is very rare.

Imaging Finding

• The most sensitive and specific method for diagnosis of PVNS is MRI.
• Characteristic MR finding is nodular intraarticular masses of profound low signal intensity throughout the lesion on T1- and T2-weighted images. This low signal intensity is the result of hemosiderin deposits.
• PVNS also can be aggressive with bony destruction of the adjacent skull base and resultant intracranial extension.
• Contrast-enhanced T1WI shows peripheral or nodular enhancement of the lesion.
• Non-enhanced CT show a homogenous hyperdense mass encircling head of condylar process of the mandible. The engulfed condyle is usually normal in appearance. High attenuation on precontrast CT is owing to extensive iron deposition.
• See the Figure 14.
< Calcium Pyrophosphate Dihydrate Diposition Disease (Pseudogout) >

- Calcium pyrophosphate dihydrate (CPPD) deposition disease, or pseudogout, infrequently affects the TMJ.
- Mild cases of this condition have been described with subtle calcifications in the disk and in the joint space. More extensive cases present with enlarging masses. There can be associated swelling and degenerative changes in the joint.

Imaging Finding

- CT is the best imaging modality of demonstration of the minute intraarticular calcifications.
- There can be significant erosion of the mandibular contyle as well as the condylar fossa. Malignancy may be suspected because of apparent aggressiveness and bone destruction shown at imaging.
- See the Figure 15.

GIANT CELL LESION INVOLVING TM JOINT

- Among the TMJ lesions, it is very difficult to radiologically distinguish giant cell tumor (GCT), giant cell reparative granuloma (GCRG), and pigmented villonodular synovitis (PVNS).
- All these tumors have similar radiologic findings. On CT, they are presented as hyperdense mass with various degree of osteolytic change. And on MRI, they show very low signal intensity on T1- and T2WI with partial enhancement after contrast injection. This low signal intensity is the result of presence of hemosiderin deposition.
- These entities have similar histologic appearance, being composed of various amount of mononuclear histiocyte-like cells, foamy histiocytes, lymphocytes, and osteoclast-type multinucleate giant cells. Therefore, there has been confusing factor over the absolute criteria for histologic differentiation, and these disease has been regarded as a spectrum of single disease process containing giant cell or histologically identical.
- However, there are some important clues for differential diagnosis, radiologically and clinically.
- PVNS is a neoplasm with identical histologic features with GCT, but it arises in the soft tissue and synovial lining of large joints, while GCT is a bone origin tumor. PVNS of TMJ is primarily joint space disease, so joint space alteration is occur in early stage of disease. But, GCT is a primarily bone tumor, so joint space can be spared until late stage of disease.
- GCT and GCRG have similar radiologic findings, but, calcified matrix are not observed, while varying digree of calcified matrix and cortical destruction can be observed in the case of GCRG.
- Clinically, GCRG has a more benign course than GCT, which reportedly has a higher incidence of recurrence, metastasis, and malignant transformation.
The clinical-radiologic correlation can be helpful in distinguishing the giant cell lesions involving TMJ.

Images for this section:

**Fig. 1:** Normal sagittal oblique imaging anatomy of the TMJ in the closed-mouth position. Posterior band of the disk is lying over the condyle. The central thin zone of the disk is between the anterior prominence of the condyle and the articular eminence. Two retrodiskal layers and some vasculoskeletal structures form an anatomic area called retrodiskal tissue, or the bilaminar zone. Surface of the condylar head and mandibular fossa are covered with articular cartilage.
**Fig. 2:** Closed mouth sagittal T1 MR image shows the condylar head seated in the mandibular fossa. The low signal articular disc had a "sigmoid shape" and is seen in the anterior half of the joint space. Notice that the junction between the low signal posterior band of the disc and intermediate signal of the bilaminar zone is normally found at "12 o'clock" relative to the condylar head in the closed mouth position.

**Fig. 3:** Diseases Involving TM Joint

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**Temporal bone**
- Benign tumor
  - Fibrous dysplasia
  - Giant cell tumor
  - Eosinophilic granuloma
  - Chondroblastoma
  - Aneurysmal bone cyst
  - Meningioma
- Malignant tumor
  - Chondrosarcoma
  - Metastasis
  - Lymphoma

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**Mandibular Condyle**
- Benign tumor
  - Fibrous dysplasia
  - Osteochondroma
  - Chondroblastoma
  - Giant cell tumor
  - Aneurysmal bone cyst
  - Eosinophilic granuloma
  - Simple bone cyst
  - Giant cell granuloma
  - Meningioma
- Malignant tumor
  - Osteosarcoma
  - Chondrosarcoma
  - Metastasis
  - Lymphoma
- Normal variation
  - Unilateral condylar hyperplasia

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**Joint Space**
- Benign tumor/cyst
  - Chondroblastoma
  - Synovial cyst
- Malignant tumor
  - Synovial sarcoma
- Synovial proliferative disease
  - Synovial chondromatosis
  - Pigmented villonodular synovitis
  - Calcium pyrophosphate dihydrate deposition disease (Pseudogout)
**Fig. 4:** Osteochondroma. A 39-year-old female with incidental abnormality. Axial and coronal CT sections in the bone window show bony excrescence medial to the mandibular condyle. Continuity of the cortex and medulla of the tumor (yellow arrows) with the condyle of the mandible is well demonstrated. Note that the normal outline of the condylar head (white arrows) is also preserved.

**Fig. 5:** Unilateral Condylar Hyperplasia. A 41-year-old male with facial asymmetry. Axial CT scan shows enlarged condylar process (white arrow) with anterior dislocated position.
Fig. 6: Fibrous Dysplasia (FD). A 41-year-old female with right TMJ swelling. Axial and coronal CT sections in the bone window show extensive overgrowth of right temporal bone and condylar process by fibrous dysplasia of sclerotic form. Note the joint space is decreased symmetrically.

Fig. 7: Giant Cell Tumor (GCT). A 34-year-old male with left ear fullness. Axial and coronal CT sections (a, b) in the bone window show purely osteolytic and expansile mass in the petrosquamous portion of the temporal bone with thin incomplete bony shell. However, the mandibular head is preserved and calcified matrices are not observed. On MRI, heterogeneous signal intensity are observed on T2WI (c) and heterogeneous and
strong enhancement are seen after contrast injection (e). High-power photomicrograph (f) shows mixture of mononuclear cells and giant phagocytic cells (white arrow).

Fig. 8: Eosinophilic Granuloma. A 2-year-old female with left otorrhea and otalgia. The temporal bone CT scan shows a destructive lesion with punched-out appearance (white arrowhead) of the left mastoid and temporal bone. Of note is the erosion of the anterior and superior wall of the external auditory canal (white arrows) and attic portion (yellow arrow). On MRI, the lesion is seen as nonspecific enhancing soft tissue mass. On F/U MRI after 3 months (g), The signal intensity of the tumor (yellow arrowhead) is decreased on T2WI.
Fig. 9: Osteosarcoma. A 32-year-old female with palpable mass at right parotid area. Axial and coronal CT sections in the bone and soft tissue window show large osteoblastic mass involving the right mandibular condyle. Abundant osteoid calcification and typical periosteal reaction are also observed.
**Fig. 10:** Chondroblastoma. A 32-year-old female with left TMJ pain and swelling. Temporal bone CT scans (a ~ d) show a lobulating mass with ostolytic expansion of the condylar fossa. There are scattered amorphous calcifications within the mass and the juxtaarticular soft tissue, suggesting involvement of the joint space. Note the joint space is widened by the soft tissue mass with chondroid calcification (white arrows). On MRI (e - g), the mass shows heterogeneous high signal intensity with multifocal low signal areas on T2WI. By contrast agent, the mass is heterogeneously enhanced.

**Fig. 11:** Chondroblastoma. A 41-year-old male with right TMJ swelling and palpable mass. Coronal and axial precontrast CT scans (a, b) show destruction of the squamous portion of the temporal bone and the condylar fossa by an expansile mass. Joint space is narrowed by the mass with chondroid calcification, but bony contour of condylar process
are well preserved. On MRI (c-e), the mass shows low to intermediate signal intensity on T1 and T2-weighted images, which shows heterogenous enhancement by contrast agent. Histopathologic slide after H&E stain (f) shows islands of polyhedral, proliferating mononuclear and multinucleated cells in an eosinophilic cartilaginous matrix.

Fig. 12: Synovial Chondromatosis. A 40-year-old woman with left TMJ dysfunction. Coronal CT scans show small ovoid calcified lesion, about 2 mm in diameter at lateral to the mandibular condyle (white arrow). Coronal and sagittal MR images show several calcified bodies scattered within the joint space (yellow arrows). Most of them are very small and within a joint space. T2WIs (c,d) shows the lesion of mixed density, hyperintense synovial fluid and isointense solid component due to abnormal thickened synovium around mandibular condyle.
**Fig. 13:** Synovial Chondromatosis. A 50-year-old female with left TMJ pain during 6 months. Pre- and postcontrast CT scans show multiple irregular calcified nodules partly attached to the left mandibular condyle at the anteromedial aspect of the TMJ. Note thin rim of calcification at the lower aspect of the mass suggesting calcified widened joint capsule (white arrow). Courtesy of Jinna Kim.

**Fig. 14:** Pigmented Villonodular Synovitis (PVNS). A 28-year-old woman with right ear fullness and hearing disturbance. Axial pre-contrast CT scan (a) shows subtle hyperdense soft tissue mass (white arrow) anterior to the mandibular condyle. Axial and coronal postcontrast CT scans (b, c) show mild enhancement of the mass with narrowing
of the joint space (blue arrow). Axial T2-, T1- and postcontrast T1W MR images (e - g). The mass shows profound hypointensity on T2- and T1WIs (yellow arrow), which shows homogeneous enhancement. The engulfed condyle (arrowhead) show normal signal intensity. Coronal postcontrast T1WI (h) also demonstrates intracranial extension of the tumor, with adjacent dural thickening, and narrowing of the joint space by the tumor. On Brain FDG PET (d), the lesion is hypermetabolic. Courtesy of Ji-hoon Kim.

**Fig. 15:** Calcium Pyrophosphate Dihydrate Diposition Disease (Pseudogout).
Conclusion

The TMJ is anatomically small but complex articulation. Although most of TMJ diseases are presented with functional abnormality related with internal derangement or trauma, a variety of miscellaneous disease such as tumor or tumor-mimicking disease can affect the TMJ.

But, most of these disease are very rare and majority of radiologist are not familiar with their specific imaging findings and the radiologic finding in some TMJ lesions may be non-specific. Therefore, it is very difficult to accurately diagnosis the specific disease involving TMJ.

However, imaging pattern or clinical symptoms are somewhat different between diseases involving bony structure and joint space.

Thus, understanding of specific imaging pattern according to the involved structure, and specific CT or MRI findings of various disease can be helpful in the accurate diagnostic approach for radiologists, in particular in cases of giant cell lesions such as GCT, GCRG and PVNS, having similar radiologic and pathologic features.

In this review, we showed a normal imaging anatomy of TMJ, and, illustrated the radiologic and pathologic findings in various TMJ lesions to aid in narrowing the differential diagnosis.

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