MRI Findings of Rheumatoid Arthritis in the Temporomandibular Joint

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Introduction

Rheumatoid arthritis is a chronic systemic inflammatory condition in which synovial membranes and articular surfaces of multiple joints are involved. The temporomandibular joint is no exception, although this joint tends to be overlooked by clinicians. The cause of rheumatoid arthritis is not known, although many factors including infection, genetic pre-disposition, and autoimmune response are thought to play roles. Patients may experience symptoms such as pain and swelling in the joint area, stiffness and restricted range of mouth opening, dental occlusion problems, crepitation and clicking sounds, and disc displacement. Magnetic resonance imaging (MRI) is a useful imaging modality to evaluate rheumatoid arthritis in the temporomandibular joint. Imaging findings such as cortical erosions, marrow edema, disc displacement and destruction, bone and disc fragments, pannus, and synovial enhancement may be seen with rheumatoid arthritis. This educational exhibit will introduce the reader to MRI evaluation of the temporomandibular joint and review the appearance of joints affected by rheumatoid arthritis. Comparisons with other disease processes will also be made. Processes such as ankylosing spondylitis and psoriatic arthropathy may mimic or appear identical to rheumatoid arthritis. Osteoarthritis, calcium pyrophosphate dehydrate crystal deposition disease (pseudogout), pigmented villonodular synovitis, and synovial chondromatosis can also affect the temporomandibular joint.

MRI Evaluation

A number of imaging modalities have been used in the past and are still used to examine patients with TMJ problems. MRI is an appropriate imaging modality for most patient categories. The imaging protocol consists of oblique sagittal and oblique coronal images that are obtained perpendicular or parallel to the long axis of the mandibular condyle. The diagnostic accuracy of MRI on fresh autopsy material using this protocol has been found to be nearly 95% in determining disc position and cortical bone status. If not specifically mentioned, all images in this poster are proton density or T1-weighted MR images at closed mouth, obtained perpendicular to the long axis of the mandibular condyle. In most images the posterior band of the disc is indicated by an arrow.

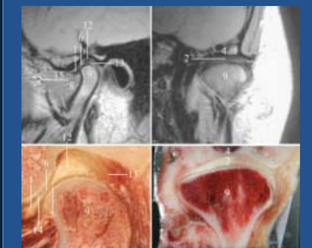


Figure 1. MRI and autopsy midcondyle anatomy of normal temporomandibular joint: *upper left* oblique sagittal MRI, *upper right* oblique coronal MRI, *lower left* oblique sagittal section, *lower right* oblique coronal section.

1. Anterior band of articular disc
2. Articular disc
3. Articular tubercle (eminence)
4. Glenoid fossa
5. Inferior joint space
6. Intermediate (central) thin zone
7. Lateral pterygoid muscle raphe
8. Lower head of lateral pterygoid muscle
9. Mandibular condyle (head)
10. Mandibular condyle articulating surface
11. Mandibular condyle marrow
12. Posterior band of articular disc
13. Posterior disc attachment
14. Superior joint space
15. Upper head of lateral pterygoid muscle

Rheumatoid Arthritis [Figures 2-5]

Clinical Features

- Swelling of joint area, not frequently seen in TMJ
- Pain (in active disease) from joints
- Restricted mouth opening capacity
- Morning stiffness, in particular stiff neck
- Dental occlusion problems; "my bite doesn't fit"
- Anterior bite opening, contact only on molars at closed mouth
- Crepitation due to secondary osteoarthritis
- Symptoms may be similar to those of common TMJ disorders
- Clicking sounds uncommon
- Disc displacement may occur in a rheumatic joint

Imaging Features

- Cortical punched-out erosions
- Abnormal disc (flattened, elongated), most frequently in normal position
- Disc fragments, or completely destroyed disc may be found
- Active disease: marrow edema and/or joint effusion
- Active disease: enhancement of synovial membrane, pannus after intravenous contrast injection
- Fibro-osseous ankylosis may be 'end-stage' of inflammatory disease
- Secondary osteoarthritis
- Disc displacement may occur in joints with inflammatory arthritis

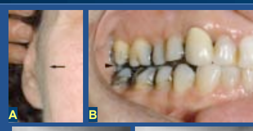


Figure 2 A-D. Rheumatoid arthritis: A. Clinical photograph shows swelling over joint area (*arrow*). **B.** Dental occlusion does not fit properly (*arrowhead*). **C.** Conventional tomography 1 year previously showed normal position of condyle in fossa and normal bone; note in particular the eminence (*arrow*). **D.** Tomography now shows condyle displaced anteriorly (probably due to joint effusion) and erosion in articular eminence (*arrow*).

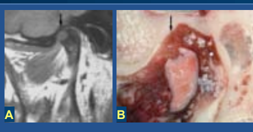


Figure 3 A-B. Rheumatoid arthritis: A. MRI shows completely destroyed disc, replaced by fibrous or vascular pannus and cortical punched-out erosion (*arrow*) with sclerosis (shown by CT) in condyle. **B.** Autopsy specimen from patient with known long-standing rheumatoid arthritis shows no disc structure, but pannus and erosion in condyle (*arrow*).

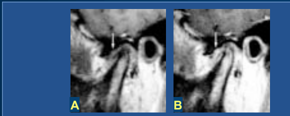


Figure 4 A-B. Rheumatoid arthritis: A, B. T1-weighted pre-Gd (**A**) and T1-weighted post-Gd (**B**) MRI shows contrast enhancement of pannus that has replaced disc structure (*arrow*), and cortical erosions in condyle and temporal bone. Note contrast enhancement also in condyle.

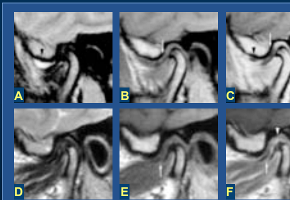


Figure 5 A-F. Rheumatoid arthritis and disc displacement of right (**A, B, C**) and left (**D, E, F**) joint. **A.** T2-weighted MRI shows joint effusion in upper compartment of anterior recess (*arrowhead*). **B, C.** T1-weighted pre-Gd (**B**) and T1-weighted post-Gd (**C**) MRI shows anteriorly displaced disc (*arrow*) and contrast enhancement in peripheral rim of joint effusion (*arrowhead*) and in posterior attachment, consistent with thickened synovium. Secondary osteoarthritis. **D.** T2-weighted MRI shows no effusion. **E, F.** T1-weighted pre-Gd (**E**) and T1-weighted post-Gd (**F**) MRI shows anteriorly displaced disk (*arrow*) and slight contrast enhancement around disc and in joint space (*arrowhead*), consistent with thickened synovium.

Juvenile Idiopathic Arthritis [Figure 6]

Rheumatoid arthritis with onset before 16 years of age

Clinical Features

- Juvenile arthritis differs in many respects from rheumatoid arthritis in adults
- Heterogeneous disease with different subgroup classifications
- Rheumatoid factor seropositivity not common
- Two peaks of onset, between 1 and 3 years of age and around 9 years of age
- Large joints (knees, wrists, and ankles) are more prominently involved than small peripheral joints
- Bony ankylosis in cervical spine is characteristic
- Underdeveloped mandible, micrognathia, is characteristic
- Restricted mouth-opening capacity
- Pain from TMJs not so common

Imaging Features

- Bony joint components abnormal, frequently without cortical erosions
- Flat fossa, underdeveloped eminence
- Condyle deformed: short, thick, flat, round
- Condyle located anteriorly in fossa at closed mouth
- Restricted condylar translation at opened mouth
- Soft-tissue abnormalities: flat, thin, elongated, or destroyed disc
- Active disease: bone marrow edema and/or joint effusion
- Active disease: enhancement of synovial membrane, pannus after intravenous contrast injection
- Secondary osteoarthritis, remodeling

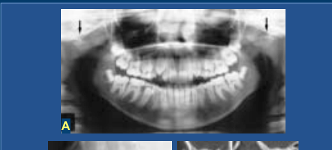


Figure 6 A-F. Juvenile idiopathic arthritis in a 12-year-old female with no history of generalized joint disease. **A.** Panoramic view shows flattened condyles bilaterally (*arrows*). **B.** Lateral cephalography shows anterior bite opening at orthodontic consultation. **C.** Oblique coronal and sagittal CT of right joint (similar changes in left joint) shows deformed condyle: flat, short and small in mediolateral direction (*left image*), and condyle located at eminence at closed mouth, with abnormal flat fossa (*right image*). **D, E, F.** T1-weighted pre-Gd (**D,E**) and T1-weighted post-Gd (**F**) MRI of left joint (similar changes in right joint) shows normally positioned disc (*arrow*) and contrast enhancement of upper and lower joint compartment (**F**), consistent with thickened synovium. Patient was referred for rheumatologic examination which confirmed diagnosis of juvenile idiopathic arthritis.

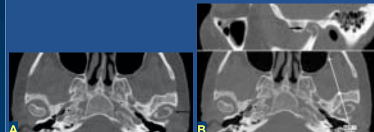
Psoriatic Arthropathy and Ankylosing Spondylitis [Figures 7-10]

Clinical features can be similar to rheumatoid arthritis, and no principal difference in TMJ imaging signs of ankylosing spondylitis or psoriatic arthropathy with rheumatoid arthritis.

Figure 7 A-D. Psoriatic arthropathy: A,C. Oblique coronal (**A**) and oblique sagittal (**C**) CT images show punched-out erosion in lateral part of condyle (*arrow*). **B,D.** Similar CT sections of contralateral joint show normal bone.

Figure 8 A-D. Psoriatic arthropathy (same patient as in Fig. 7). **A.** Direct sagittal CT image shows punched-out erosion (*arrow*). **B, C.** T1-weighted pre-Gd (**B**) and T1-weighted post-Gd (**C**) MRI shows contrast enhancement within bone erosion (*arrow*) and in joint space, consistent with thickened synovium/pannus formation. **D.** Openmouth MRI shows reduced condylar translation but normally located disc (and normal bone in this section).

Figure 9 A-C. Ankylosing spondylitis: A, B. T1-weighted pre-Gd (**A**) and T1-weighted post-Gd (**B**) MRI shows cortical erosion, deformed, thin disc in normal position (*arrow*) and contrast enhancement in upper and lower compartment and within condyle marrow (*asterisk*). **C.** T2-weighted MRI shows bone marrow edema in entire condyle (*arrow*).



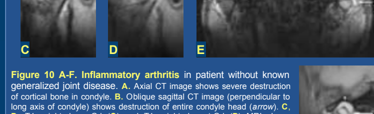


Figure 10 A-F. Inflammatory arthritis in patient without known generalized joint disease. **A.** Axial CT image shows severe destruction of cortical bone in condyle. **B.** Oblique sagittal CT image (perpendicular to long axis of condyle) shows destruction of entire condyle head (*arrow*). **C, D.** T1-weighted pre-Gd (**C**) and T1-weighted post-Gd (**D**) MRI shows contrast enhancement, particularly in upper compartment and in condyle head (*arrow*), and thin, elongated disc, apparently in normal disc position. **E.** Coronal STIR image shows marrow edema or vascular pannus in condyle and vascular pannus in joint space, particularly in lateral region (*arrow*). **F.** Oblique sagittal open-mouth MRI shows increased signal from condyle marrow (*arrow*) and increased signal from joint space (*small arrowhead*). Disc is anteriorly displaced and deformed (*large arrowhead*). Surgery confirmed severe condyle destruction and inflammatory pannus within and around condyle, particularly in lateral part of joint (patient was referred for rheumatologic evaluation due to family history of rheumatic disease, but had no symptoms from other joints).

Osteoarthritis [Figures 11-12]

Non-inflammatory focal degenerative disorder of synovial joints, primarily affecting articular cartilage and sub-condylar bone; initiated by deterioration of articular soft-tissue cover and exposure of bone.

Clinical Features

- Crepitation sounds from joint(s)
- Restricted or normal mouth opening capacity
- Pain or no pain from joint areas and/or masticatory muscles
- Occasionally, joints may show inflammatory signs
- A variety of other symptoms such as headache
- Older age groups more frequent than younger age groups
- Arthrosis deformans juveniles in young patients

Imaging Features

- Disc displacement, degenerated or absent disc very frequent
- Abnormal cortical bone; both joint components; most evident in condyle
- Early stage: cortical erosion
- Advanced stage: joint space reduction, bone production; osteophytosis, sclerosis
- Joint effusion may be seen, either in early or advanced stage
- Bone marrow edema or bone marrow sclerosis, or in combination, may be seen, either in early or advanced stage
- Usually intravenous contrast injection is not applied but occasionally osteoarthritis may be clearly inflammatory and thus demonstrate contrast enhancement of thickened synovium
- Osteoarthritis secondary to trauma or arthritides

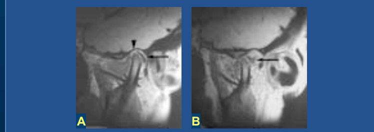


Figure 11 A-B. Osteoarthritis and posterior disc displacement: A. MRI shows disc perforation and cortical irregularities of condyle (*arrowhead*), and posteriorly displaced disc (*arrow*). **B.** Open-mouth MRI shows disc (*arrow*) adherent to condyle.

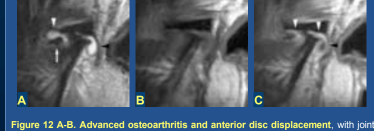


Figure 12 A-B. Advanced osteoarthritis and anterior disc displacement, with joint effusion and synovitis. **A.** T2-weighted MRI shows anteriorly displaced, deformed disc (*arrow*), deformed condyle with osteophytosis and sclerosis, and large joint effusion in anterior (*white arrowhead*) and posterior (*black arrowhead*) compartments. **B, C.** T1-weighted pre-Gd (**B**) and T1 weighted post-Gd (**C**) MRI show contrast enhancement in periphery of joint effusion in anterior (*white arrowhead*) and posterior (*black arrowhead*) compartments, and in joint space (*central arrowhead*), consistent with thickened (inflamed) synovium.

Calcium Pyrophosphate Dehydrate Crystal Deposition Disease (Pseudogout) [Figure 13]

Gout-like joint inflammation with subtle or severe calcium crystal deposits (chondrocalcinosis), not uric acid as in gout.

Clinical Features

- Joint pain and swelling
- Symptoms may be similar to those of common TMJ disorders

Imaging Features

- Calcifications within joint space
- Subtle or massive calcifications
- Both condyle and glenoid fossa may be eroded and actually simulate malignancy

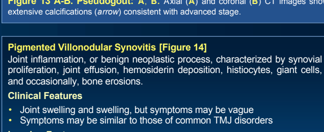


Figure 13 A-B. Pseudogout: A, B. Axial (**A**) and coronal (**B**) CT images show extensive calcifications (*arrow*) consistent with advanced stage.

Pigmented Villonodular Synovitis [Figure 14]

Joint inflammation, or benign neoplastic process, characterized by synovial proliferation, joint effusion, hemosiderin deposition, histiocytes, giant cells, and occasionally, bone erosions.

Clinical Features

- Joint swelling and swelling, but symptoms may be vague
- Symptoms may be similar to those of common TMJ disorders

Imaging Features

- Condyle may show erosions
- Glenoid fossa may show erosions, with intracranial extension
- Periarticular soft tissue density may be seen
- T1-weighted and T2-weighted MRI shows characteristic (almost pathognomonic) low signal because of hemorrhage by-products

Figure 14. Pigmented villonodular synovitis: Coronal T1-weighted MRI shows large mass of very low signal (*arrow*), penetrating skull base (*arrowhead*). Very low signal also characteristic on T2-weighted and post-Gd MRI (not shown).

Synovial Chondromatosis [Figure 15]

Benign tumor characterized by cartilaginous metaplasia of synovial membrane, usually in knee, producing small nodules of cartilage, which essentially separate from membrane to become loose bodies that may ossify.

Clinical Features

- Joint pain and swelling, but symptoms may be vague
- Facial asymmetry
- Dental occlusion problems; "my bite doesn't fit"
- Symptoms may be similar to those of common TMJ disorders

Imaging Features

- Calcifications within joint space
- Large or small calcifications, usually multiple
- Joint effusion, synovitis
- Condyle normal or osteoarthritis
- May be locally aggressive with destruction of fossa
- Intracranial extension has been reported

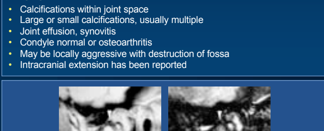


Figure 15 A-D. Synovial chondromatosis: A. T1-weighted MRI shows large structure (*arrow*) posterior to condyle, which is normal but displaced anteriorly with normal disc (*arrowhead*) at closed mouth. **B.** T2-weighted MRI shows increased signal from expansive process (*arrow*) and effusion in upper joint space; *arrowhead* condyle. **C.** Coronal CT image confirms calcifications posterior to condyle (*arrow*). **D.** Axial 3D CT image before surgery shows large calcification (*black arrow*) and smaller ones (*white arrow*).

Acknowledgment: All images were adapted with permission from the book *Maxillofacial Imaging* by Drs. TA Larheim and P-L Westesson.

References

1. Larheim TA and Westesson P-L (2006) Maxillofacial Imaging. Springer, pp16-20, 143-177.
2. Larheim TA (1993) Rheumatoid arthritis and related joint diseases. In: Katzberg, RW, Westesson, P-L (eds) Diagnosis of the Temporomandibular Joint. Saunders, pp 303-326.
3. Larheim TA (1991) Imaging of the temporomandibular joint in juvenile rheumatoid arthritis. In: Westesson P-L and Katzberg RW (eds) Imaging of the Temporomandibular Joint, Vol. 1. Cranio Clinics International. Williams and Wilkins, pp155-172.
4. Westesson P-L, Yamamoto M, Sano T, Okano T (2003) Temporomandibular Joint. In: Som PM, Curtin HD (eds) Head and Neck Imaging, 4th ed. Mosby pp 995-1053.