

# CBCT/MRI Hands on

John R Droter DDS  
Annapolis, Maryland

Annapolis, Maryland  
John R Droter DDS

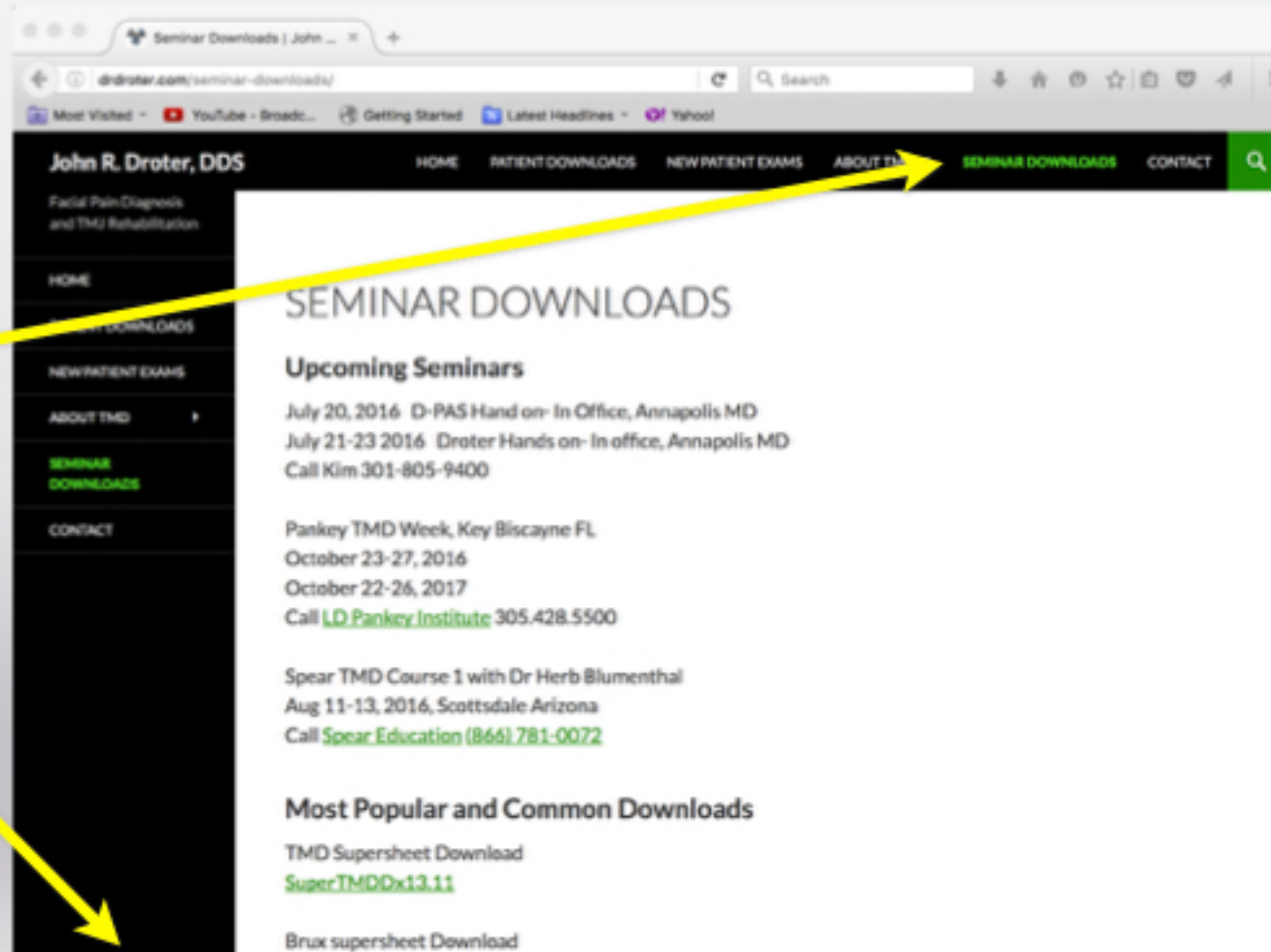
[www.jrdroter.com](http://www.jrdroter.com)

John R Droter, DDS

To get today's lecture slides:  
go to [www.drdroter.com](http://www.drdroter.com)

Seminar Download

Star of the North





Hello. I am:

John R Droter DDS  
Annapolis, Maryland

Annapolis, Maryland  
John R Droter DDS

# Milestones



Visiting Faculty LD Pankey Institute 2008-

Visiting Faculty Spear Education 2013-2020

Visiting Faculty Orthodontic Program  
Washington Hospital Center 2000-2012

Past staff AAMC: Orthopedic Rounds  
In OR for TMJ Surgeries

Devoted Facial Pain Practice 1996  
(No Hygiene to Check!!)

CT and MRI Imaging Joints 1992  
Guy Haddix, DDS: Mentor  
(3,000+ images and rising)

Post Grad CE- GPR, LD Pankey Institute, Dawson, Mahan, Gremillion, Spear, Kois



# Disclosures:

Atomic Skis- Sponsored.  
I got stuff.

LD Pankey Institute TMD Course  
Honorarium

Co-Owner of ArrowPath Sleep  
Patent on sleep device: LatBrux

Living Tree Dental Lab  
High Quality Dental Orthotics  
License fee on my designs



Ski Coach for National Ski Patrol  
Level 3 Certified Professional Ski Instructors of America



# TMDs- What are the choices? (190 Diagnoses, 7 Categories)

## 1. TMJ Damage

Adhesions and ankylosis of temporomandibular joint  
Avascular Necrosis Mandibular Condyle  
Cartilage Fibrillation, Mandibular Condyle, Fossa  
Closed Lock, Jaw Cartilage, Acute  
Closed Lock, Jaw Cartilage, Chronic  
Closed Lock, Jaw Cartilage, Intermittent, Mechanically dysfunctional  
Crush Injury Mandibular Condyle  
Crystal arthropathy, unspecified, TMJ  
Dislocation jaw cartilage due to injury, Sequela  
Dislocation jaw cartilage with reduction, favorable adaptation, TMJ  
Dislocation jaw cartilage without reduction, favorable adaptation, TMJ  
Effusion, TMJ

Impingement Retrodiscal Tissue  
Inflammatory Tissue Bone Resorption, TMJ Condyle  
Loose Body (Joint Mice), TMJ  
Malignant neoplasm of bones of skull and face  
Open Lock TMJ, Recurring  
Osteoarthritis TMJ, active degeneration  
Osteoarthritis- inactive  
Osteochondritis Dissecans TMJ  
Osteolysis Mandibular Condyle, Active  
Perforation Meniscus, TMJ  
Perforation Pseudodisc, TMJ  
Psoriatic Arthritis TMJ  
Rheumatoid Arthritis Sero Negative TMJ  
Synovitis

## 2. Muscles of the TMJ

Dystonia  
Habitual posture forward mandible  
Hemifacial Muscle spasm  
Inhibitory Reflex Dysfunction, Periodontal Ligament Masseter Muscle  
Muscle Atrophy, TMJ  
Muscle Bracing Neck Stabilization  
Muscle Bracing Pain Avoidance  
Muscle Bracing TMJ stabilization  
Muscle Bracing Airway **Patency** (with Tongue)  
Muscle Contracture Fibrosis Lateral Pterygoid  
Muscle Contracture Fibrosis Masseter, Medial Pterygoid, Temporalis  
Muscle Fatigue Overuse  
Muscle Hypertrophy TMJ Muscles

## 3. Cranial Alignment/Occlusion

Cranial Distortion / Misalignment  
Hemifacial Hypoplasia  
Hyper Occlusal Awareness  
Idiopathic Orthodontic Damage  
Malocclusion Anterior Open Bite  
Malocclusion Centric occlusion Max/IC discrepancy  
Malocclusion Deep Bite  
Malocclusion due to mouth breathing  
Malocclusion due to TMJ bone loss  
Malocclusion due to tongue, lip or finger habits  
Malocclusion Insufficient anterior occlusal guidance  
Malocclusion lack of posterior occlusal support  
Malocclusion Posterior Openbite Bilateral  
Malocclusion Posterior Openbite Unilateral  
Malocclusion unspecified

Malposition/Misalignment: Maxilla, Temporal Bone, Mandible  
Mandibular asymmetry  
Mandibular hyperplasia  
Mandibular hypoplasia  
Mandibular Retrognathia  
Maxillary asymmetry  
Maxillary hyperplasia  
Maxillary hypoplasia  
Maxillary Retrognathia  
Occlusal Adaptation, Favorable  
Occlusal Dependency for Joint Stabilization/ Proprioception  
Tooth Intrusion  
Tooth Supereruption

## 4. Cervical Damage

Cervical Vertebrae Alignment Dysfunction  
Cervicocranial Syndrome  
Muscle Guarding due Neck Instability  
Trigger Point Neck Muscle with Referred Pain  
Trigger Point Neck Muscle, Localized Pain

## 5. Parafunction

Excessive Tooth Wear, Damage  
Hypersensitive Occlusion  
Parafunctional Clenching Teeth, Awake  
Parafunctional Clenching Teeth, Sleep  
Parafunctional Grinding Teeth, Awake  
Parafunctional Grinding Teeth, Sleep  
Parafunctional Clench/Grind Wiggle  
Parafunctional Tongue Bracing avoiding uncomfortable tooth contact  
Parafunctional Tongue Bracing Neck stabilization  
Parafunctional Tongue Bracing to maintain Airway  
Parafunctional Tongue Bracing unknown cause

## 6. Whole Body / Systemic

Lyme Disease Arthritis  
Magnesium Deficiency  
Obstructive Sleep Apnea  
Osteoporosis without current pathological fracture  
Pathological Habitual Movement Pattern  
Postural Disharmony Standing  
Postural Disharmony Walking  
Postural Forward Head Position  
Upper Airway Resistance, UARS

## 7. Other

Nerve Entrapment Masseteric Nerve due to Masseteric hypertonicity  
Neuroma Trigeminal Nerve  
Obsessive-Compulsive Personality Disorder  
Other  
Otitis Ear Infection  
Pain disorder exclusively related to psychological factors, Somatoform pain disorder  
Pain disorder with related psychological factors  
Peripheral Sensitization

## 1. TMJ Damage and Diseases

Adhesions and ankylosis of temporomandibular joint  
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Cartilage Fibrillation, Mandibular Condyle, Fossa  
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Crystal arthropathy, unspecified, TMJ  
Dislocation jaw cartilage due to Injury, Sequela  
Dislocation jaw cartilage with reduction, favorable adaptation, TMJ  
Dislocation jaw cartilage without reduction, favorable adaptation, TMJ  
Effusion, TMJ  
Fracture of subcondylar process of mandible  
Gout, TMJ  
Growth Disturbance Prepuberty due to TMJ damage  
Hemarthrosis TMJ, Traumatic  
Hyperplasia Mandibular Condyle,  
Hypoplasia Mandibular Condyle  
Hypoxia Reperfusion Injury, TMJ Cartilage Damage  
Hypoxic Progressive Condylar Resorption

Impingement Retrodiscal Tissue  
Inflammatory Tissue Bone Resorption, TMJ Condyle  
Loose Body (Joint Mice), TMJ  
Malignant neoplasm of bones of skull and face  
Open Lock TMJ, Recurring  
Osteoarthritis TMJ, active degeneration  
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Osteochondritis Dissecans TMJ  
Osteolysis Mandibular Condyle, Active  
Perforation Meniscus, TMJ  
Perforation Pseudodisc, TMJ  
Psoriatic Arthritis TMJ  
Rheumatoid Arthritis Sero Negative TMJ  
Rheumatoid Arthritis TMJ  
Sprain Discal Ligament TMJ, acute with joint edema  
Subluxation on Loading, TMJ  
Subluxation on Movement, TMJ  
Synovial Cyst (Ganglion Cyst)  
Synovial Hyperplasia  
Synovitis

# My Core Belief

The TMJ is a synovial joint of the human body and will undergo the same disease processes as any other synovial joint

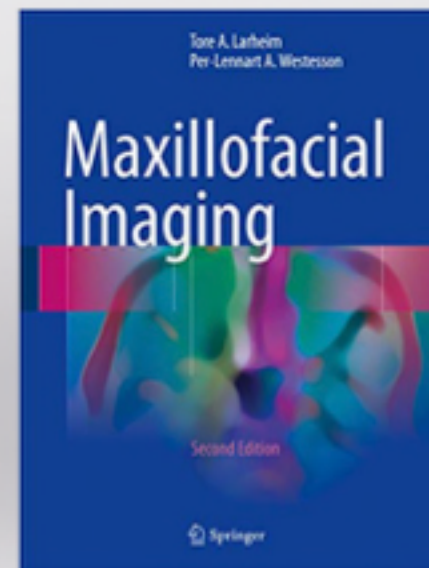
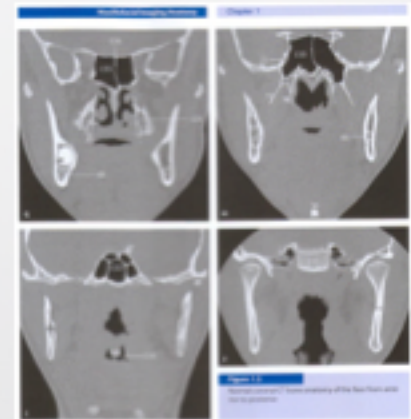
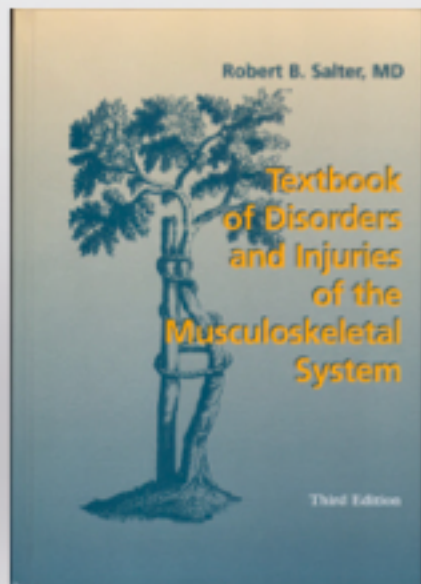
Understanding orthopedic medicine is the key to understanding joints, including the TMJ

Imaging is key in diagnosing which orthopedic condition a patient has

Buy Salter's Orthopedic Textbook.  
When you have a patient with specific disease (i.e. osteoarthritis), read that chapter.

Textbook of Disorders and Injuries of  
the Musculoskeletal System  
Robert Salter MD

Maxillofacial Imaging  
Larheim  
Westesson



CT and MRI Scans in my practice since 1992.

**Dr Guy Haddix**  
had been taking CT  
scans since 1990

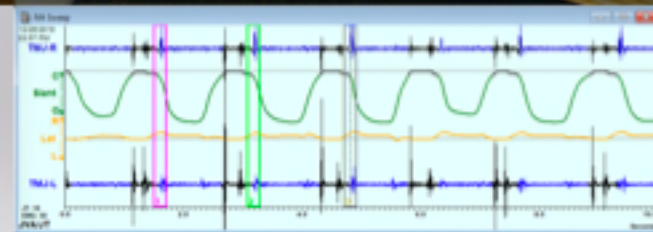
Compare CT, Mounted models, MRI, JVA  
before and after a case.  
What can I see now looking back?



Closet full of printed  
scans just as digital  
appeared!!



The magic in the coronal view  
The Load Zone



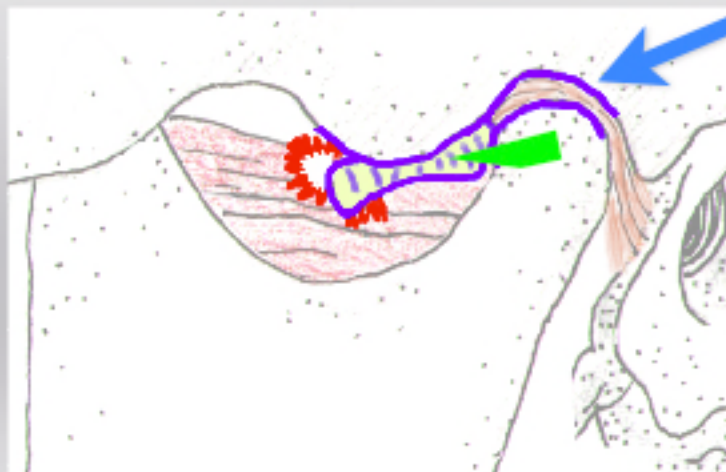
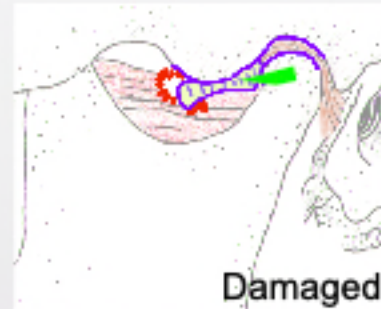
JVA since 2004

# Basic Orthopedics

Joints are either  
Healthy or  
Damaged

If damaged, joints will be either:  
Actively Breaking Down  
Adapting  
Adapted  
Structurally, Mechanically  
Favorably, Unfavorably

Majority of damaged  
TMJs adapt favorably



Posterior ligament, synovium,  
and retrodiscal tissue adapt to  
form a  
**Pseudo-disc**

Tissue Fibrosis

# **Symptoms of Temporomandibular Joint Osteoarthritis and Internal Derangement 30 years after Non-Surgical Treatment.**

**Leeuw, Boering, Stegenga, Bont,  
Journal of Craniomandibular Practice, April 1995, vol. 13, No. 2**



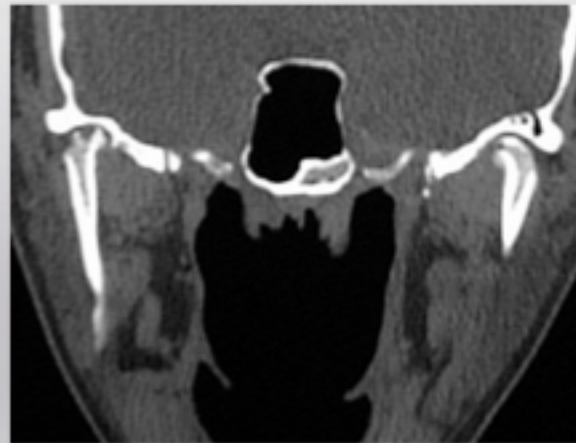
- University Hospital, Netherlands: 134 TMD patients, 30 year follow up
- Patients received good clinical work up and diagnosis 30 years ago, but basically no treatment
  - (Reassurance, PT, exercise, limited occlusal adjust)
- 70% satisfied with results
- 25% still had pain on movement
- 15% not able to eat hard foods
- 35 control patients had no apparent symptoms

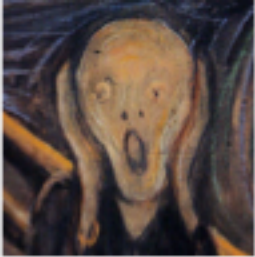
**If you have a disease that is  
one in a thousand, it is 100% for you**

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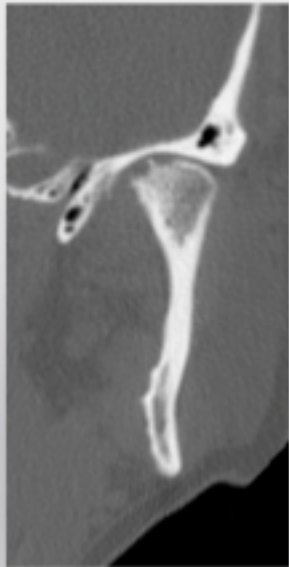
*There is no love sincerer than the love of food.*

*G. B. Shaw*





## Damaged TMJs



**Adapt Favorably 85%**  
**Adapt Fairly 14%**  
**Adapt Poorly <1%**



Occlusal Muscle Dysfunction  
Osteoarthritis



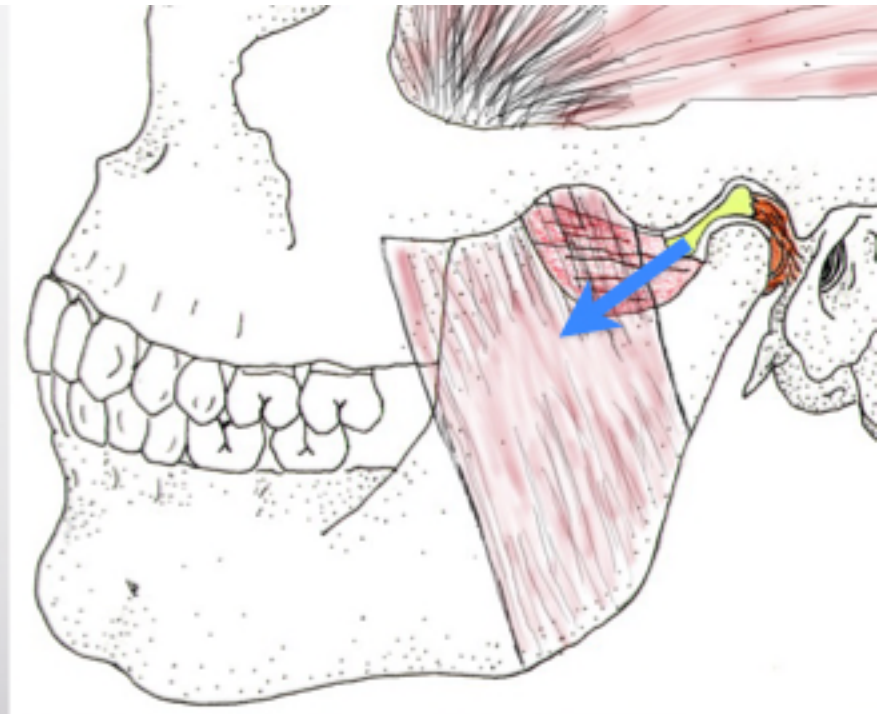
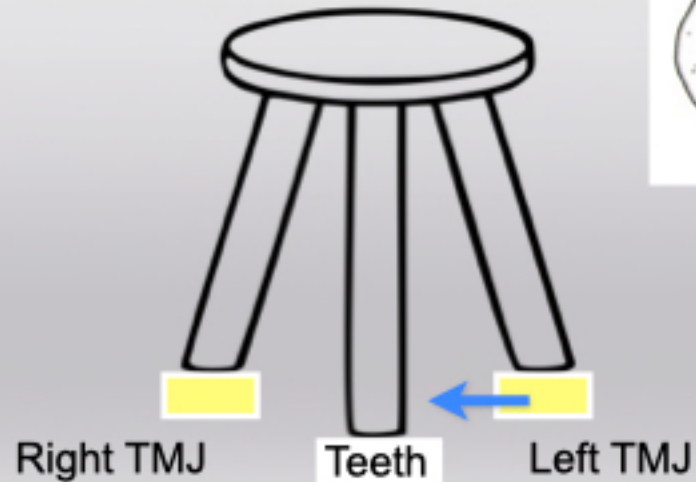
Avascular Necrosis  
Progressive Condylar Resorption

\*These are my guesses on %, no research to back up to backup

# Normal Joint with Normal Occlusion

All teeth touch evenly with condyles seated in fossa

What happens to the occlusion if the disc is dislocated?



# Damaged Joint with Malocclusion

85% damaged joints adapt favorably with respect to the TMJ.

Anteriorly Dislocated Disc, Mandible shifts:

Inadequate Anterior Guidance, Posterior Disclusion

Uneven Occlusion,

CR≠MaxIC

Occlusal Muscle Disharmony develops.

Treat Adapted joints with OMD

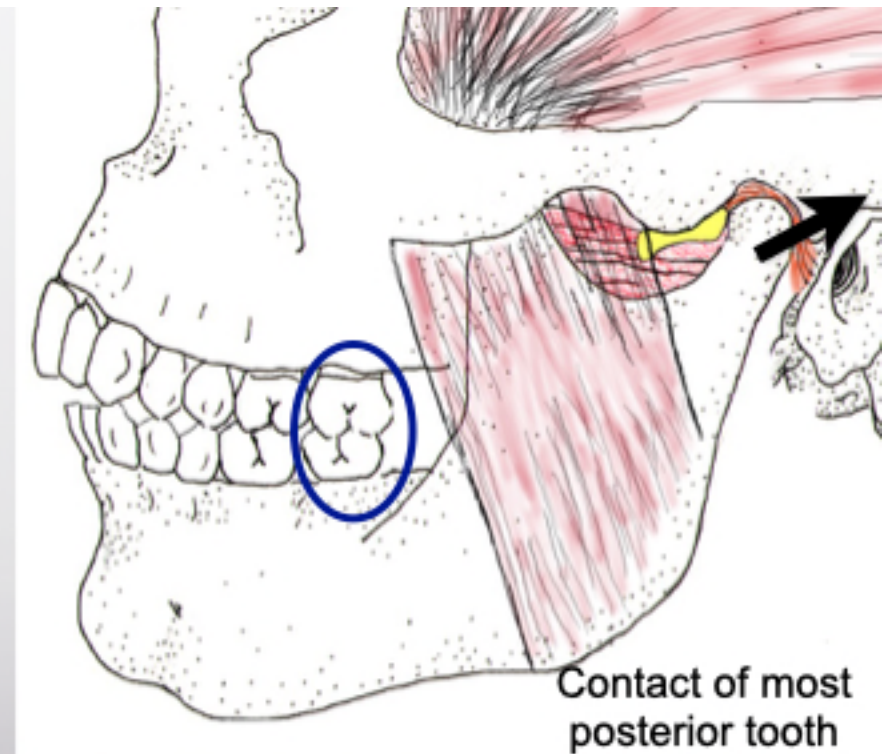
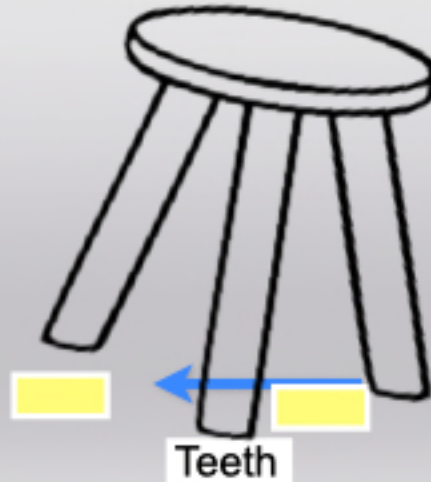
the same as healthy joints with OMD:

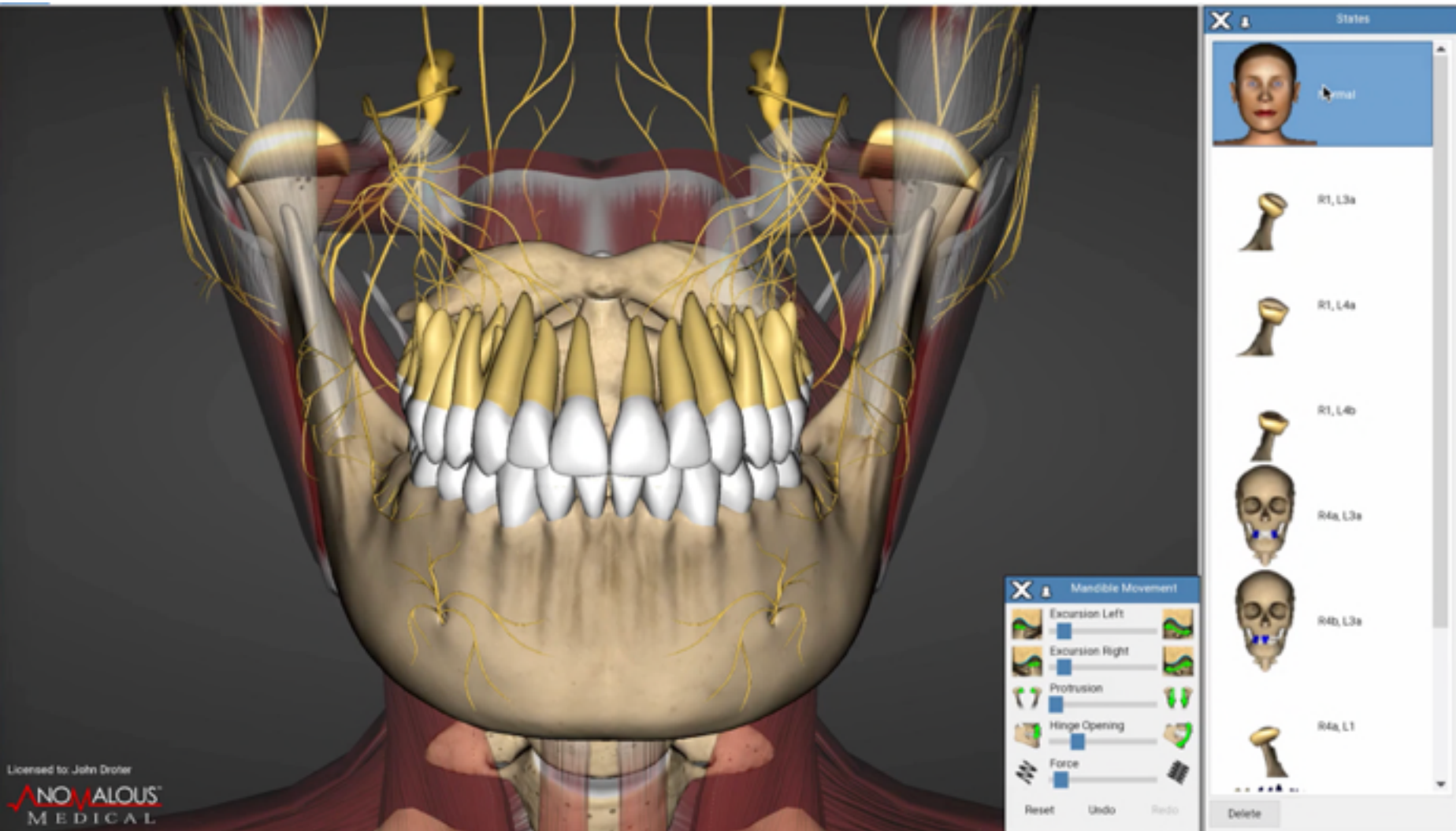
Occlusal Adjustment

CR≠MaxIC should be 2mm or less.

(Horizontal 2mm)

If >2mm something else is going on.



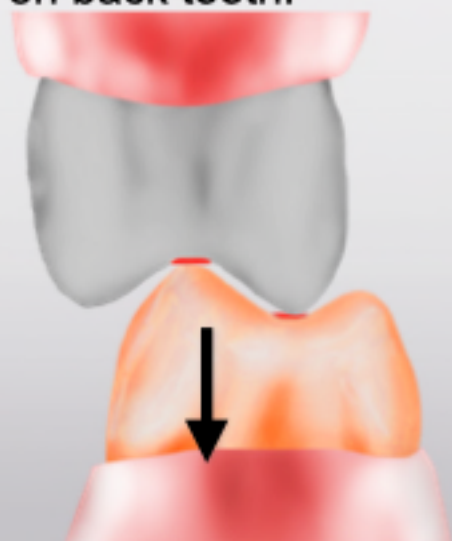


Occlusal  
Shift

## Ideal Occlusion for Comfortable Muscles

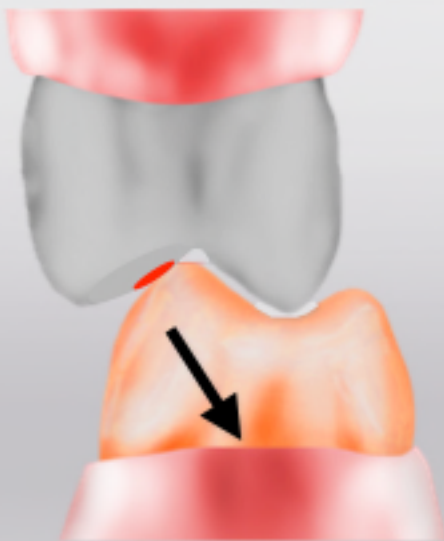
### Ideal

No sideways forces on back teeth.



### Not Ideal

Tense Muscles  
Teeth can fracture

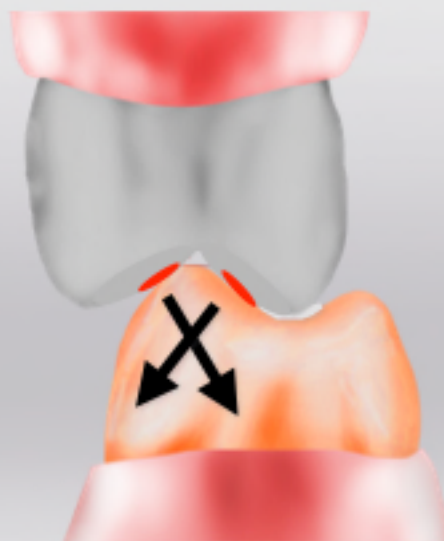


Sideways forces can fracture teeth

### Not Ideal

Tense Muscles

Back teeth will have sideways force when the jaw moves left or right.



### Not Ideal

This is now a functionless tooth.  
Other teeth now have more force.

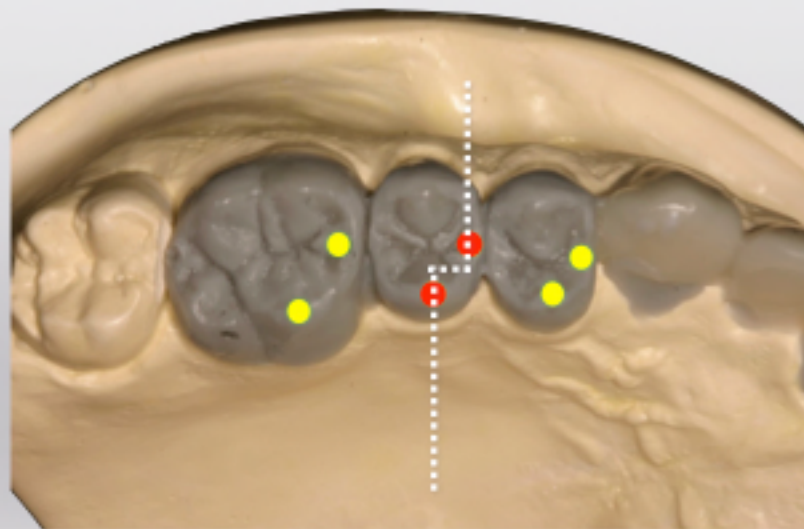
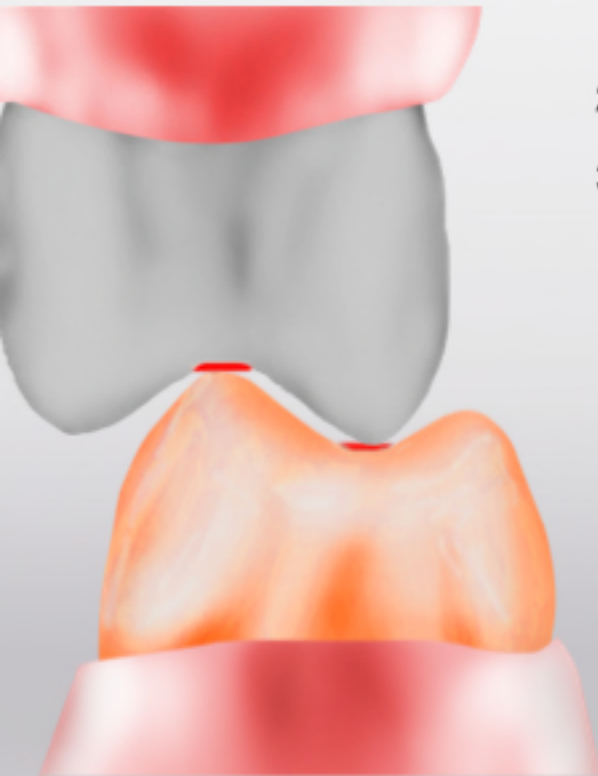
# Occlusal Sculpting

Reshape



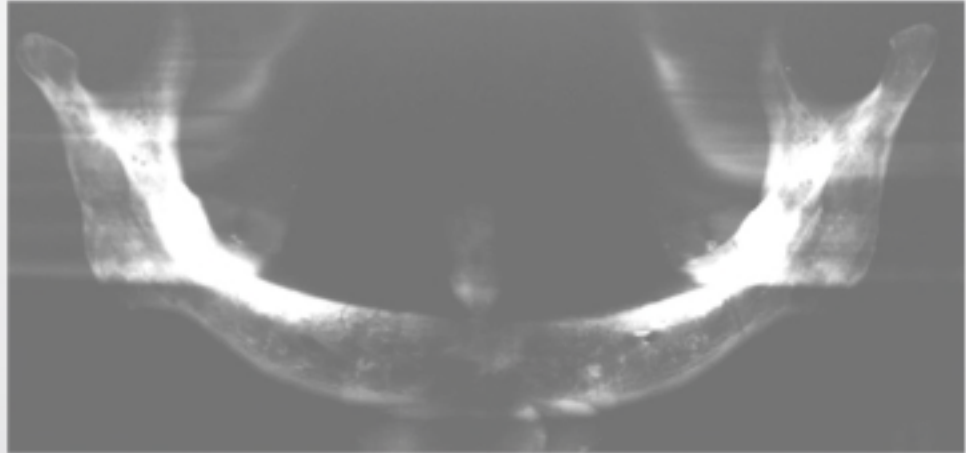
## LD Pankey's 3 Rules of Occlusion (Clyde Schuyler)

1. With the condyles fully seated in the fossa, all the posterior teeth touch simultaneously and even, with the anterior teeth lightly touching.
2. When you squeeze, neither a tooth nor the mandible moves (in a lateral direction).
3. When you move the mandible in any excursion, no back tooth hits before, harder than, or after a front tooth.



Drawing by Dr Jim Kessler

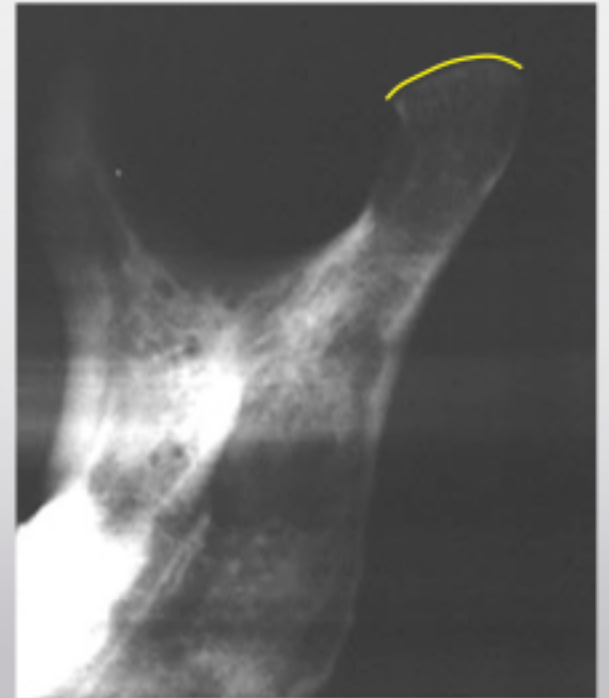
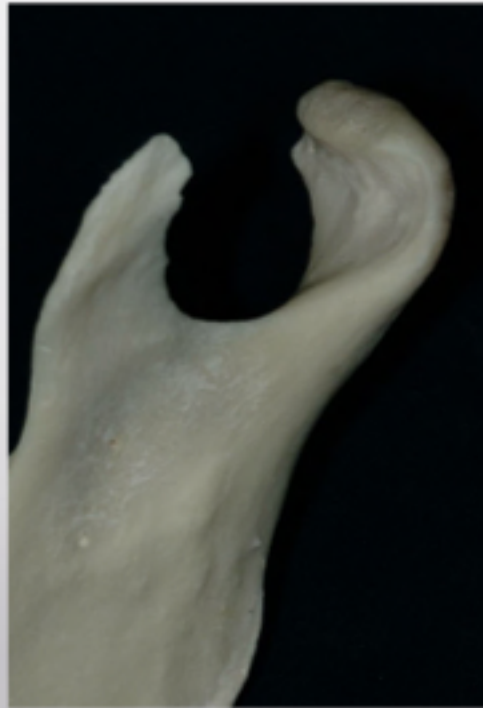
# Pan-X of Skull Mandible



Note: This Mandible had plastic teeth added



# Pan-X not Accurate



Fallon S, Fritz G, Laskin D, Panoramic Imaging of the Temporomandibular Joint: An experimental Study Using Cadaveric Skulls. J Oral Maxillofac Surg 64:223-229, 2006

# Computerized Axial Tomography (CT, CAT)

Spiral CT Scanner  
12 sec acquisition Time



Note: prior to 2001 CT Scan took 25 min

Cone Beam CT Scanner  
20 sec acquisition time

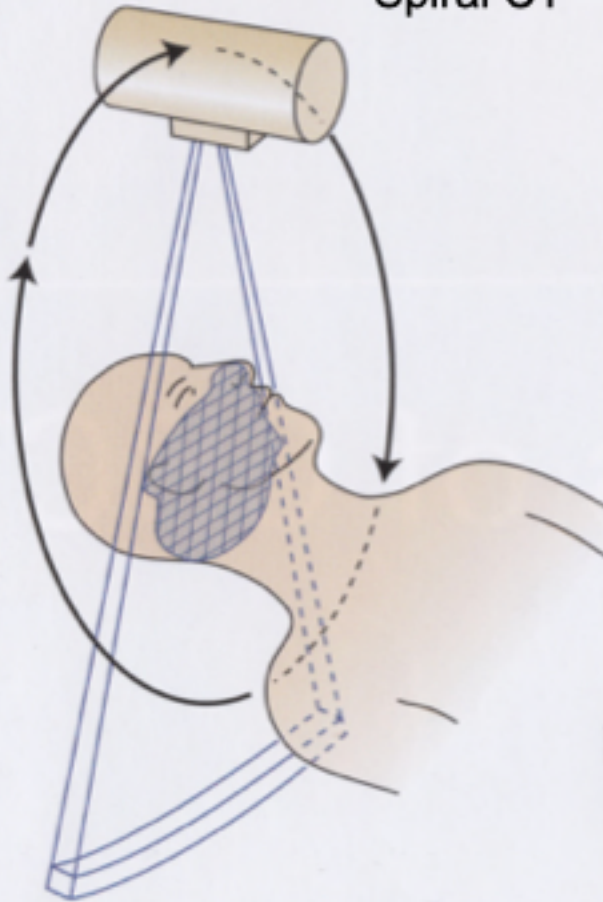


**vatech**

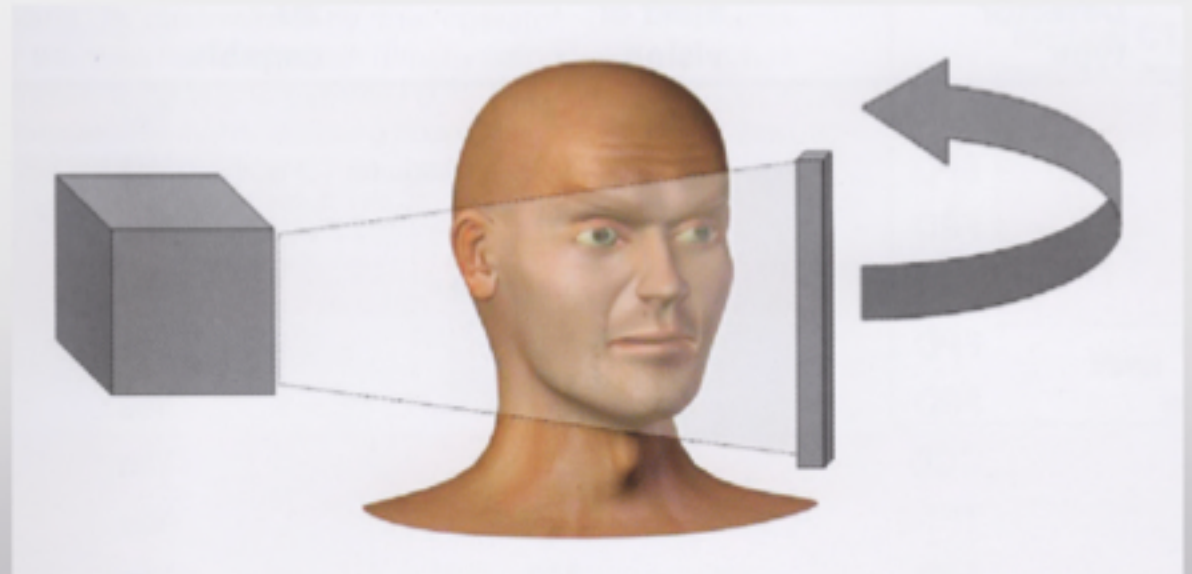
**i3D Premium**



Spiral CT



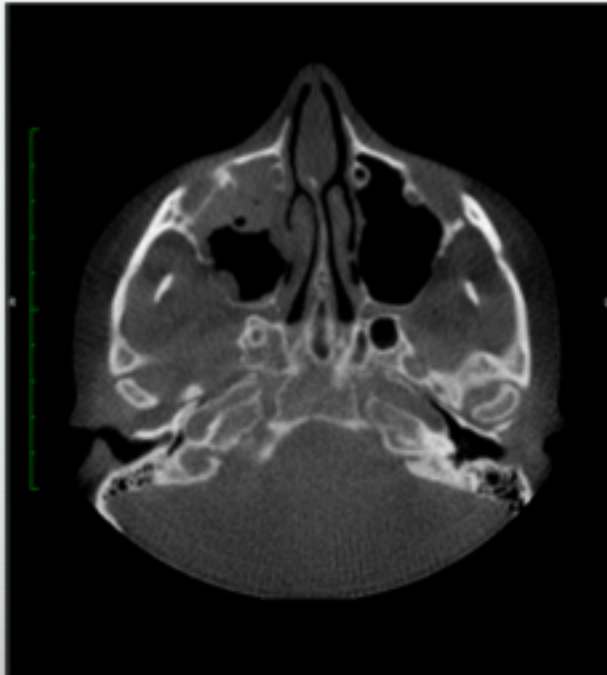
CBCT



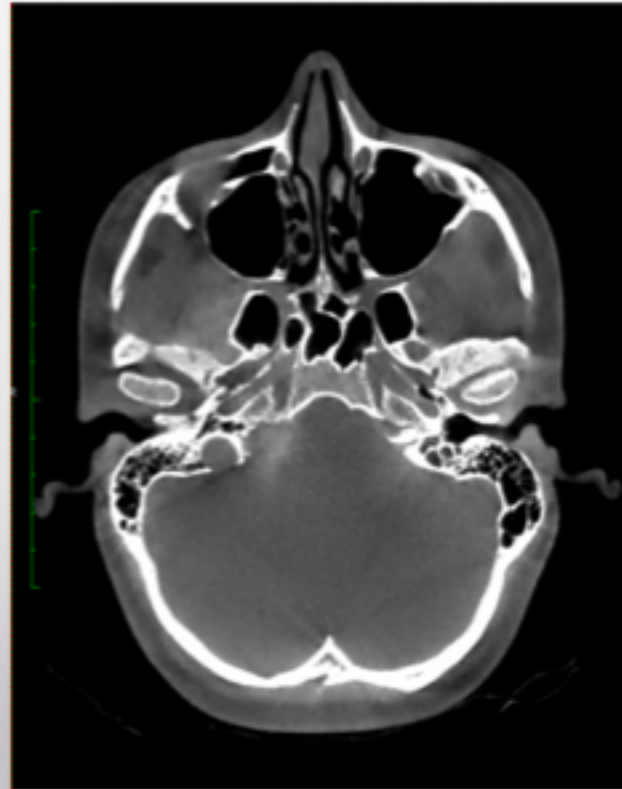
Atlas of Cone Beam Imaging  
Dale Miles DDS

Compare CT scans

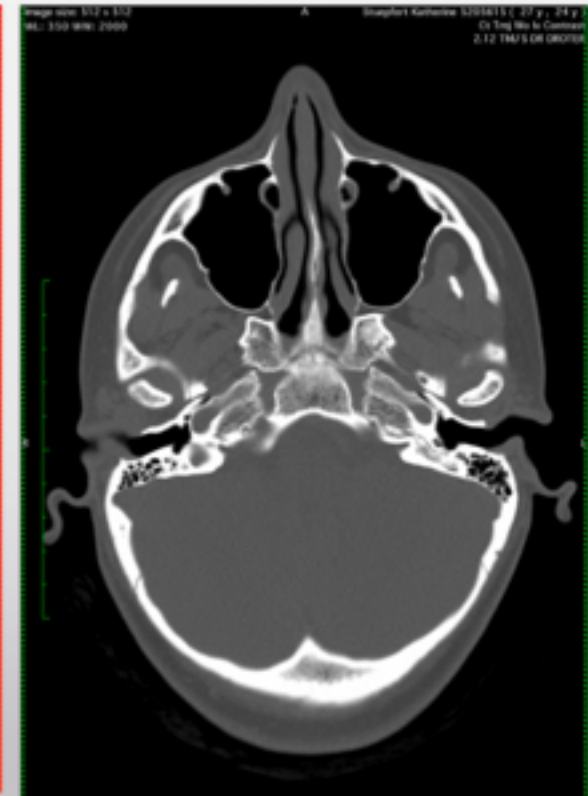
CBCT- iCAT



CBCT- Vatech i3D Premium



Spiral CT



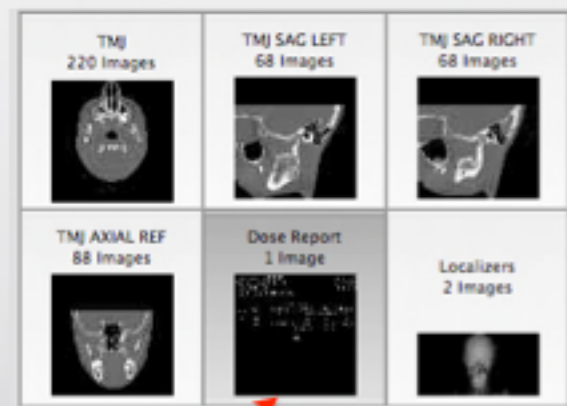
Best Contrast  
Much more radiation

# Radiation Exposure Comparison

|                                                                   |                       |
|-------------------------------------------------------------------|-----------------------|
| Daily Background/day                                              | 0.008 mSv             |
| Panoramic                                                         | 0.02 mSv              |
| 1 Trans Atlantic Flight                                           | 0.03 mSv              |
| Chest Film                                                        | 0.1 mSv (0.1-0.2 mSv) |
| i-CAT Head                                                        | 0.1 mSv               |
| Full Mouth Series Digital                                         | 0.12 mSv              |
| Full Mouth Series F Speed                                         | 0.17 mSv              |
| Conventional CT Head                                              | 0.5 mSv               |
| Spiral CT Head                                                    | 2.7 mSv               |
| <b>Daily Background/year</b>                                      | <b>3.1 mSv/year</b>   |
| Airline Crews (additional)                                        | 4.6 mSv/year          |
| Highest Safe Dose (public)                                        | 20 mSv/year           |
| Max Safe Exposure US Worker                                       | 50 mSv/year           |
| Exposure that can lead to Cancer                                  | 100 mSv/year          |
| Japanese Government Safe Level<br>(After Fukushima 2011 Disaster) | 250 mSv/year          |

Comparison conversions done by John R Droter DDS  
Gy converted to Sv using 1mGy/cm head = .0022mSv

Gy= Gray (Joules/kg)  
Sv=Sievert (Joules/kg)



Spiral CT Dose Report → Dose Length Product  
1244 mGy/cm x .0022 = 2.7 mSv

Spiral CT 27x more than CBCT, but about half of airline crews yearly exposure.  
Radiation is cumulative over lifetime.  
Safe dose of a harmful substance?  
MRIs have no Radiation.

## Key Features for TMJ Images

**Large Field of View 15cm Tall (12cm is minimum)  
Excellent raw image quality**

Recommend Best Raw Image Quality in 2017:

3D Accutomo 170 J Morita 12cm

VaTech i3D Premium 19cm

Most important is service behind the product



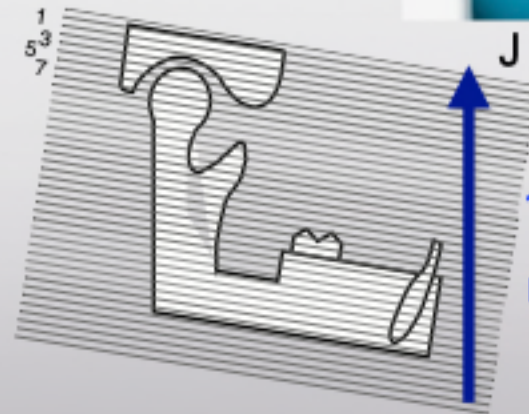
VaTech

Not recommend:

Any Sirona including Galileos: Marginal raw image quality, motion artifact



J Morita



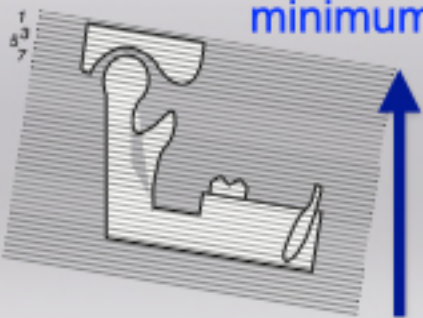
12 cm tall  
minimum

**Green = LOW Contrast**

## VaTech Green Series



12 cm tall  
minimum



VaTech Green X  
15mm tall

VaTech Green X 21  
19mm tall



|                      | FOV 4x4/5x5                                                                                                                                                                                | FOV 8x5/8x8                                                                                                                                                  | FOV 12x5/12x9                                                                                                                                                | FOV 18x15                                                                                                                                                                                         | FOV 21x19                                                                                                                                                                                                       |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| REGION               | <ul style="list-style-type: none"> <li>- Single tooth capture</li> </ul>                                                                                                                   | <ul style="list-style-type: none"> <li>- Central dentition</li> <li>- TMJ (R or L)</li> </ul>                                                                | <ul style="list-style-type: none"> <li>- Dual arch including sinus and nerve</li> <li>- TMJ (R or L)</li> </ul>                                              | <ul style="list-style-type: none"> <li>- Back border of jaw (Ramus)</li> <li>- Dual arches back to the 3<sup>rd</sup> molars plus sinus</li> <li>- Central incisor to spine</li> </ul>            | <ul style="list-style-type: none"> <li>- Nearly entire cranium</li> <li>- Tip of nose to posterior of cranium</li> <li>- C5, C6 to superior sinus</li> </ul>                                                    |
| CLINICAL IMPLICATION | <ul style="list-style-type: none"> <li>- Implant single site</li> <li>- Endo</li> <li>- Perio</li> <li>- Complex impaction (3rd)</li> <li>- OMS</li> <li>- Supernumerary: Ortho</li> </ul> | <ul style="list-style-type: none"> <li>- Implantology</li> <li>- Guided Surgery</li> <li>- General Dentist</li> <li>- OMS</li> <li>- Orthodontics</li> </ul> | <ul style="list-style-type: none"> <li>- Surgical guides</li> <li>- Sinus lifts</li> <li>- Bone grafting</li> <li>- Bi lateral sinus augmentation</li> </ul> | <ul style="list-style-type: none"> <li>- Surgical Guides</li> <li>- Sinus lifts for both sinuses</li> <li>- Complex orthognathic cases</li> <li>- Simultaneous diagnosis for both TMJs</li> </ul> | <ul style="list-style-type: none"> <li>- Airway</li> <li>- Oral and maxillofacial surgery</li> <li>- facial reconstructions</li> <li>- Orthodontic treatment planning for complex orthognathic cases</li> </ul> |

# Making a Great TMJ Scan

## Rx for CBCT

Adding a chair vastly improves image quality



Form on  
drdroter.com  
seminar downloads

### 1. LargeField of View

15cm tall field of view or greater

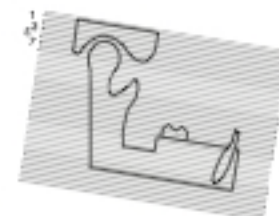
At 12cm tall you will miss some joints. 15cm and up is better

Note: 17cm x12 cm is 12 cm tall. The smaller # is the height, and is listed last

### 2. Scan Area

Scan Area to include 1cm above condylar head,

1 cm behind condylar head and 1 cm below chin.



### 3. KVP and AMP

Use highest KVP and Amperage the machine allows to get best contrast.

### 4. Voxel Size

Lesser scan time minimizes movement artifact. 0.3 voxel will give a better image than

0.1 voxel

### 5. No Metal-

No hair ties/clips, facial piercings, partials, glasses, etc.

### 6. Natural Neck Posture

Side view: Neck in natural postural alignment, and Frankfurt horizontal plane parallel to the floor. Avoid reaching for chin-rest with head forward posture.

Align head frontal view: Laser aligner down middle of face, can see both ears equally

### 7. Hold Still

Goal: Patient to hold very, very still for 20 seconds while scan is being taken

Sitting is more stable than standing. A hard chair works well.

Practice swallowing, back teeth touching, tongue lightly resting back of front teeth.

Practice lightly breathing.

Give patient a 7 second warning before you take the scan so they can swallow, get back teeth touching, and have tongue lightly resting back of front teeth.

# Rx for Medical Grade CT

Form on [drdroter.com](http://drdroter.com)  
 seminar downloads

- Do not take scan if not able to send DICOM images to me.
- Must be a spiral CT scanner, 16 or 64 slice. Do not show the head holder in any images.

1. Please review the "Patient Instructions" with the patient before starting the scan.

## 2. Axial C.T.

Head stabilization to prevent movement, pads on zygoma

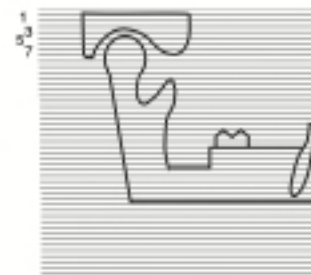
Superior-Inferior

Bone Algorithm/ No contrast

Teeth together. If patient has Dr. Droter's appliance, that is to be worn.  
 1mm slices or less. The smaller the better.

Start 5 mm superior to the roof of the TMJ fossa and  
 continue down to include the hyoid bone and C4

Be sure to capture the tip of the chin and the back of the Occipital Bone



## 3. Reconstruct Coronal and Corrected Sagittal Views off of the Axial Scan 1mm slice thickness or less

### ☐ If Checked: Direct Coronal C.T.

Head stabilization, 2/3 weight on zygoma, 1/3 on chin

Force on chin is superior not posterior

Teeth together. If patient has Dr. Droter's appliance, that is to be worn.

Bone Algorithm/ No contrast

PA, both right and left TMJ in same slice.

1mm slices or less. The smaller the better.

Start behind auditory canal and continue past the crest of the eminence.

This usually takes about 25 slices

Align slices so they are parallel with the posterior ramus



## 4. Printed images not acceptable. Must be Dicom digital images. Do not take the scan if you can not send DICOM images.

# Dicom Viewers



Mac

OsiriX



FDA Cleared

Horos



Free but not FDA cleared

Both Mac and PC

Planmeca Romexis



PC

Invivo 7 - was Anatomage

Dolphin

Scanner software that comes with 3D Scanners

Viewer on CD disc— very slow

# Normal TMJ- Bone

## Bone Density

Intact Cortex

Even pattern Trabecular bone

## Normal Size/Shape Condyle/Fossa

Ovoid Condylar Shape

Non-Congruent Condyle/Fossa

Condyle 70% Size Fossa

## Condyle Centered in Fossa

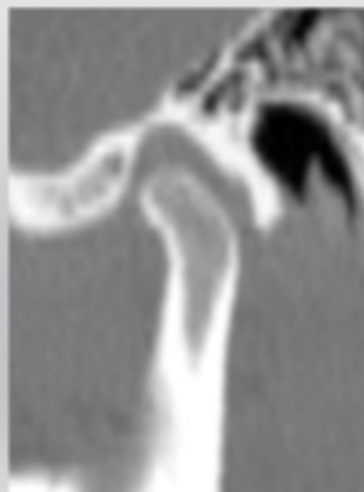
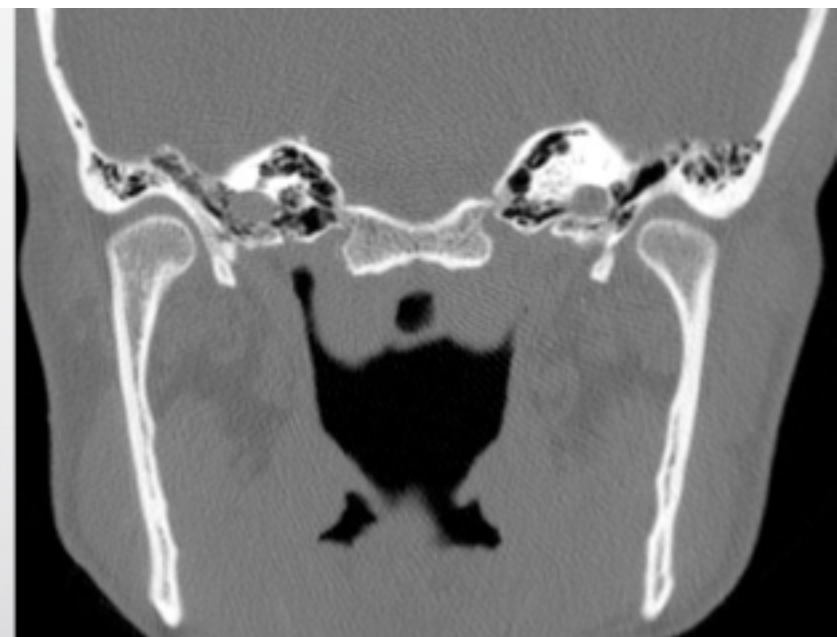
Coronal and Sagittal

Room for Disc

## Stable CR load Zone

Condyle closest to fossa

CT Scan  
Coronal View



CT Scan  
Sagittal View

# Interpreting CBCT

**Review of Scan: CBCT**  
**John R Droter, DDS**

Name \_\_\_\_\_ Scan Date \_\_\_\_\_

*For a quick scroll through axial, coronal, and sagittal for global impressions.*

**Right TMJ** *Small Coronal Sagittal and Coronal Coronal*

Condyle: ☐ Normal Size ☐ Small condylar size ☐  
☐ Normal Shape ☐ Altered condylar shape ☐  
☐ Cortex Intact ☐ Cortex not intact ☐  
☐ Cortex Even ☐ Hypertroplification ☐

Fossa: ☐ Normal Size ☐ Small fossa size ☐  
☐ Normal Shape ☐ Flattened fossa shape ☐  
☐ Cortex Intact ☐ Cortex not intact ☐

Condyle Position: ☐ Centered in fossa ☐ Condyle distalized ☐  
 Joint spacing: ☐ Room for disc ☐ No room for disc ☐

CR Load Zone: ☐ Superior medial ☐ Superior Lateral ☐

Estimate Piger: R1 R2 R3a R3b R4a R4b R5a R5b

Right TMJ Health: ☐ Healthy ☐ Damaged ☐ Active Degeneration ☐ Adapting ☐ Adapted

**Left TMJ** *Small Coronal Sagittal and Coronal Coronal*

Condyle: ☐ Normal Size ☐ Small condylar size ☐  
☐ Normal Shape ☐ Altered condylar shape ☐  
☐ Cortex Intact ☐ Cortex not intact ☐  
☐ Cortex Even ☐ Hypertroplification ☐

Fossa: ☐ Normal Size ☐ Small fossa size ☐  
☐ Normal Shape ☐ Flattened fossa shape ☐  
☐ Cortex Intact ☐ Cortex not intact ☐

Condyle Position: ☐ Centered in fossa ☐ Condyle distalized ☐  
 Joint spacing: ☐ Room for disc ☐ No room for disc ☐

CR Load Zone: ☐ Superior medial ☐ Superior Lateral ☐

Estimate Piger: L1 L2 L3a L3b L4a L4b L5a L5b

Left TMJ Health: ☐ Healthy ☐ Damaged ☐ Active Degeneration ☐ Adapting ☐ Adapted

**Swelling** *Coronal View, Sagittal View, Axial View*

All Tissue: ☐ Right = Left ☐ = Except \_\_\_\_\_  
 Look for tumors Brain, Muscle, Parotid Submand Gland, Hypertrophy

All Bones: ☐ Right = Left ☐ = Except \_\_\_\_\_  
 Look for hypercalcified or radiolucent areas, cysts

Nasal (Sagittal, Cor): ☐ Open ☐ Restricted ☐ Deviated Septum ☐  
 Sinuses: ☐ Clear ☐ Thickened Lining ☐ Muc Polyps ☐  
 Airway: ☐ Adequate ☐ Restricted ☐  
 Teeth (Sagittal, Cor): ☐ No PAP ☐ PAP # \_\_\_\_\_  
 (Axial): ☐ No Gross Caries

Perio (Thick Sagittal): ☐ No Gross Perio Bone Loss

Artes: ☐ ID ☐ Appears Centered ☐ Not Level with Skull Base ☐  
 C2, C3, C4: ☐ Aligned ☐ Misaligned

Max Mand Relation: ☐ Normal Sagittal ☐ Retrognathic ☐ Maxilla ☐ Mandible

Max Mand Casting: ☐ Normal Coronal ☐ Asymmetric Cast ☐ Maxilla ☐ Mandible

Impression: \_\_\_\_\_

Signature: \_\_\_\_\_

www.jdroter.com

## Review of Scan: CT/CBCT Guide

### TMJ

#### Condyle

##### Fossa

☐ Normal Size, Normal Shape, Cortex Intact  
 Condyle is 32% size of the fossa, with an oval shape. The condyle and fossa are noncongruent convex surfaces. The outer cortex of bone is a solid continuous line with no breaks. Look for areas of hypertroplification which are indicative of excess load in that area or damage and repair. The right and left TMJs should be the same size.

#### Condylar Position

☐ Centered in fossa

The condyle should be centered in the fossa. A distalized condyle is indicative of either joint damage and disc dislocation anteriorly or heavy anterior tooth contact. An anteriorly positioned condyle is indicative of a large CR/CO discrepancy, usually associated with an adapted mandibular retrognathia.

#### Joint Spacing

☐ Centered in fossa

There should be room to "draw" a disc between the condyle and fossa.

#### CR Load Zone (Centric Relation Load Zone)

☐ Superior medial

Ideally the condyle in its optimal load bearing position (Centric Relation) should load on the superior medial surface. In the coronal view the area where the condyle is closest to the fossa is the Centric Relation Load Zone. A variant of normal is to have both condyles load on the superior lateral surface. If the load zones of the right and left do not match (i.e. one is medial the other lateral) this is indicative of joint damage and disc dislocation. Need to evaluate for joint mechanical stability (joint wobble) with a DPMs. Clinically these patients may have a hyperactive "bite".

#### Estimate Piger

This estimation combines clinical data from the clinical history, exam, joint palpation, arthroscopy, socalization, Doppler (JVA) (Joint Vibration Analysis) and the CT scan. If you see a left distalized condyle and no clicking is either a Piger 4b or a health joint distalized due to heavy anterior contact (usually isotropic). In the case of the 4b, JVA would show some slight "scratch vibrations", where as a health TMJ distalized due to occlusion would show "smooth vibrations", and clinically have fremitus on the anterior teeth.

1. Normal joint - MRI and CT are normal (See all above). No joint sounds, full range of motion, JVA no vibrations, quiet Doppler.

2. The TMJ is damaged but disc is still in place so MRI and CT are normal. Usually the cartilage is damaged, roughened from parafunctional bruxing. Doppler and JVA will both indicate slight vibrations. A well adapted 4b will also have the same vibratory signals as a Piger 2, but the 4b will show changes in condylar position on the CBCT, and the MRI will show the disc dislocation.

3a. This is a partial dislocation of the disc, usually in an anterior medial direction with the lateral ligament being taut or stretched. The joint reduces on opening and will make a vibration, either a click or wobble on JVA. If a 3a is opposite a health joint there is not a change in occlusion so CT is normal. A Piger 3a is often contralateral to a 4b. With loss of the opposing disc, the mandible shifts coronally the CR load zone changes in both joints leading to 3a.

3b. Same as above except screwing and therefore no clicking vibration. CT is normal

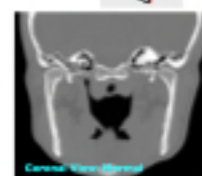
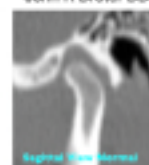
4a. The disc is fully displaced off the head of the condyle and reduces on opening. There will be a shifting of the mandible which can be seen on the CBCT. Condyle not centered in fossa. Clinically there will "click or wobble" vibration as the disc reduces and subluxates. While most vibrations are in the subtle range some may not be. These will be detected with JVA.

4b. The disc is fully displaced off the head of the condyle and does not reduce on opening. This will look the same on CBCT as a 4a. Condyle not centered in fossa. While limited opening may occur, many can have a full range of motion. Range of motion should not be a sole determine factor on whether a joint is 4b.

5a. Osteoarthritis. There will be changes to the condylar shape and cortex seen on the CBCT. Osteoarthritis is the inflammatory phase of Osteoarthrosis. Look for missing cortex indicative of active degeneration. The joint will be tender to palpation. An MRI is helpful in detecting extent of inflammation.

5b. Osteoarthrosis. There will be changes to the condylar shape and cortex seen on the CBCT. The Cortex however will be intact and the joint will not be tender to palpation. Hypertroplification will be seen having reinforced the damaged areas. There is a loss of congruency as the condyle and fossa wear down and become flattened. Parafunctional tooth grinding increases OA bone wear.

John R Droter DDS



First do quick scroll through axial, coronal, and sagittal for global impression.

## **Right TMJ**

Scroll Corrected Sagittal and Corrected Coronal

Condyle:

- |                                        |                                                 |                          |
|----------------------------------------|-------------------------------------------------|--------------------------|
| <input type="checkbox"/> Normal Size   | <input type="checkbox"/> Small condylar size    | <input type="checkbox"/> |
| <input type="checkbox"/> Normal Shape  | <input type="checkbox"/> Altered condylar shape | <input type="checkbox"/> |
| <input type="checkbox"/> Cortex Intact | <input type="checkbox"/> Cortex not intact      | <input type="checkbox"/> |
| <input type="checkbox"/> Cortex Even   | <input type="checkbox"/> Hypercalcification     | <input type="checkbox"/> |

Fossa:

- |                                        |                                                |                          |
|----------------------------------------|------------------------------------------------|--------------------------|
| <input type="checkbox"/> Normal Size   | <input type="checkbox"/> Small fossa size      | <input type="checkbox"/> |
| <input type="checkbox"/> Normal Shape  | <input type="checkbox"/> Flattened fossa shape | <input type="checkbox"/> |
| <input type="checkbox"/> Cortex Intact | <input type="checkbox"/> Cortex not intact     | <input type="checkbox"/> |

Condyle Position

- |                                            |                                             |                          |
|--------------------------------------------|---------------------------------------------|--------------------------|
| <input type="checkbox"/> Centered in fossa | <input type="checkbox"/> Condyle distalized | <input type="checkbox"/> |
|--------------------------------------------|---------------------------------------------|--------------------------|

Joint spacing

- |                                        |                                           |                          |
|----------------------------------------|-------------------------------------------|--------------------------|
| <input type="checkbox"/> Room for disc | <input type="checkbox"/> No room for disc | <input type="checkbox"/> |
|----------------------------------------|-------------------------------------------|--------------------------|

CR Load Zone

- |                                          |                                           |                          |
|------------------------------------------|-------------------------------------------|--------------------------|
| <input type="checkbox"/> Superior medial | <input type="checkbox"/> Superior Lateral | <input type="checkbox"/> |
|------------------------------------------|-------------------------------------------|--------------------------|

Estimate Piper:

- |    |    |     |     |     |     |     |     |
|----|----|-----|-----|-----|-----|-----|-----|
| R1 | R2 | R3a | R3b | R4a | R4b | R5a | R5b |
|----|----|-----|-----|-----|-----|-----|-----|

Right TMJ Health:

- |                                  |                                   |                                              |
|----------------------------------|-----------------------------------|----------------------------------------------|
| <input type="checkbox"/> Healthy | <input type="checkbox"/> Damaged  | <input type="checkbox"/> Active Degeneration |
|                                  | <input type="checkbox"/> Adapting | <input type="checkbox"/> Adapted             |

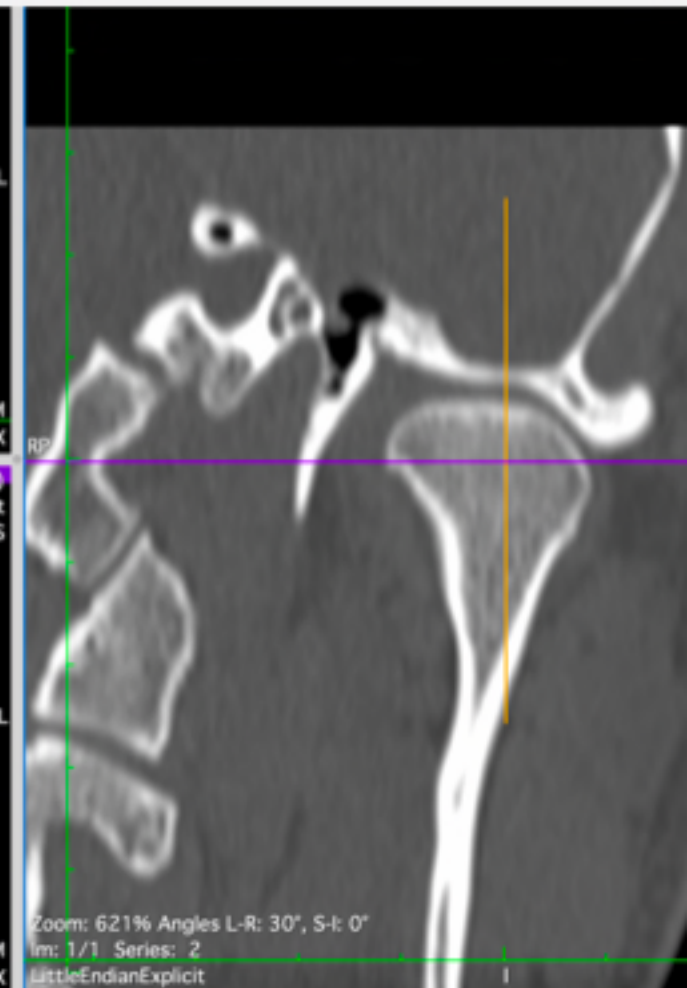
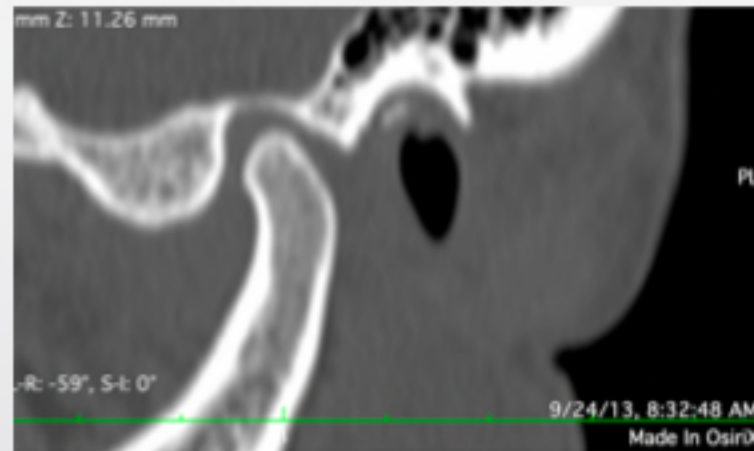
# CT Left Piper 2 from MRI

|                  |                                                   |
|------------------|---------------------------------------------------|
| Condyle:         | <input checked="" type="checkbox"/> Normal Size   |
|                  | <input checked="" type="checkbox"/> Normal Shape  |
|                  | <input checked="" type="checkbox"/> Cortex Intact |
|                  | <input type="checkbox"/> Cortex Even              |
| Fossa:           | <input checked="" type="checkbox"/> Normal Size   |
|                  | <input checked="" type="checkbox"/> Normal Shape  |
|                  | <input checked="" type="checkbox"/> Cortex Intact |
| Condyle Position | <input type="checkbox"/> Centered in fossa        |
| Joint spacing    | <input checked="" type="checkbox"/> Room for disc |
| CR Load Zone     | <input type="checkbox"/> Superior medial          |

☒ Hypercalcification

☒ Condyle distalized

☒ Superior Lateral



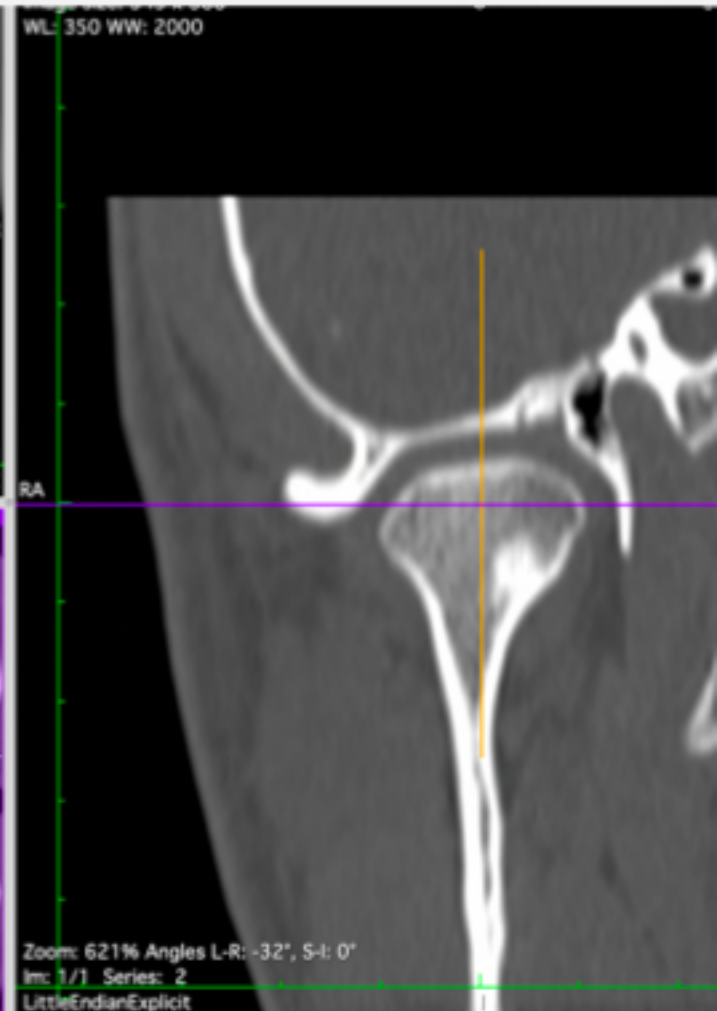
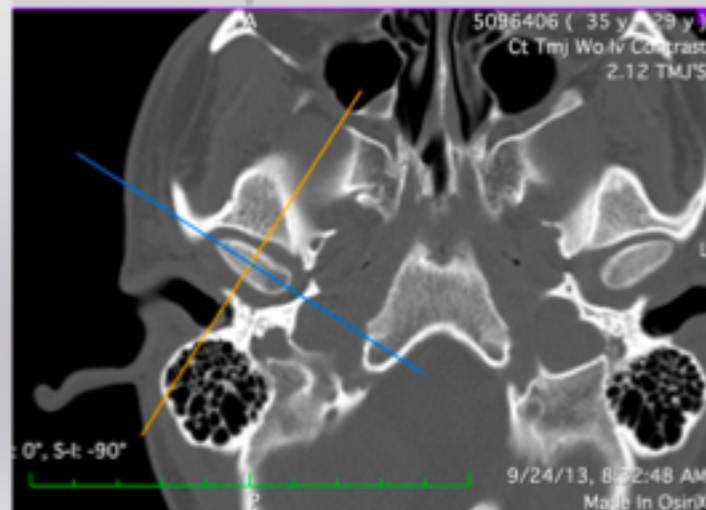
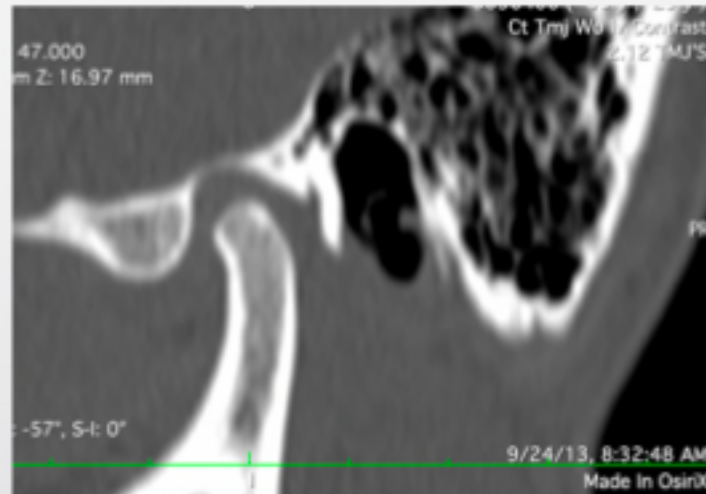
# CT Right Piper 4a-e from MRI

- Condyle:
- ☒ Normal Size
  - ☒ Normal Shape
  - ☒ Cortex Intact
  - ☐ Cortex Even
- Fossa:
- ☒ Normal Size
  - ☒ Normal Shape
  - ☒ Cortex Intact
- Condyle Position
- ☒ Centered in fossa
- Joint spacing
- ☒ Room for disc
- CR Load Zone
- ☐ Superior medial

☒ Hypercalcification

☒ Superior Lateral

☒ Note: Large joint space

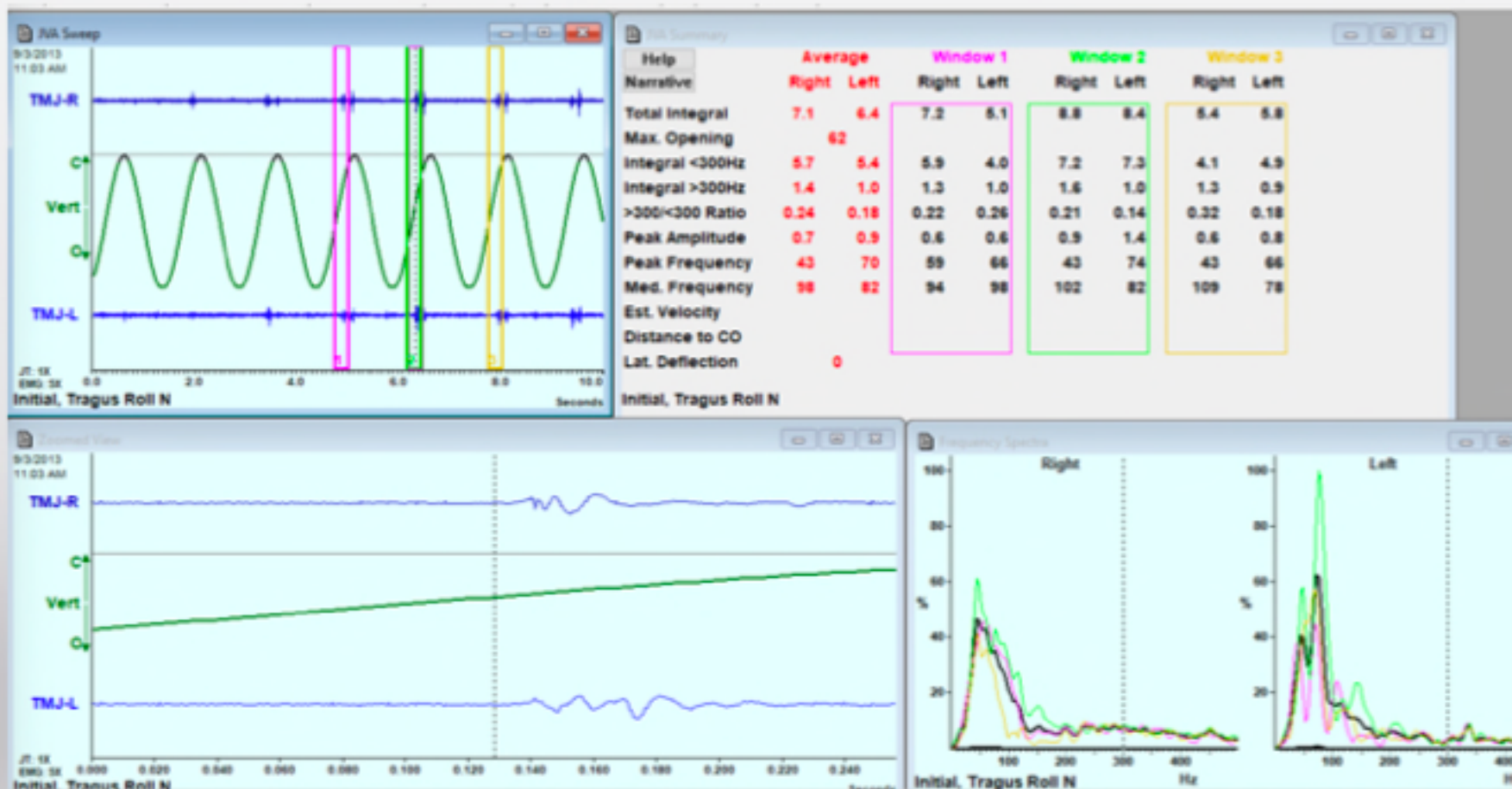


Slight Wobble  
before tooth  
contact

Joint  
subluxation  
on movement

Clinical  
Relevance?

Early damage  
from  
parafunction

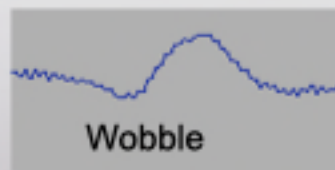
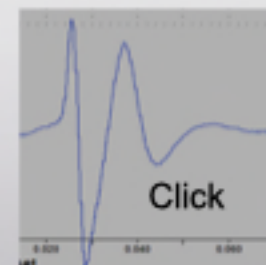


# Joint Vibration Analysis

Objectively measures and quantifies joint vibrations during motion which is an indication of cartilage health



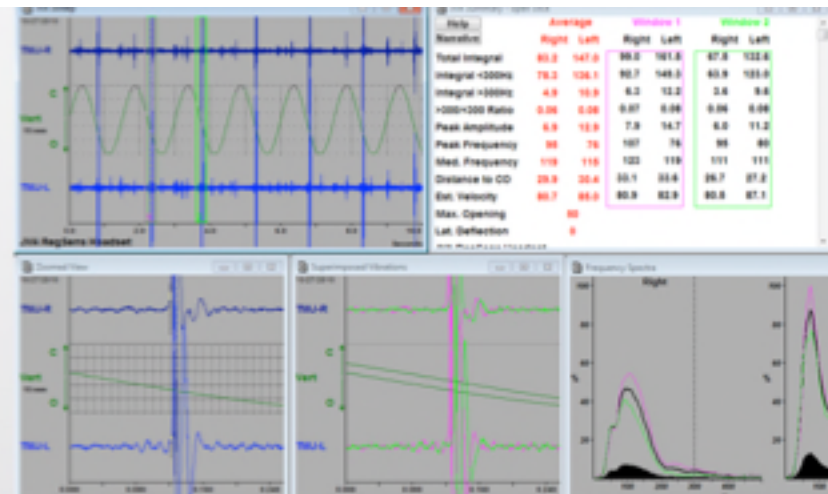
## Three main types of sounds



Disc Reduction  
Disc Dislocation  
Adhesion crackle  
tooth tap

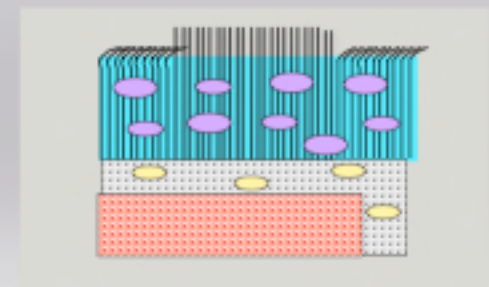
Osteoarthritis  
Pseudo Disc  
Damaged Cartilage

Disc Subluxation  
Joint Subluxation  
Disc Reduction  
Disc Dislocation

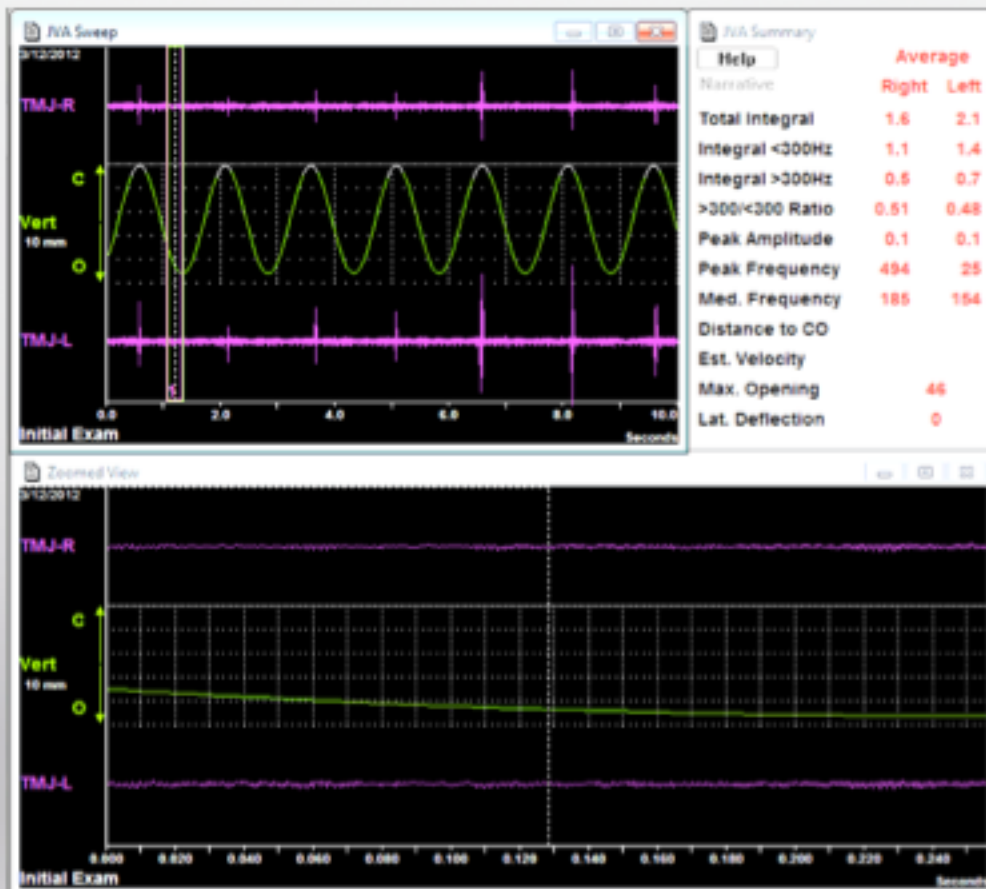


Based on Sonar.  
It is not a microphone

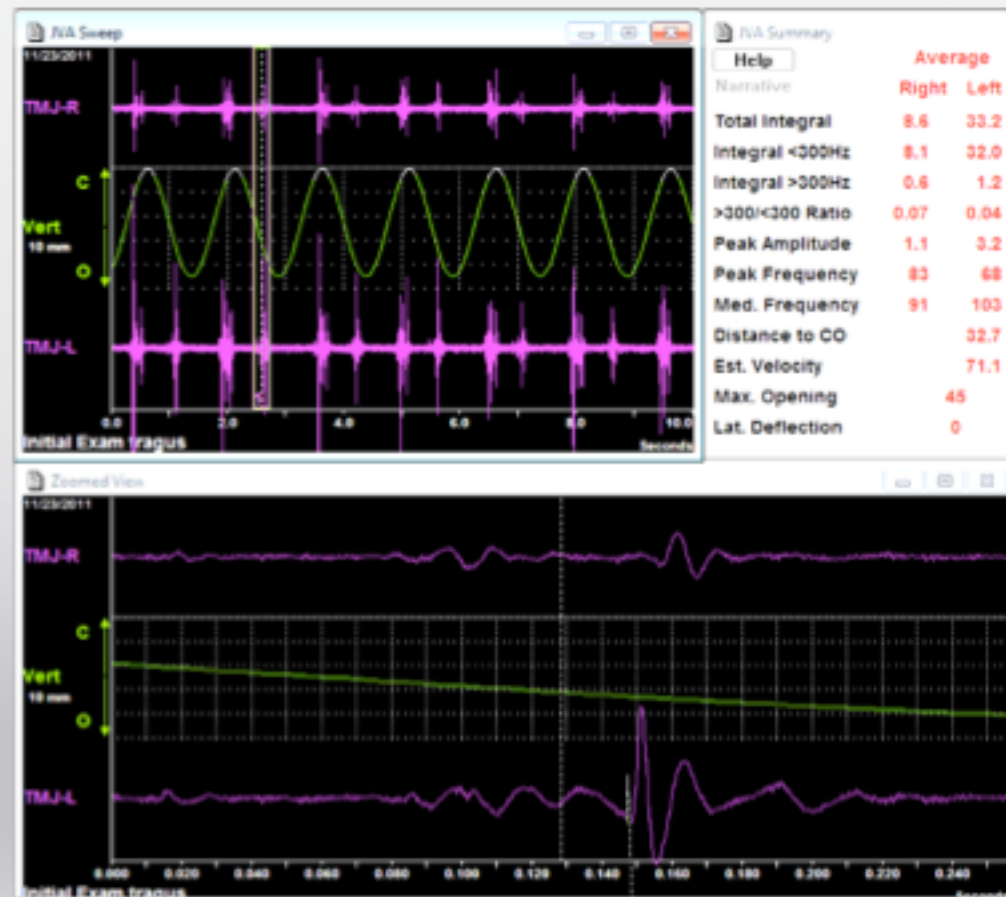
JVA measures the health of the cartilage



## Healthy or Damaged?



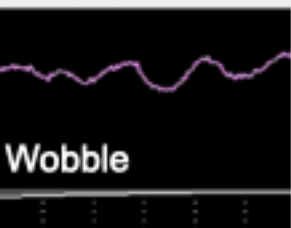
## Healthy or Damaged?



# Why is Joint making this vibration?



Good Vibrations  
Healthy Cartilage  
No Movement



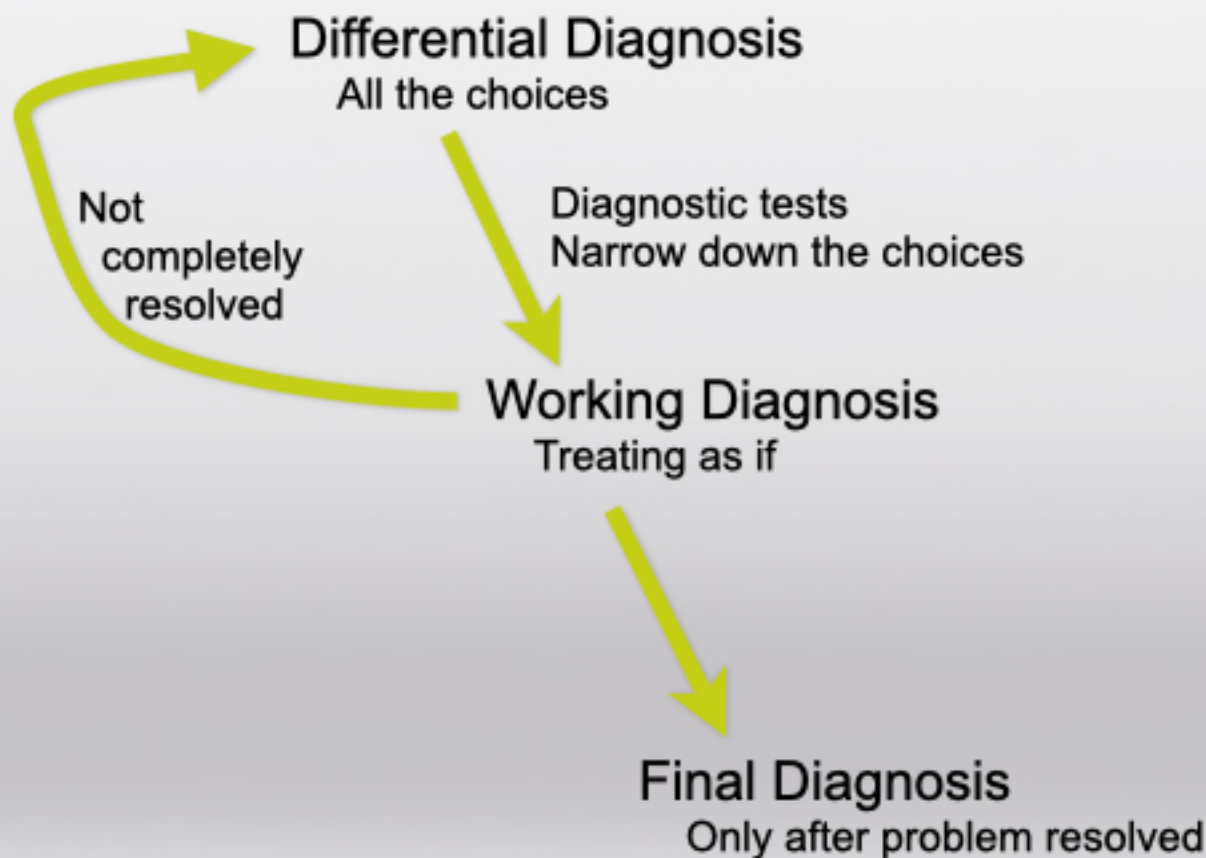
Wobble  
Disc Dislocation  
Disc Reduction  
Disc subluxation  
Joint subluxation  
Condyle bumps Disc  
Sensor roll on face



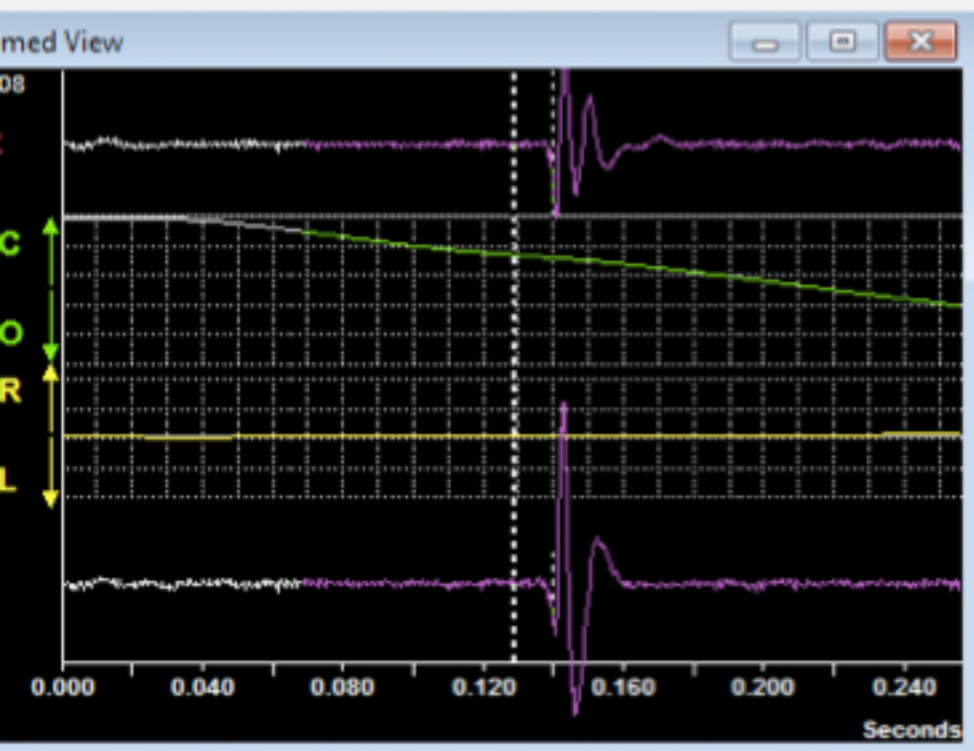
Click  
Disc Reduction  
Disc Dislocation  
Adhesion Crackle  
Tooth Tap  
Contralateral Transference



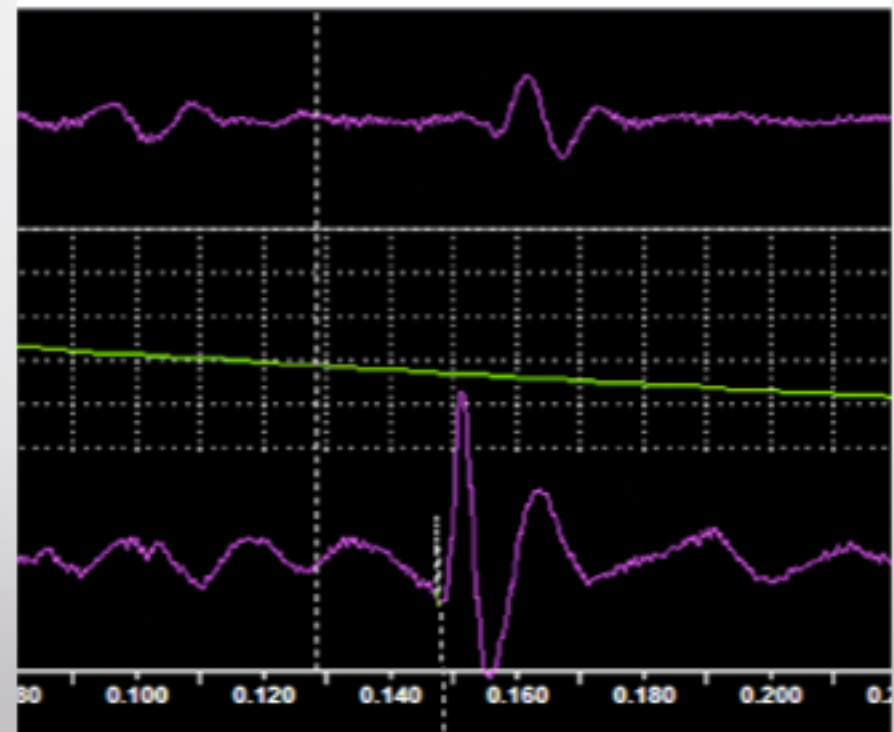
Scratch  
Cartilage Fibrillation  
Cartilage against tissue  
Bone against bone  
Velcro Noise



## Simple or Complex



Simple left click with transference vibration to right  
L4a



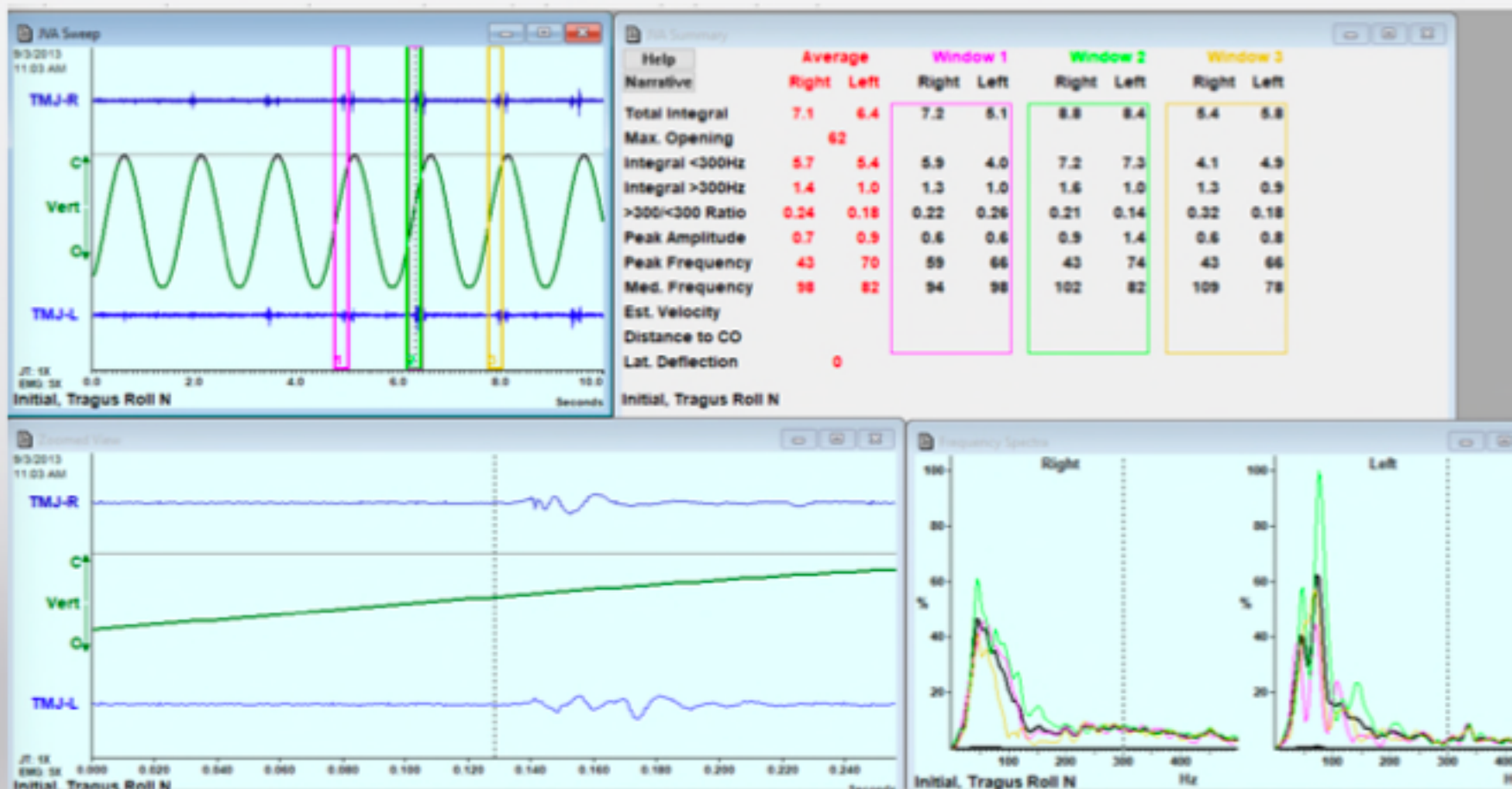
Complex Click  
L3a, R4b

Slight Wobble  
before tooth  
contact

Joint  
subluxation  
on movement

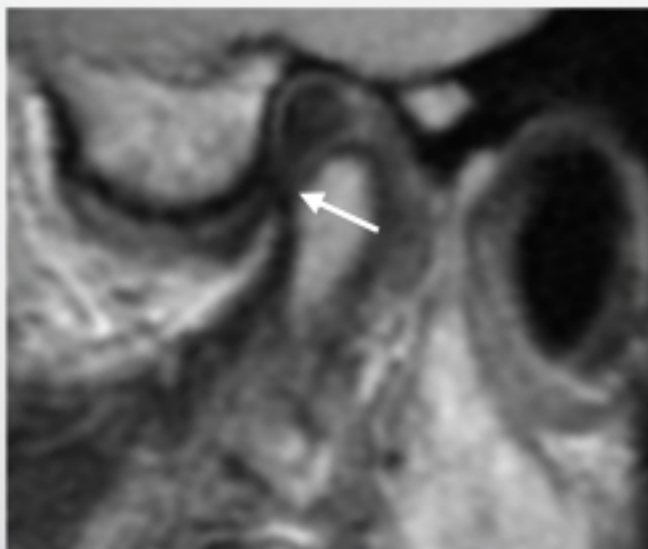
Clinical  
Relevance?

Early damage  
from  
parafunction

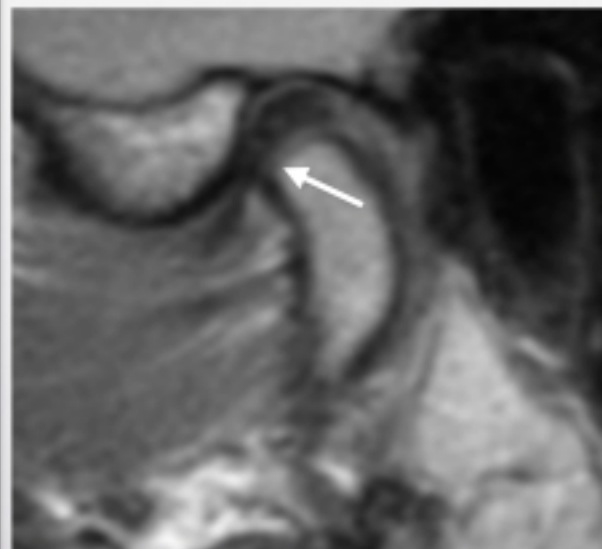


MRI  
R4a-e, L2

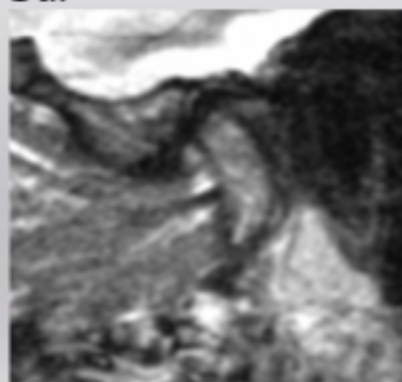
Right  
PD Closed



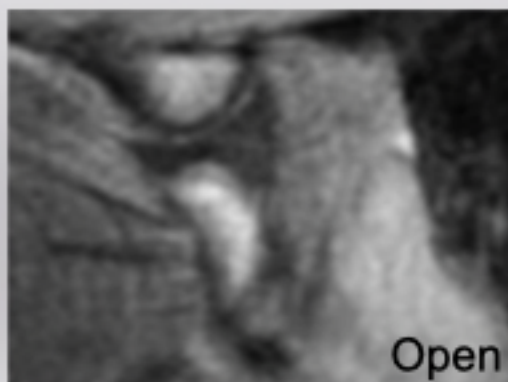
Left  
PD Closed



Stir



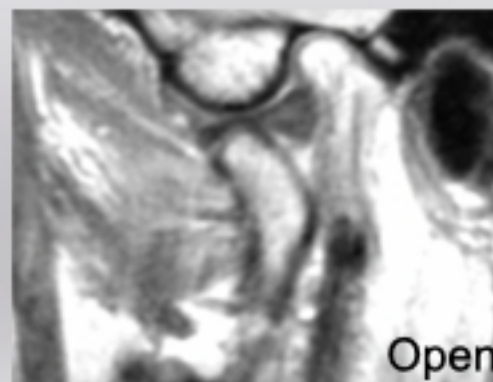
Open



Stir



Open





**Know Yourself**

**Know Your Work**



**Know Your Patient**

**Apply Your Knowledge**

LD Pankey Institute

Write your Dream

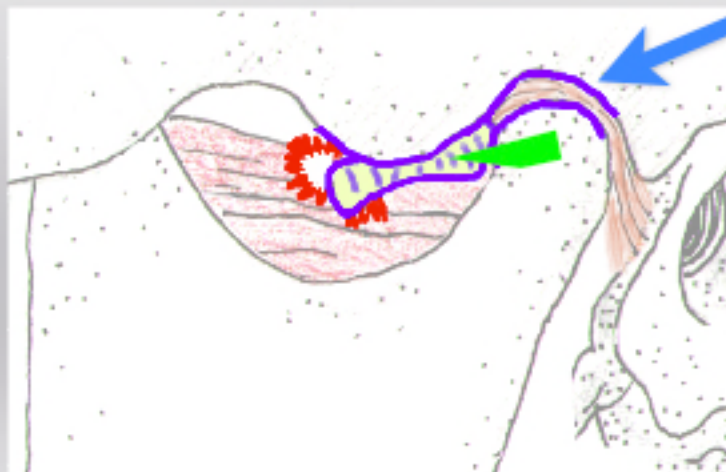
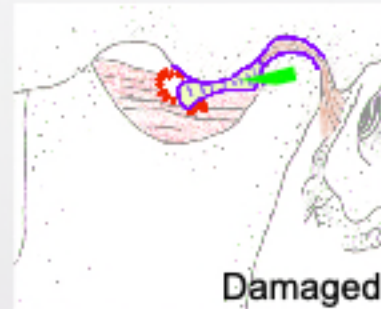
John R. Droter, DDS  
drdroter@mac.com  
301-805-9400

# Basic Orthopedics

Joints are either  
Healthy or  
Damaged

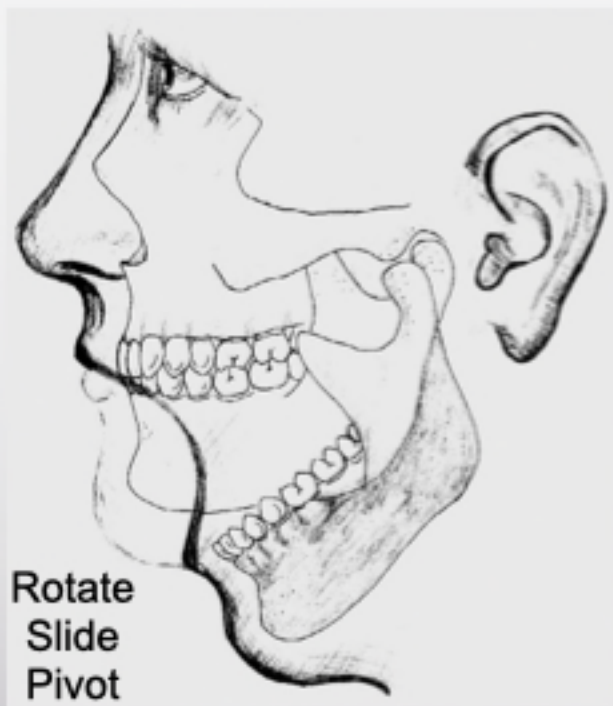
If damaged, joints will be either:  
Actively Breaking Down  
Adapting  
Adapted  
Structurally, Mechanically  
Favorably, Unfavorably

Majority of damaged  
TMJs adapt favorably



Posterior ligament, synovium,  
and retrodiscal tissue adapt to  
form a  
**Pseudo-disc**

Tissue Fibrosis



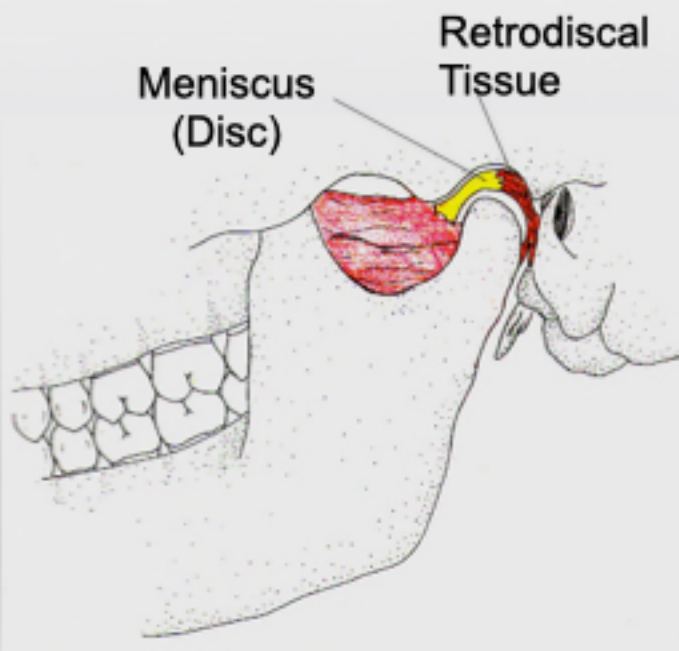
Rotation only 25mm

|               |         |
|---------------|---------|
| Max Open      | 40-55mm |
| Right Lateral | 10-12mm |
| Left Lateral  | 10-12mm |
| Protrusive    | 10-12mm |

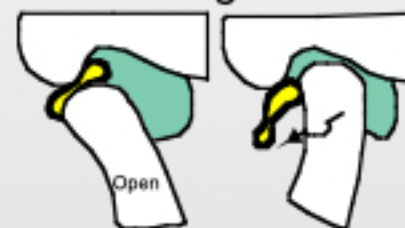


TMJ has 2 Joint Compartments:

Upper- Translation  
Lower- Rotation



Reducing "Click"



non-Reducing Disc

The background of the slide is a photograph of a park. In the foreground, there is a large, ornate black metal fountain with a tiered basin. Behind the fountain, a large, light-colored building with multiple windows and a central tower is visible. The scene is surrounded by green trees and a paved path. The text is overlaid on the center of the image.

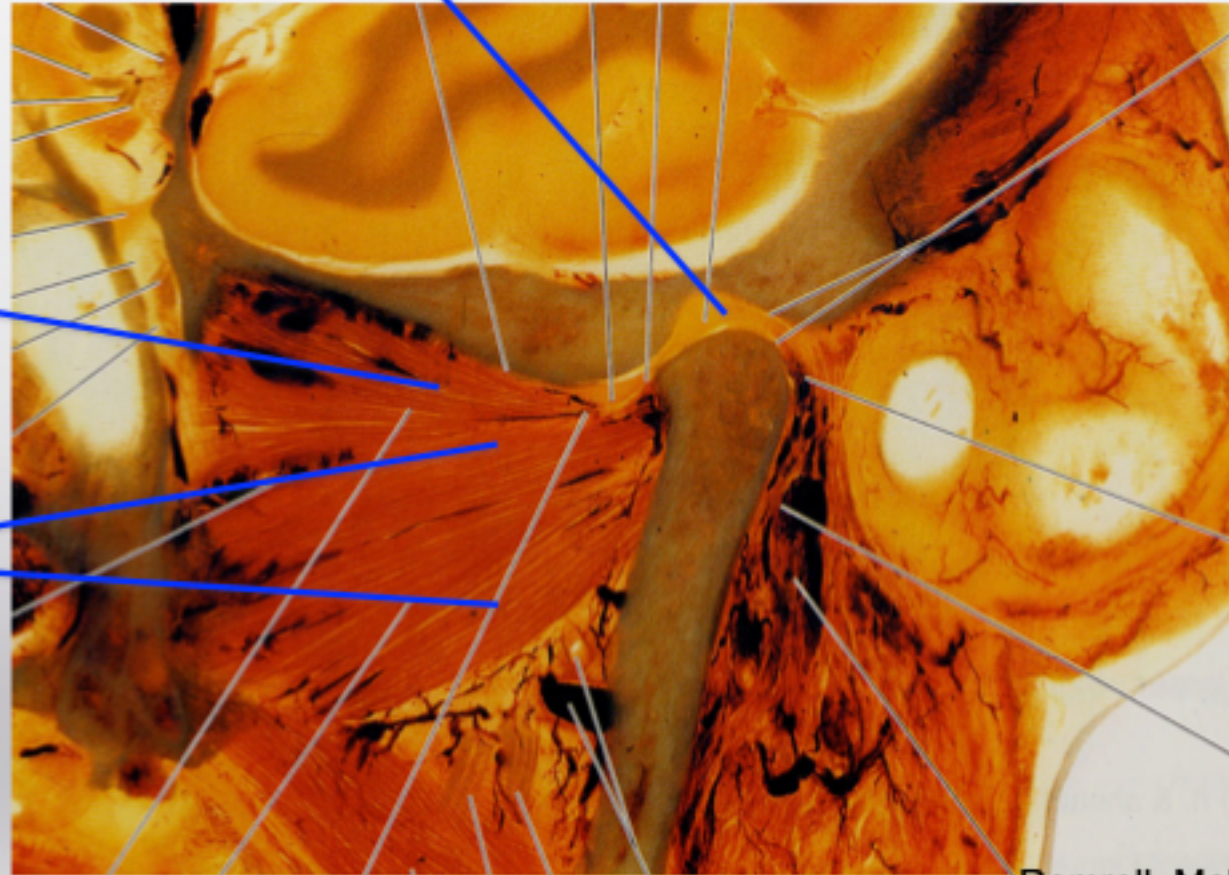
**Condylar and Disk  
Movements in Dissected  
TMJ Autopsy Specimens**

## Oblique Sagittal View

Disc: Thick-Thin-Thick

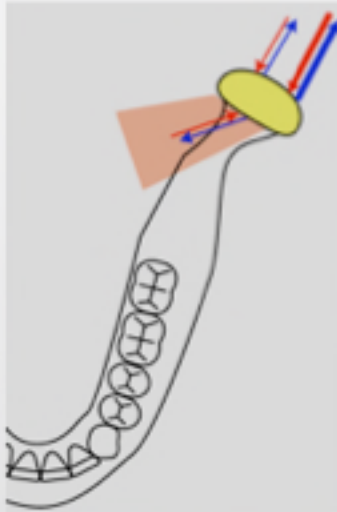
Lateral Pterygoid  
Superior Head

Lateral Pterygoid  
Inferior Head



Romrell, Mahan

Axial View



## Normal TMJ Blood Flow, Marrow

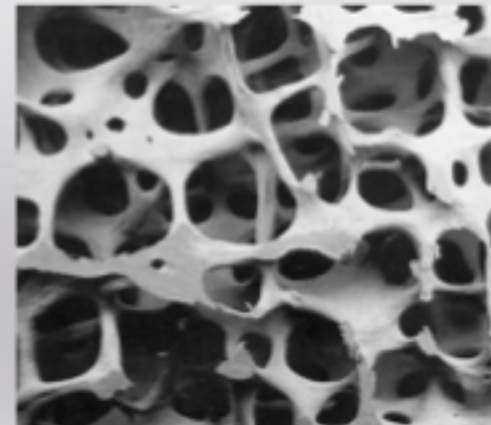
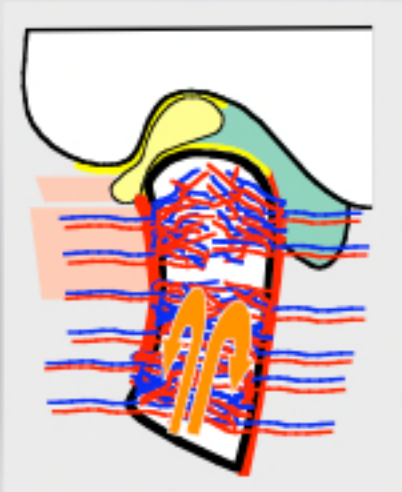
Condylar head limited collateral circulation

Epiphyseal growth center

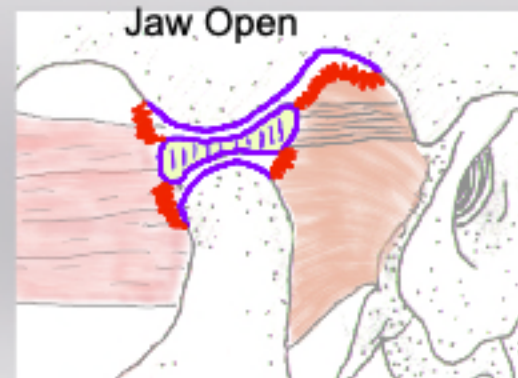
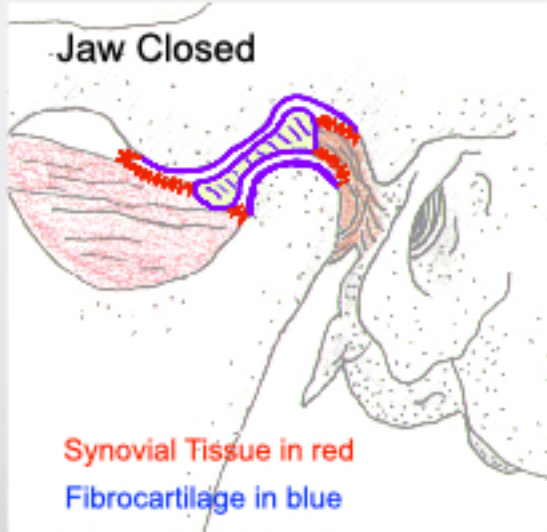
Marrow is fatty tissue with blood vessels, containing the precursor for blood cells

No Blood vessel inside joint

Closed  
Sagittal

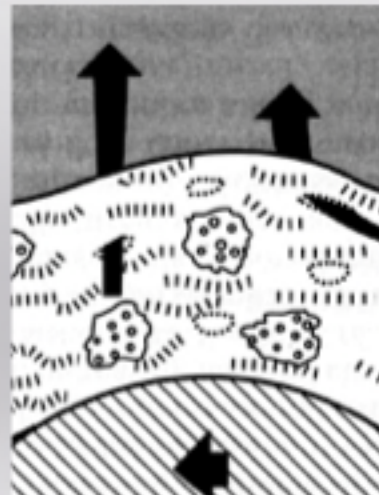


# Normal TMJ- Synovium, Cartilage

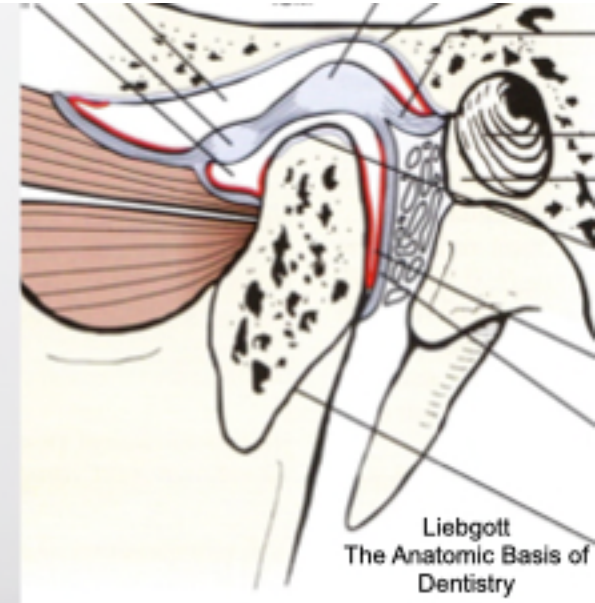


Fibrocartilage-  
Slope of Eminence  
Disc  
Top of Condyle

Synovial Tissue makes Synovial Fluid  
No blood vessels in a health joint  
Nutrition to the cartilage cells  
Lubrication- Hyaluronic Acid and Lubricin



Fibrocartilage surface covered in fluid  
Cartilage is hydrophilic  
Proteoglycan negative charge  
Surface Active Phospholipids  
Fluid slides against fluid  
5x slipperier than ice

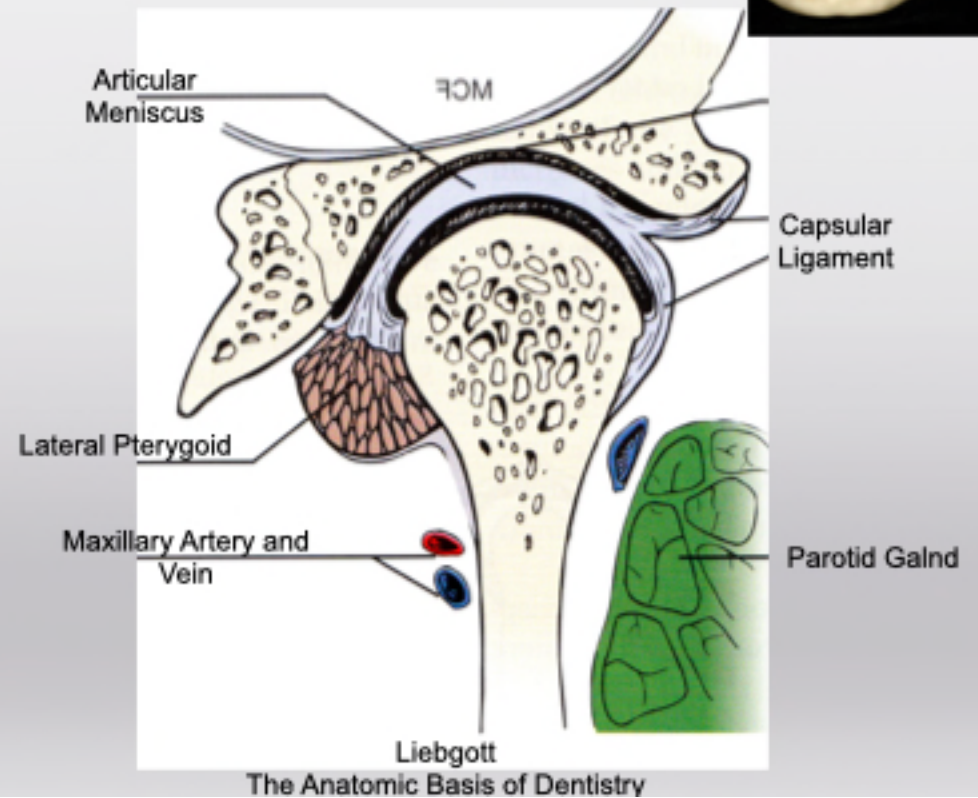
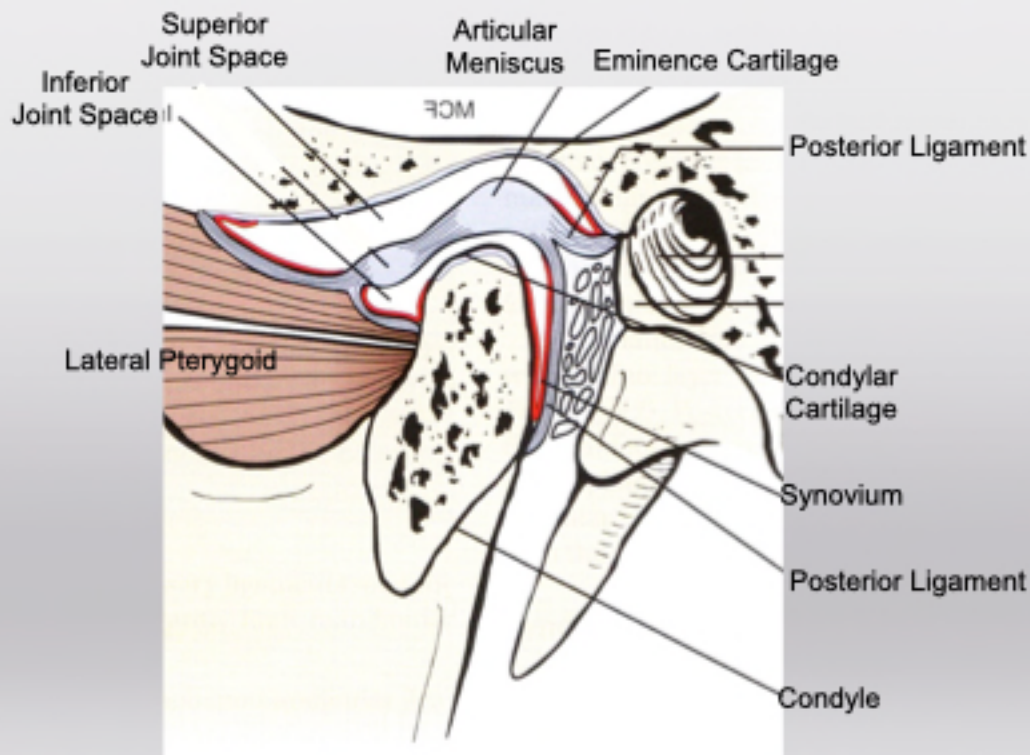




Left TMJ Sagittal View



Left TMJ Coronal View



# Normal TMJ

Jaw Closed



Synovial Tissue in red  
Discal Ligament in green

Discal Ligaments attach Disc to  
Condyle

## Synovial Tissue

- Covers Front , Back and Sides
- Collapsed due to negative joint pressure

Disc viewed from above

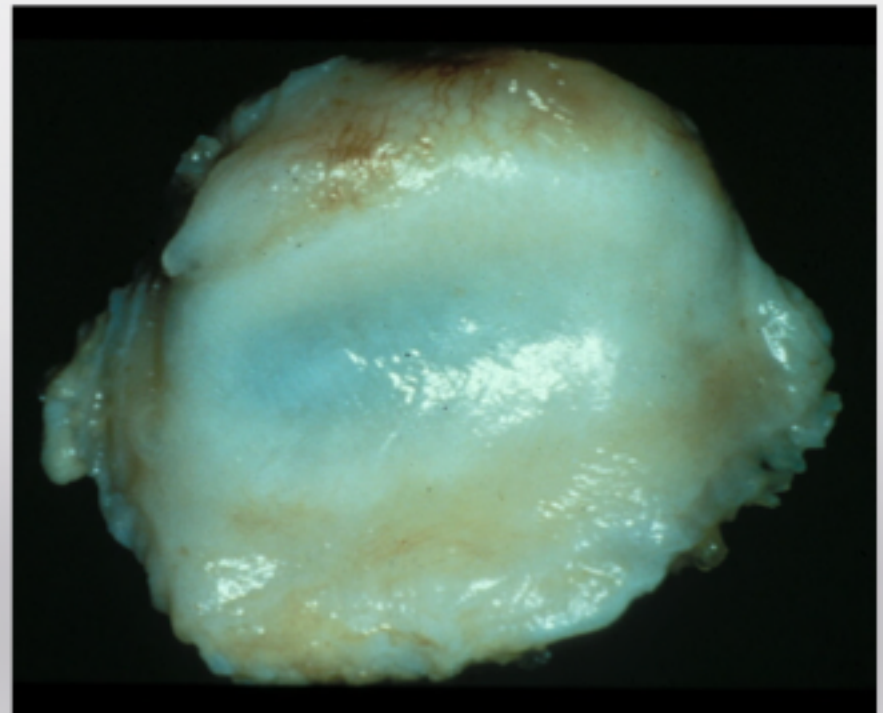
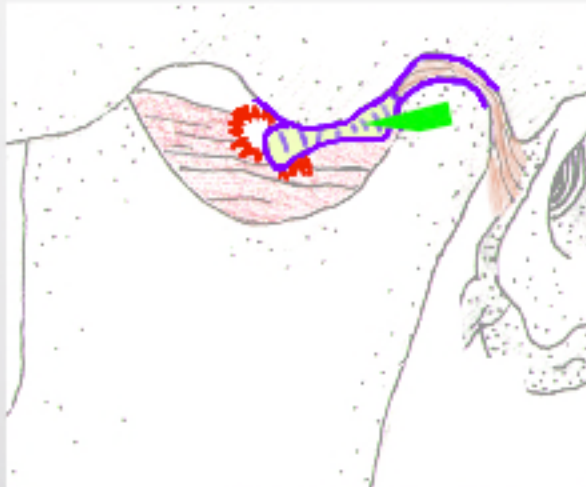


Photo Courtesy of Dr Henry Gremillion

## Damaged TMJ- Anteriorly Dislocated Disc



Torn or stretched Meniscal ligaments

Anterior Dislocated Disc

Damaged Synovium

Retrodiscal Tissue pulled up and over the condyle

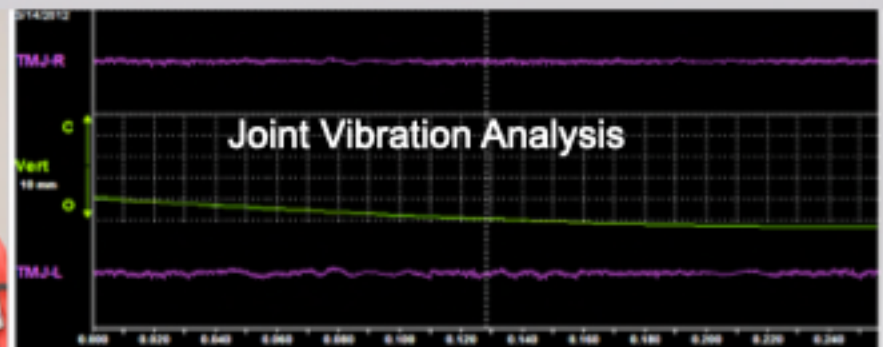
Retrodiscal tissue in direct contact with fibrocartilage

Major Increase in friction

Retrodiscal tissue adapts into fibrous "pseudodisc"

85% of all damaged joints adapt favorably without treatment

Cartilage sliding on tissue creates vibrations that can be detected



# Damaged Joint with Malocclusion

85% damaged joints adapt favorably with respect to the TMJ.

Anteriorly Dislocated Disc, Mandible shifts:

Inadequate Anterior Guidance, Posterior Disclusion

Uneven Occlusion,

CR≠MaxIC

Occlusal Muscle Disharmony develops.

Treat Adapted joints with OMD

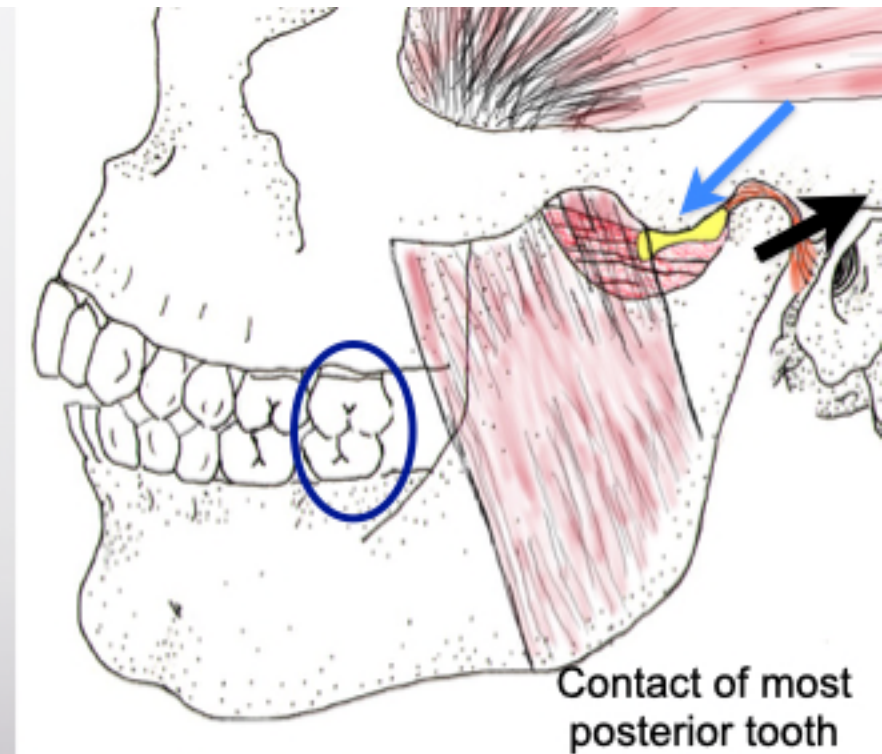
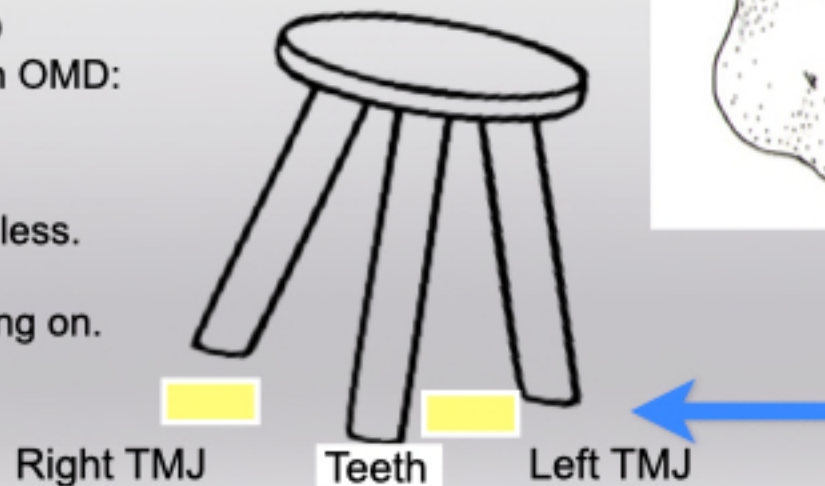
the same as healthy joints with OMD:

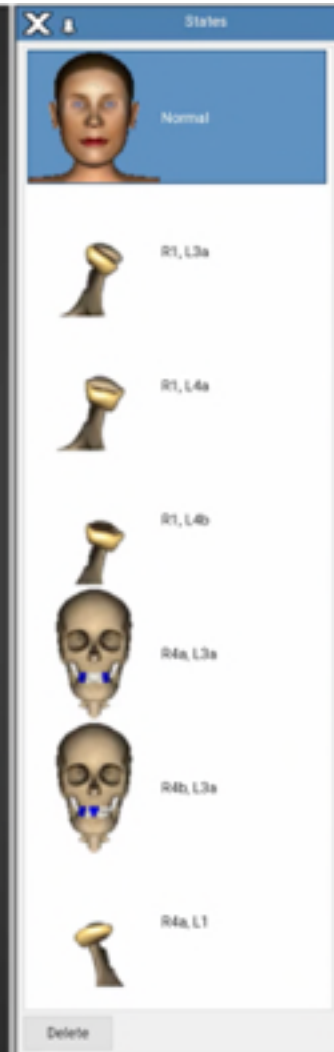
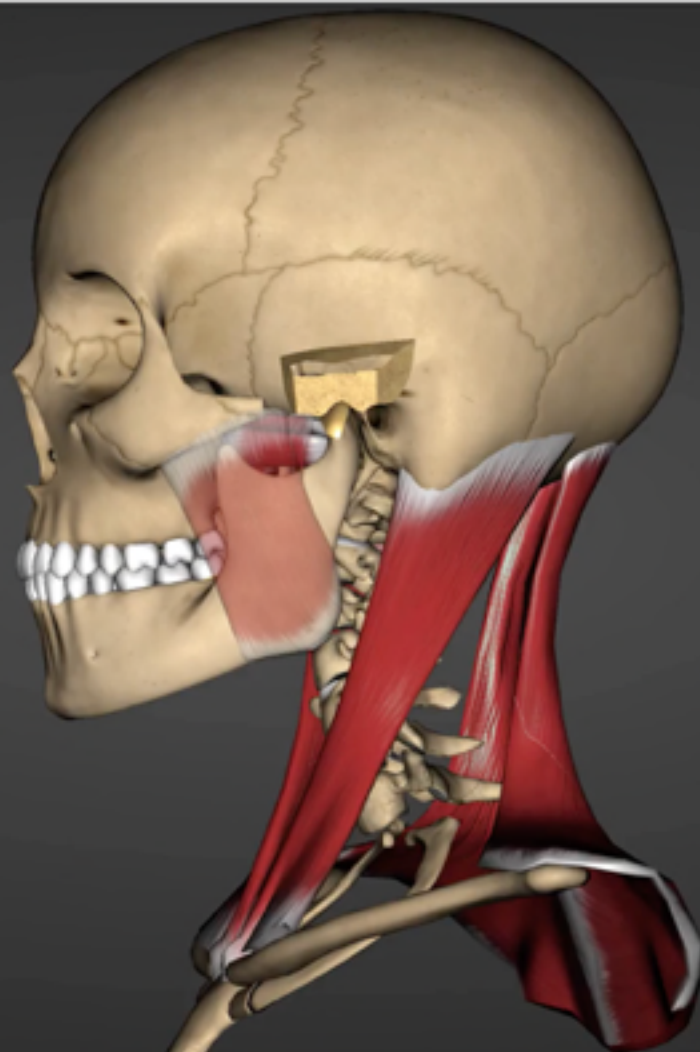
Occlusal Adjustment

CR≠MaxIC should be 2mm or less.

(Horizontal 2mm)

If >2mm something else is going on.





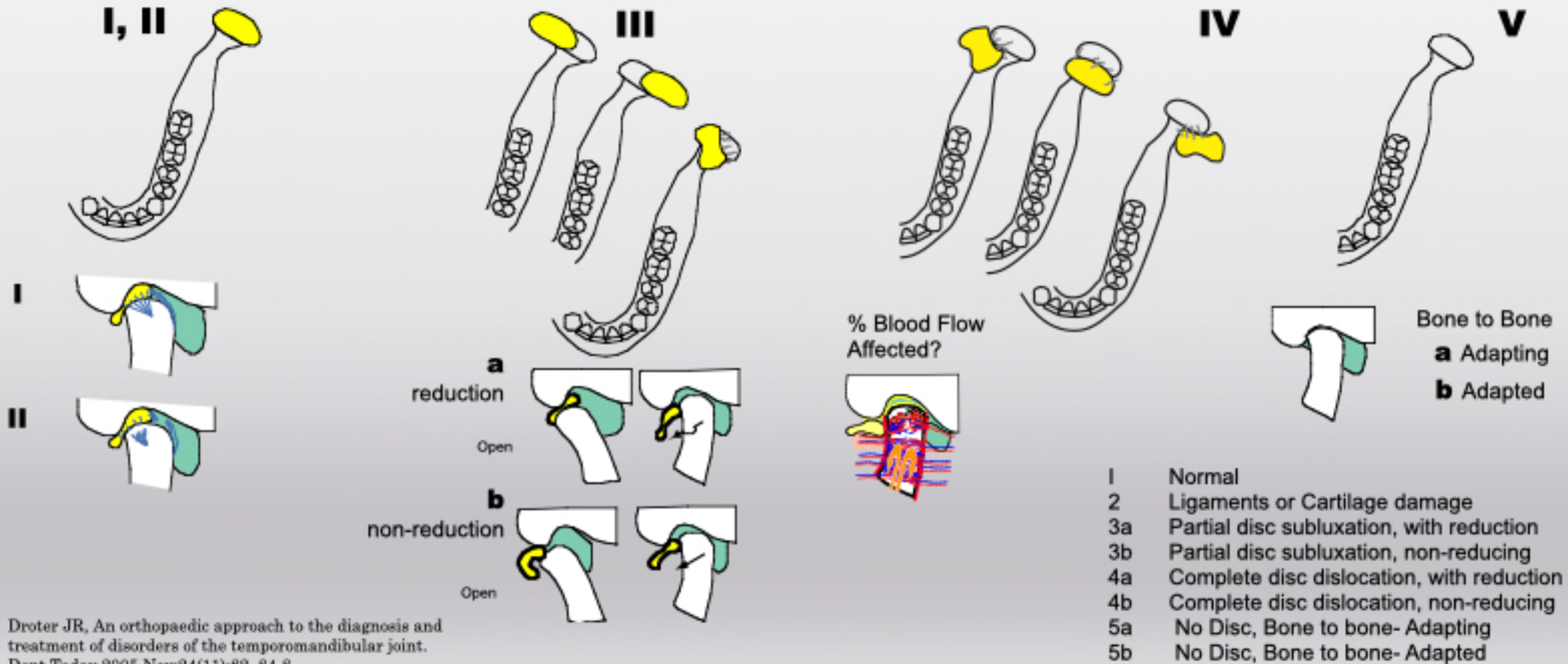
## Skull Anatomy 4a

Licensed to: John Droter

**NOVALOUS**  
MEDICAL

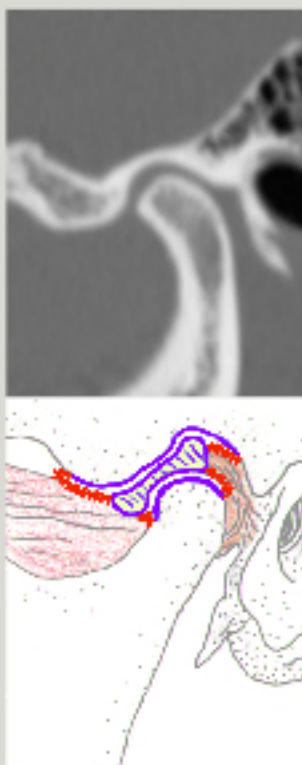
# Dr. Mark Piper's Classification

Left TMJ



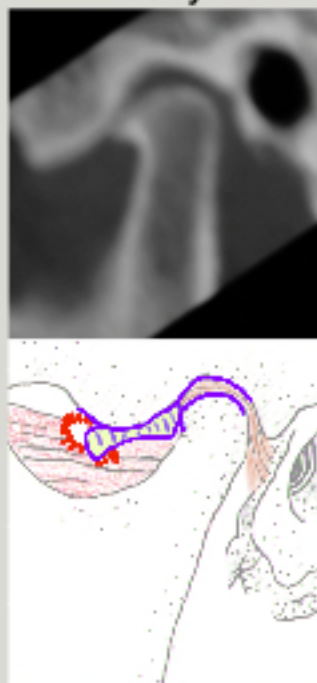
Droter JR, An orthopaedic approach to the diagnosis and treatment of disorders of the temporomandibular joint. Dent Today 2005 Nov;24(11):82, 84-8

Normal



## Osteoarthrosis/Osteoarthritis

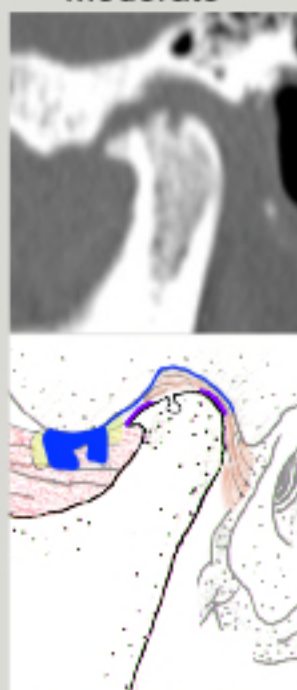
Early



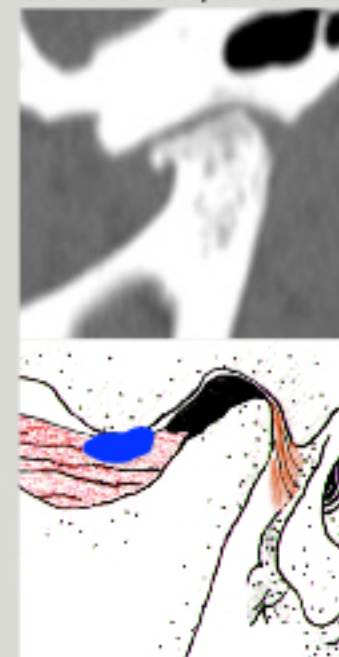
Early/ Moderate



Moderate



Severe OA, Eburnation



Healthy joints have no friction or wear.

Damaged joints have Friction. Friction causes wear.

OA is a wearing out of a joint which starts in cartilage.

**Parafunction increases wear.**

Representative examples of OA  
in different patients

Drawings by Gretta Tomb DDS and John Droter DDS

### 3 Outcomes of Compromised Condylar Perfusion



Bone cells die

### Avascular Necrosis



or

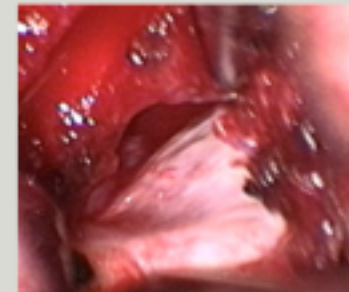
### Inflammatory Tissue Bone Resorption

Cortex Collapses, Cartilage tears  
Inflamed tissue contacting bone  
Inflammatory cells activate Osteoclasts



One and Done

Condyle collapses 1y later.  
Cartilage remains intact  
Occlusion shifts once, AVN is finished.



### Nothing

Compromised but adequate.  
99% patients have no problems



**Know Yourself**

**Know Your Work**



**Know Your Patient**

**Apply Your Knowledge**

LD Pankey Institute

Write your Dream

John R. Droter, DDS  
drdroter@mac.com  
301-805-9400

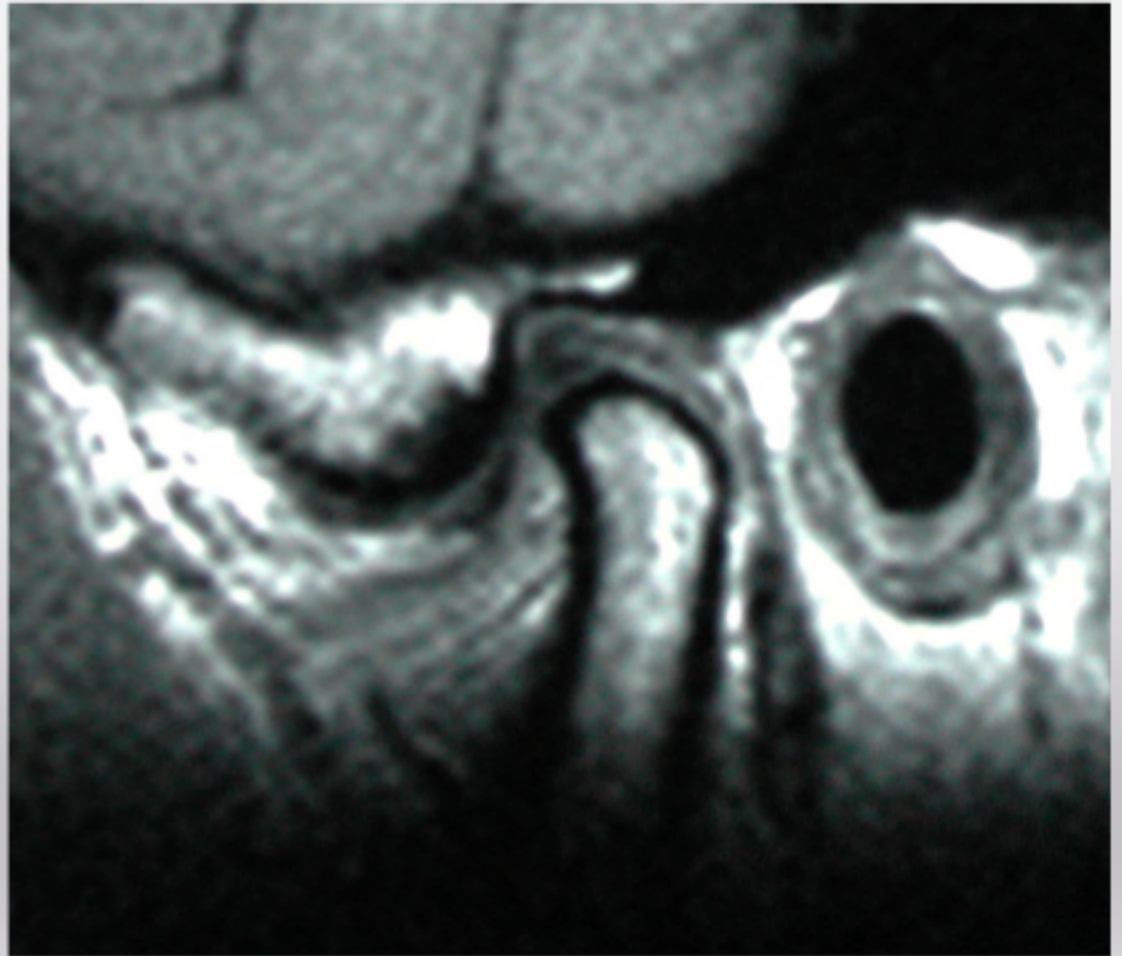
# Facial Pain Diagnosis

## Diagnostic Tools

- 1 Written and Oral History
- 2 Observation
- 3 Physical Exam
  - Muscle Palpation
  - Joint Palpation
  - Joint Auscultation
  - Joint Motion
- 4 Anterior Stop Test
- 5 Sleep Airway Screening
- 6 CT Scan

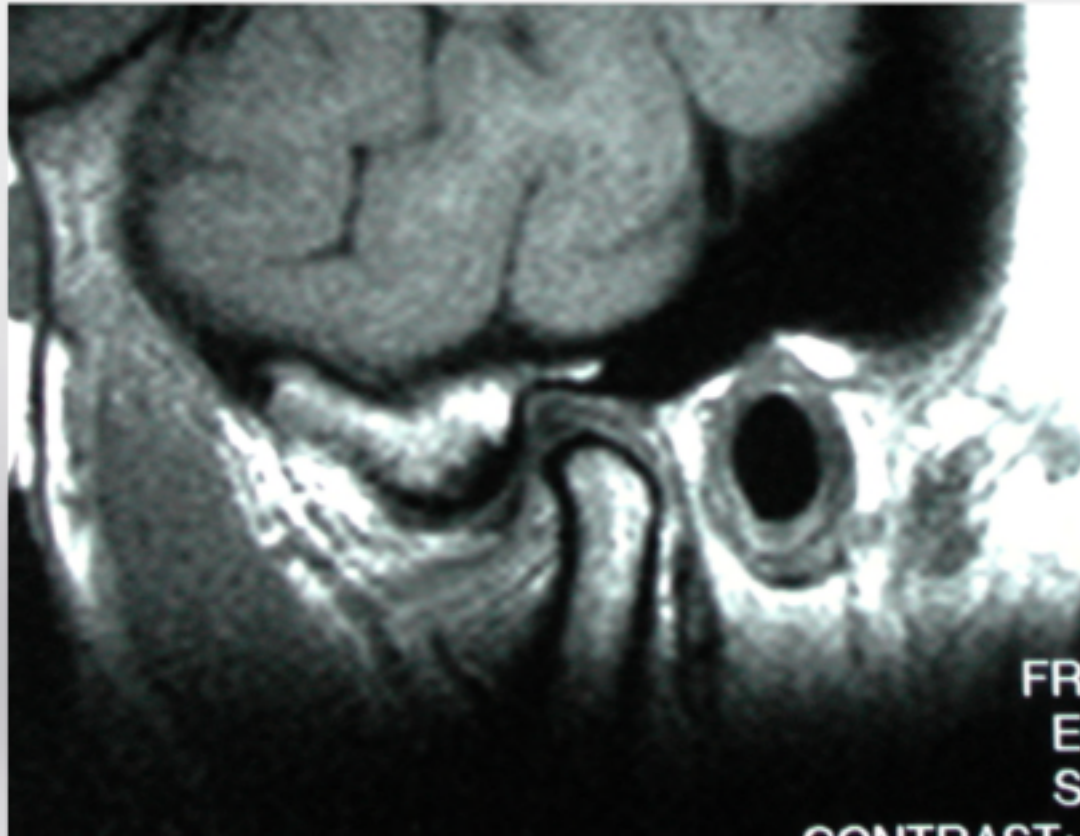
## **MRI**

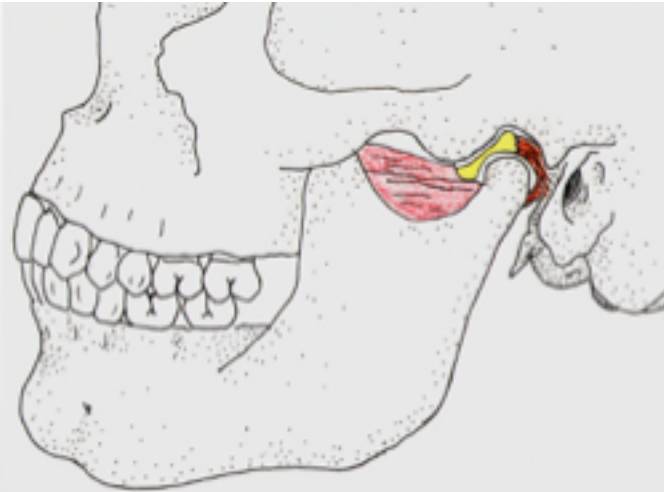
Blood Tests



## **MRI- T1 Oblique Sagittal View**

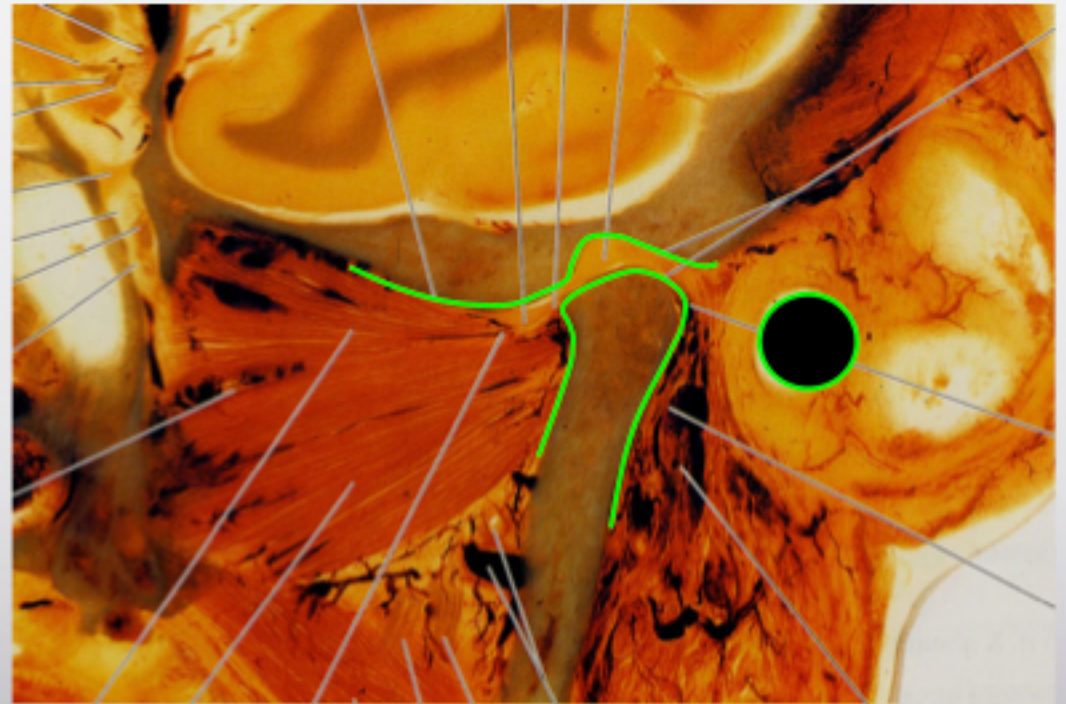
MRI you can see soft tissue





**Find the...**  
**Ear**  
**S-shaped Bone**  
**Condyle**  
**Disc**

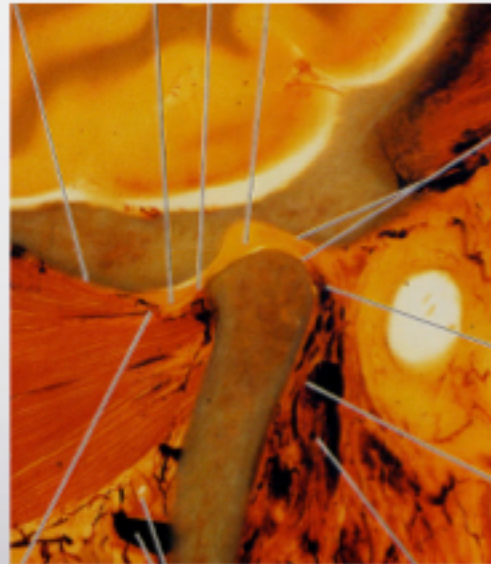
## Oblique Sagittal View

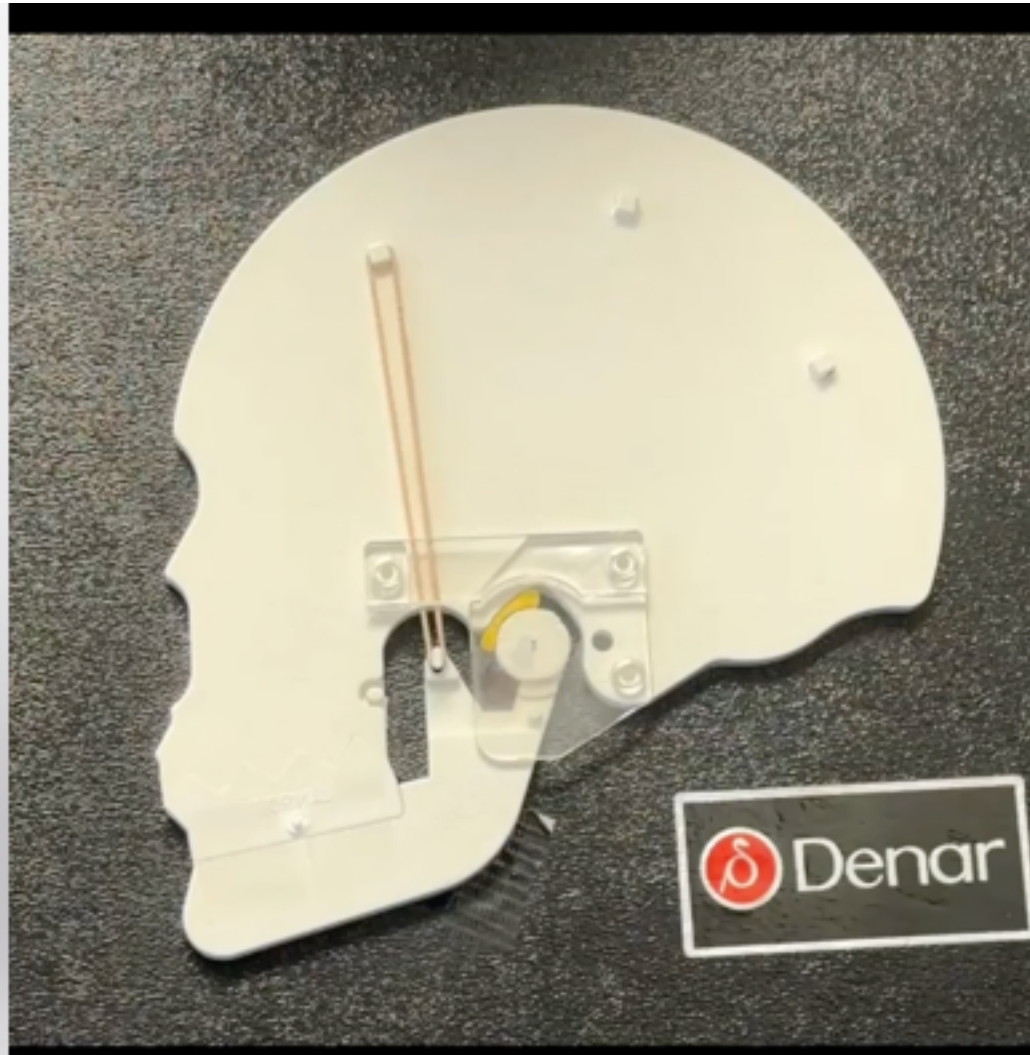


T1 Inverted

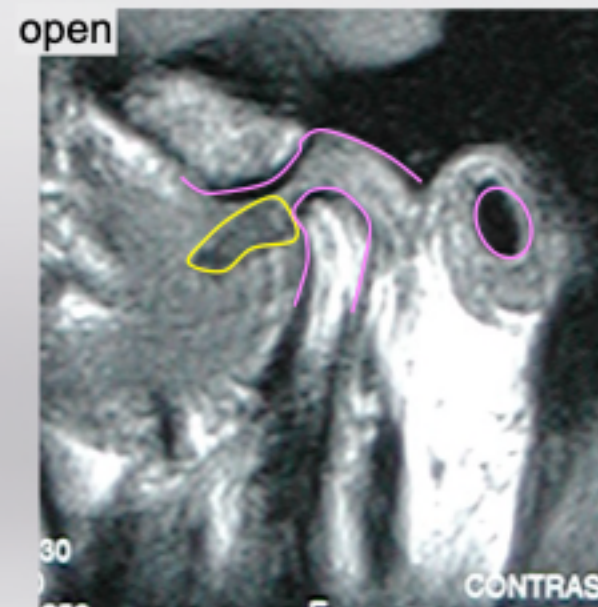
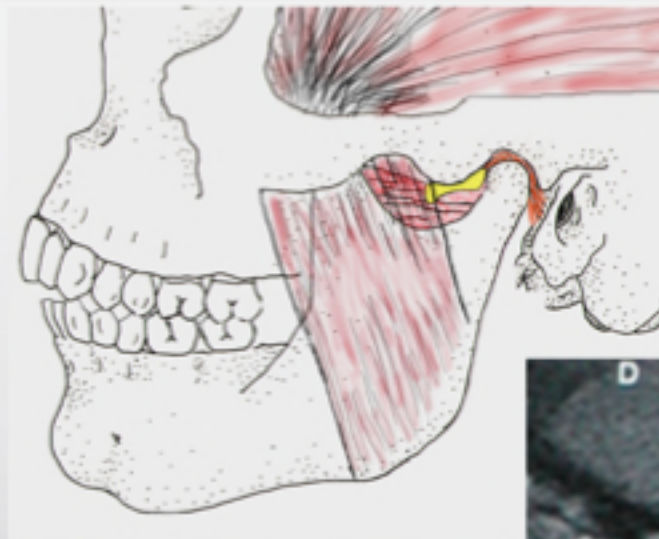


T1 Sagittal Closed





## Dislocated Disc and Condyle Subluxation





# MRI Scanners

MRI Scanner  
3 Tesla  
Magnet Strength



## Head Coil

MRI Scan of the Temporomandibular Joint  
3 Tesla Magnet

date \_\_\_\_\_

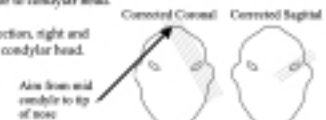
Please evaluate \_\_\_\_\_

Significant History: ☐ See Exam Form

☐ Facial Pain 784.0  
☐ Vascular Necrosis 826.4  
☐ Osteoarthritis 715.2

- Use 3 Tesla Magnet. Use highest resolution as possible. Do not use a short flip angle.
- Limit field of view to the TMJ to allow for maximal resolution.
- Show orientation views.
- Closed views are with back teeth together.
- Use a roll of tape (GM Transport Tape 1 inch wide) for the open view. The roll is two inches in diameter. Have patient open as wide as they can comfortably and place the tape roll as far back as possible with the flat side toward the teeth. They should be biting into the tape with their back molars on both sides.
- Copy DICOM images to a CD and give to patient.
- If at Anne Arundel Medical Center, Radiologist Kerry Thompson, MD is to read the scan.
  - ☐ Patient has wax index to wear on teeth to stabilize jaw for closed view.
  - ☐ Patient is to wear Dr. Doctor's appliance for all closed views.
  - ☐ Give Rx for \_\_\_\_\_. They will take it 1 hour before scan.
  - ☐ Patient to get braces off molars before scan. No orthodontic wire in place.

1. T1, mouth closed, corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head.
2. T2 scan mouth closed, corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head.
3. STIR (T1 inversion recovery) corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head.
4. Proton Density, mouth closed, corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head.
5. Proton Density, mouth closed, corrected coronal projection, right and left TMJ. 8 or more views: in front of condylar head, through condylar head, behind condylar head. Be sure to go at least one slice distal, and one slice anterior to condylar head.
6. Proton Density, mouth open fully, corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head. Use roll of tape for open view as described above. Take this view last.



Thank You

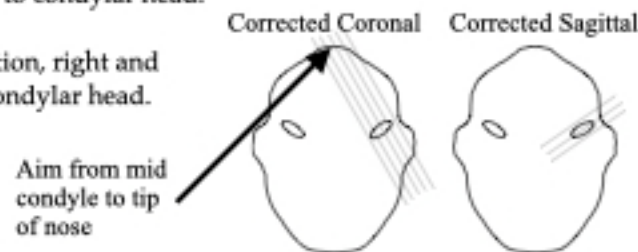
# Rx 3T MRI of the TMJ

- Use 3 Tesla Magnet. Use highest resolution as possible. Do not use a short flip angle.
- Limit field of view to the TMJ to allow for maximal resolution.
- Show orientation views
- Closed views are with back teeth together.
- Use a roll of tape (3M Transpore Tape 1 inch wide) for the open view. The roll is two inches in diameter.  
Have patient open as wide as they can comfortably and place the tape roll as far back as possible with the flat side toward the teeth. They should be biting into the tape with their back molars on both sides.
- Copy DICOM images to a CD and give to patient.
- If at Anne Arundel Medical Center, Radiologist Kerry Thompson, MD is to read the scan.
  - ☐ Patient has wax index to wear on teeth to stabilize jaw for closed view.
  - ☐ Patient is to wear Dr. Droter's appliance for all closed views.
  - ☐ Gave Rx for \_\_\_\_\_. They will take it 1 hour before scan.
  - ☐ Patient to get braces off molars before scan. No orthodontic wire in place.

# Rx 3T MRI of the TMJ

1. T1, mouth closed, corrected sagittal projection, right and left TMJ.  
8 or more views: lateral, medial, 4 cuts through condylar head.
2. T2 scan mouth closed, corrected sagittal projection, right and left TMJ.  
8 or more views: lateral, medial, 4 cuts through condylar head.
3. STIR (T1 inversion recovery) corrected sagittal projection, right and left TMJ.  
8 or more views: lateral, medial, 4 cuts through condylar head.
4. Proton Density, mouth closed, corrected sagittal projection, right and left TMJ.  
8 or more views: lateral, medial, 4 cuts through condylar head.
5. Proton Density, mouth closed, corrected coronal projection, right and left TMJ.  
8 or more views: in front of condylar head, through condylar head, behind condylar head.  
Be sure to go at least one slice distal, and one slice anterior to condylar head.
6. Proton Density, mouth open fully, corrected sagittal projection, right and left TMJ. 8 or more views: lateral, medial, 4 cuts through condylar head.  
Use roll of tape for open view as described above.  
Take this view last.

Thank You



# Older MRI Scanners

MRI Scanner  
1.5 Tesla  
Magnet Strength

Open MRI Scanner  
0.7 Tesla

Shoulder Coil

Dual TMJ Coils



# How an MRI Works

Magnet lines up protons: Water and fat

Magnet is on the whole time

RF Pulse (Radiofrequency): 1 millisecond

Knocks protons out of alignment

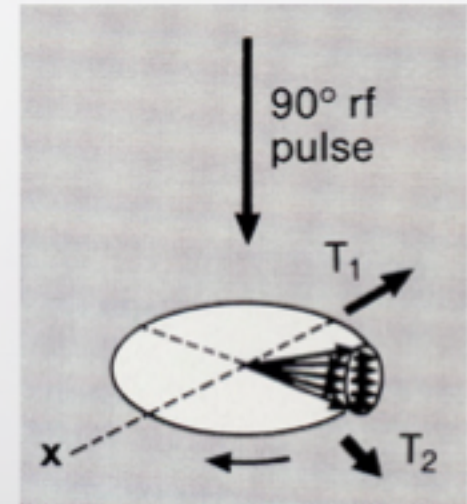
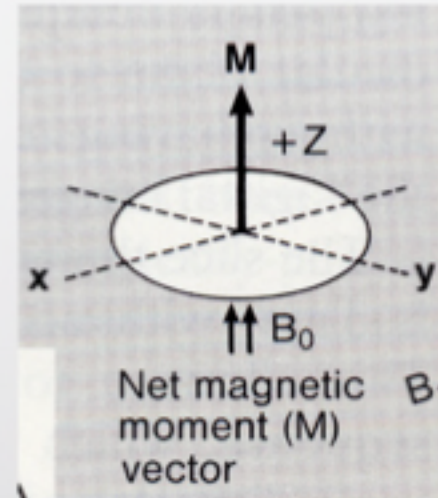
Time Constant: RF pulse off and then look

T1 : Shows more fat

T2 : Shows more water

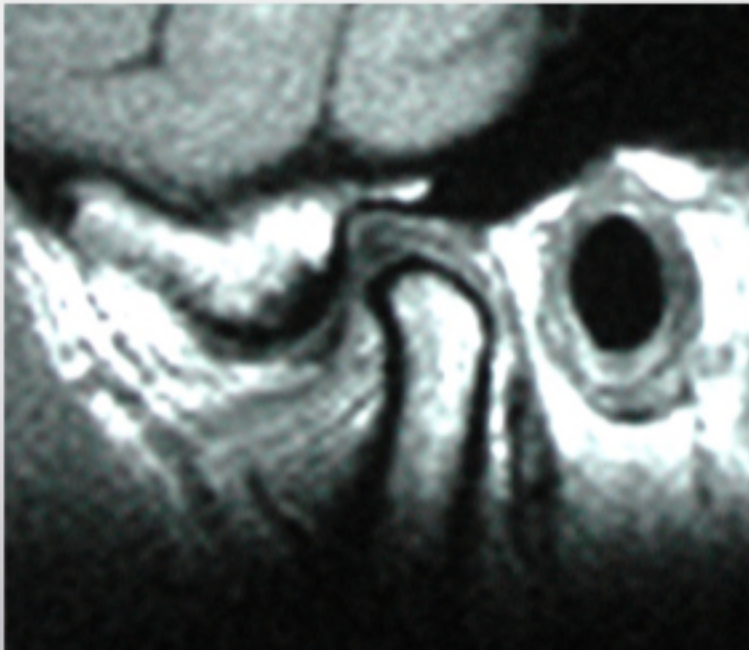
PD Proton Density- Between T1 and T2

STIR Short T1 Inversion Recovery- Shows more water



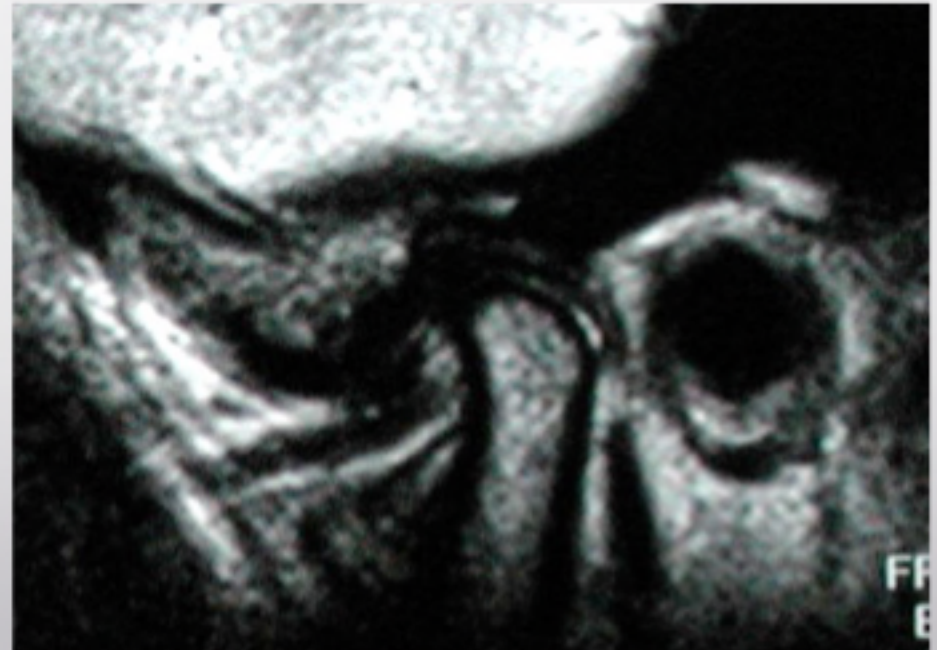
## Normal MRI T1 and T2

T1 Sagittal Closed



T1 shows more fat

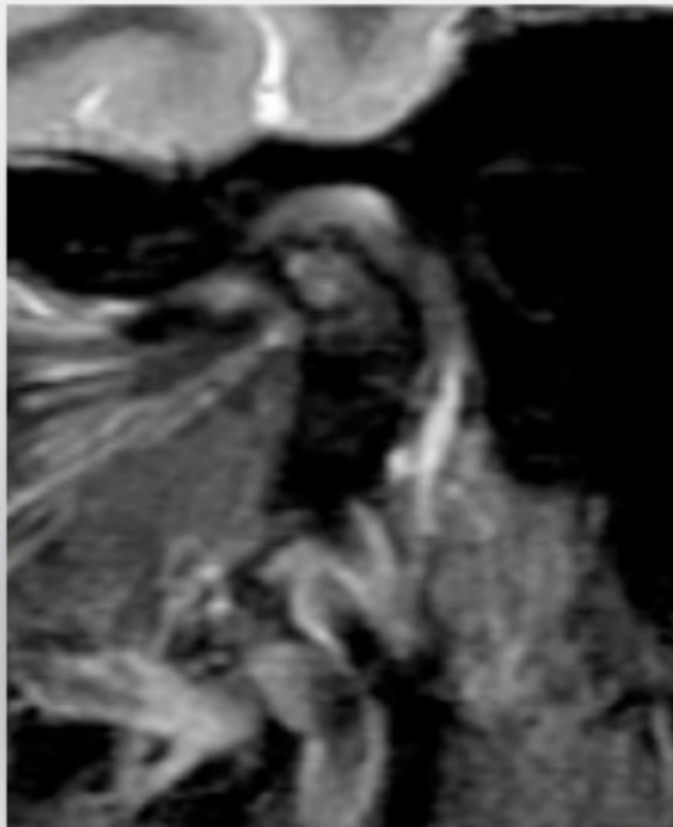
T2 Sagittal Closed



T2 shows more water:  
Inflammation  
Pathology

# MRI STIR Image

STIR- Short T1 Inversion Recovery



STIR- “Supercharged” T2

Retrodiscal Inflammation

Marrow Edema

Diff Dx is active AVN, Osteoarthritis, Lyme Ds, RhA,  
Hypoxic Progressive Condylar Resorption

STIR and T2 shows water as white



**Know Yourself**

**Know Your Work**



**Know Your Patient**

**Apply Your Knowledge**

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