

CBCT: Indications and Applications



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Lecture Objectives:



Cone Beam Computed Tomography:

- REVIEW EVIDENCE-BASED CBCT INDICATIONS FOR USE IN DENTISTRY
- CLINICAL APPLICATIONS OF CBCT IN DENTISTRY
- REVIEW OTHER POTENTIALLY REQUIRED ADVANCED IMAGING MODALITIES



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Presenter Disclosure

- **Faculty Member:** Dr. Meredith Brownlee
- **Relationships with commercial interests:**
 - None to report



Computed Tomography (CT)

- 3-Dimensional imaging modality
- Utilized to visualize the body without superimposed anatomical structures of conventional imaging
- In the medical field, the modality of choice is the multi-slice computed tomography (MSCT)
- In the dental field, use of cone beam CT has been growing in popularity since the late 1990's



CBCT Desirable Dental Features:

- Most machines are small enough for in-suite in the dental office
- Less radiation dose than MSCT (although considerably more than conventional imaging)
- Various fields of view (FOVs) available, but are machine dependent
- Fast acquisition and processing of images
- Much less expensive to purchase and upkeep
- Better spatial resolution than MSCT in all dimensions (axial, coronal, and sagittal)



2D versus 3D

	Conventional Imaging	CBCT
Use	Screening	Diagnostic
Radiation Dose	Very low dose	Lower dose than MSCT
Radiation Risk vs Benefit	Benefit >> Risk	Increased risk, especially in younger patients
Number of Projections	1 per captured image	Many projections per acquired volume
Anatomical Structures	Superimposed over region of interest	No superimposed structures
Distortions	Projection geometry of 2D imaging has multifaceted inherent distortions of anatomical structures	No distortions of the anatomy, unless artifact (patient movement or inherent CBCT artifacts)



CBCT

- When to utilizing CBCT in your practice?



CBCT and Dentistry

1. Perform a thorough clinical history and examination
2. Choose appropriate conventional imaging (2D)
3. Treatment plan and differential diagnosis
4. Identify justified indications for the use of CBCT
5. Select optimized CBCT FOV and spatial resolution



CBCT and Dentistry

6. Implants: is a radiographic stent/guide required for imaging?
7. Interpret the ENTIRE acquired volume for incidental and pathological findings and compose radiographic report
8. Definitive or differential diagnosis and complete treatment planning



< 80mm x 80mm are
considered Small
FOVs

Single arch (100mm x
50mm) FOVs are
Medium FOVs

\geq 80mm x 80mm are
Large FOVs

Default Settings include spatial resolutions of:

40 x H 40 mm: 80 μm

60 x H 60 mm: 125 μm

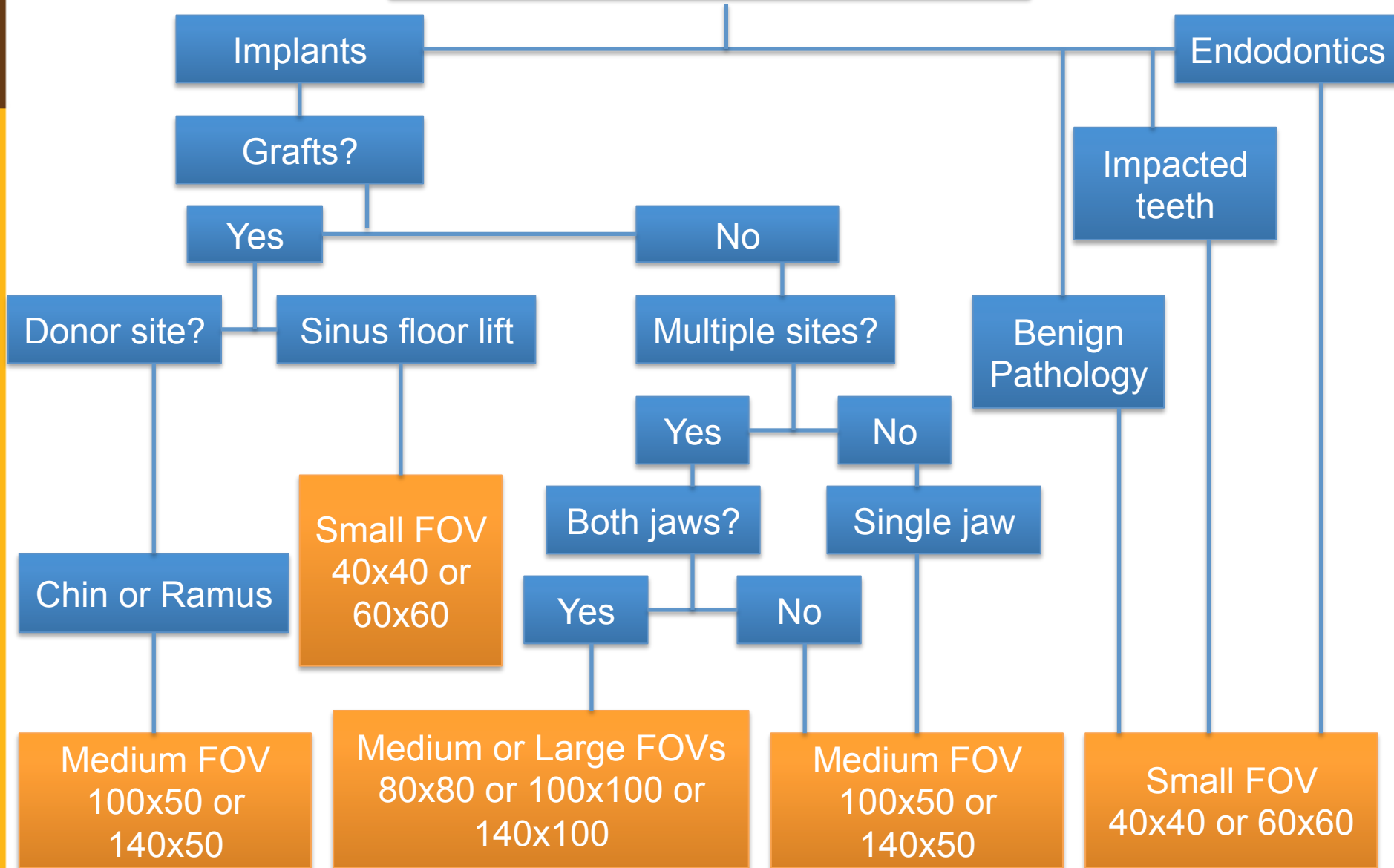
80 x H 80 mm: 160 μm

100 x H 100 mm: 250 μm

170 x H 120 mm: 250 μm



FOV Selection for CBCT



Adapted from Fig. 6, MacDonald (2015)



CBCT FOV Selection

- Always utilize the smallest FOV to capture the region of interest (ROI) for the treatment or diagnosis:
 - Decreases radiation dose to the patient
 - Optimizes the imaging via spatial resolution
 - Decreases the size of the data set to review and report on, as the entire captured volume is the responsibility of the practitioner



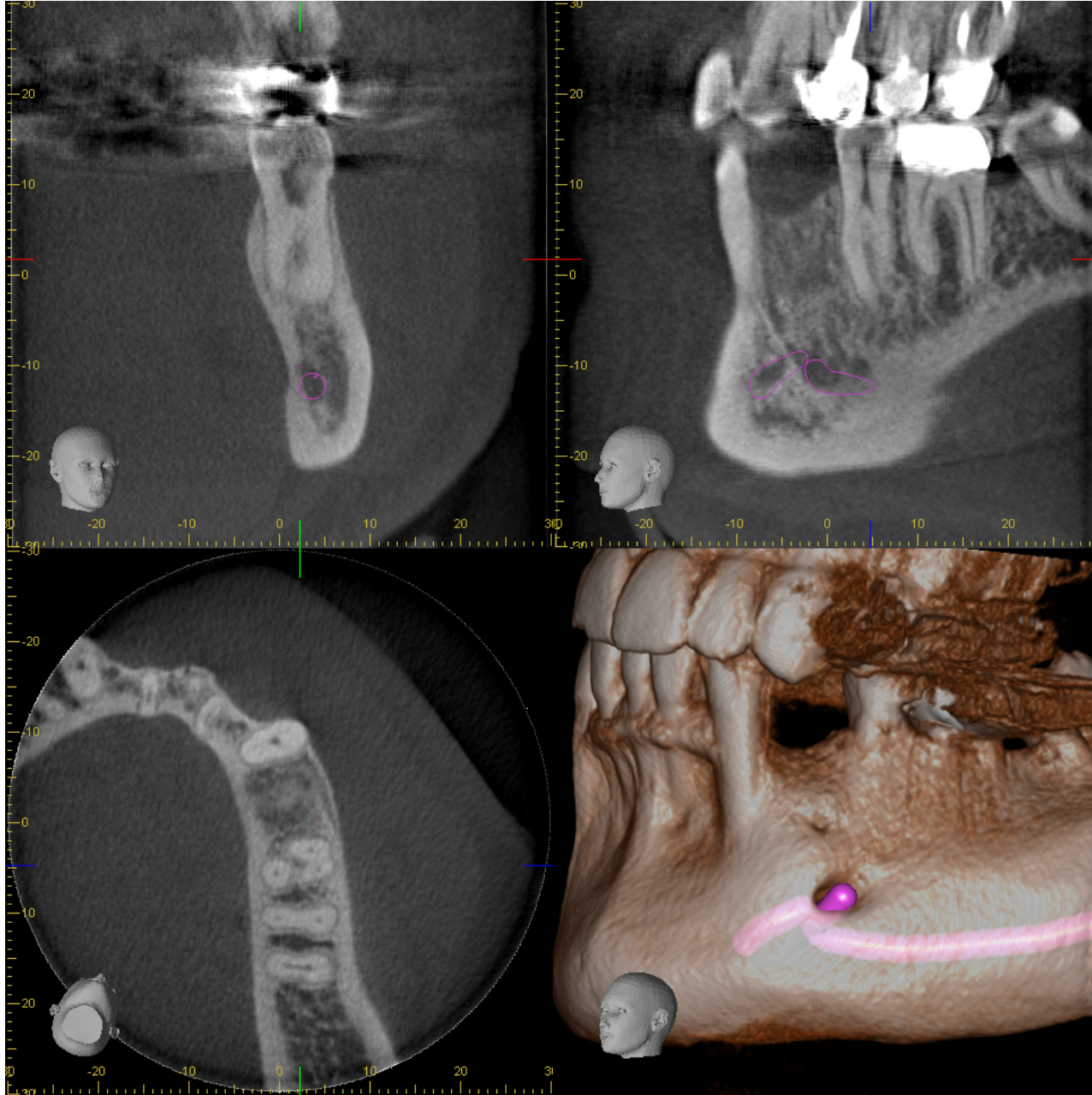
Small CBCT FOV

- Incorporates the dento-alveolar structures of a portion of the maxilla or mandible
- Volume acquired ranges from 4cm-6cm in height
- Indicated for definitive diagnosis or treatment treatment planning of:
 - Single implant fixtures
 - Endodontic evaluation
 - Assessment of impacted tooth/teeth
 - Pathological lesion investigation



Small and Medium CBCT FOVs

Phantom Size	Effective Dose (μSv)
Adult	11-674(61)
10 Year Old	16-214(43)
Adolescent	18-70(32)



Source: Dr. M. Brownlee



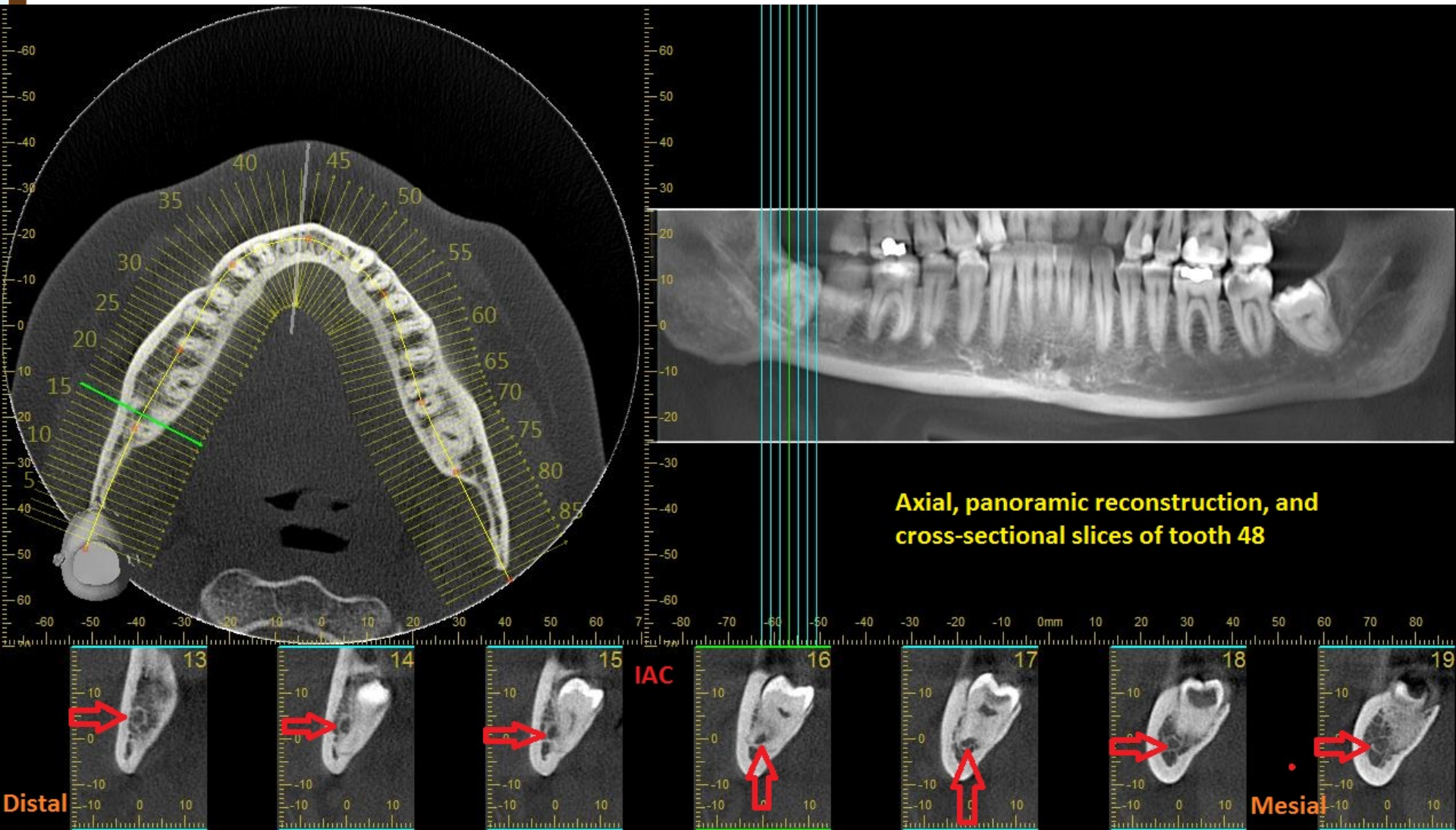
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Medium CBCT FOVs

- Encompasses the dentoalveolar skeleton, and volume acquired is $\leq 8\text{cm}$ in height or includes one entire dental arch
- Indicated primarily for definitive diagnosis and treatment planning of:
 - Single or multiple implant fixtures
 - Bone graft harvesting from chin or ramal regions
 - Assessment of impacted tooth/teeth
 - Pathological lesion investigation

Medium FOV



Source: Dr. Brownlee



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Large CBCT FOVs

- Encompasses the craniofacial skeleton and volume acquired is $\geq 10\text{cm}$ in height
- Indicated primarily for:
 - Facial anomalies
 - Cleft lip and palate patients
- Enables cephalometric analysis of the patient
 - **NB: this is not a justifiable use of CBCT imaging**

Large CBCT FOVs

Phantom Size	Effective Dose (μSv)
Adult	30-1073 (87)
10 Year Old	114-282 (186)
Adolescent	81-216 (135)

TD
Care

R

L

Bolton, Bruce
08/15/1964
M

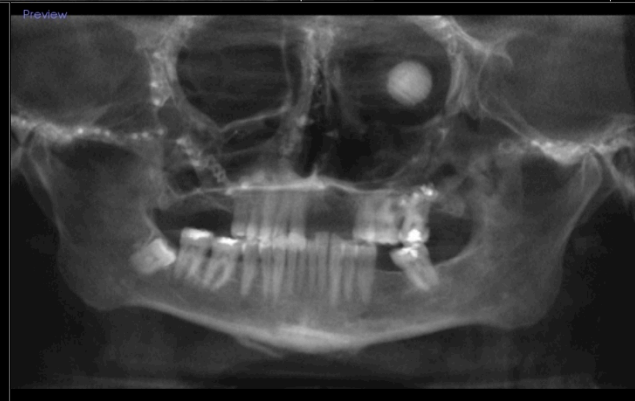
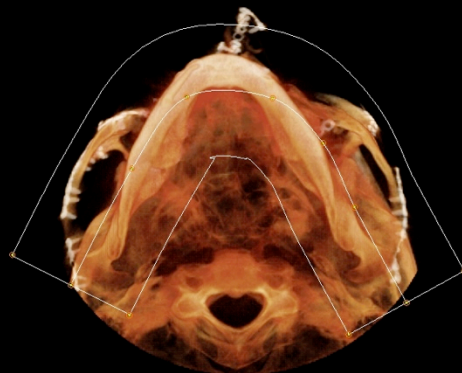
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30
cpm

Upper-Lower Limit

Focal Trough

Preview



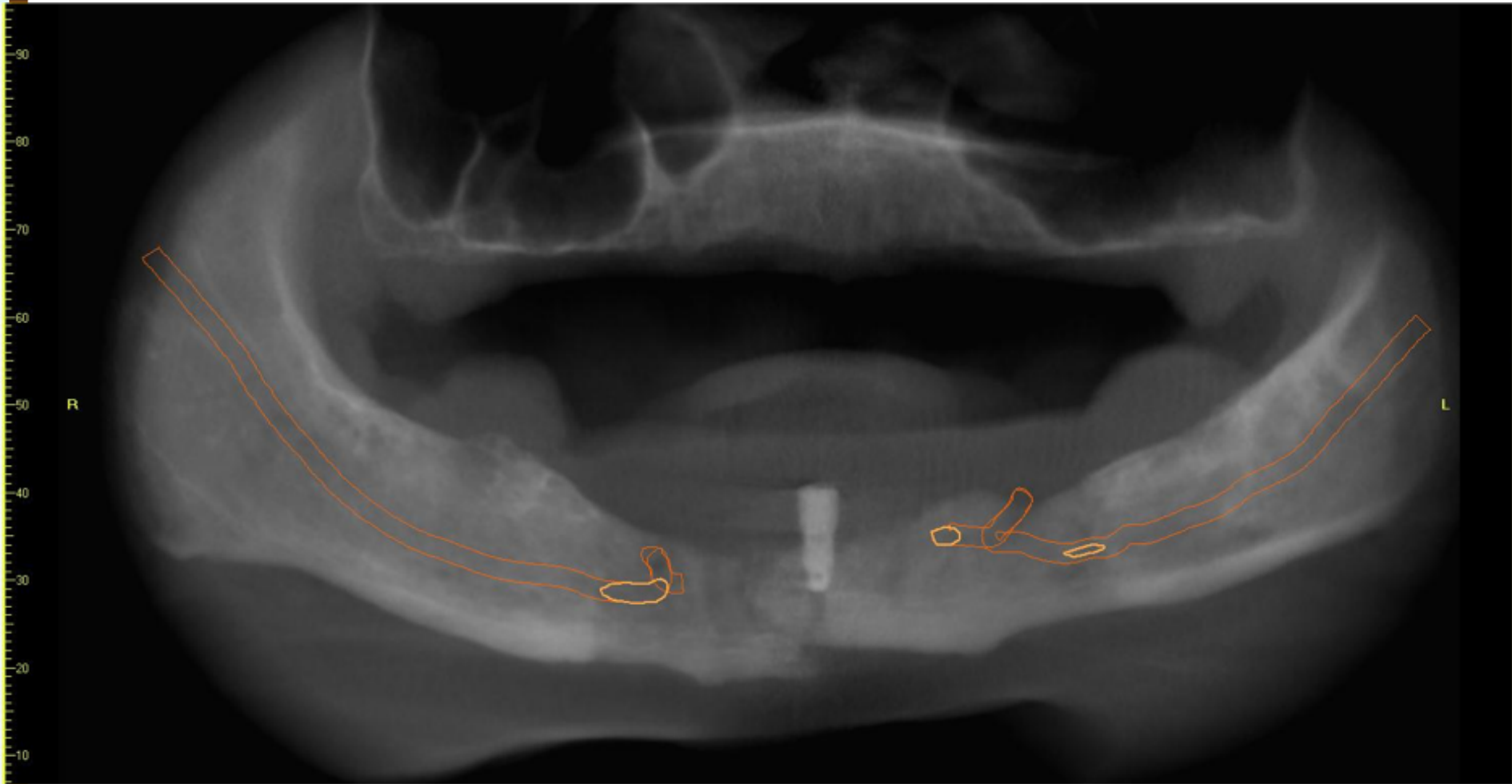
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Facial Trauma



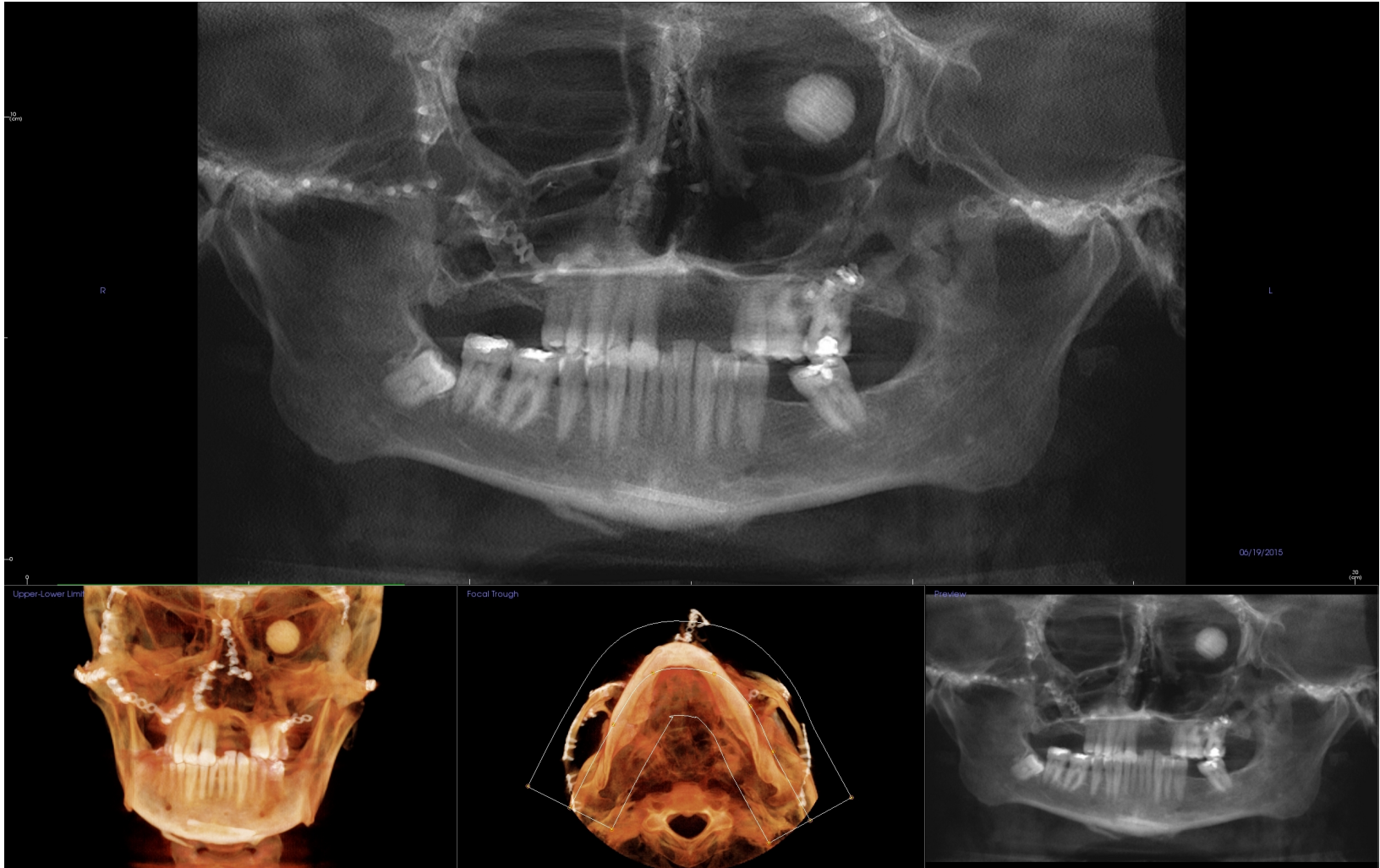
Source: Dr. M. Brownlee Patient Files



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Surgical Reconstruction

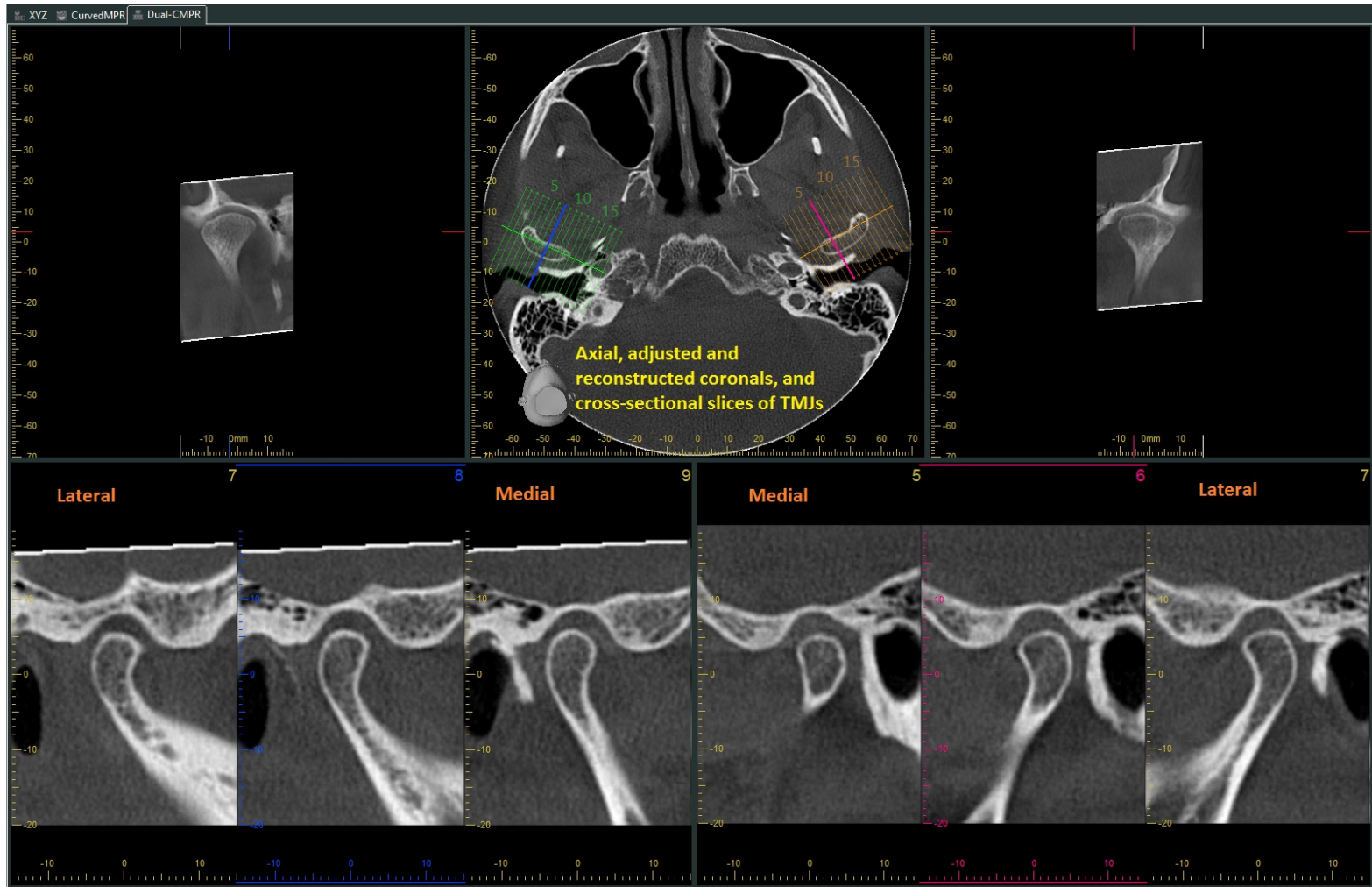


Source: Dr. M. Brownlee Patient Files



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Temporomandibular Joints



Source: Dr. M. Brownlee



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CBCT Principles:

- **Always:**
 - Select the smallest FOV possible for the region of interest and purpose of study
 - Maintain appropriate clinical records of CBCT imaging (justification for imaging requests, retake log, QA, QC test, etc.)
 - Evaluate the ENTIRE acquired volume
 - Summarize imaging findings in a radiographic report



CBCT

- When to utilizing CBCT in your practice?



CBCT and Dentistry

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CBCT and Dentistry

6. Implants: is a radiographic stent/guide required for imaging?
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CBCT FOV Selection

- Always utilize the smallest FOV to capture the region of interest (ROI) for the treatment or diagnosis:
 - Decreases radiation dose to the patient
 - Optimizes the imaging via spatial resolution
 - Decreases the size of the data set to review and report on, as the entire captured volume is the responsibility of the practitioner
- If requesting imaging from another provider, include as much clinical history, and justification of imaging for appropriate FOV selection



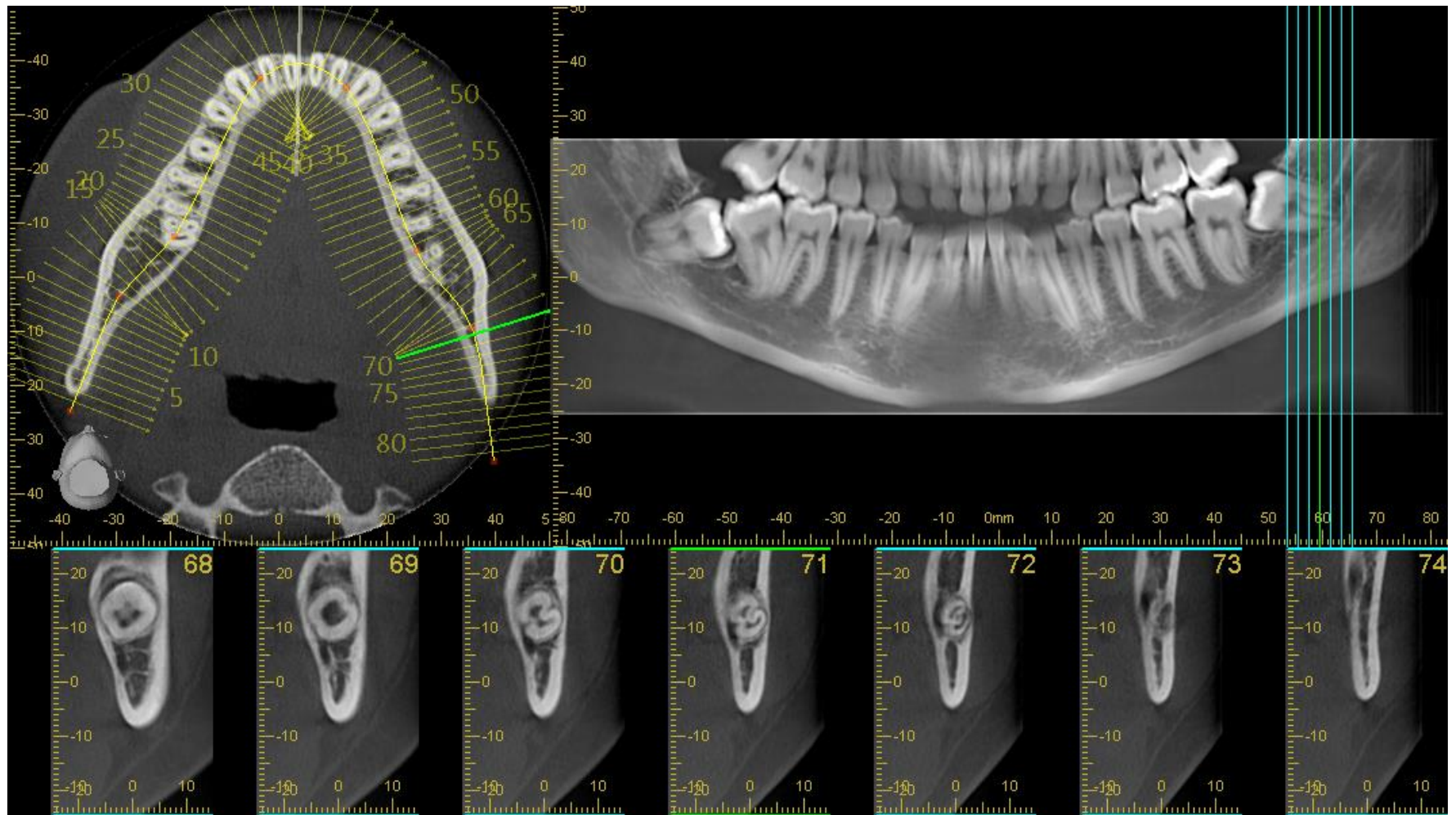
Evidenced-Based Indications:

- Developing dentition:
 - Localized
 - Generalized
- Restoring the Dentition:
 - Endodontic evaluation
 - Dental trauma

Evidenced-Based Indications:

- Surgical Applications:
 - Exodontia
 - Implants
 - Intraosseous pathology
 - Facial trauma
 - Orthognathic surgery
 - Temporomandibular joint disease

Localized Assessment of an Impacted Tooth/Teeth



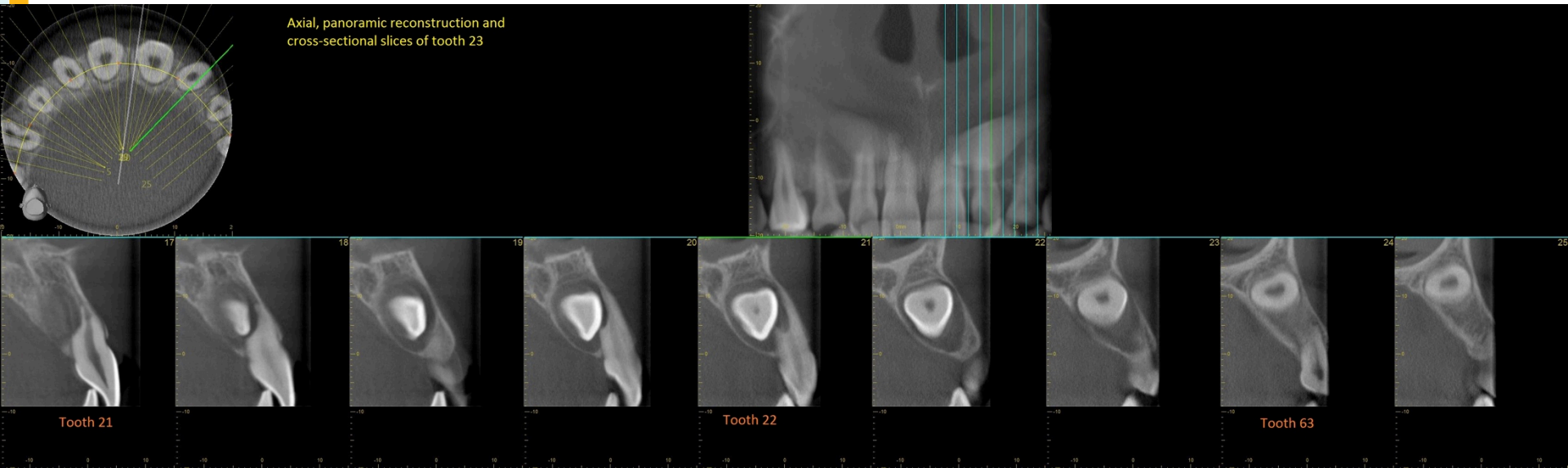
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Localized Assessment of an Impacted Tooth (Root Resorption)



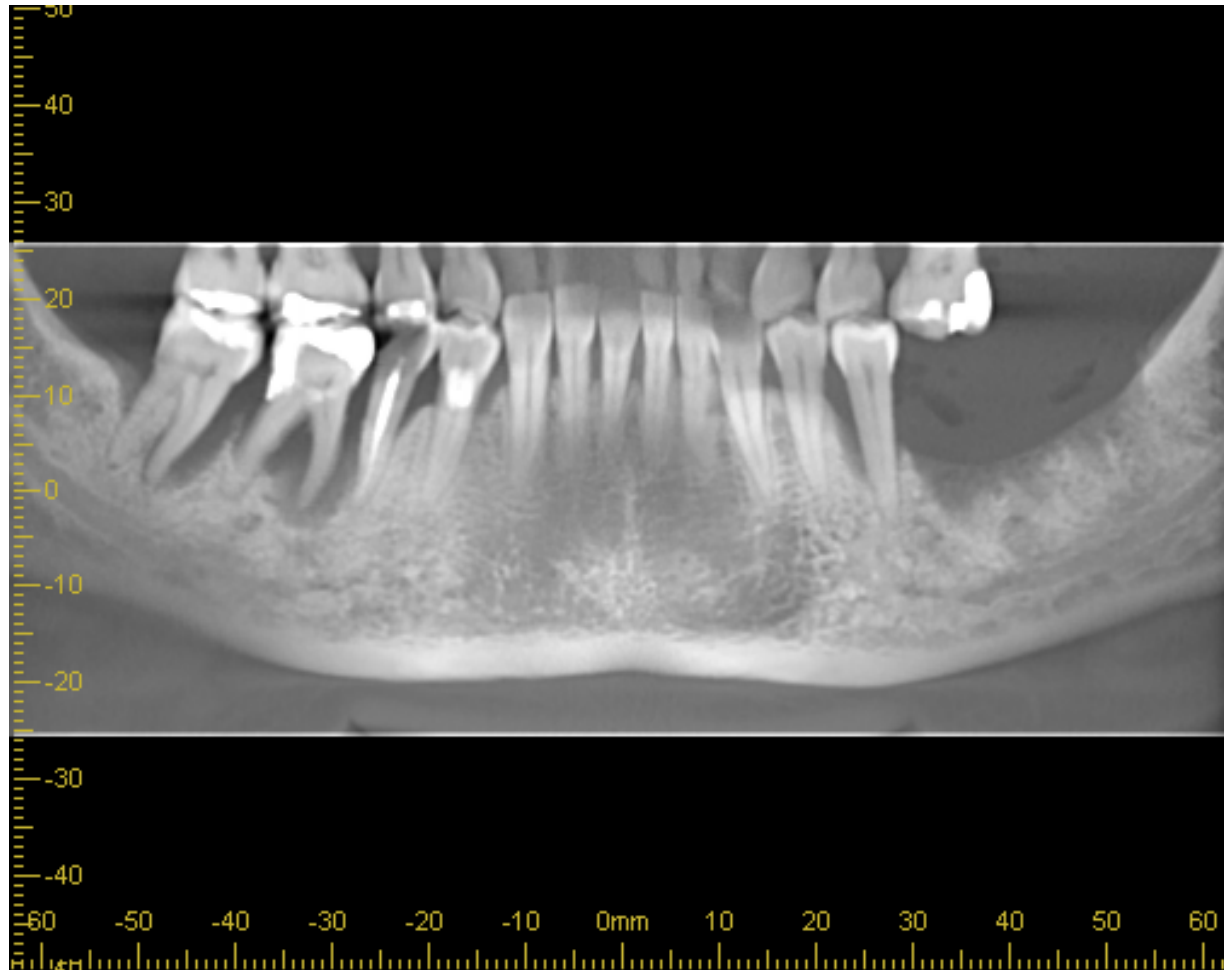
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Select Periodontal Infrabony Defects or Furcational Lesions



Source: Dr. M. Brownlee



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Periapical Inflammatory Lesions: Select Cases



Source: Dr. M. Brownlee



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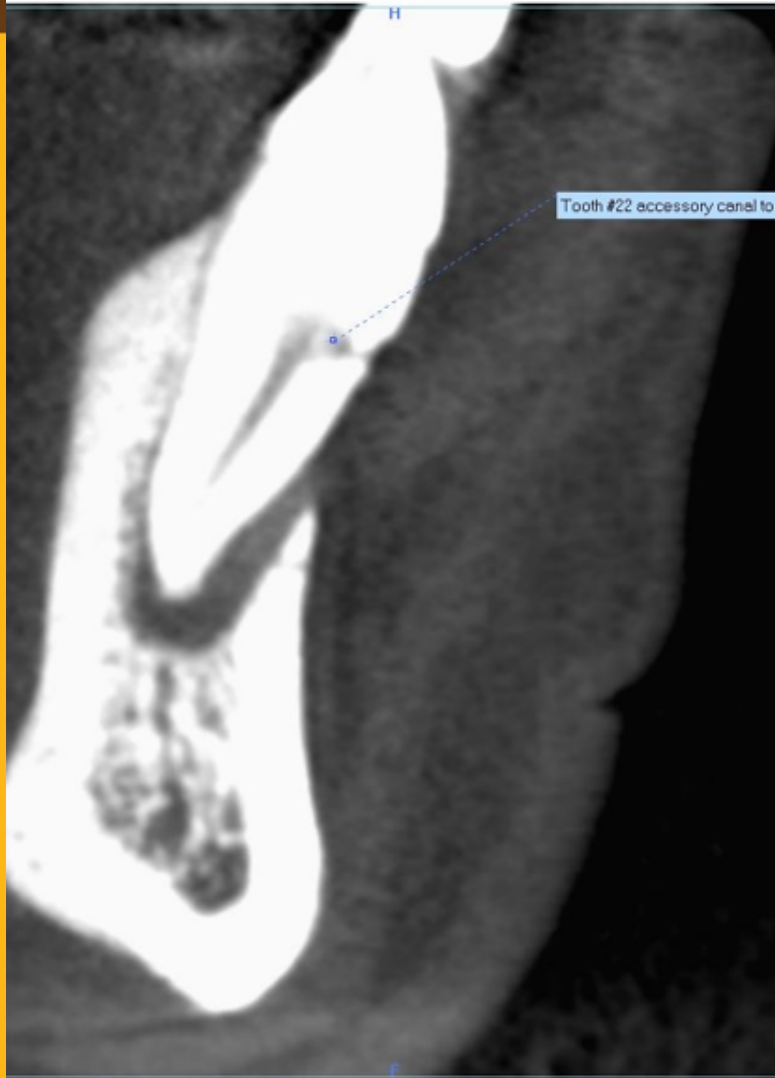
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Endodontic Evaluations:

- Complex multi-rooted teeth
- Surgical endodontic treatment – to evaluate proximity to adjacent anatomical structures
- Internal or external root resorption
- Endo-perio lesions
- Atypical pulpal anatomy



Endo-Perio Lesions



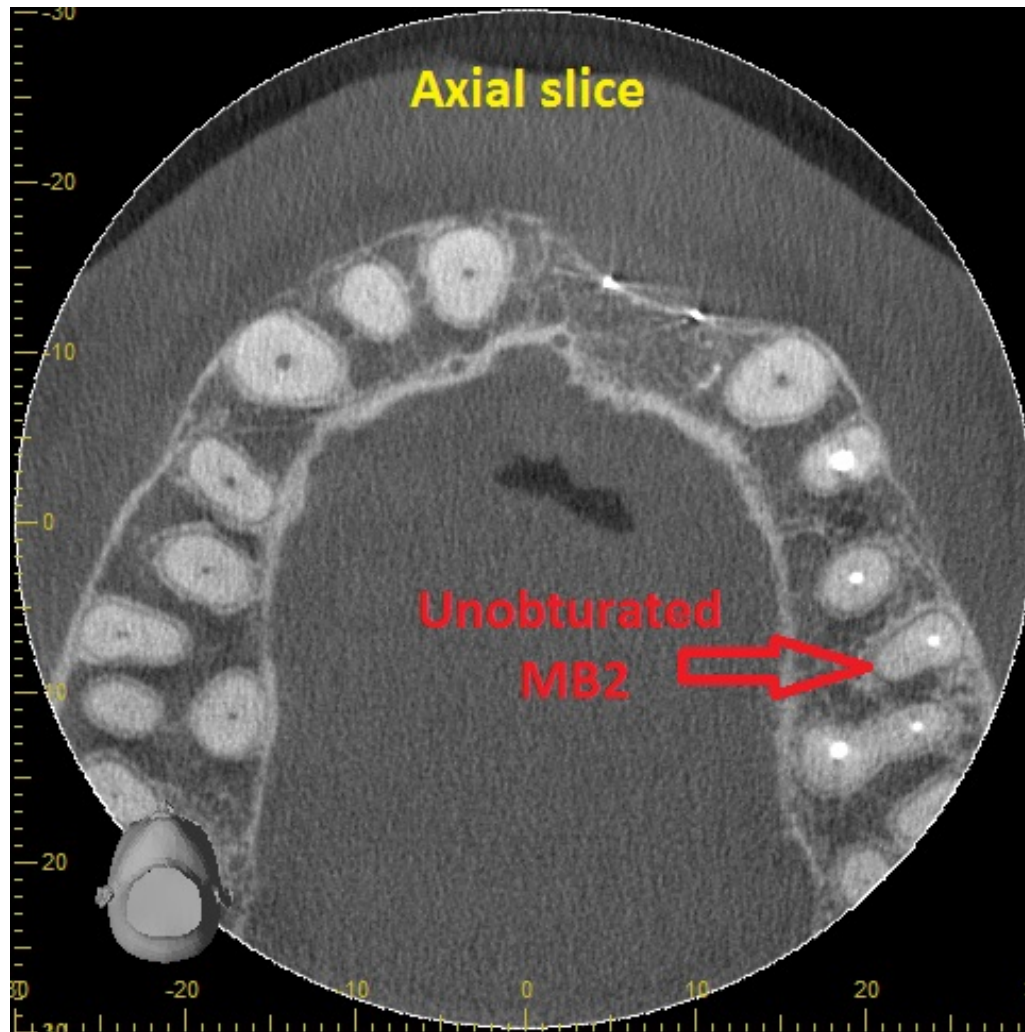
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Retreats: Missed Canals



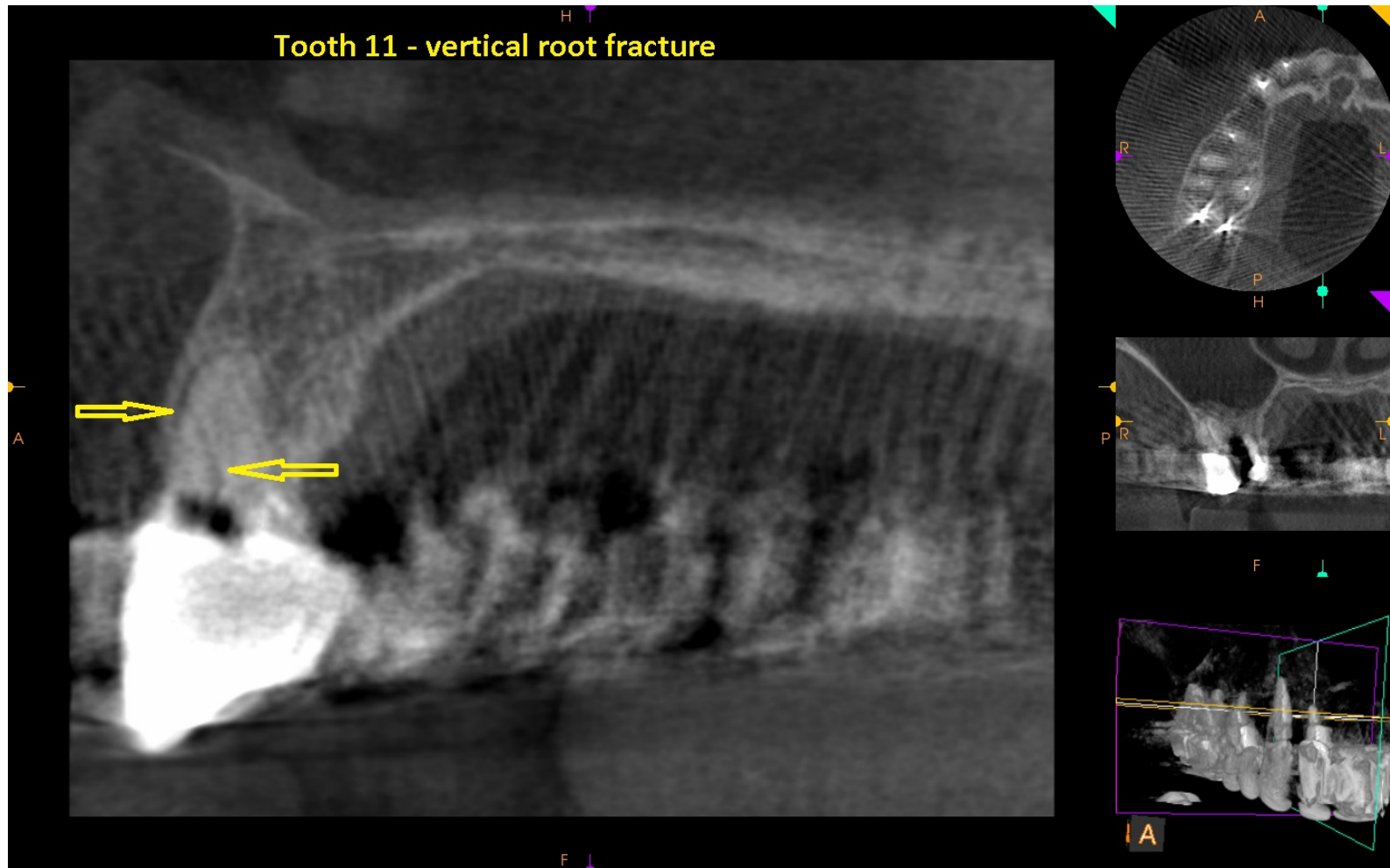
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Dental Trauma: Tooth Fractures



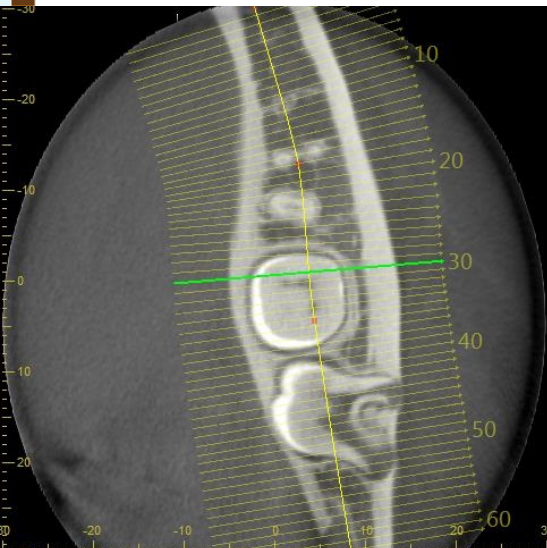
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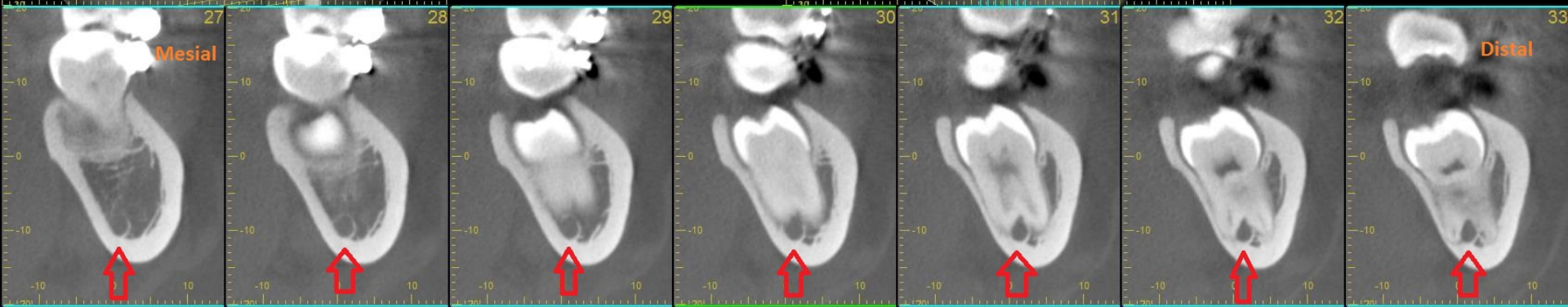
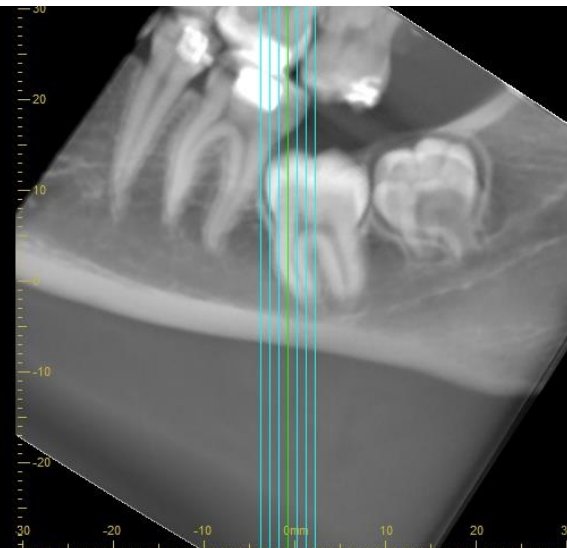
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Exodontia



Axial, panoramic reconstruction and cross-sectional slices of 37M



Source: Dr. M. Brownlee



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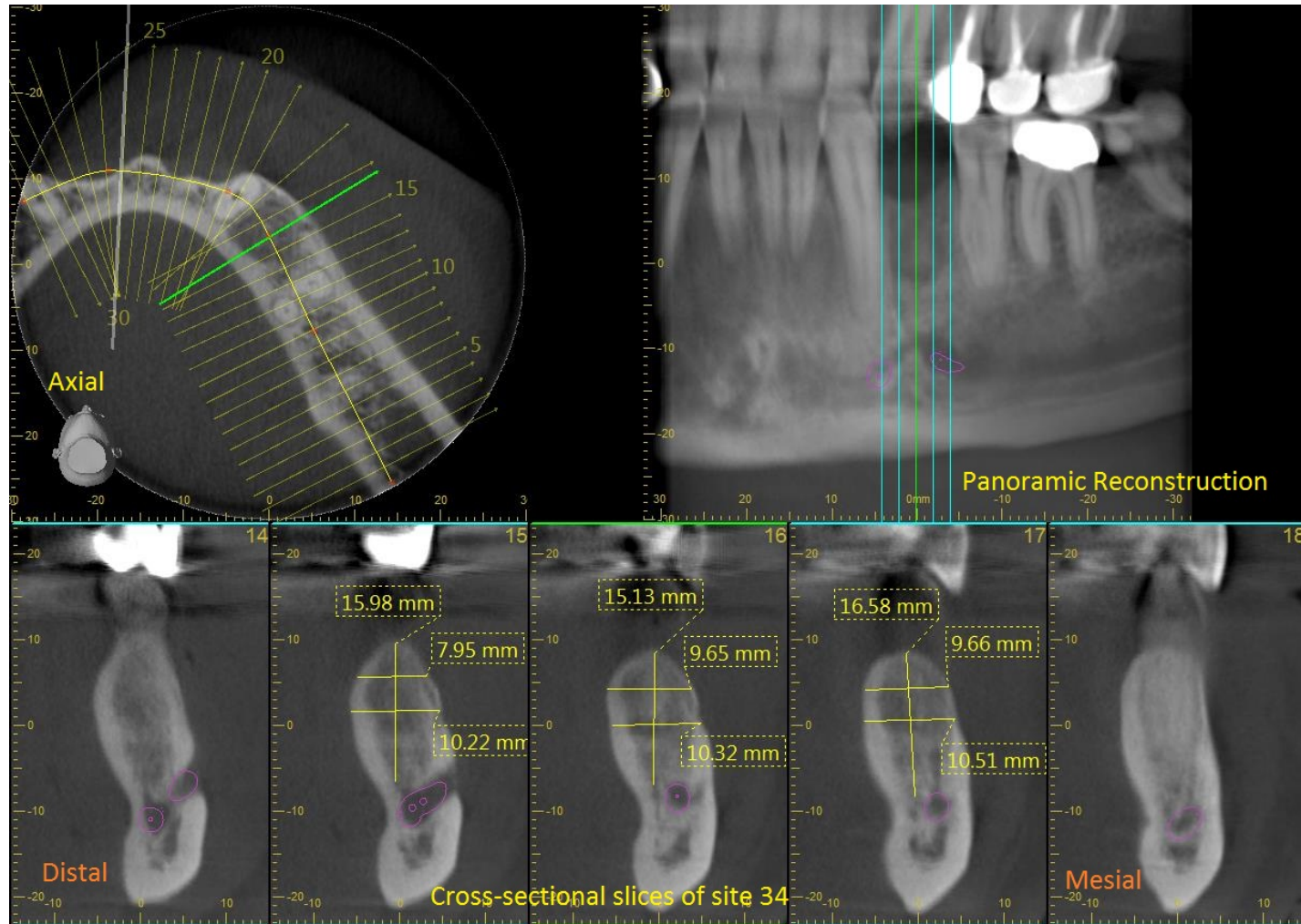
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Implant Treatment Planning

- May include various stages of treatment:
 - Pre-bone graft evaluation of ridges
 - Post-bone graft imaging for integration
 - Immediately post-surgical Implant placement (ensure not penetrating into inferior alveolar or lingual canals)
 - Re-evaluation, if symptomatic
- Utilization of Radiographic Stent/Guide
 - Has it been tried in clinically?



Implant Treatment Planning



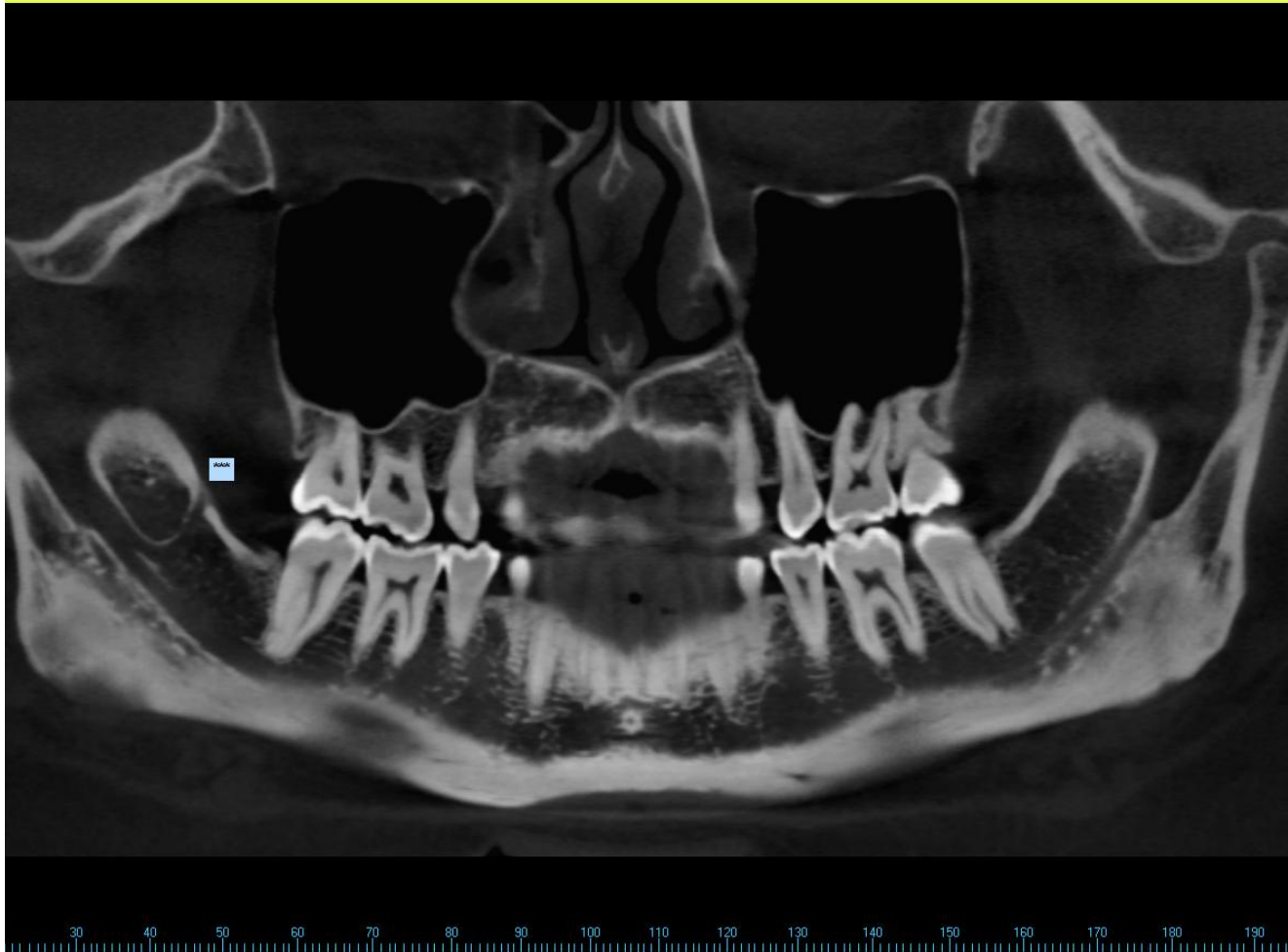
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Implant Treatment Planning: Bone Harvesting for Graft



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Intraosseous Pathology



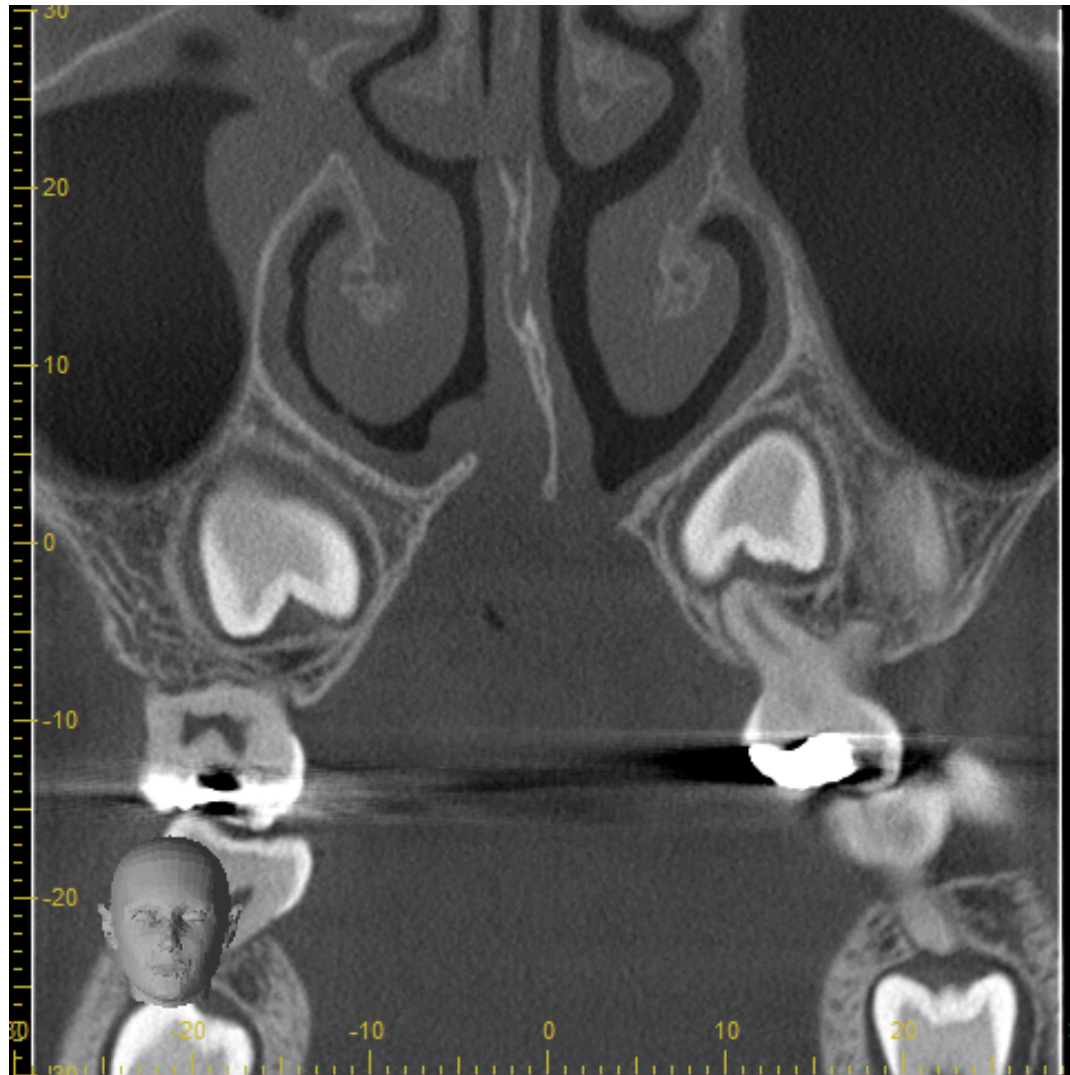
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Cleft Palate



Source: Dr. M. Brownlee Patient Files



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CBCT Imaging & Governing Bodies

- <http://oasisdiscussions.ca/2014/05/19/cbct-3/>
- Most provincial regulatory bodies are developing a CBCT protocols for their practitioners:
 - RCDSO: regulations as to who may own and operate a CBCT machine, who may interpret volumes, and CBCT certification is required prior to purchasing a CBCT unit
 - ADAC: regulations as to who may operate a CBCT machine
 - CDSBC: regulations, as per SEDENTEXTCT report
 - MDA: virtually none

Other Imaging Modalities

- Depending on what information is necessary, a dentist or dental specialist may need to order a different imaging modality or refer to a specialist or physician to obtain one, such as:
 - Multislice Computed Tomography (MSCT)
 - Magnetic Resonance Imaging (MRI)
 - Ultrasound (US)
 - Nuclear Medicine



MSCT

- Provides a variety of windowing to visualize soft tissue details (improved contrast resolution)
- Can provide tissue specific identification, or abnormal versus normal
 - This does not mean biopsy is no longer required!
- Very important for evaluating fascial spatial infections
- Contrast enhancement possible



Fig. 20-30 White
and Pharoah



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MRI

- Radio frequency emitted into the patient while in a magnetic field, and radio signal back to the receiver is computed into an image
- Only imaging modality to evaluate the TMJ discs
- Useful in evaluating salivary gland pathology
- T1 sequence primarily utilized for anatomy
- T2 sequence primarily utilized for pathology
- Multitudes of additional sequences, but well-beyond the scope of dentistry
- Contrast enhancement with Gadolinium
- Hotbed of research in dental field, as utilizes non-ionizing radiation



TMJ MRI

Fig. 27-19 White and Pharoah



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Ultrasound

- Limited usefulness in the dental field
- Study salivary gland pathology
- Very technique sensitive
- 3D modality only in obstetrics
- Utilizes non-ionizing radiation
- Can use Doppler to visualize blood flow through a vessel and calculate stenosis of the vessel



Ultrasound Doppler Image

Fig. 14-29 White and Pharoah



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Nuclear Medicine

- Injectable radiopharmaceuticals are administered to the patient intravenously or orally and emit γ (gamma) rays
- Gamma receptors capture the images showing the metabolic activity of the body
- Metabolic function captured is dependent on radionuclide utilized
- SPECT and PET scans are tomographic advanced nuclear medicine studies
- e.g. Technetium 99 bone scans show metabolic bone activity
- e.g. Gallium citrate scans show inflammatory cell infiltrate



^{99}Tc -MDP study

Fig. 14-22 White and Pharoah



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Questions?

All images in this lecture are
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References:

- Special Committee to Revise the Joint AAE/AAOMR Position Statement on use of CBCT in Endodontics. AAE and AAOMR Joint Position Statement: Use of Cone Beam Computed Tomography in Endodontics 2015 Update. Oral Surg Oral Med Oral Pathol Oral Radiol. 2015;120:508–512.
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- Clinical recommendations regarding use of cone beam computed tomography in orthodontics. Position statement by the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Path Oral Radiol. 2013;116(2): 238-257.

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- White SC, Pharoah MJ. (2014) Oral Radiology: Principles and Interpretation, 7th Ed. Mosby, St. Louis.

