AAOMR

AMERICAN ACADEMY OF
ORAL AND MAXILLOFACIAL RADIOLOGY

Box 15.1

American Academy of Oral and Maxillofacial Radiology Recommendations for Imaging the Dental Implant Patient

Recommendation 1. Panoramic radiography should be used as the imaging modality of choice in the initial evaluation of the dental implant patient.

Recommendation 2. Use intraoral periapical radiography to supplement the preliminary information from panoramic radiography.

Recommendation 3. Do not use cross-sectional imaging, including cone beam computed tomography (CBCT), as an initial diagnostic imaging examination.

Recommendation 4. The radiographic examination of any potential implant site should include cross-sectional imaging orthogonal to the site of interest.

Recommendation 5. CBCT should be considered as the imaging modality of choice for preoperative cross-sectional imaging of potential implant sites.

Recommendation 6. CBCT should be considered when clinical conditions indicate a need for augmentation procedures or site development before placement of dental implants: (1) sinus augmentation, (2) block or particulate bone grafting, (3) ramus or symphysis grafting, (4) assessment of impacted teeth in the field of interest, and (5) evaluation of prior traumatic injury.

Recommendation 7. CBCT imaging should be considered if bone reconstruction and augmentation procedures (e.g., ridge preservation or bone grafting) have been performed to treat bone volume deficiencies before implant placement.

Recommendation 8. In the absence of clinical signs or symptoms, use intraoral periapical radiography for the postoperative assessment of implants. Panoramic radiographs may be indicated for cases requiring more extensive implant therapy.

Recommendation 9. Use cross-sectional imaging (particularly CBCT) immediately postoperatively only if the patient presents with implant mobility or altered sensation, especially if the fixture is in the posterior mandible.

Recommendation 10. Do not use CBCT imaging for periodic review of clinically asymptomatic implants.

Recommendation 11. Cross-sectional imaging, optimally CBCT, should be considered if implant retrieval is anticipated.

FIG. 15.1 Periapical image of a potential implant site in the posterior left maxilla. An imaging guide containing a cylindrical radiopaque marker has been inserted intraorally to depict the desired angle of implant placement.

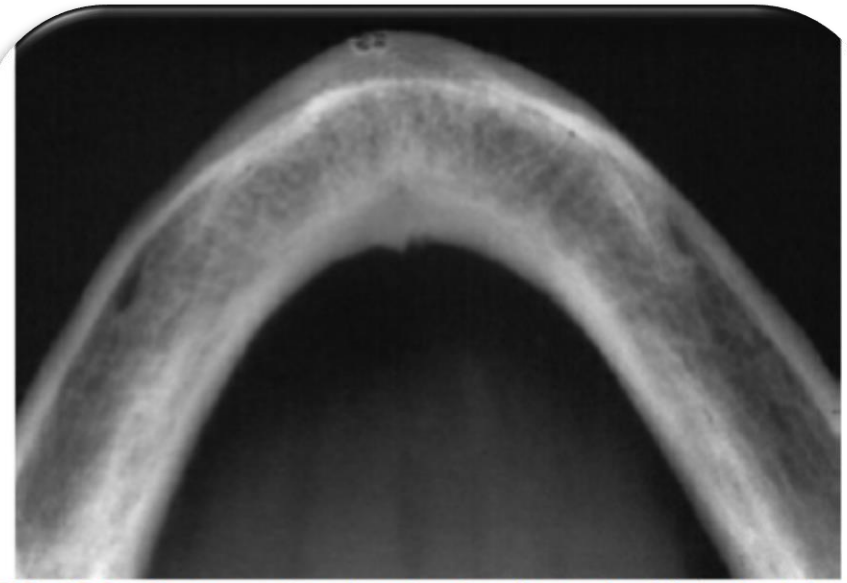
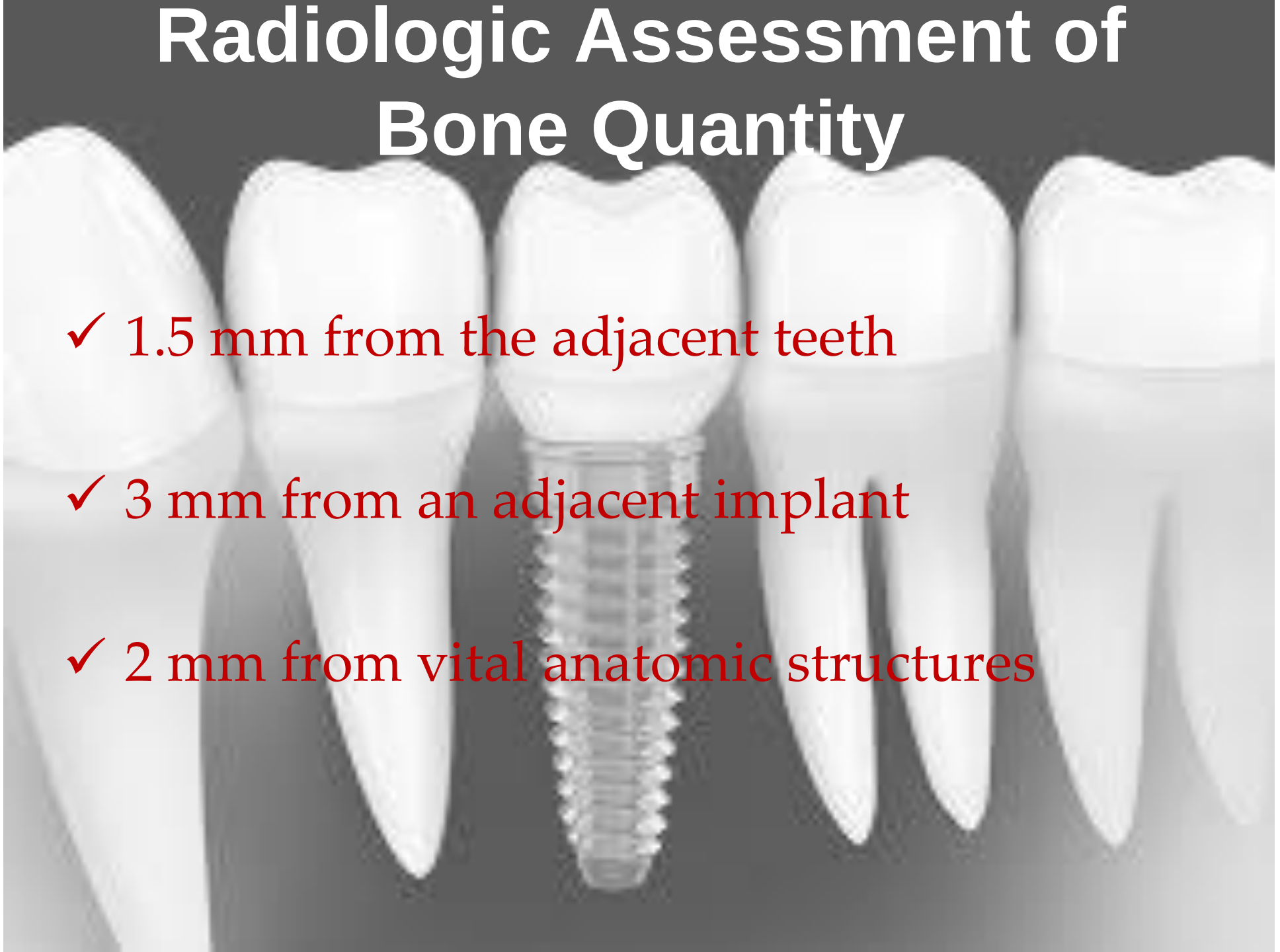


FIG. 15.2 Cross-sectional occlusal radiograph of the edentulous mandible. Note that only the widest buccolingual contours of the mandible are visualized; these are usually located inferior to the desired implant site. This could result in an overestimation of the amount of buccolingual bone available.

CBCT

- ✓ three-dimensional analyses
- ✓ thickness of cortical plates
- ✓ proximity to adjacent anatomic
- ✓ sinus floor elevation
- ✓ grafting procedures
- ✓ surgical guides
- ✓ computer-aided manufacturing (CADCAM) technology

Radiologic Assessment of Bone Quantity



- ✓ 1.5 mm from the adjacent teeth
- ✓ 3 mm from an adjacent implant
- ✓ 2 mm from vital anatomic structures

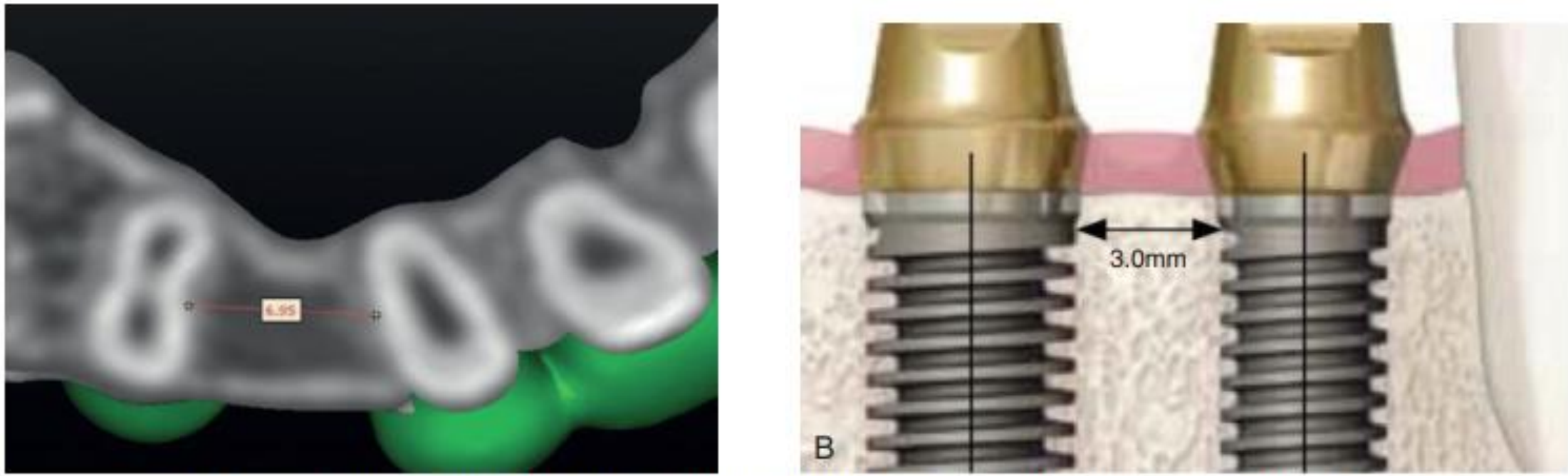
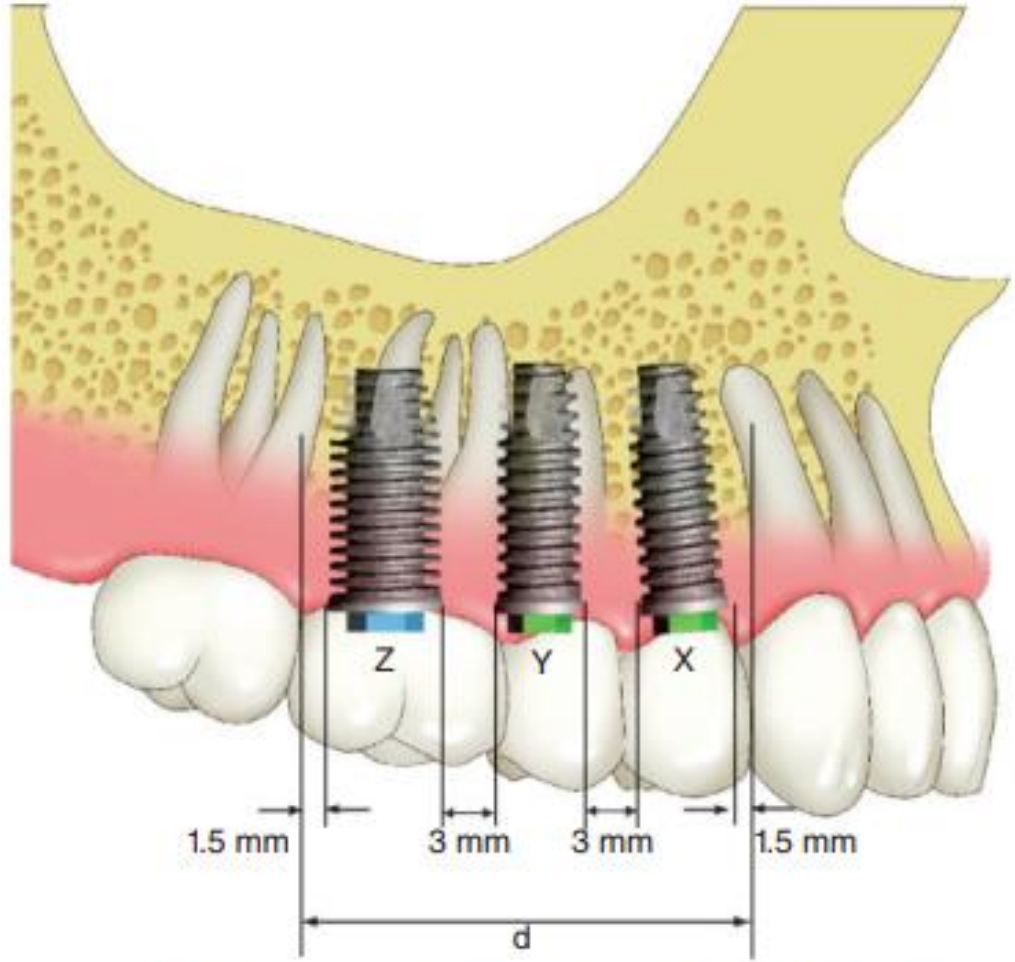


FIG 3.21 Available bone length. (A) Evaluation of available bone length between two teeth is most accurately determined with axial views. (B) In determining available bone length, a minimum of 3 mm is required for hard and soft tissue health.



d = 1.5 mm + ØZ + 3 mm + ØY + 3 mm + ØX + 1.5 mm

FIG 3.39 The maximum number of implants in an edentulous span may be determined by allowing 1.5 mm or more from an adjacent tooth and 3 mm between each implant and adding the diameter of the implants. (From Misch CE: *Dental implant prosthetics,* ed 2, St Louis, 2015, Mosby.)

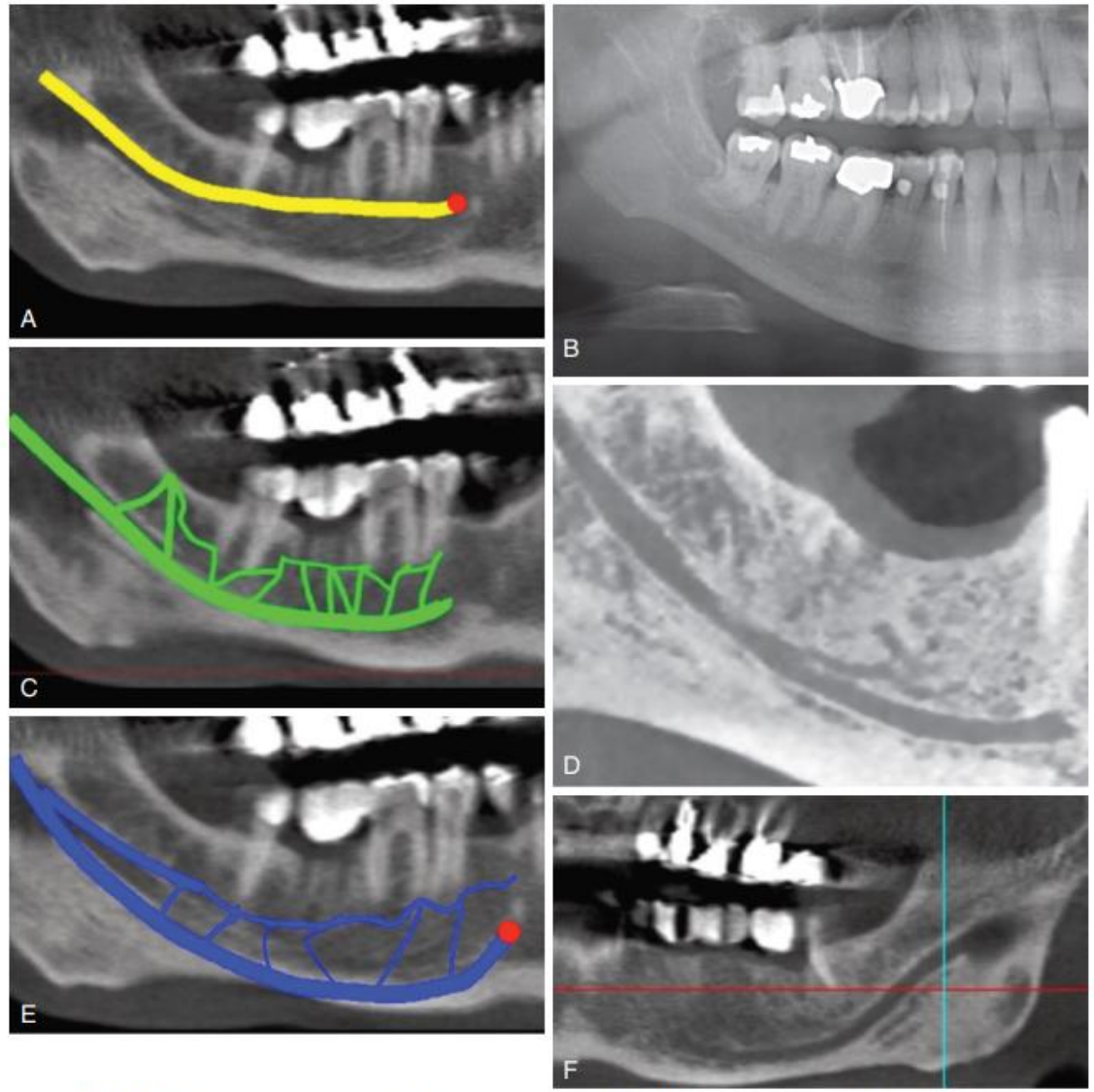


FIG 4.13 Superior-inferior mandibular nerve tracts. (A–B) Type 1: mandibular canal in close proximity to tooth roots. (C–D) Type 2: mandibular canal in center of mandible (most common). (E–F) Type 3: mandibular nerve close to inferior border of mandible.

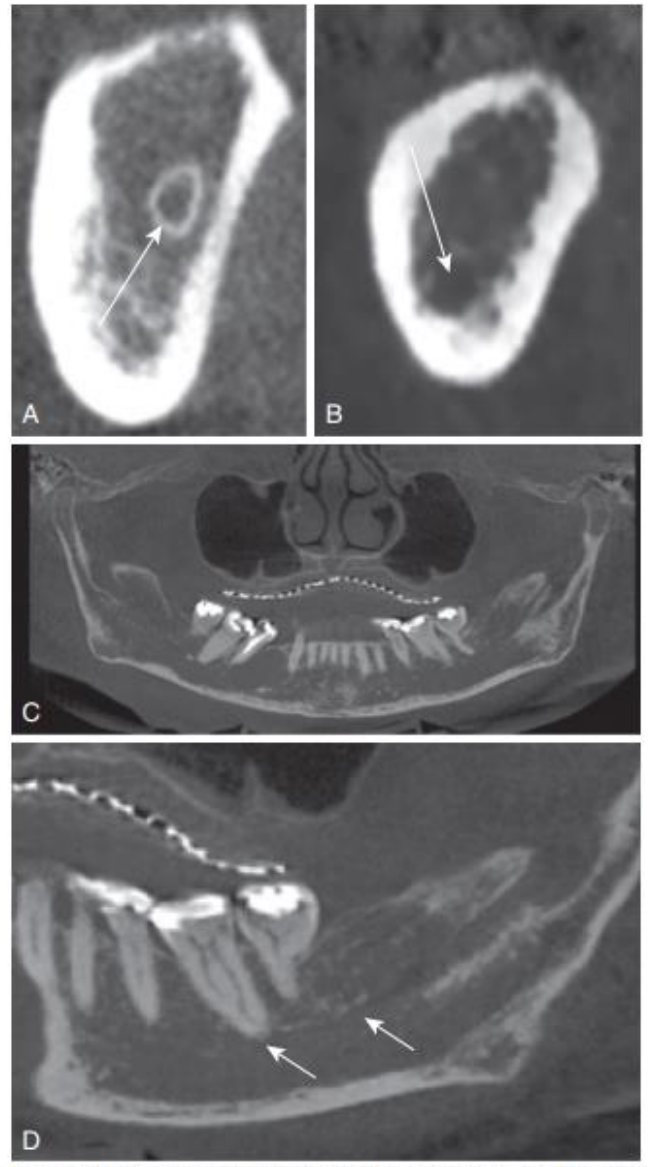


FIG 4.14 (A) The mandibular canal *(arrow)* is easily seen when a thick cortical component is present. (B) However, in 30% of patients, the mandibular canal will not have a cortical component *(arrow)*. (C) CBCT panoramic view depicting thin cortical outline with poorly defined internal bony trabecular pattern indicative of osteoporosis/osteopenia. (D) Poorly defined mandibular canal *(arrows)*.

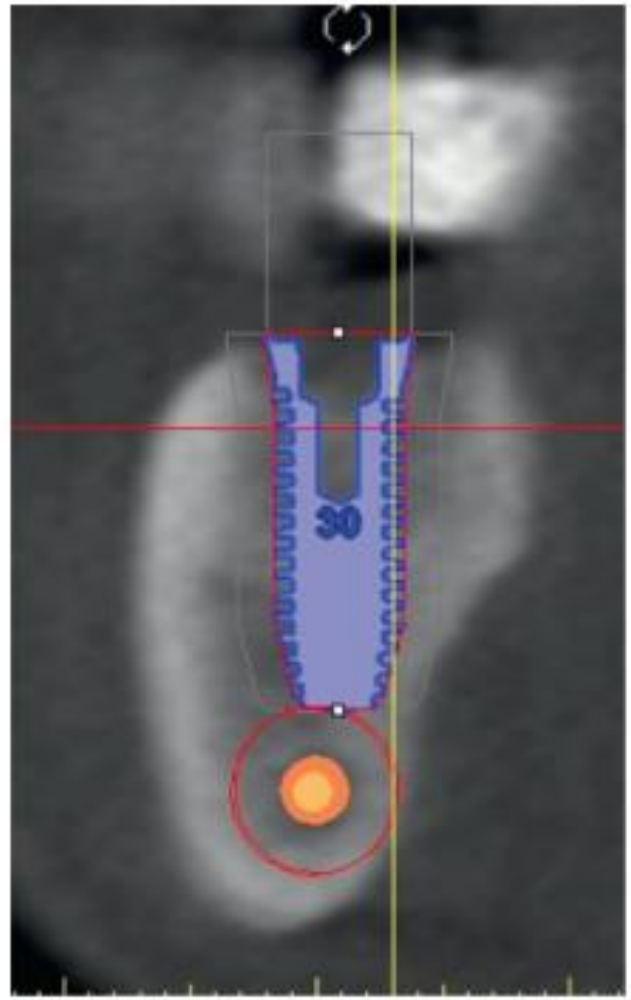


FIG 3.18 The posterior mandible has less bone height because the variable position of the inferior alveolar canal which dictates the size and positioning of the implant.

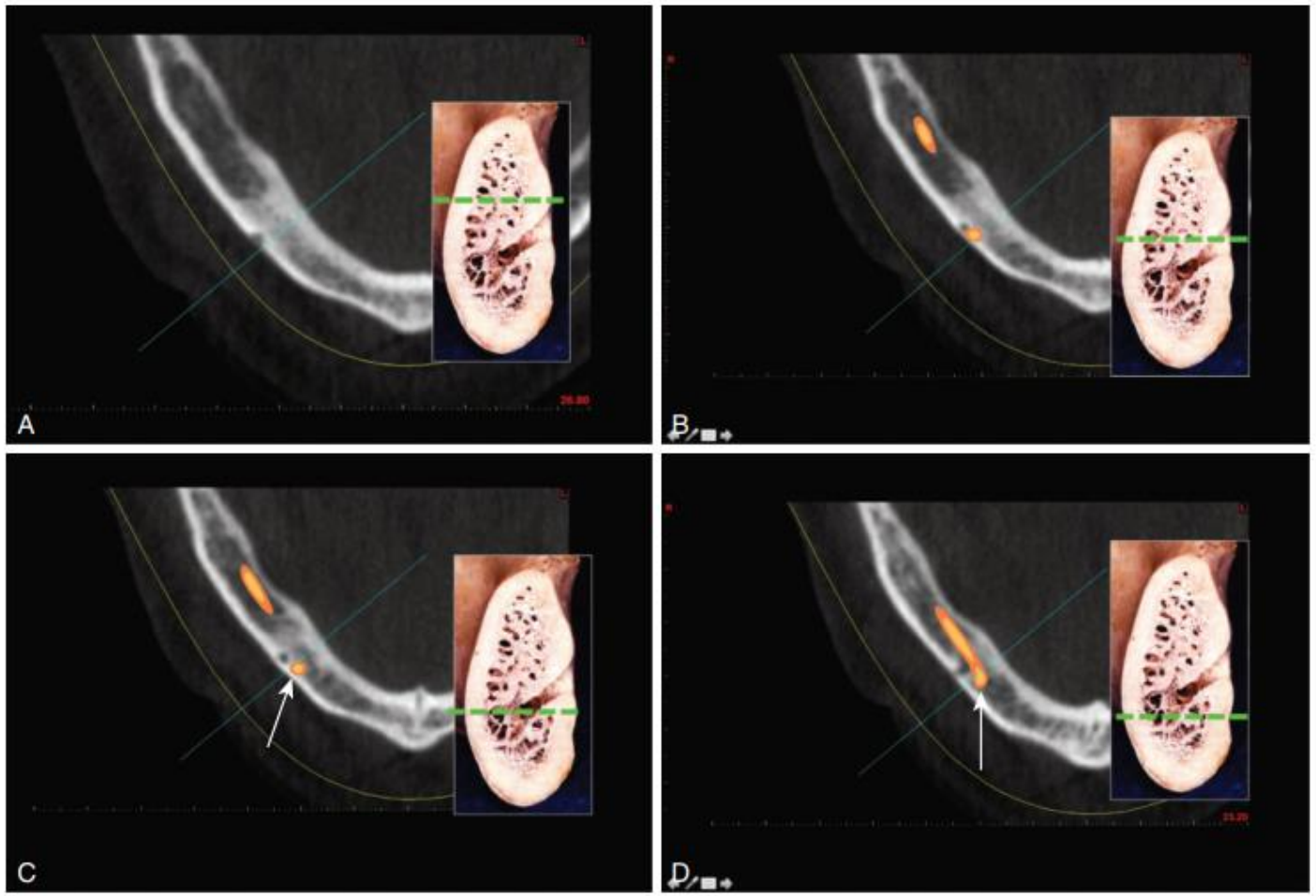


FIG 4.17 An anterior loop is determined by evaluating axial images in a superior to inferior direction. (A) The anterior aspect of the foramen should be marked (line that remains constant in the vertical plane). (B) As the axial images are sequentially evaluated from superior to inferior, if any part of the marked canal extends anterior to the line (C–D, *arrows*), a anterior loop exists.

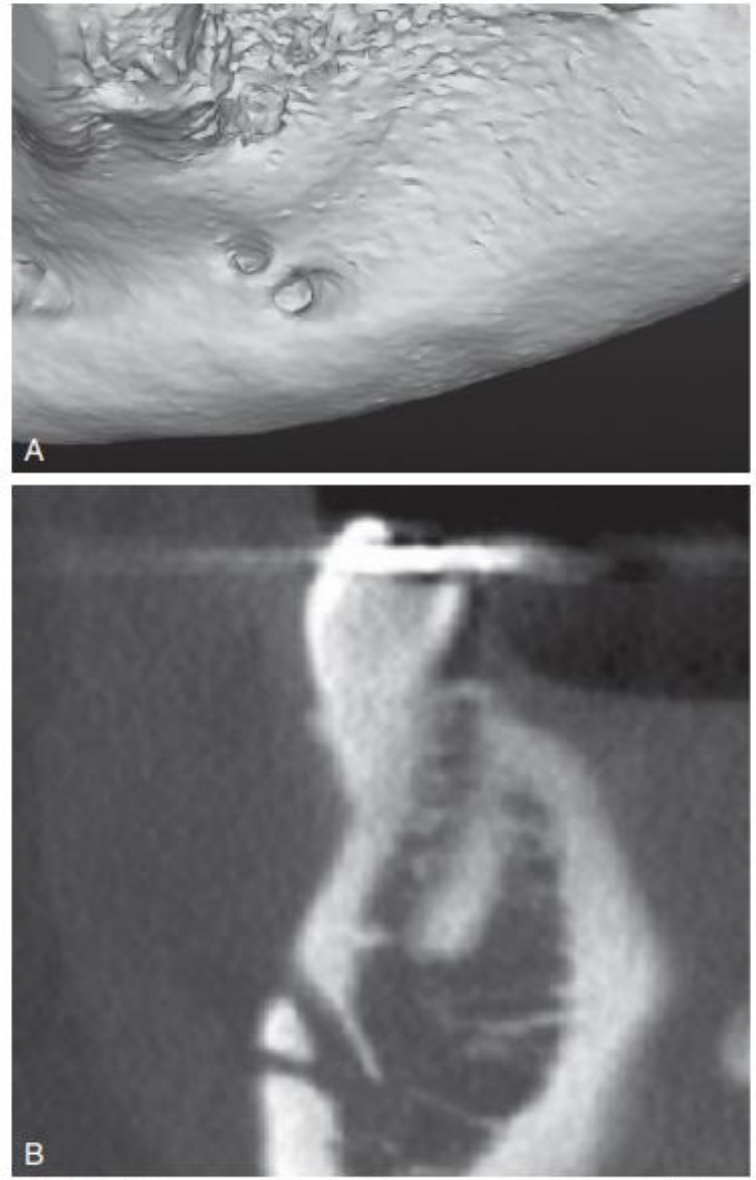


FIG 4.18 Accessory (double) foramina can be evaluated on (A) 3-D images or (B) coronal images.

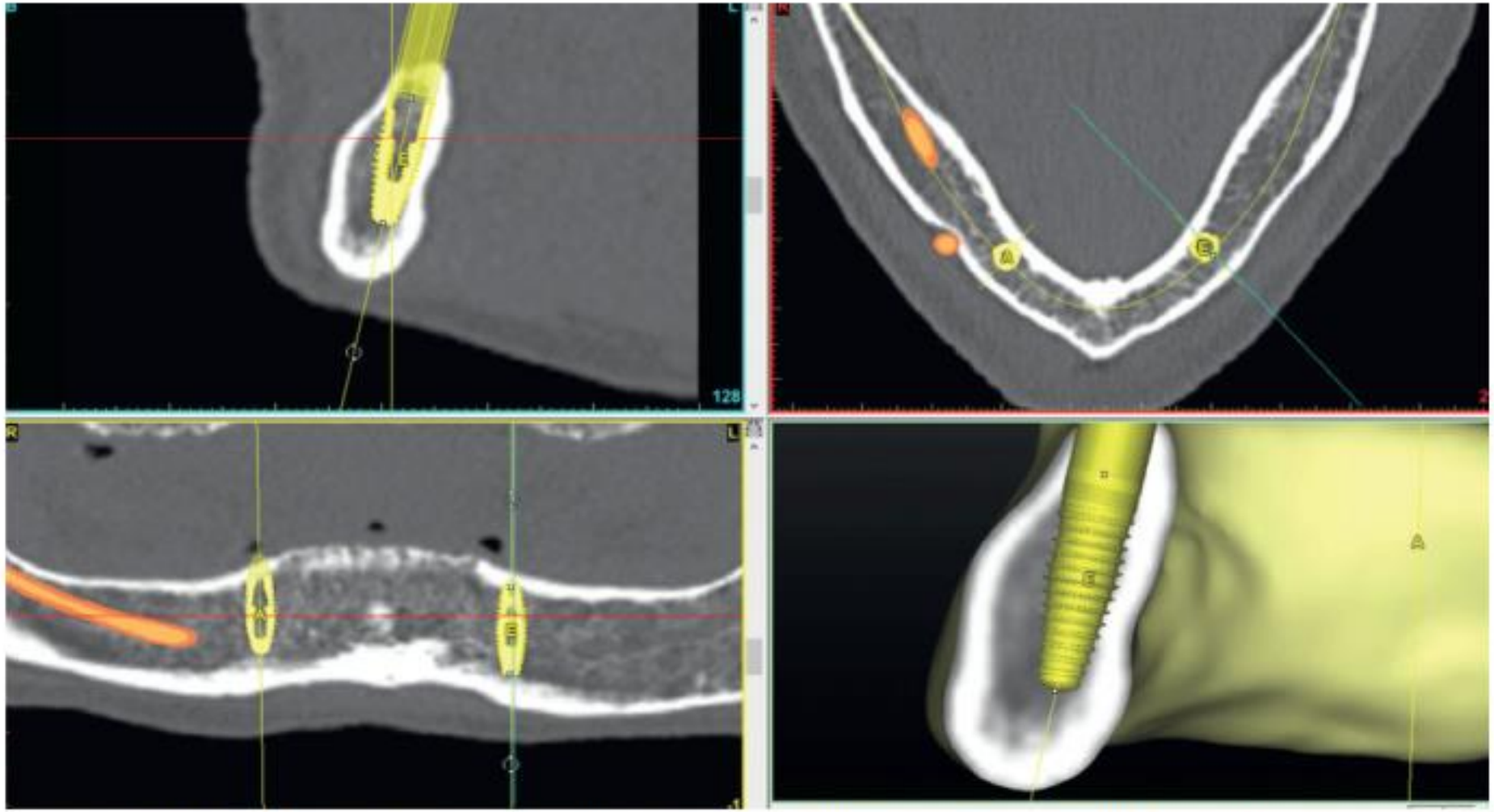


FIG 3.17 The anterior mandible has the greatest bone height of any region of the jaws. However, because of the variable osseous angulation in the anterior mandible, the implant often engages the lingual plate of bone.

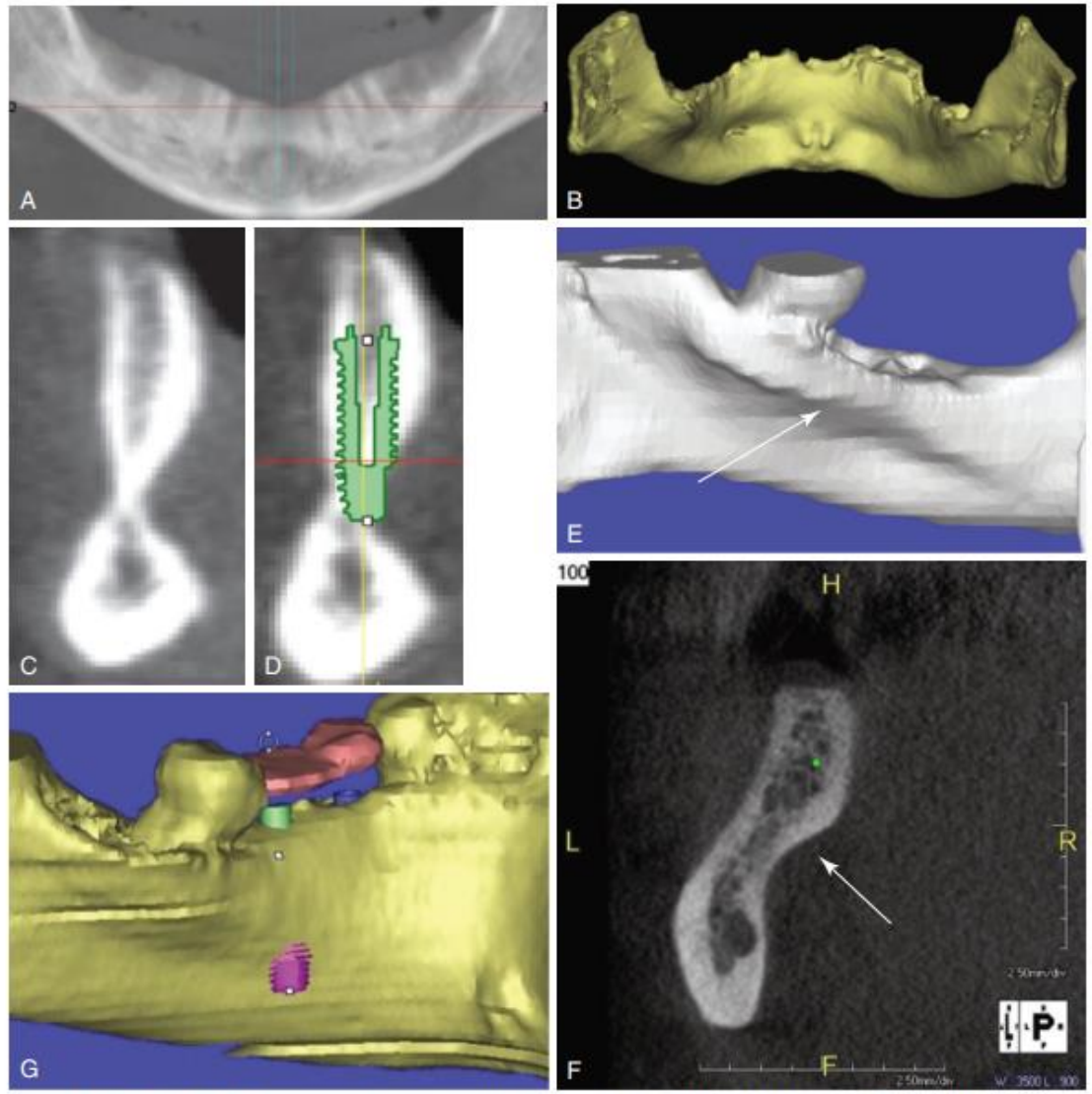
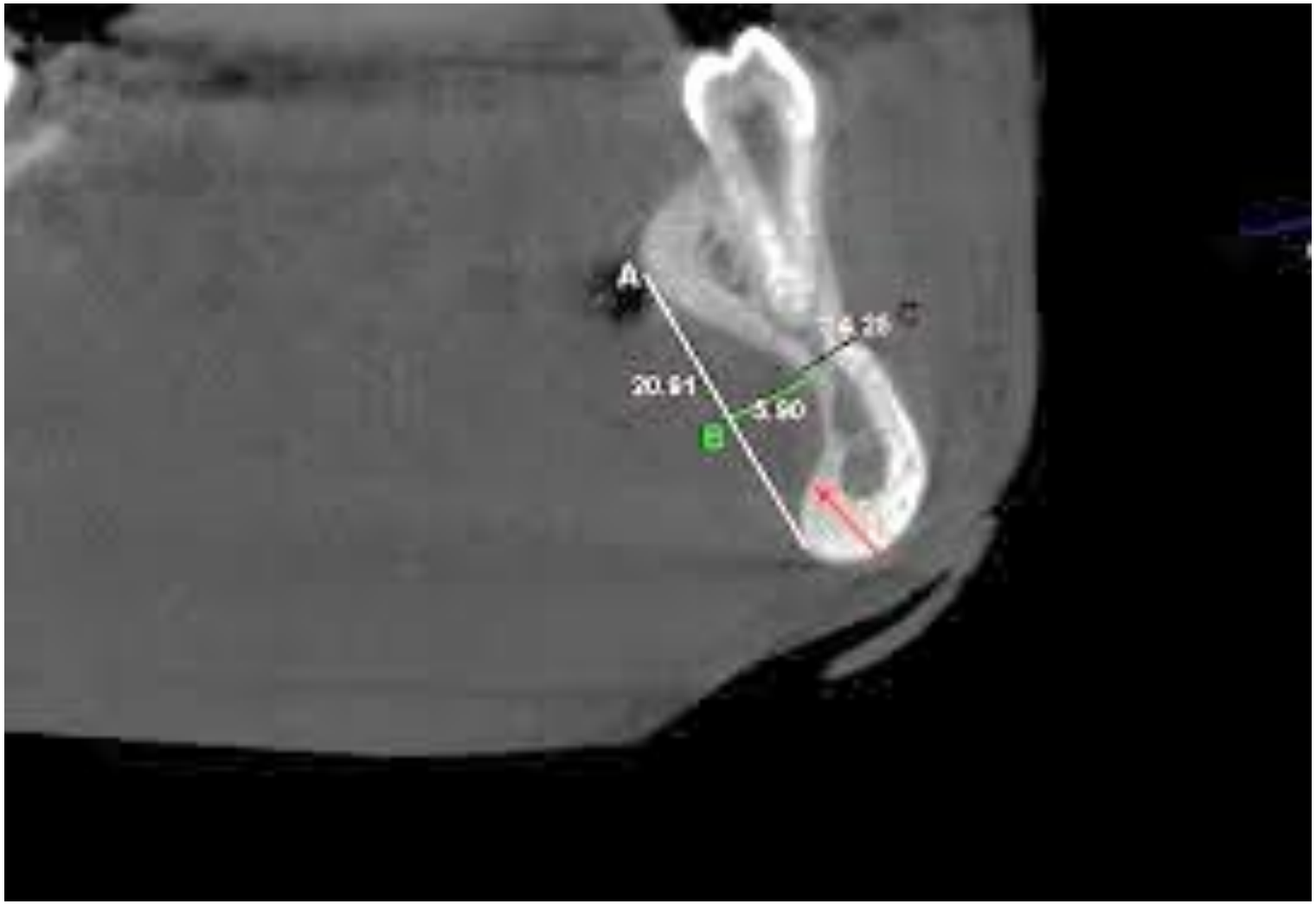


FIG 4.19 (A) CBCT panoramic view of anterior mandible depicting significant quantity of bone; (B–C) however, when viewed three-dimensionally, resultant hourglass concavities present in the anterior mandible; (D) complication of sublingual perforation which may lead to bleeding complications. (E) 3-D images depicting sublingual undercut; (F) cross section depicting significant undercut; and (G) complication of sublingual perforation.


A
20.61
B
5.90

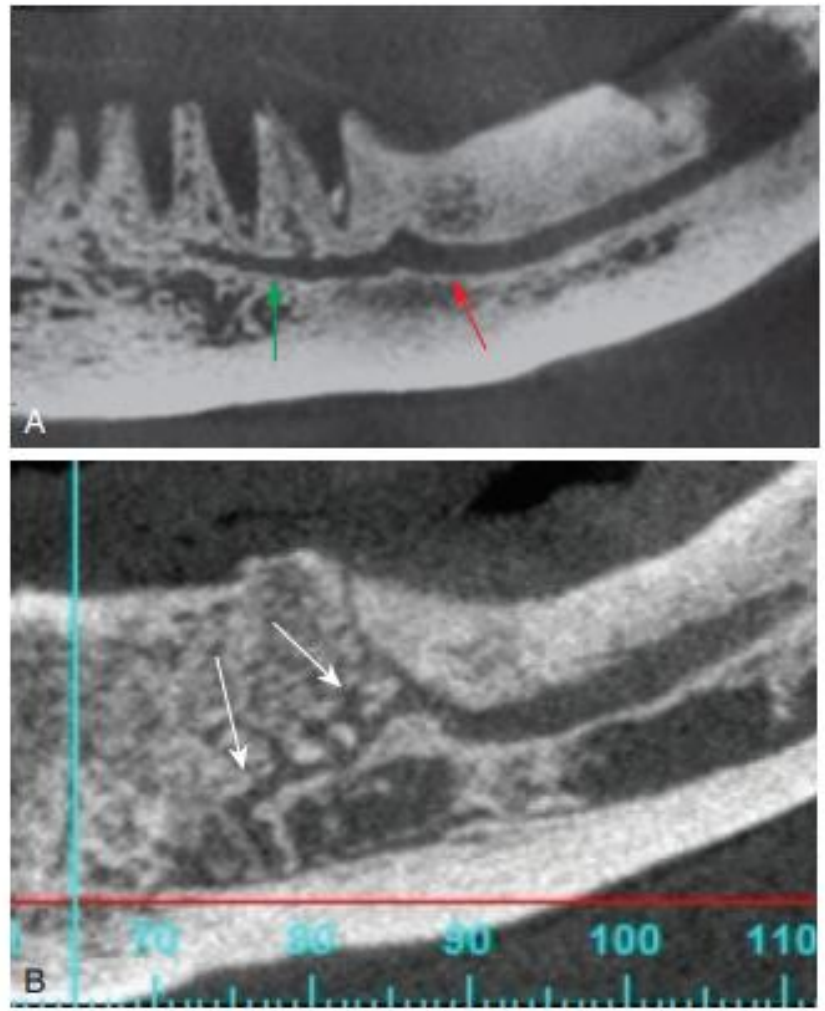


FIG 4.20 The incisive canal is a continuation of the inferior alveolar canal, which contains the incisive nerve, which innervates the mandibular anterior teeth (red shows the inferior alveolar canal; green shows the incisive canal). (A) CBCT image showing incisal canal extension from mandibular canal, and (B) CBCT panoramic image showing branching of incisive canal *(arrows)*.

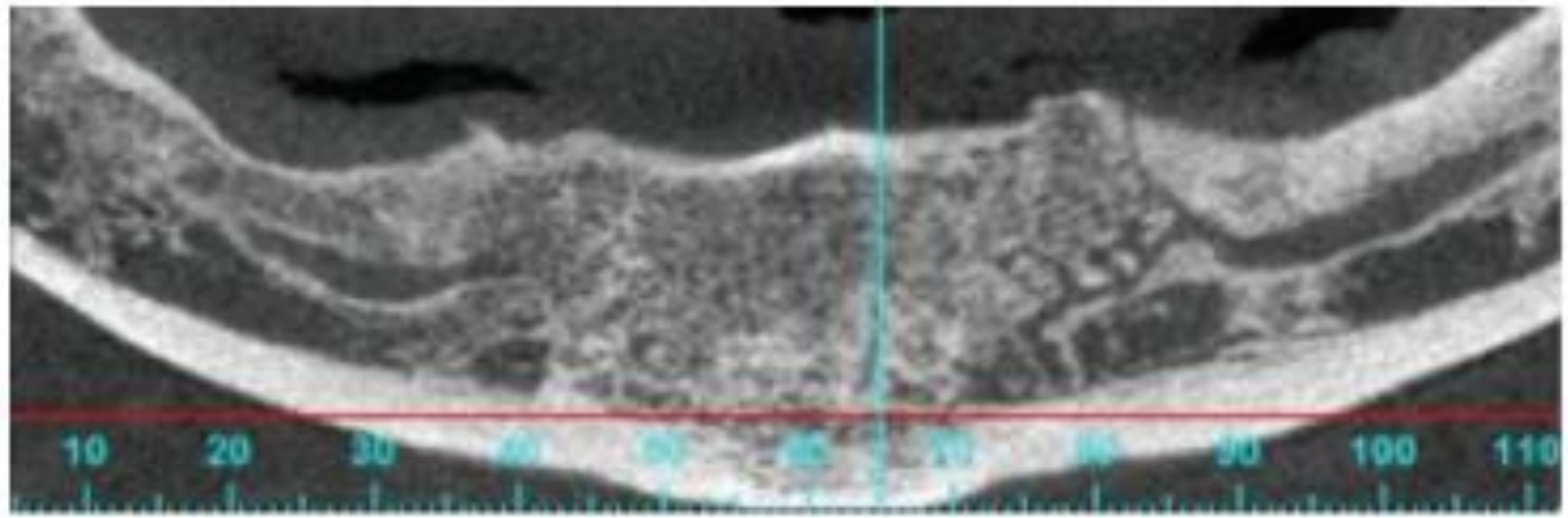


FIG 7.22 Incisive canal. Placement of implants in the interforaminal area may lead to increased bleeding; it is usually self-limited.

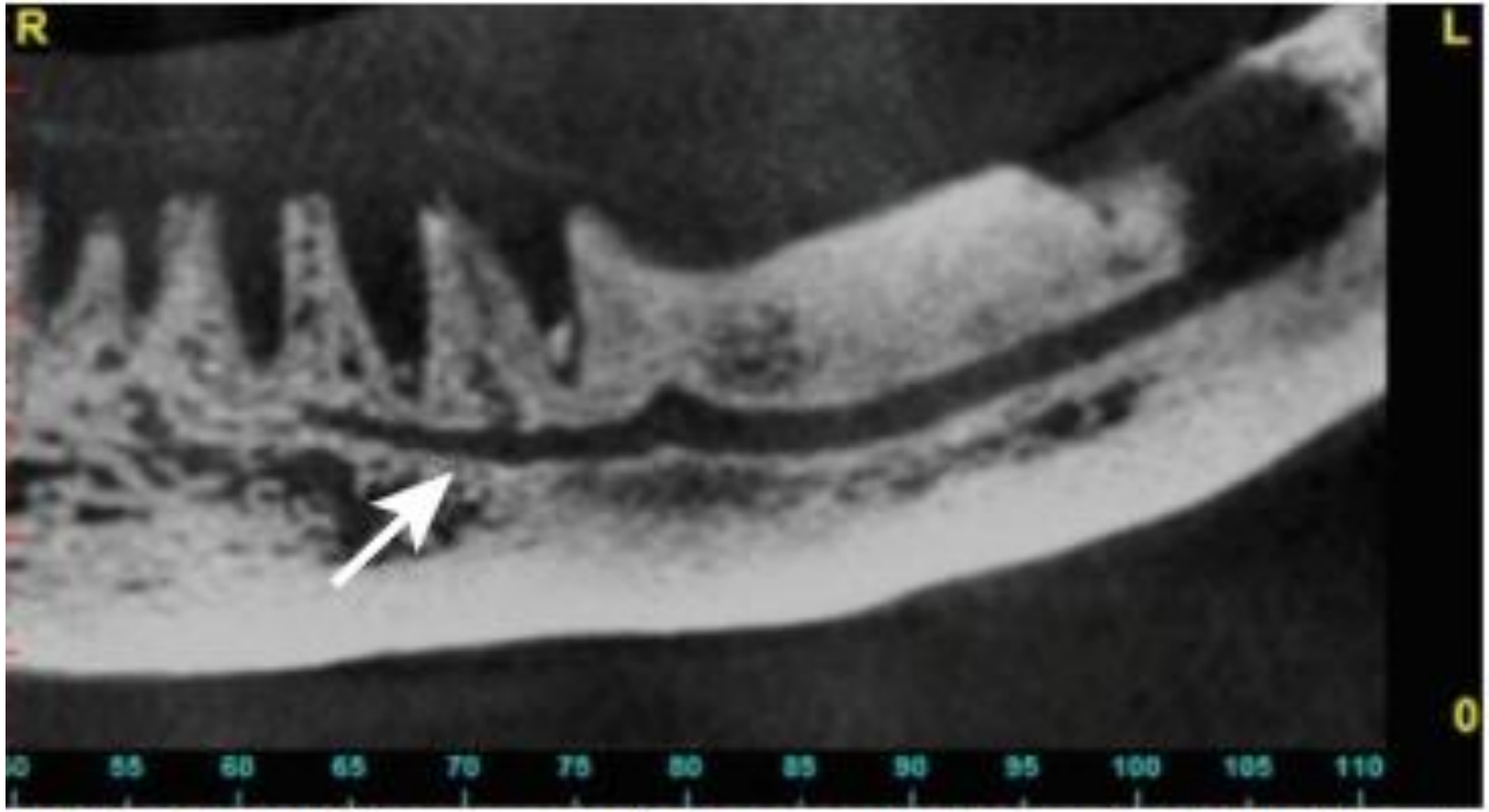
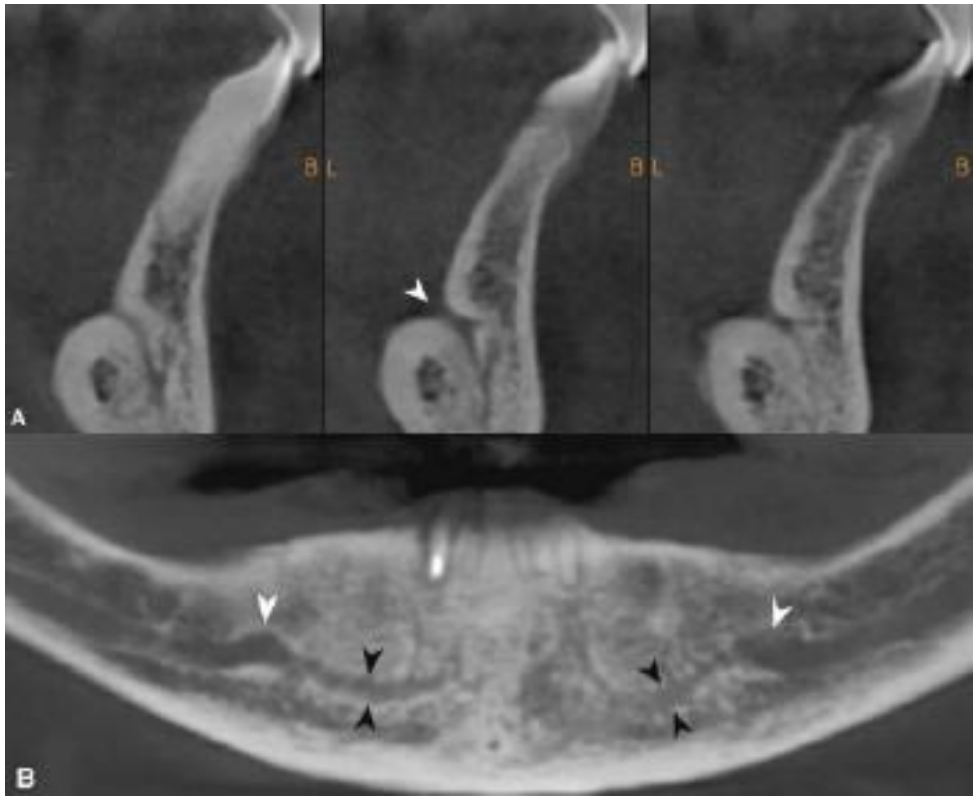
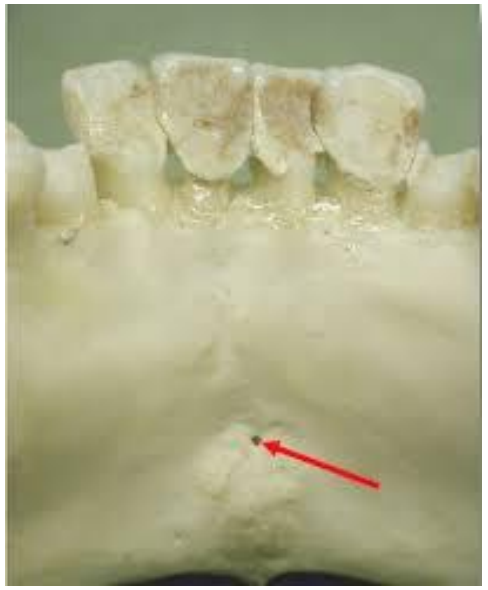
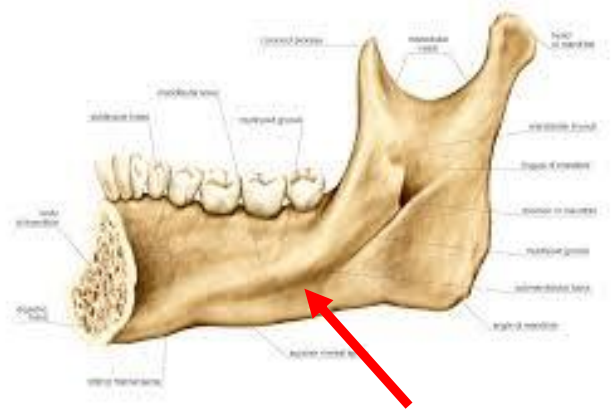
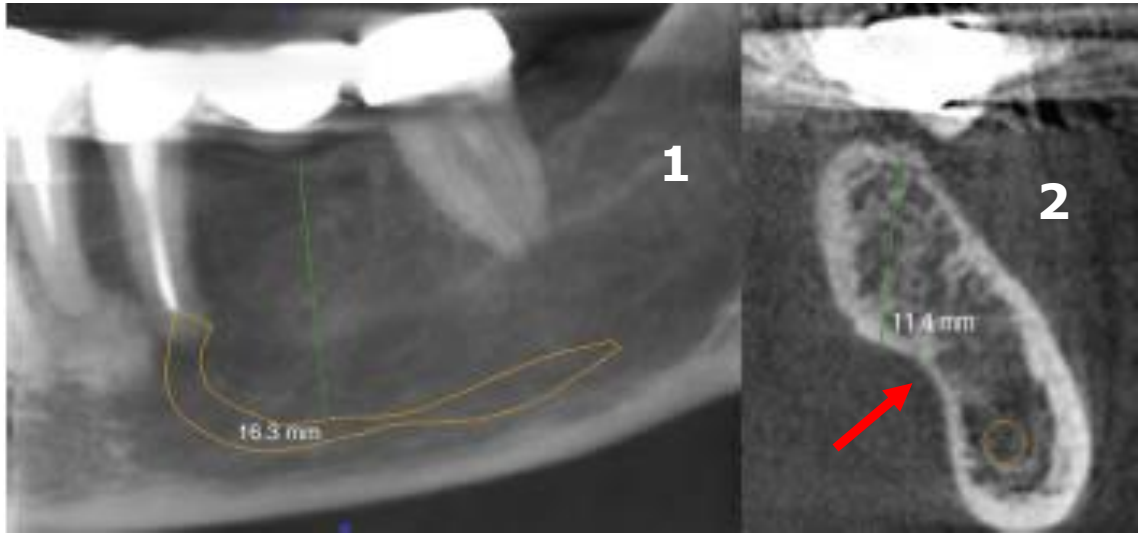


FIG 9.27 CBCT panoramic image depicting incisive branch of IAN *(arrow)*.


A
B






1
16.3 mm
2
11.4 mm

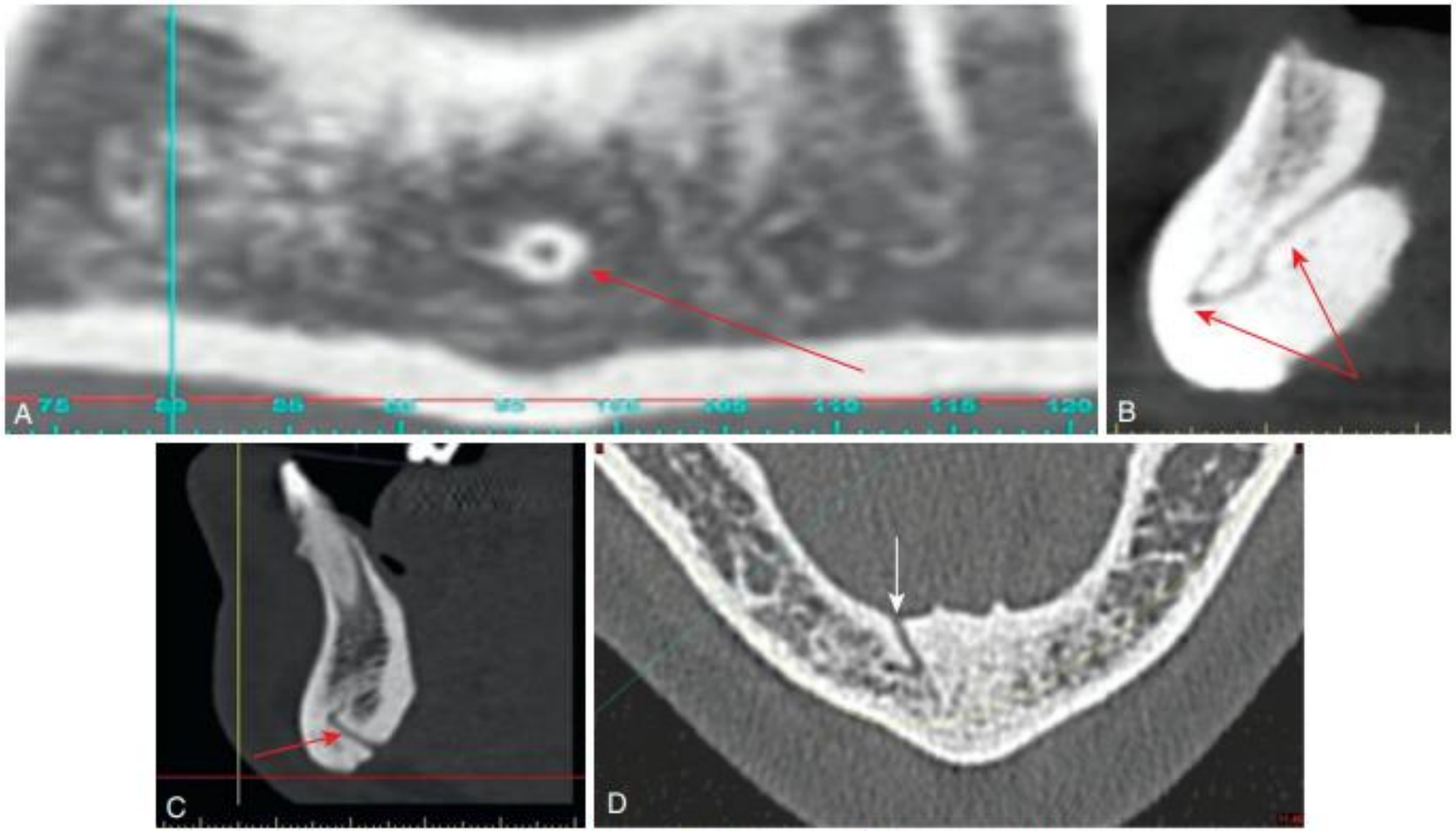
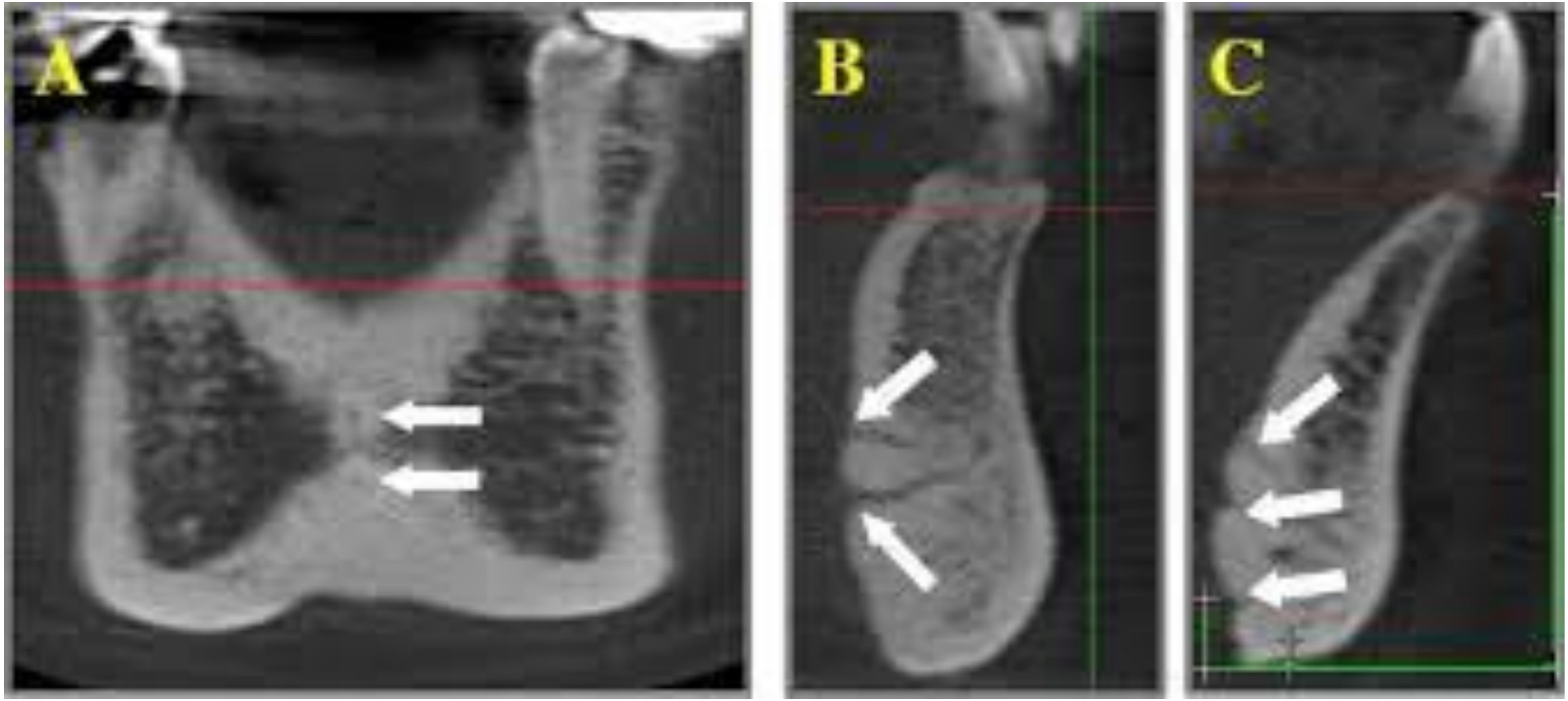


FIG 4.21 Mandibular vascular canal. (A) Lingual foramen, where right and left sublingual arteries enter the mandible *(arrow)*; (B–C) mandibular vascular canal that contains the sublingual artery anastomosis; and (D) off midline lingual vascular canal *(arrow)*.


A
B
C

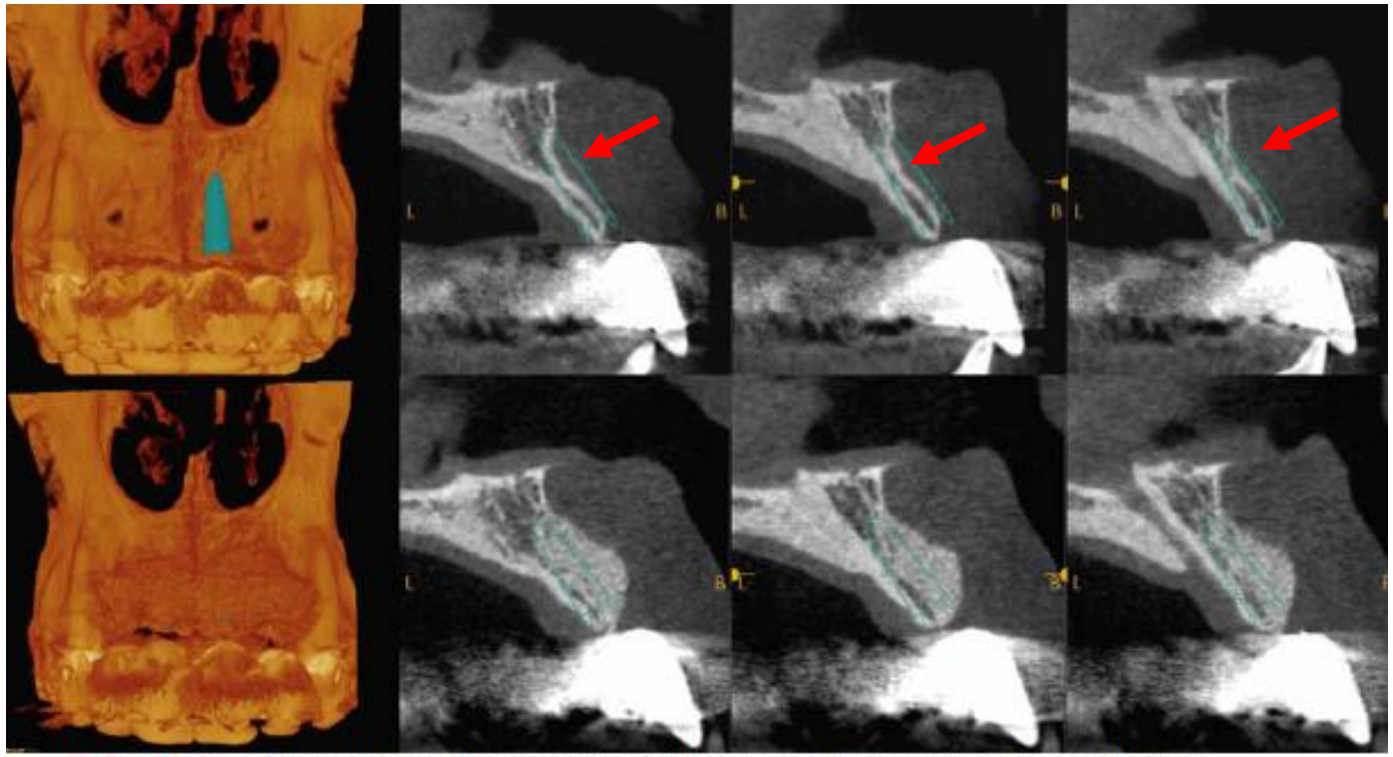


FIG. 15.5 *Top*: Three-dimensional volume rendering and buccolingual cross-sections of an edentulous maxillary left central incisor site. Note the prominent buccal concavity of the alveolar process, which prevents the desired implant to be placed without significant esthetic compromises. The virtual implant shows extensive buccal thread exposure if placed in the ideal inclination, identifying the need for buccal bone augmentation prior to implant placement. *Bottom*: Cone beam computed tomography sections following buccal bone grafting. Note how the desired implant size is now fully embedded in bone.

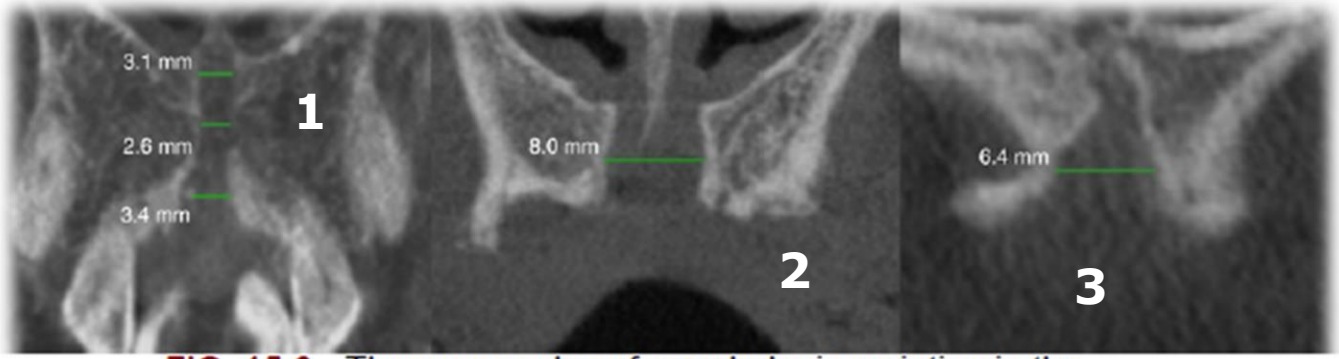
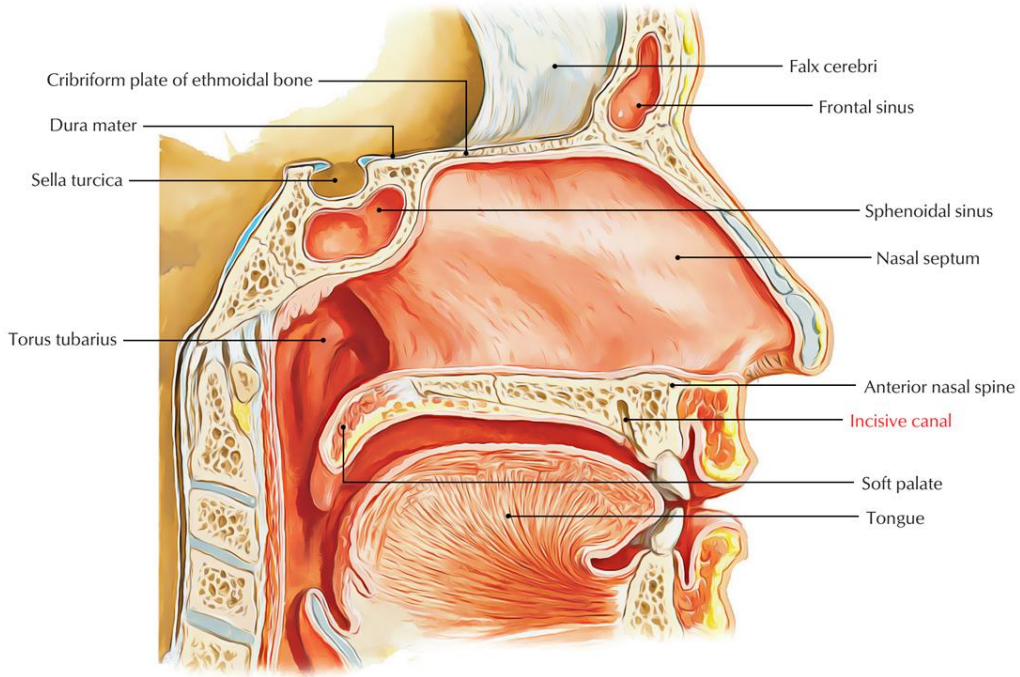


FIG. 15.6 Three examples of morphologic variation in the nasopalatine canal. Coronal slices depicting a thin, uniform canal *(left)*, two wide, converging canals *(middle)*, and a funnel-shaped canal *(right)*.



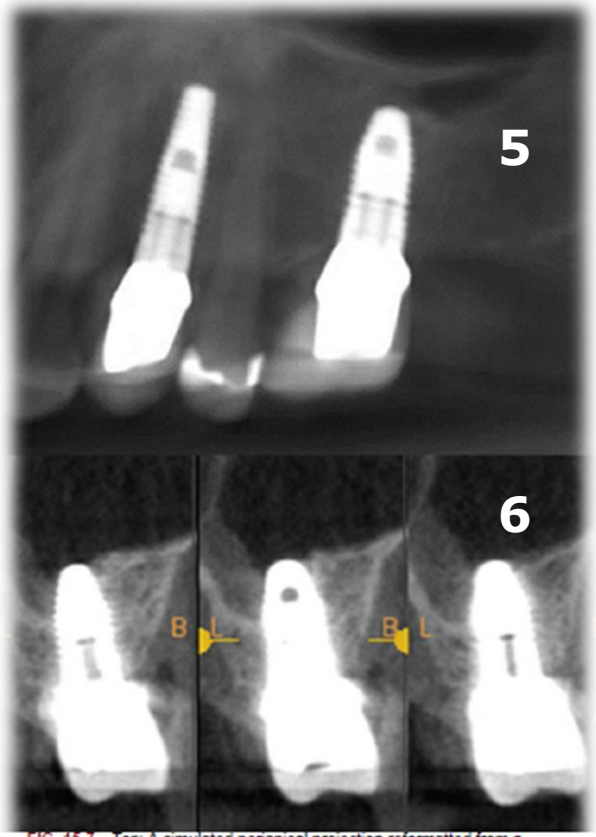
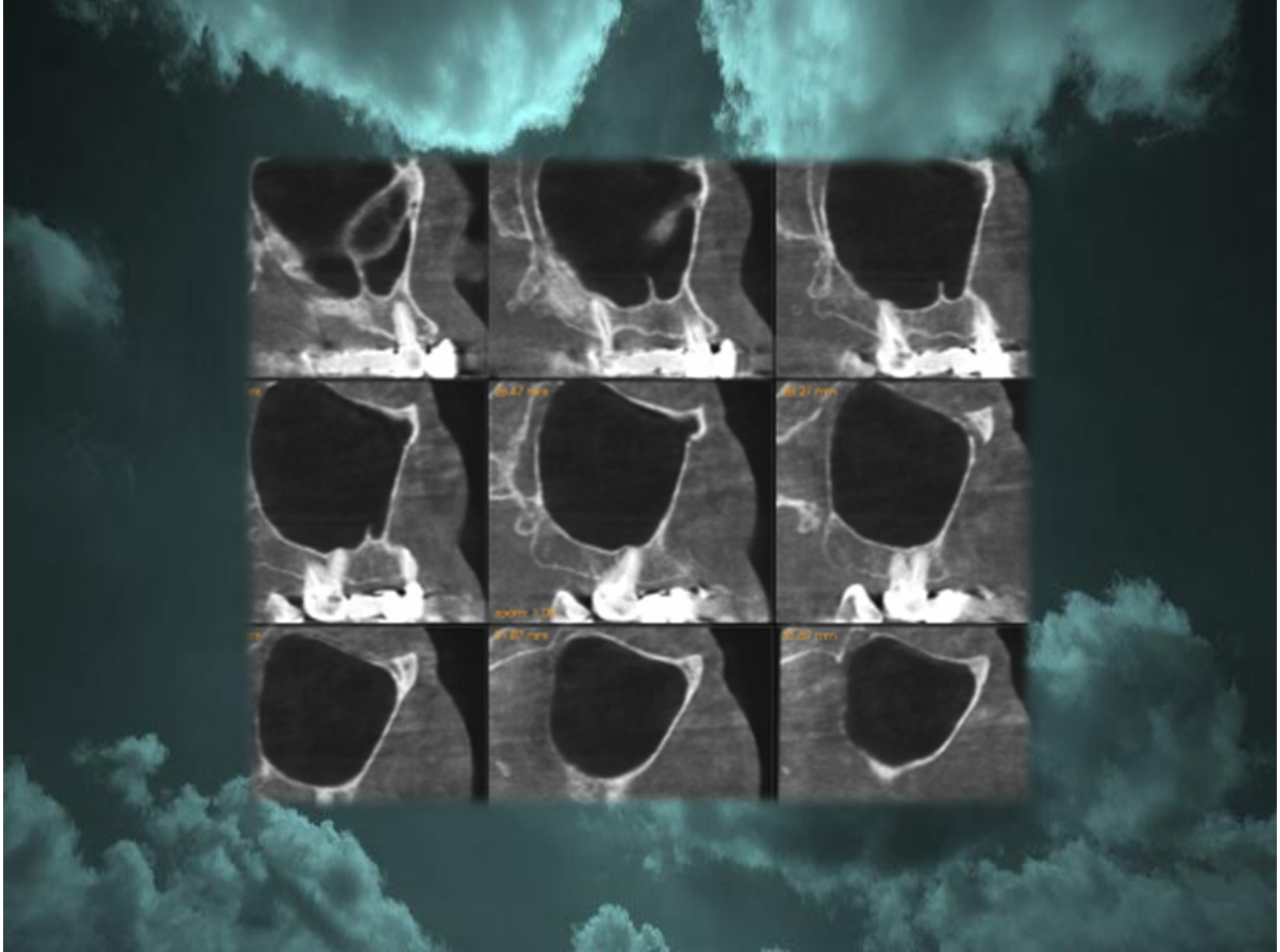
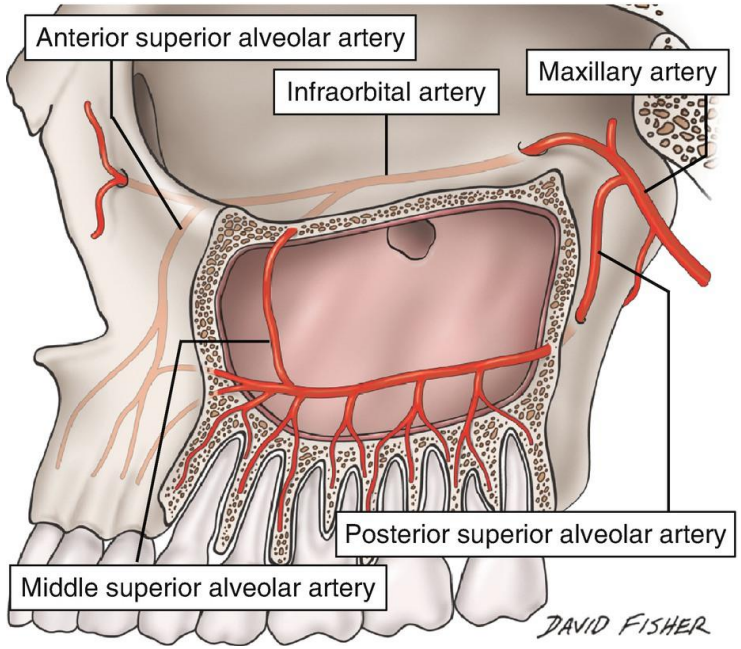


FIG. 15.7 *Top:* A simulated periapical projection reformatted from a cone beam computed tomography study. The position of the maxillary sinus floor relative to the apex of the implant placed at the maxillary left first molar site is difficult to determine due to anatomic superimposition.



- ✓ presence of septa
- ✓ inflammatory disease
- ✓ branches artery



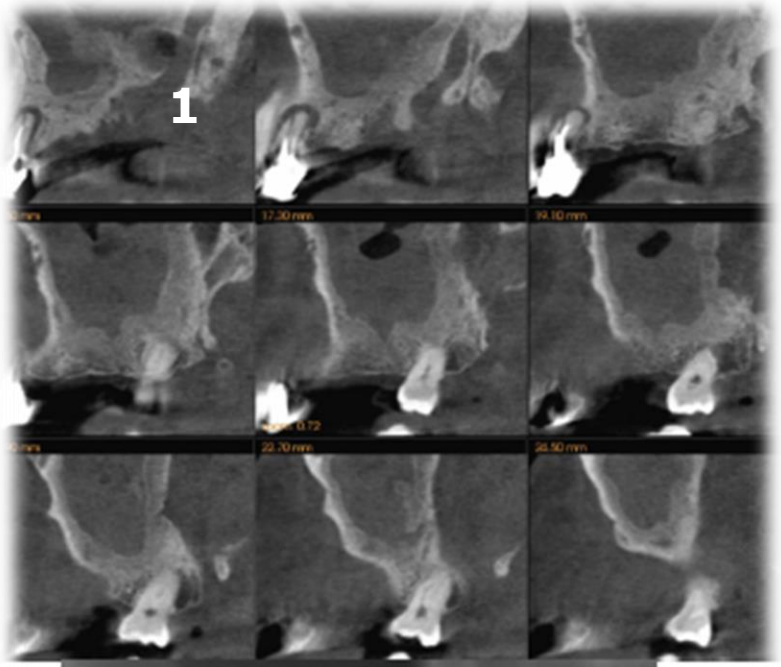
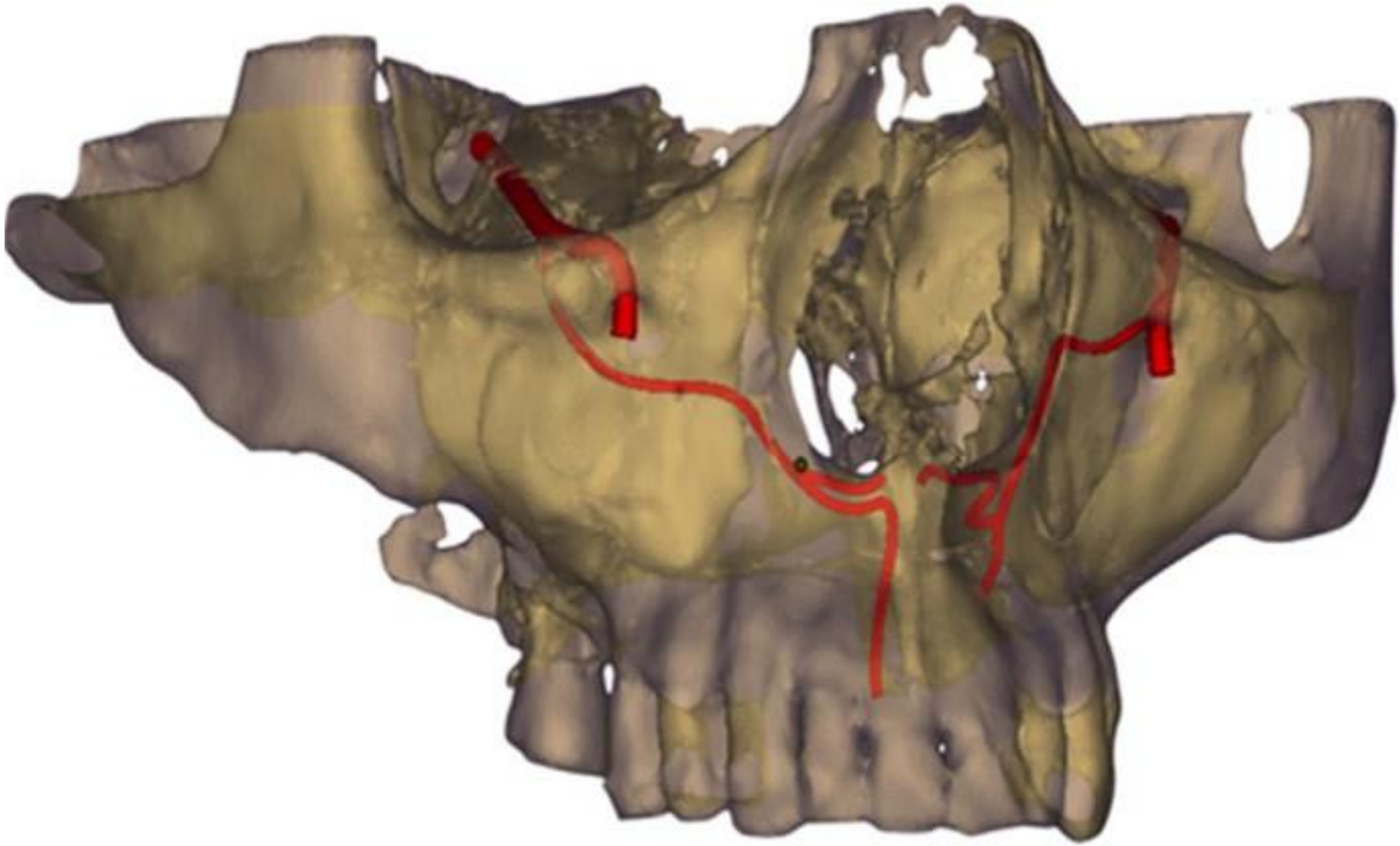


FIG. 15.8 (A) Serial sagittal cross sections of a right maxillary sinus demonstrating a transverse ridge located along the sinus floor apical to the edentulous first molar region, which may complicate a sinus lift



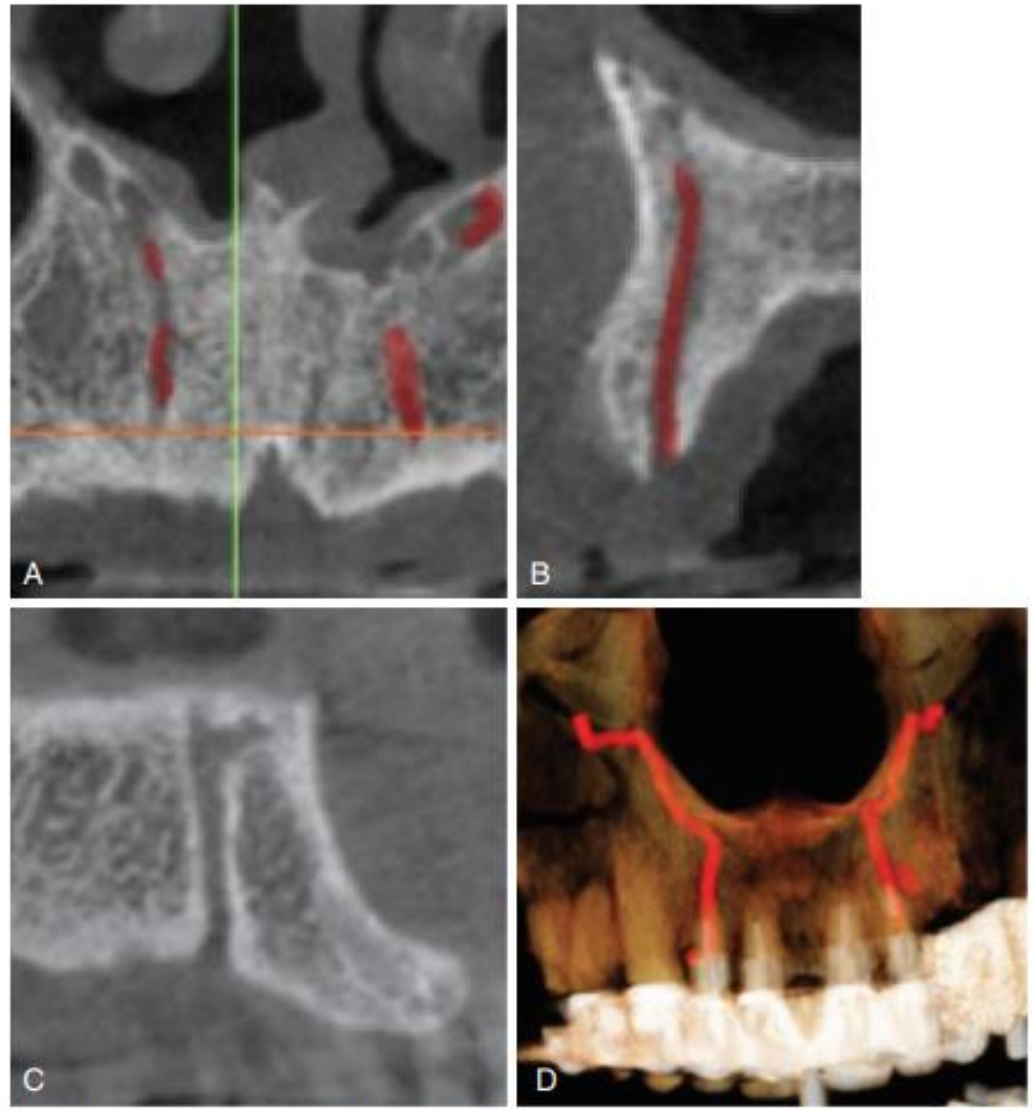


FIG 4.36 Canalis sinuosus. (A) Panoramic image depicting the canalis sinuosus which transmits the anterior superior alveolar vessels; (B–C) cross-sectional image; (D) 3-D image showing course of the canal.

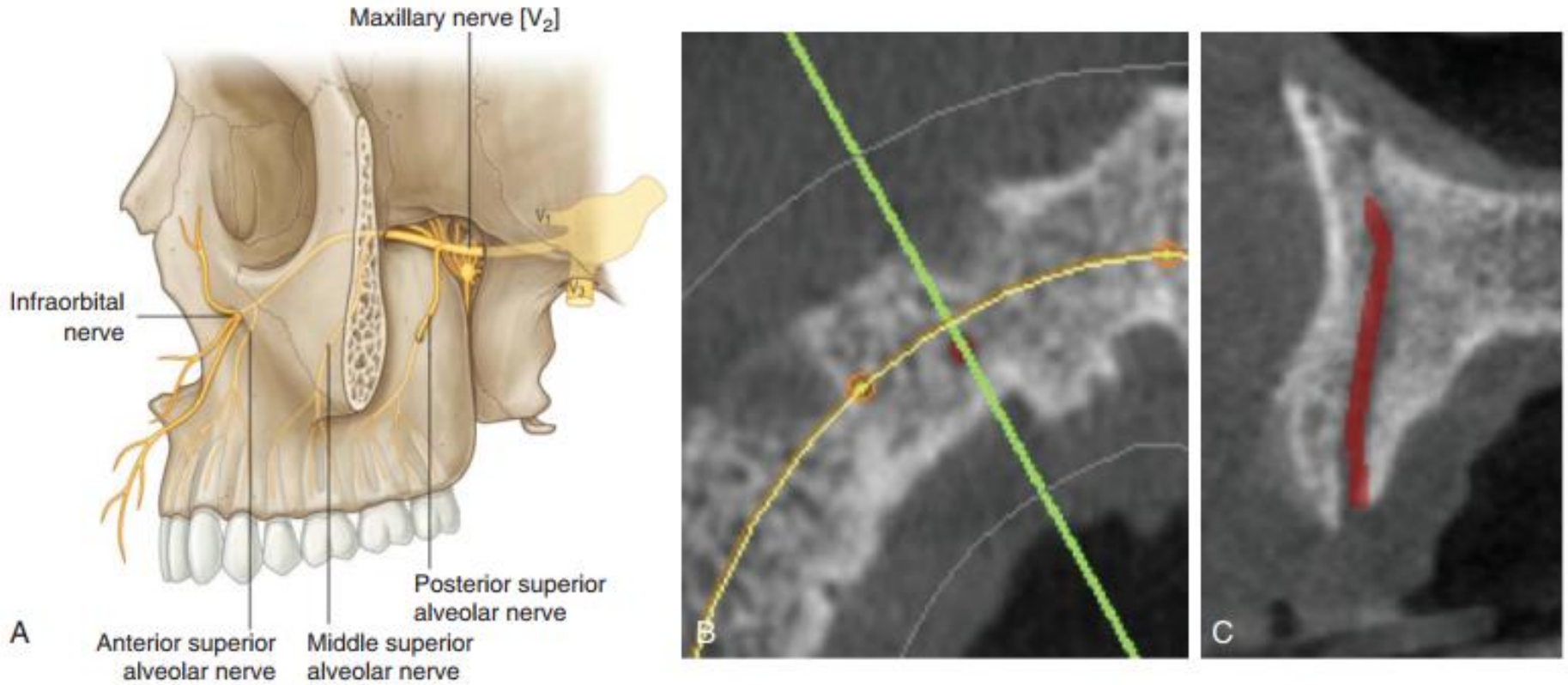
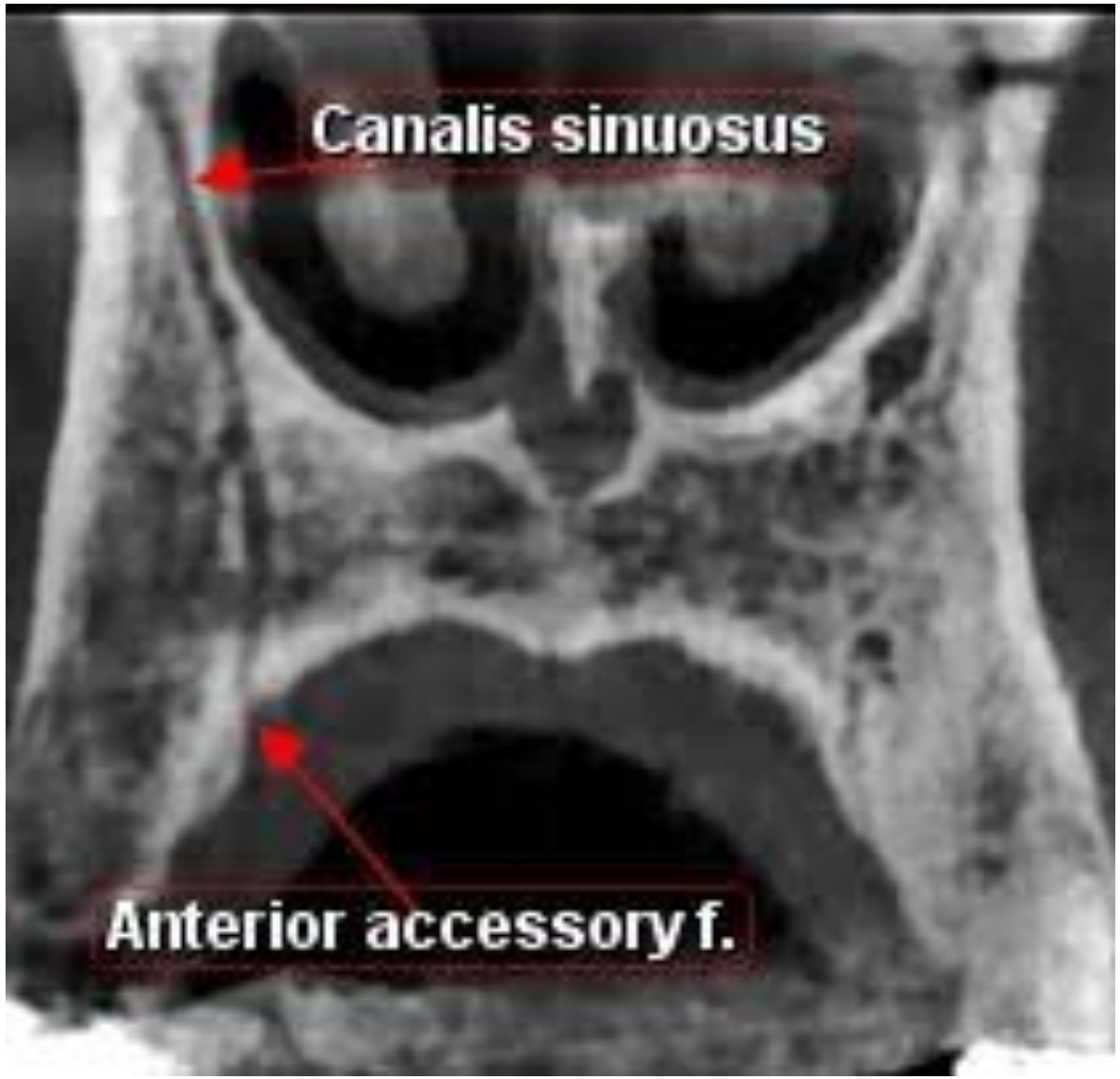
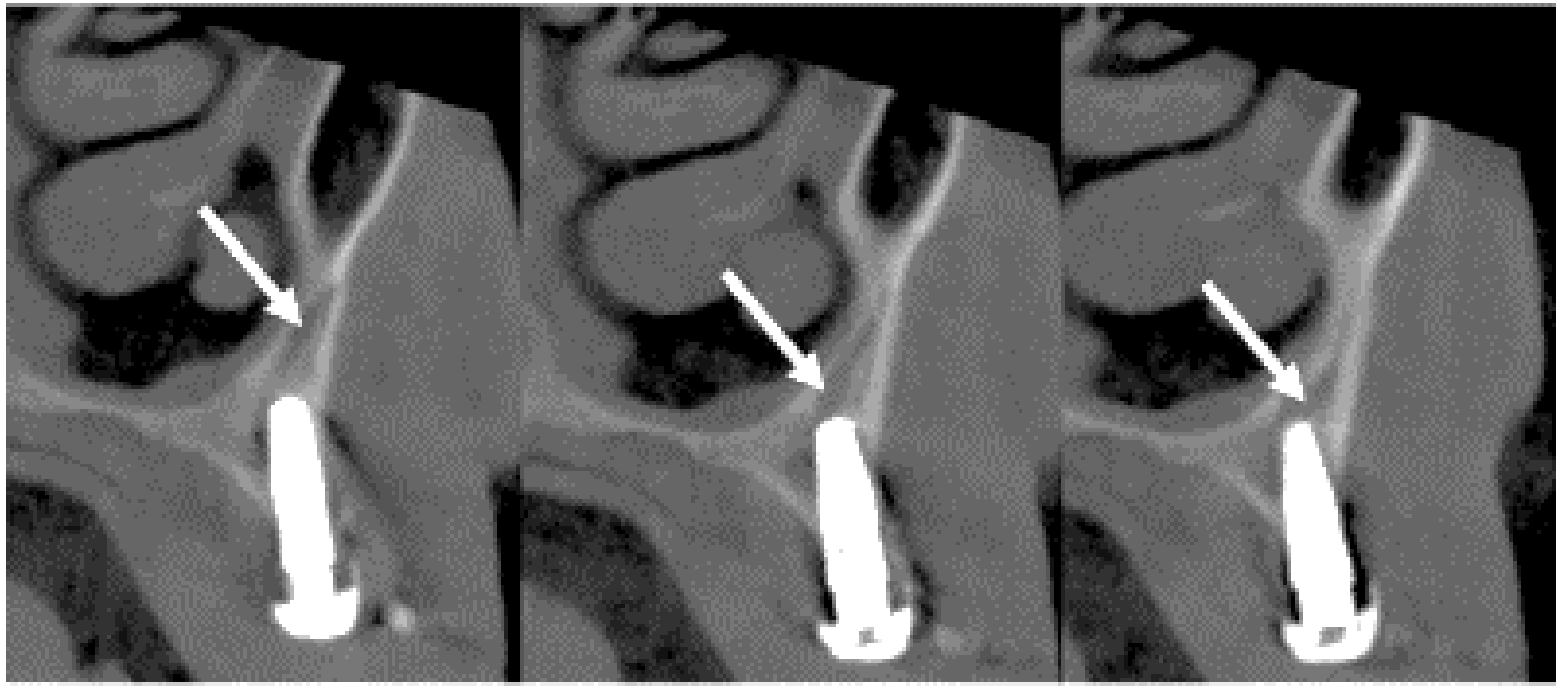


FIG 9.6 (A) Anterior superior alveolar nerve. (B) Canalia sinuosus is an anatomic variant leading to placement of implants into the canal leading to a soft tissue interface. Axial CBCT image showing location in center of residual ridge. (C) Cross-sectional CBCT image depicting the canalia sinuosus. (A, From Wells M: *Local and regional anaesthesia in the emergency department made easy*, Edinburgh, 2010, Churchill Livingstone.)

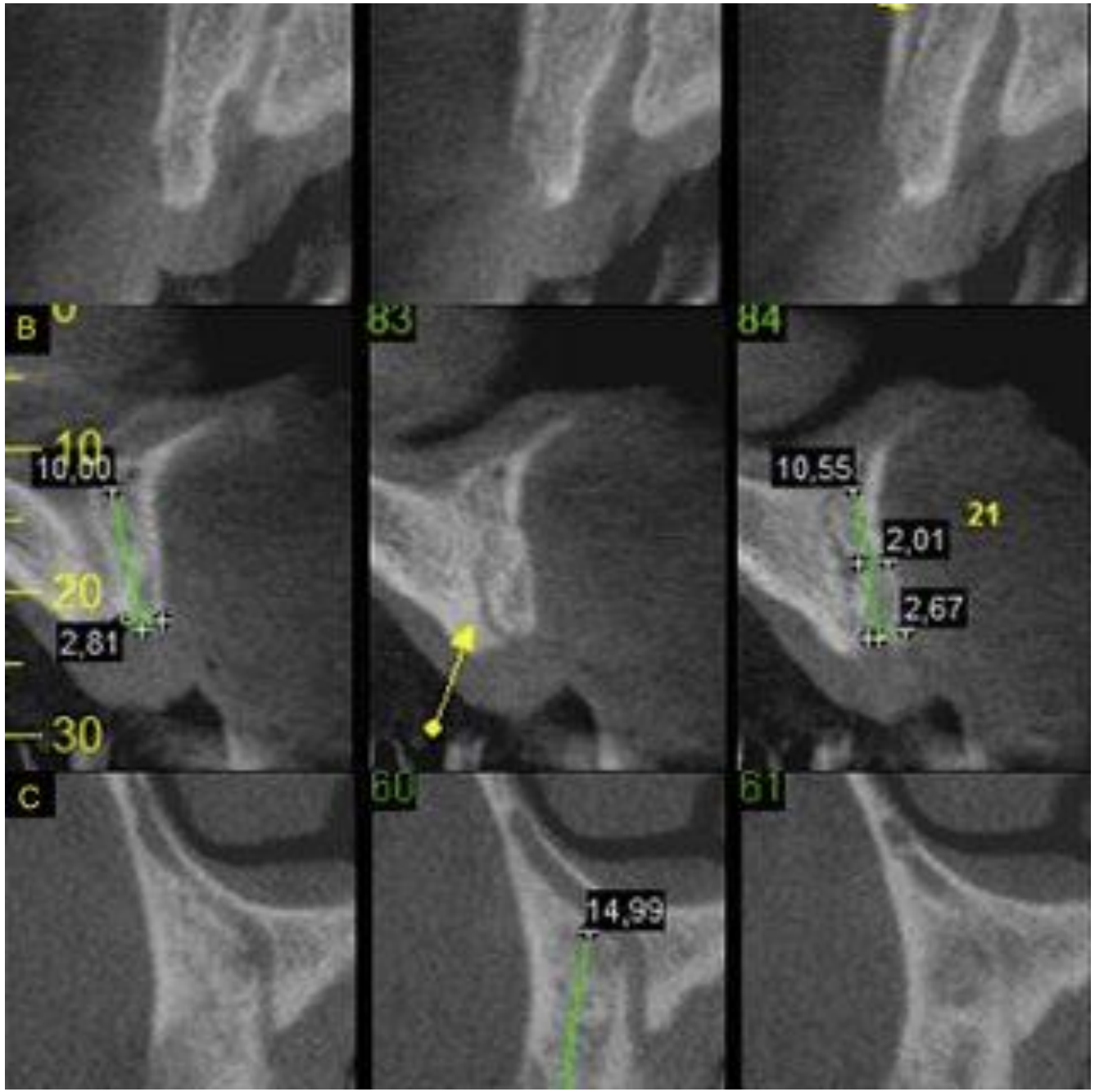

30
40
50
60
70

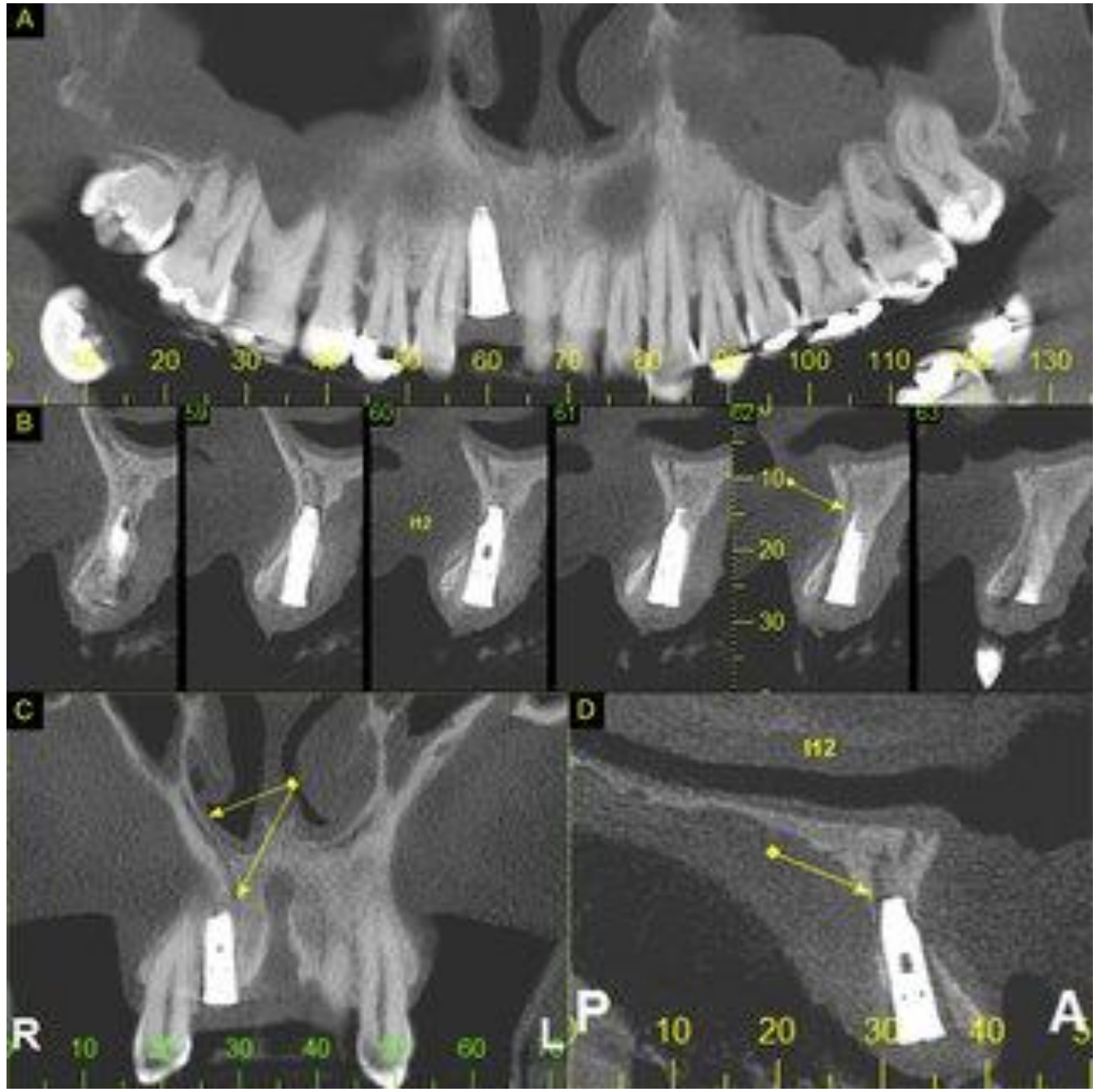

Canalis sinuosus
Anterior accessory f.


CS




a
oral
labial / buccal
1 cm
b
oral
labial / buccal
1 cm


B
10
10,66
20
2,81
30
83
84
10,55
21
2,01
2,67
C
60
14,99
61


A
B
C
D
M2
R
L
P
A

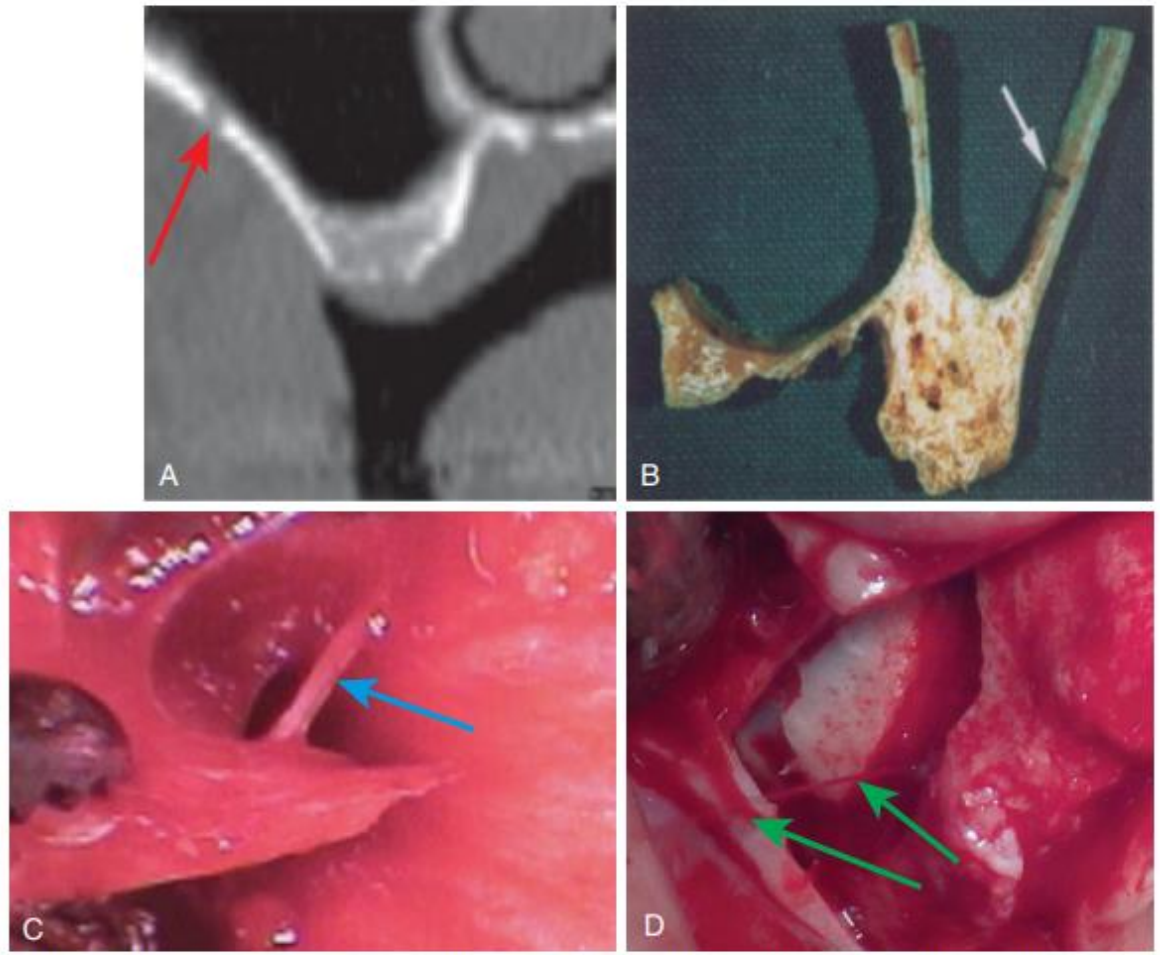


FIG 7.28 Intraosseous anastomosis. (A) Cross-sectional image showing radiolucent notch on the lateral wall of the sinus *(red arrow)*. (B) Intraosseous notch *(white arrow)*. (C) Clinical view of lateral wall removed showing size of intraosseous anastomosis *(blue arrow)*. (D) Intraosseous anastamosis pulsating bleed.

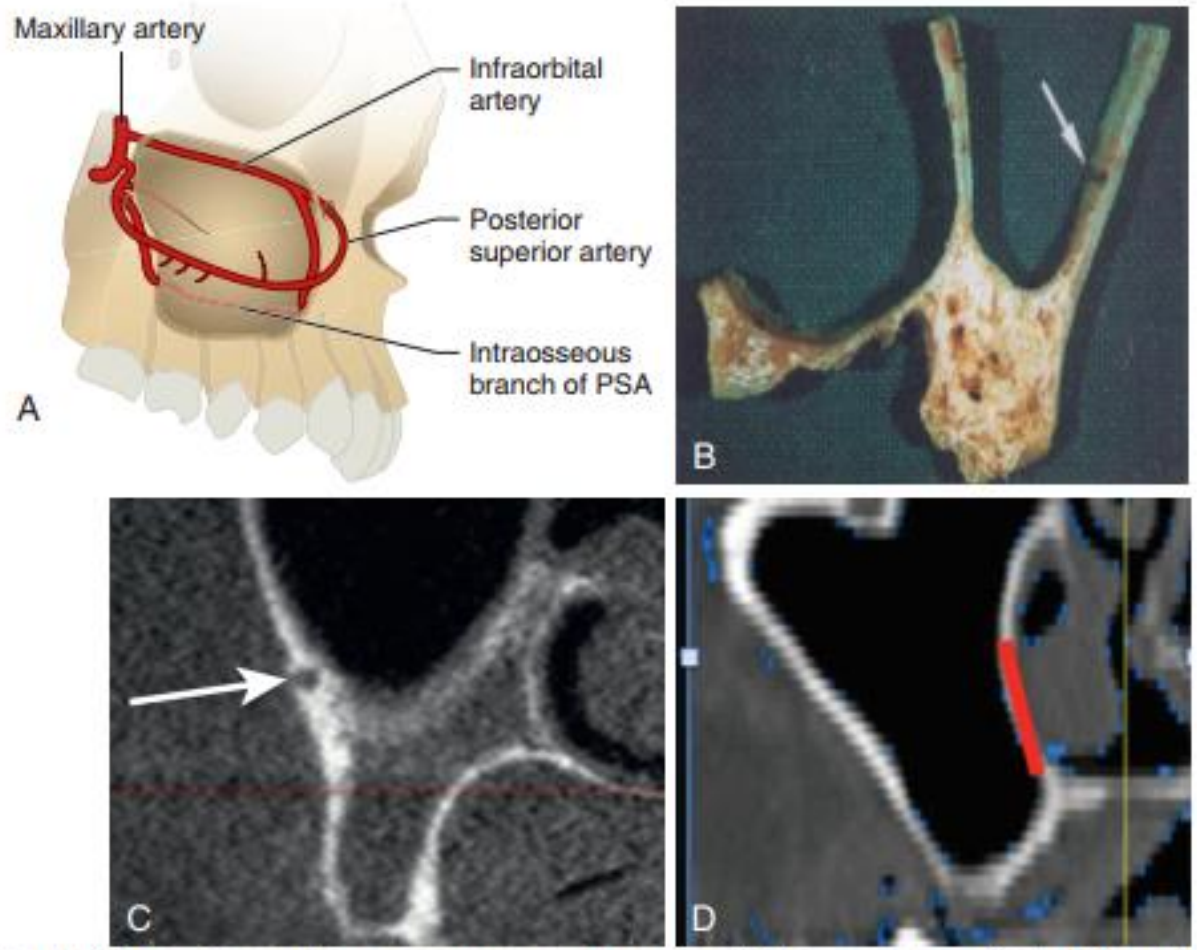


FIG 13.7 (A) The extra- and intraosseous anastomosis, which is made up of the infraorbital and posteriorsuperior artery. (B) Intraosseous notch *(arrow)* containing the intraosseous anastomosis, which comprises the posterior superior artery and infraorbital artery. (C) Cross-sectional CBCT image depicting intraosseous anastamosis *(arrow)*. (D) Posterior lateral nasal artery location in the medial wall of the maxillary sinus.

the lateral-access wall (lateral wall osteotomy) for the sinus graft often severs these blood vessels.

Radiographic Evaluation. The intraosseous anastomosis is easily seen on cross-sectional or coronal views of a CBCT scan as a discontinuation of the lateral wall with a radiolucent notch (opening). On average, this structure is approximately 15 to 20 mm from the crest of a dentate ridge.

Clinical Significance. When lateral wall sinus augmentation is indicated, evaluation of the CBCT should be completed to determine location and size. If bleeding does occur during the lateral wall osteotomy, it can be addressed by cauterization by the hand piece and diamond bur without water, electrocautery, or pressure on a surgical sponge while the head is elevated (Fig. 4.35).

Canalis Sinuosus

The anterior superior alveolar nerve branches from the infraorbital canal, just lingual to the cuspid area. This radiolucent canal is called the *canalis sinuosus*. The canal runs forward and inferior to the inferior wall of the orbit and follows the lower margin of the nasal aperture and opens to lateral to the nasal septum.[62] The canalis sinuosus transmits the anterior superior alveolar nerve, artery, and vein.

Radiographic Evaluation. If the clinician is unaware of the canalis sinuosus, the anatomic structure may be misinterpreted as apical pathology on 2-D radiographs. Therefore, on CBCT scans, the bilateral anatomic structure should be evaluated for its presence. It may be depicted on axial, cross-sectional or 3-D images. Studies have shown the canalis sinuosus to be present on 87.5% of CBCT scans (Fig. 4.36).[63]

Clinical Significance. Because the anterior maxillary region is a common area for dental implant placement, the presence of canalis sinuosus may lead to a high degree of implant morbidity. Impingement into the canal may lead to a soft tissue interface and failure of the implant, as well as temporary or permanent sensory dysfunction and possible bleeding issues.[64] However, significant sensory impairments are rare because of cross innervation.

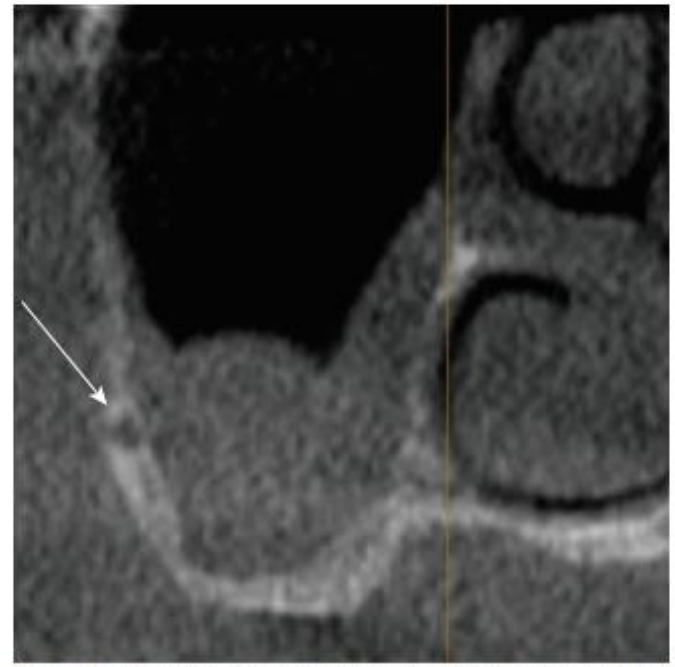
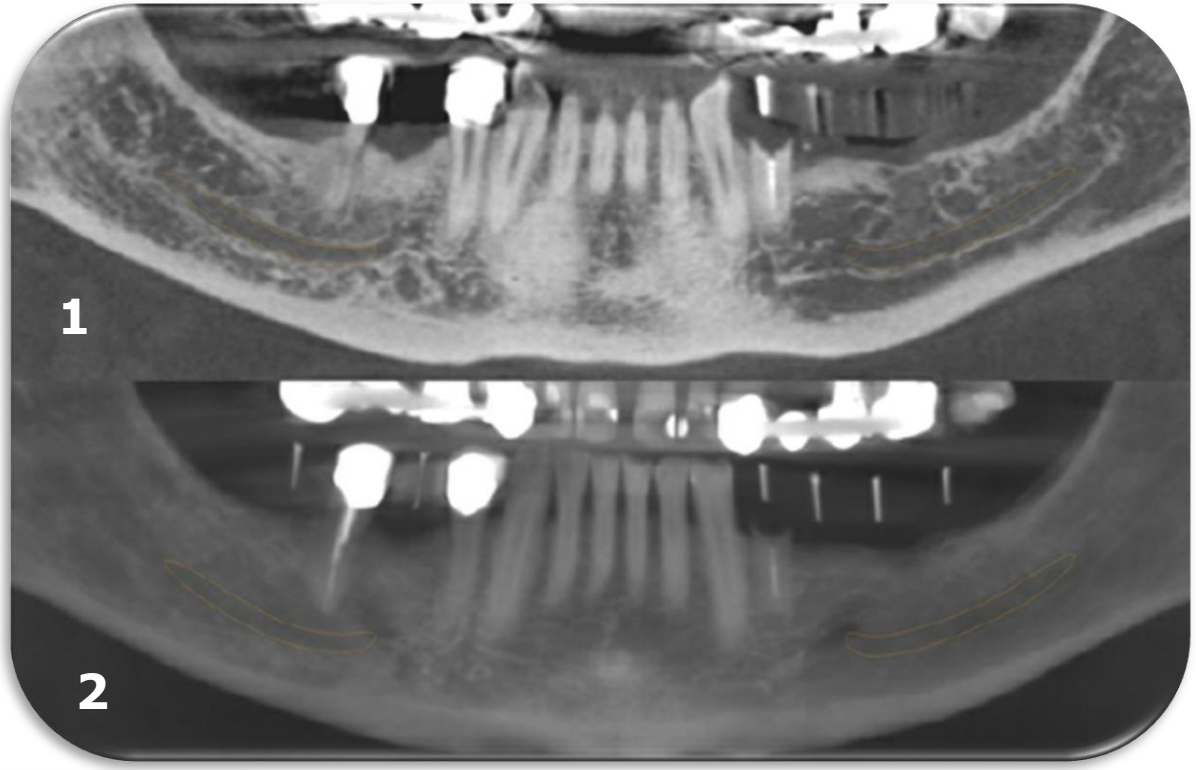


FIG 4.35 Intraosseous anastomosis *(arrow)* shown on a cross-sectional image seen as discontinuity of the lateral wall.

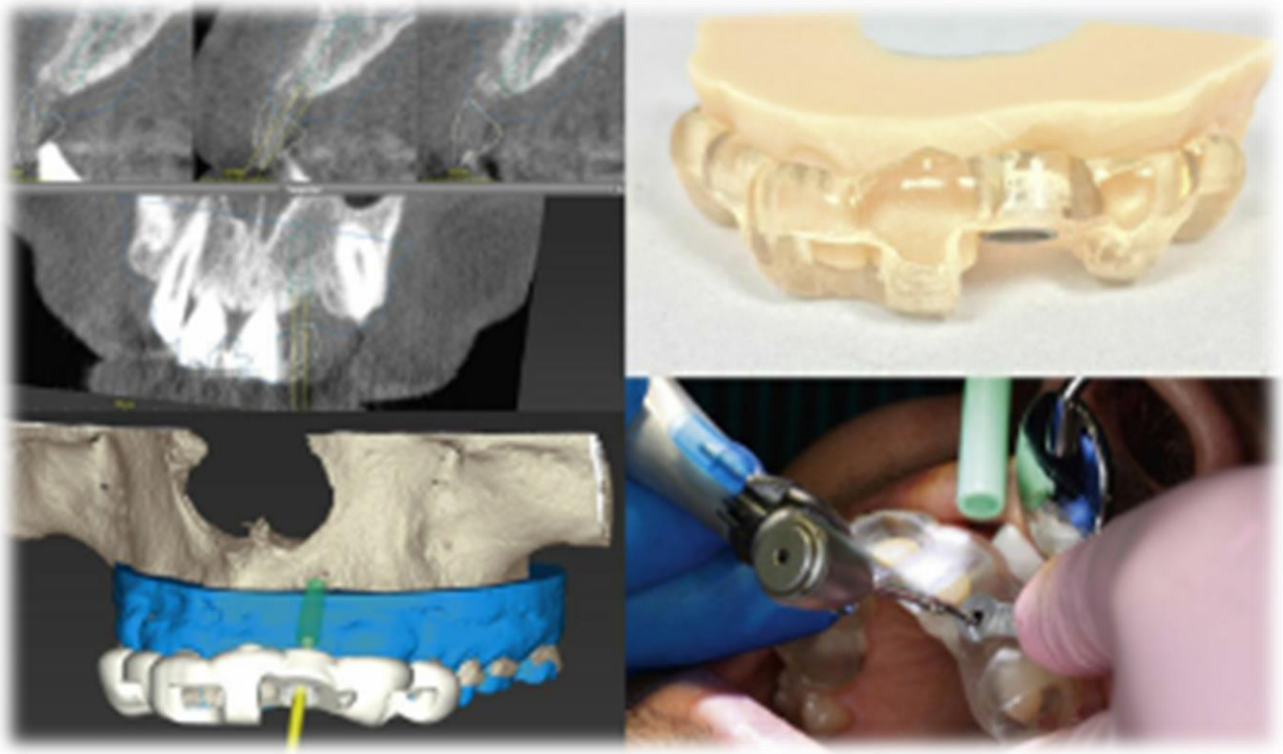

1
2


3


Perfectly Fitting Surgical Guide
For Successful Implant Surgery

Image-Guided Applications

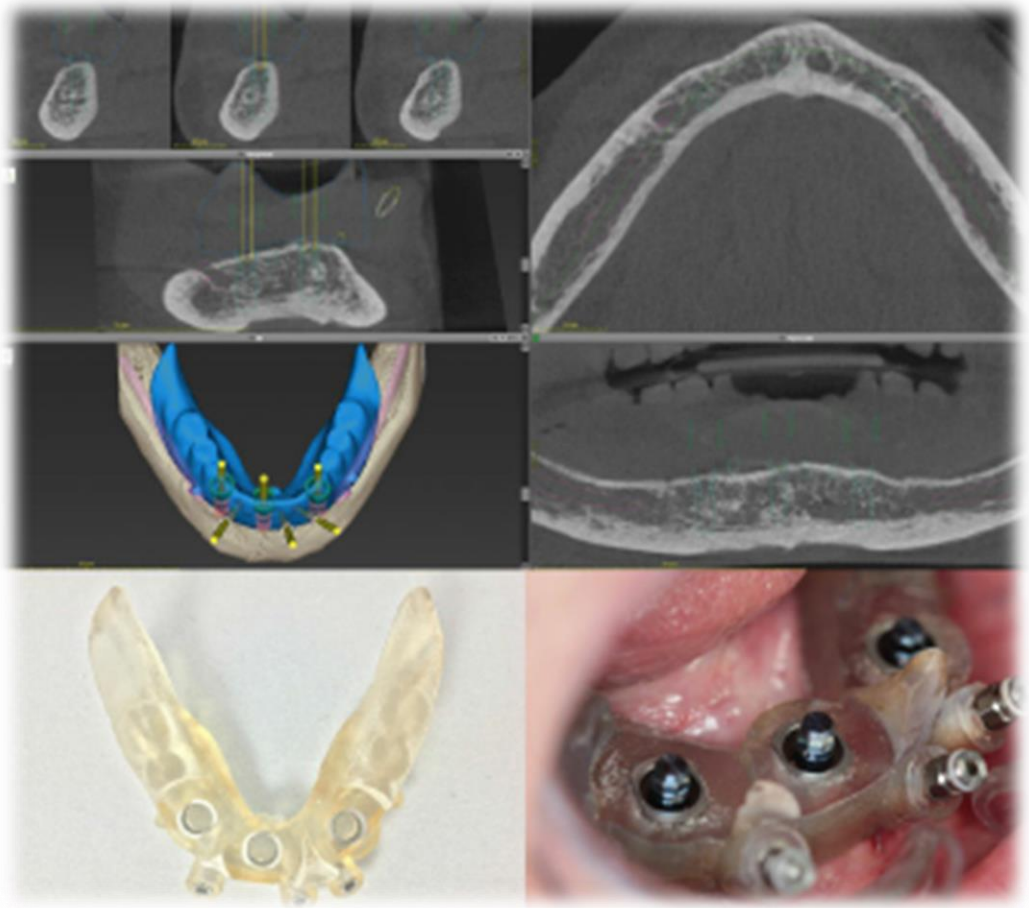
- stereolithographic guides
- three tissue types: teeth, mucosa, or bone



tooth-supported guide

Image-Guided Applications

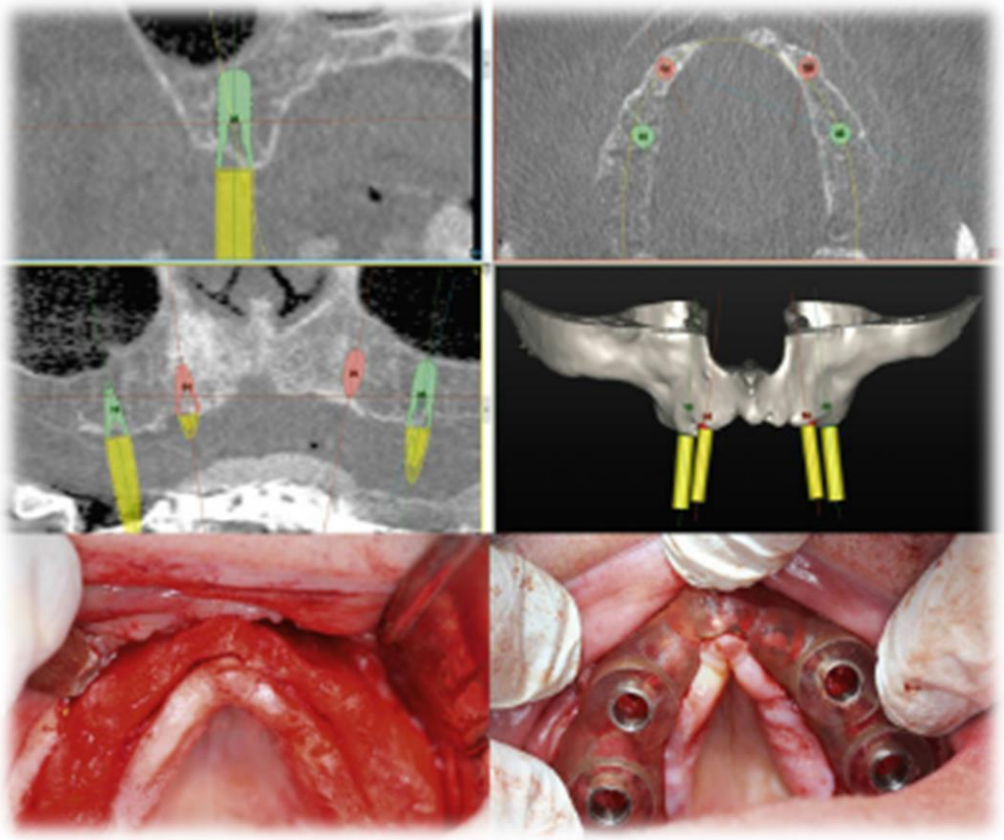
- stereolithographic guides
- three tissue types: teeth, mucosa, or bone



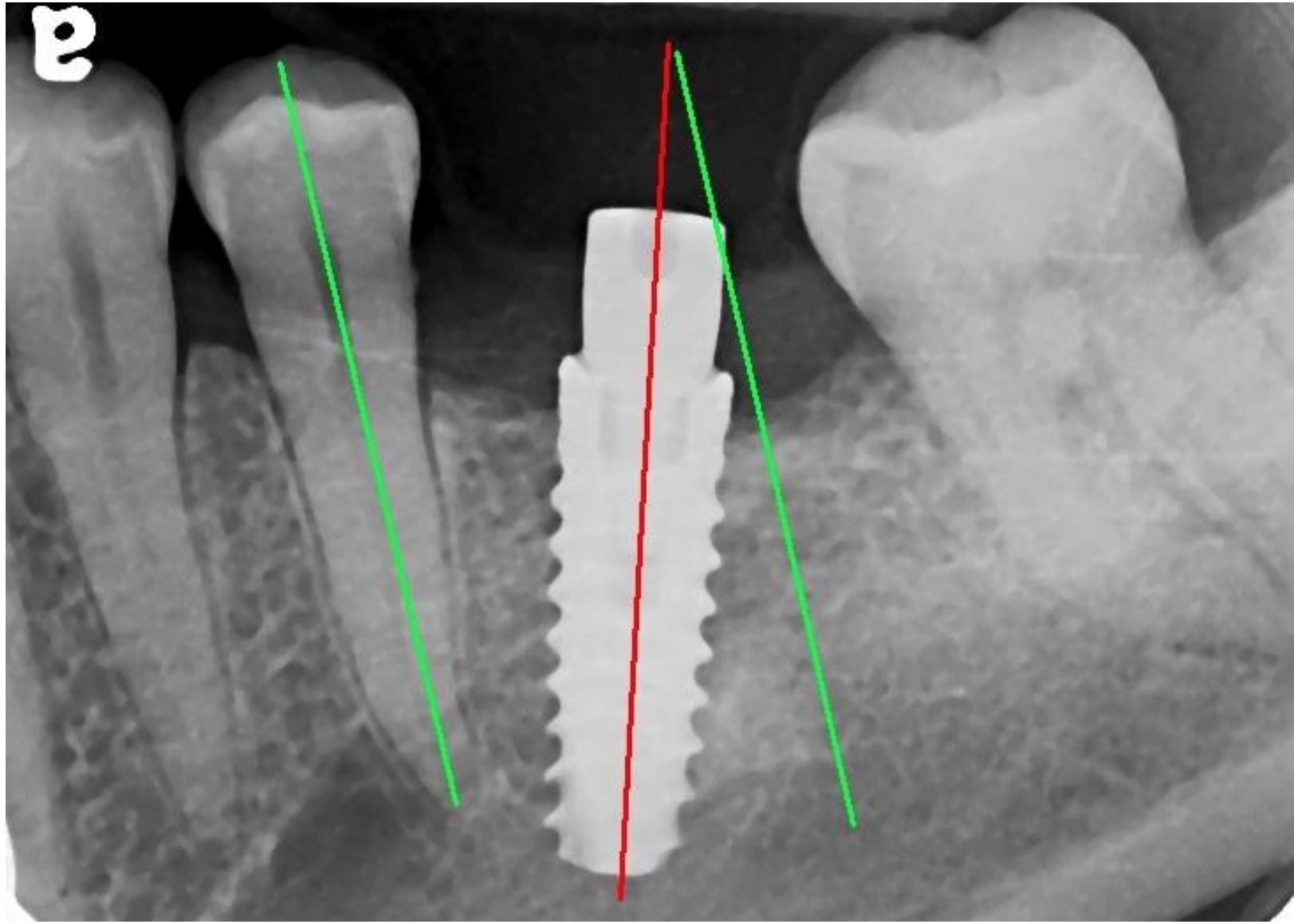
mucosa-supported guide

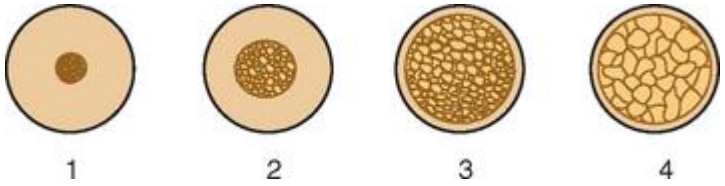
Image-Guided Applications

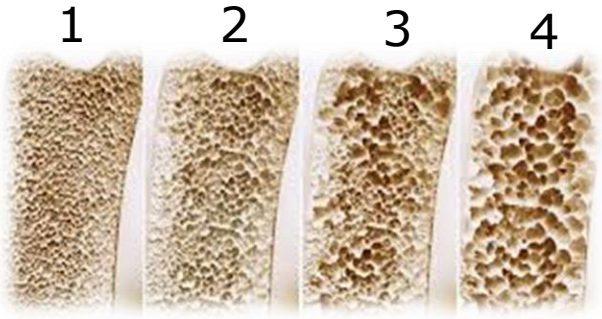
- stereolithographic guides
- three tissue types: teeth, mucosa, or bone



bone-supported guide


e





Radiologic Assessment of Bone Quality

TABLE 15.2

Misch Classification of Bone Density

Classification Type	Radiographic Appearance	Typical Anatomic Location	MDCT Density Range (HU)
D1	Primarily composed of dense cortical bone Marrow spaces are hardly visible	Occasionally in anterior mandible Rarely in posterior mandible	>1250
D2	Thick outer layer of porous cortical bone Coarse trabecular bone pattern	Commonly in anterior and posterior mandible Occasionally in anterior maxilla	850–1250
D3	Thinner layer of porous cortical bone Fine trabecular bone pattern	Commonly in anterior maxilla, posterior maxilla, and posterior mandible Occasionally in anterior mandible	350–850
D4	Faint to imperceptible outline of thin cortical bone Alveolar process is primarily composed of fine trabecular bone	Commonly in posterior maxilla Rarely in anterior maxilla	150–350

FIG 3.108 The posterior maxilla is the most common location for D4 bone. Because of the poor bone implant contact (~25%), modifications of the surgical and prosthetic procedures need to be implemented to decrease complications.

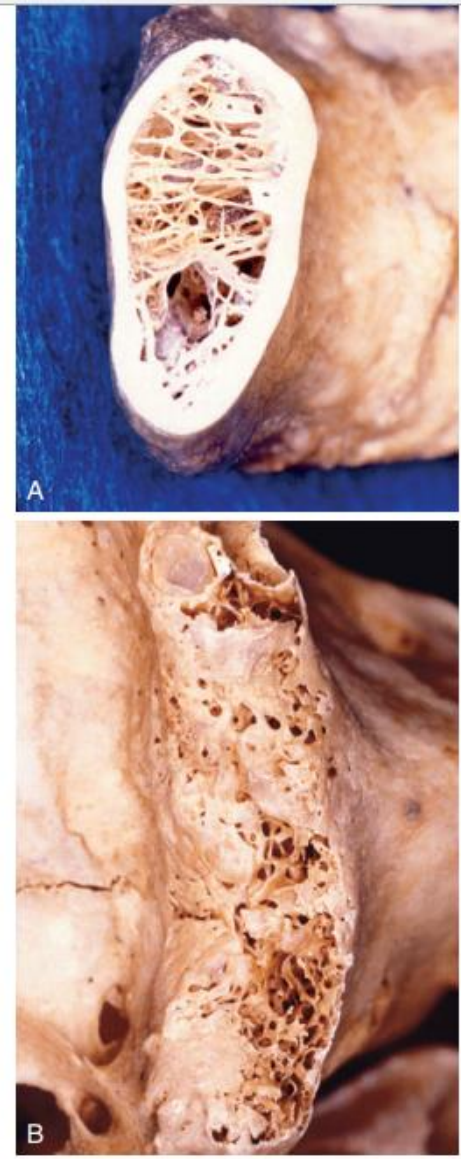


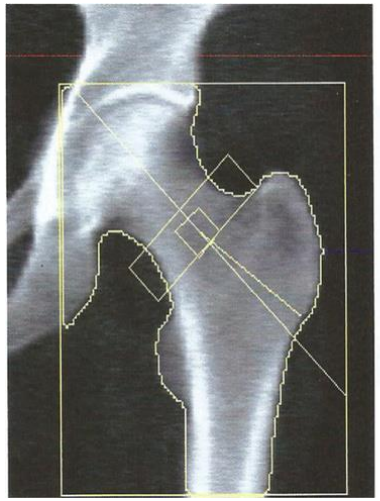
FIG 3.107 (A) and (B), D3 bone has a thin, porous cortical crest and fine trabecular bone within the alveolus. It is frequently found in a posterior mandible. (From Misch CE: *Contemporary implant dentistry,* ed 3, St Louis, 2008, Mosby.)

- ✓ subjective evaluation (CBCT)
- ✓ mineral mass per unit volume (DEXA)

bone density:

in the anterior mandible is higher

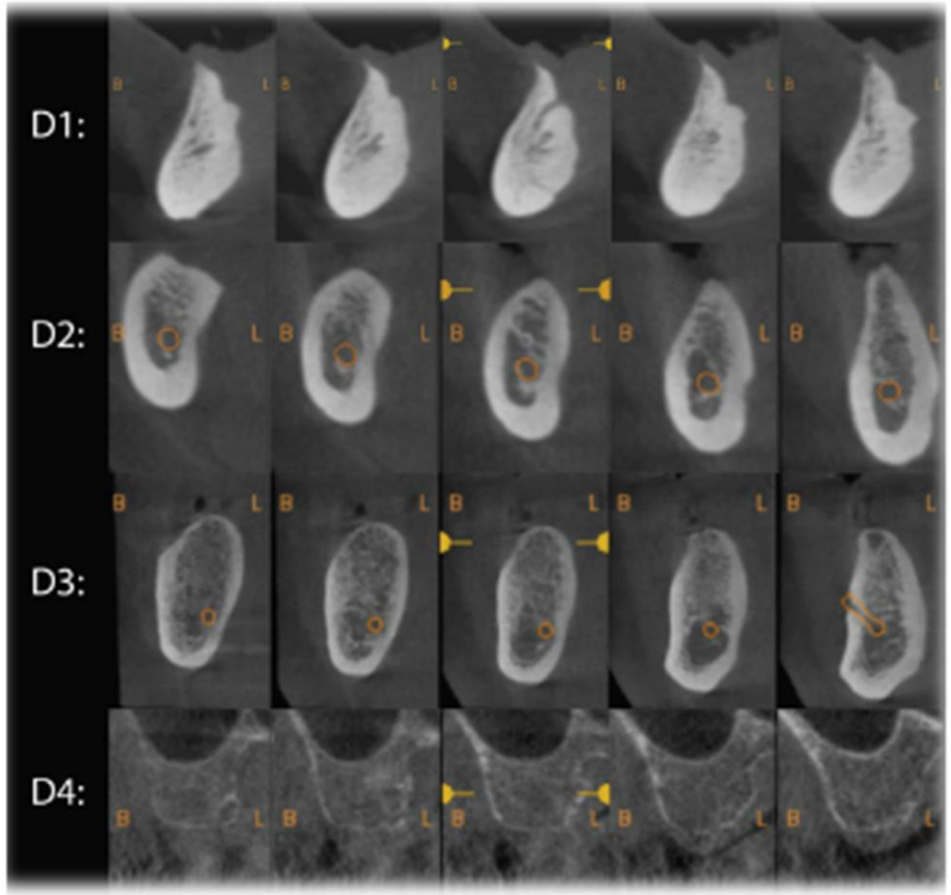
lowest in the posterior maxilla



DXA Results Summary:

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-score	Z-score
Neck	4.98	4.30	0.864	-0.5	0.5
Total	39.48	42.62	1.079	0.3	0.8

Total BMD CV 1.0%, ACF = 1.028, BCF = 1.007, TH = 5.496
WHO Classification: Normal
Fracture Risk: Not Increased



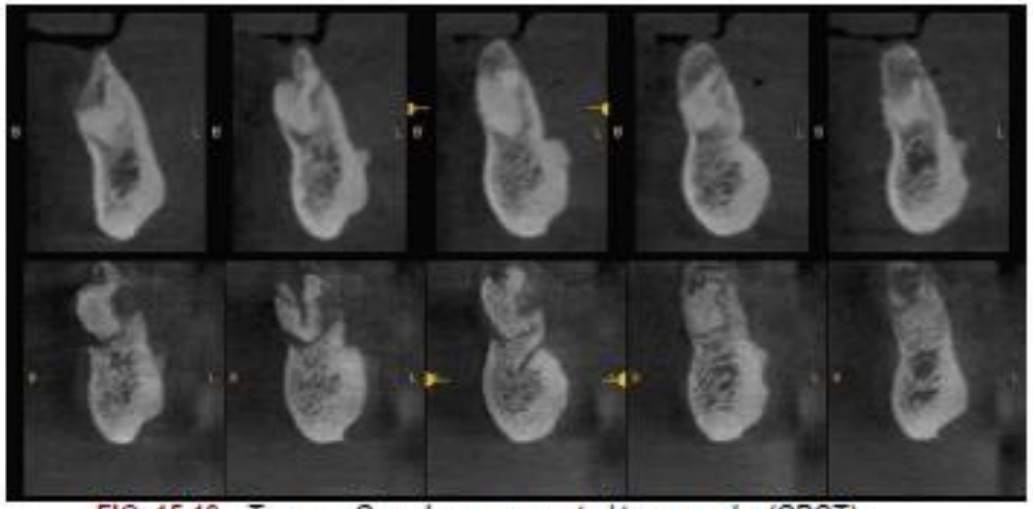
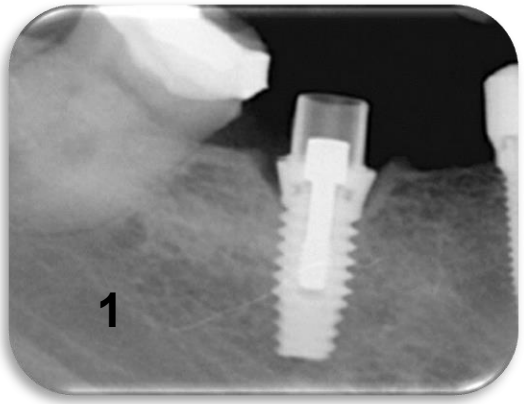
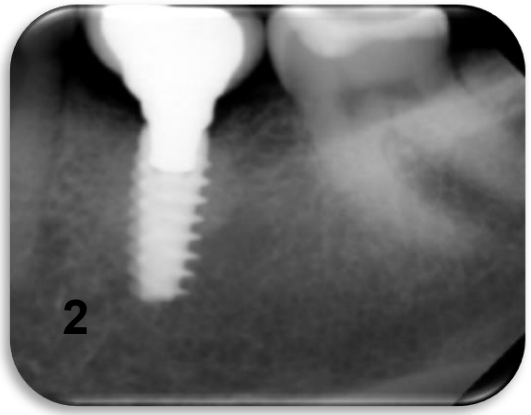


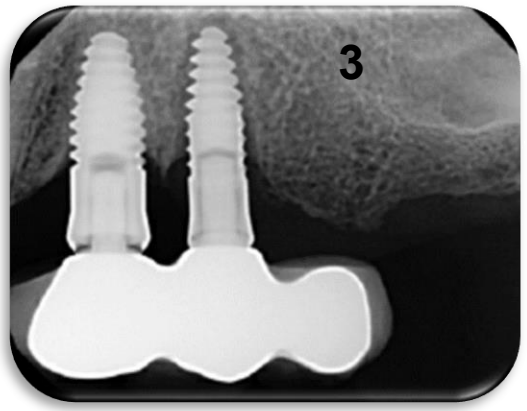
FIG. 15.13 *Top row*: Cone beam computed tomography (CBCT) images of a relatively mature focus of periapical osseous dysplasia in the anterior mandible of a patient evaluated for implant treatment planning. *Bottom row*: Following implant placement, the patient reported pain in the implant area. Two of the implants failed in the immediate postoperative period. Postoperative CBCT sections

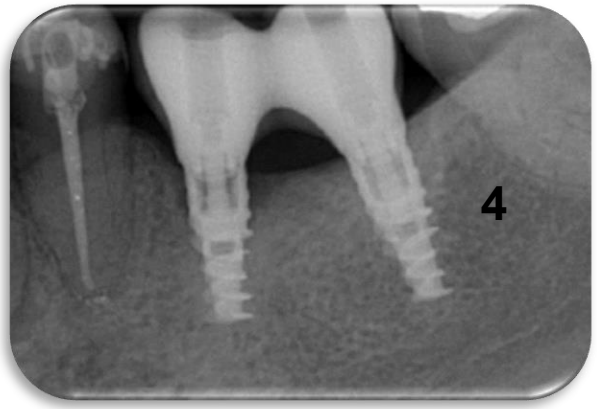
- ✓ drill deflection
- ✓ lower vascularity

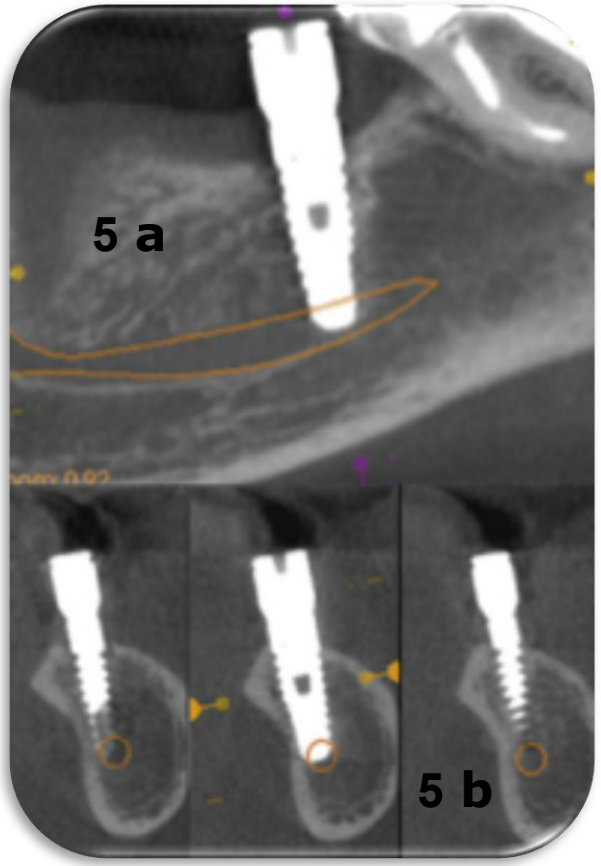
FIG. 15.12 Cone beam computed tomography section through the posterior left mandible demonstrating a large area of osteosclerosis located in the mesial aspect of an edentulous mandibular left first molar site.


1

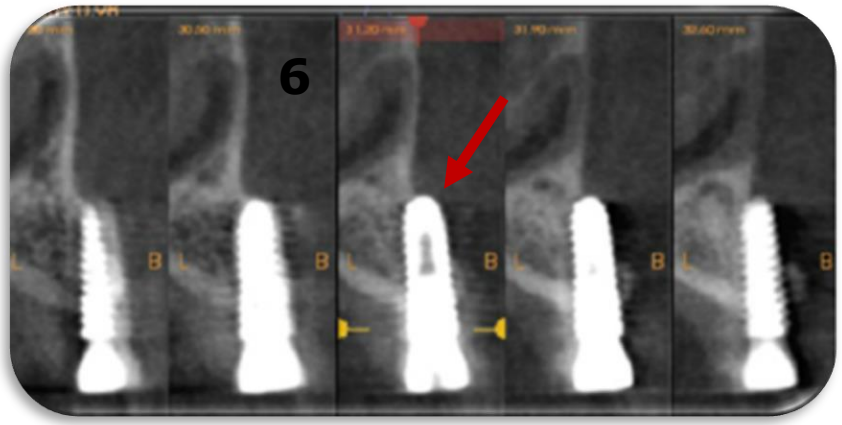

2


3

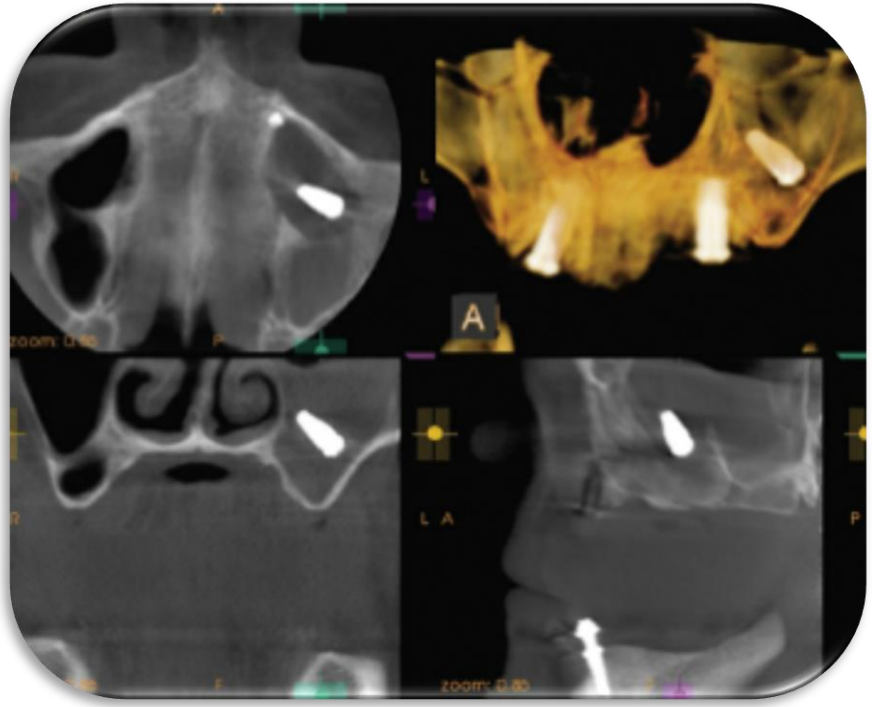

4


5 a
5 b


5


6

Intraoperative Imaging



- Periapical imaging
- Panoramic imaging
- CBCT imaging

Postoperative Imaging and Monitoring

- Periapical image: Immediately
- Panoramic image: For multiple implants
- Periapical or bite-wing: During prosthetic phase
- Annual recall imaging: Maintenance phase
- Symptomatic cases: CBCT