INNOVATIONS
for CBCT with 3D Diagnosis and Orthodontic Planning and Treatment
by Duane Grummons, DDS, MSD
3D imaging provides exceptional information about the craniofacial structures we treat. CBCT in orthodontics equips clinicians regarding problems with erupting teeth, facial asymmetry, craniofacial anomalies, temporomandibular joint (TMJ) disorders, TADs and root resorption. All scans in this article were taken using an i-CAT Platinum 17-19, model 1-10-1-0, www.imagingsciences.com. Renderings were done using Anatomage Invivo 5 and Dolphin 3D software.

**Primary Concern:** Crowding

**CBCT i-CAT Scan:** 4.8 sec/.3 voxel

**CBCT – 3D influenced orthodontic treatment:** 3D assessment affords increased precision (compared to 2D) in localizing impacted maxillary permanent canines and planning the biomechanics for recovery. Typical orthodontic opinion may have included: 1) wait to intervene, 2) advise for future orthodontic treatment and probable surgical access with forced eruption of canine, 3) potential that canine could not be rescued and would remain impacted and/or require removal and subsequent implant restoration. This CBCT data and Dolphin 3D renderings helped me conclude that the upper molar distalization would likely unlock and favorably re-direct the canine path of eruption. Both maxillary canines displayed similar position one year later.

**Primary Concern:** Impacted canines

**CBCT i-CAT Scan:** 4.8 sec/.3 voxel

**CBCT – 3D influenced orthodontic treatment:** The 3D renderings revealed sufficient anatomic separation of canines from facial roots of lower incisors. This proximity, while imposing a roots damage risk, revealed bony clearance to intervene and begin canine relocation distally with eruption vertically. The risks to benefit ratio was promising. This clinical judgment and conclusion could only be made after review of 3D CBCT data.
Primary Concern: Upper canines not erupting  
CBCT i-CAT Scan: 4.8 sec/.3 voxel  
CBCT – 3D influenced orthodontic treatment: Are these maxillary canines located palatally or facially? Are they damaging incisor roots? If surgically accessed, what strategy and path of forced eruption should be navigated? The 3D renderings made it clear that palatal surgical access and eruption vertically into the mouth, and then orthodontic guidance facially into position was preferred and eventually successful.

![Fig. 3: a. Impacted canines. b. Palatal locations of canines. c. Axial CBCT root view; upper canines and incisors. d. Transpalatal arch during canines rescue e. Canines well aligned with full root structure f. Optimal final occlusion.](image)

Primary Concern: Crowding – sleep/snore issues  
CBCT i-CAT Scan: 9 sec/.3 voxel  
CBCT – 3D influenced orthodontic treatment: Class II malocclusion treatment options exist for this adult patient. The severity of pharyngeal airway insufficiency and family history of sleep apnea make it vitally important to surgically relocate the mandible (forward BSSO) with genio-hyoid complex anteriorly. The CBCT data and maxillofacial radiologist’s report emphasizes that malocclusion treatment and mandibular structural lengthening would improve airway exchange volume, important factors for health and treatment success. Patient head posture makes a large difference in 3D airway measuring. CBCT represents one moment in time, while respiration is a dynamic process depending on what stage of breathing the image is taken.

![Fig. 4: a. Mandibular hypoplasia. b. Tongue volume encroaches upon pharyngeal airway. c. Mid-sagittal cephalogram with airway insufficiency. d. Class II mandible etiology with tongue and soft palate near retropharyngeal wall with narrowing of the oropharyngeal airway.](image)

Primary Concern: Cleft palate, major underbite  
CBCT i-CAT Scan: 9 sec/.4 voxel  
CBCT – 3D influenced orthodontic treatment: CBCT data and anatomic cranial base superimposition areas make it possible to visualize Class III craniofacial etiology. Treatment progress and therapeutic changes can be measured and viewed by utilizing and comparing maxillo-mandibular structures. Treatment changes and comparatives were created, viewed, measured and analyzed.

![Fig. 5](image)
Primary Concern: TMJ, jaw asymmetry
CBCT i-CAT Scan: 9 sec/.3 voxel

CBCT – 3D influenced orthodontic treatment: CBCT facial scan analysis revealed maxillary dysplasia and mandibular structural asymmetry. Compare L/R lateral maxillary perimeter; U/L occlusal planes; mandibular borders, rami and condylar processes. Note: traditional points location (i.e., Ag of mandible and J points of maxillae) are truly anatomic, and not misrepresented as occurs in 2D frontal tracings. CBCT scan and 3D renderings guided the combination Invisalign orthodontics and double jaw surgery. Maxillary and mandibular leveling and aesthetic asymmetry correction were achieved. Facial structural symmetry is challenging to manage, and rewarding to deliver for the patient.

Concluding Remarks
Imaging goals and CBCT protocol seek answers to specific clinical questions utilizing a precise display of relevant anatomical representation, with individualized patient findings closely viewed by the clinician. Each of us has a huge capacity to continuously learn and achieve and become brighter and better. One is not a successful clinician until fullest efforts have been made to become the best one can be for finest individualized patient care.

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Fig. 5: a. Severe mid-facial deficiency and bilateral cleft lip and cleft palate b. Class III skeletal morphology malocclusion and mandibular overclosure c. Maxillary LeFort I two-piece osteotomy and placement of skeletal fixation/external fixator for distraction osteogenesis of the maxillofacial complex. d. Maxillary complex relocated 13mm forward; facial axis opened six degrees. More orthognathic surgery at maturation. e. Superimpositions f. Maxillary/mid-facial protraction and vertical increase of anterior maxillary component by 8mm. Lip conformation and support much improved. g. Mandible clockwise rotation open; lower facial height increased.

Fig. 6: a. Accurate horizontal reference planes relative to mid-sagittal facial midline. b. Atypical condylar process morphology c, d. Osteoarthrosis on mandibular short side e. Bite changes; three lower incisors. f. TMD stabilization orthotic first; TMJ decompression. g, h. Full Invisalign for arch decompensations. i. Mirroring and merging of facial halves. j. Orthognathic surgery changes are measured at cranial base or by regional superimposition. k. Panoral view post-op; notice more lengthening on left side mandible. l. Grummons frontal 3D post-op tracing: three key areas are: upper dental midline to facial midline, occlusal plane and chin location.