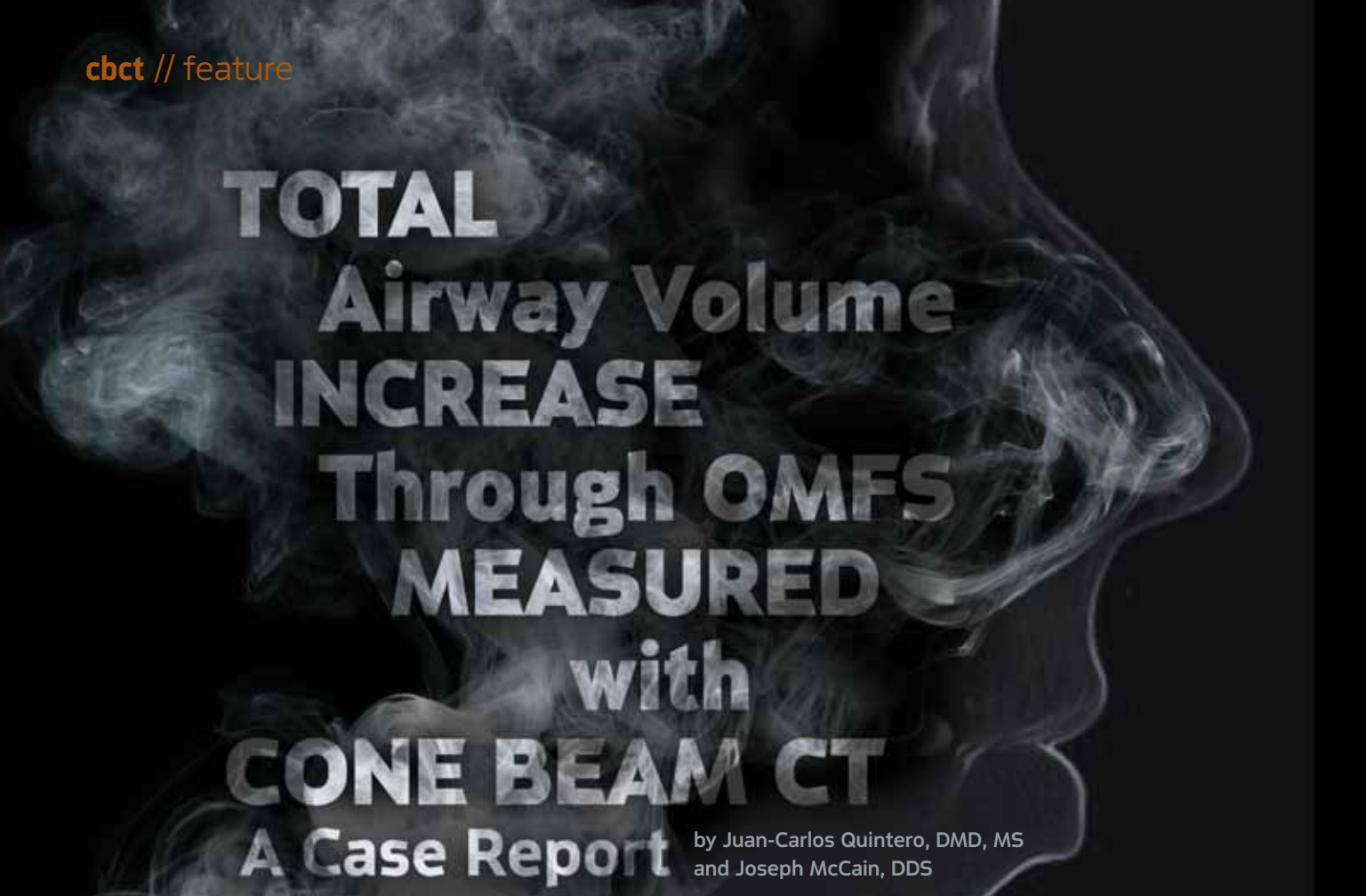

TOTAL Airway Volume INCREASE Through OMFS MEASURED with CONE BEAM CT

A Case Report

by Juan-Carlos Quintero, DMD, MS
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The advent of cone beam computed tomography (CBCT) has brought about many changes to the modern practice of orthodontics, including improved management of impactions, supernumeraries, transverse discrepancies and TMJ among others.[1] Of particular use is the ability to visualize and measure airway volume and incorporate such information into orthodontic diagnosis and treatment planning on a routine basis. Before the use of CBCT in orthodontics, dental imaging was limited to two-dimensional radiography and its inherent errors.[3] Furthermore, pharyngeal airway volume and space have been shown to be correlated with mandibular position.[2,4] Airway management has also shown to be a critical factor in the management of craniofacial growth and development.[5,6,7] Recently, a dramatic case study using pre- and post-CBCT showed significant improvement in airway volume and shape from the information gained through CBCT on a child after ENT surgery, orthodontic expansion and two years of favorable mandibular growth.[8] However, on the non-growing patient, the only hope of significantly advancing mandibular position, and thus increasing the total airway volume, is mandibular advancement (MA) or combined maxillo-mandibular advancement surgery (MMA).[9,10] In fact, MMA has been shown to have the second-highest success rate of all surgical procedures to treat OSA, second to only a tracheotomy, which is not practical for most people.[10] Therefore, information about airway (volume and shape) gained through CBCT, supplemented with medical history as it relates to breathing, should be a critical part in the management of all orthodontic cases. In fact, a primary question that should be asked of *any* orthodontic treatment plan is "what effect will a particular treatment plan have on the airway, if any?" or "which treatment will be most supportive of the best airway?"

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The following is a case report of an orthodontic treatment plan on a patient, which was highly dictated by the information gained on an i-CAT CBCT (Imaging Sciences International, Hatfield, Pennsylvania), and centered around the pharyngeal air space. The treatment result presented here supports the concept that MA or MMA are effective strategies to increase compromised or reduced airways, in addition to obtaining good facial balance, dental aesthetics and an optimal occlusion. Airway assessment should be a critical part of all orthodontic diagnosis and treatment planning, and orthodontic treatment plans should be tailored to support the healthiest airway volume possible for each specific patient. Currently, CBCT offers a practical and accurate method of evaluating the pharyngeal airspace three-dimensionally, and should thus be part of the standard orthodontic record for most growing and non-growing patients.

Case Report

Pre-treatment Workup

A 20-year-old female presented to our office for an orthodontic consultation. She reported a chief concern of wanting to straighten her lower teeth. She recalled a past history of comprehensive orthodontics whereby maxillary premolars were removed, presumably to address a skeletal CL II problem and/or crowding, as well as a recent history of her dentist extracting a lower right premolar in order to make space for crowded lower anterior teeth. The patient presented with a recent extraction site in the lower right first premolar area. A 3D diagnostic session was recommended using the i-CAT Next Generation so that the true 3D anatomical spatial relationships of the case could be considered in formulating a treatment plan. Digital modeling was used for anatomical segmentation and production of virtual models with roots and bone using AnatoModel (Anatomage Corp., San Jose, California). The patient was to return to the office for a formal treatment conference.

The records showed a CL II malocclusion due to an increased sagittal jaw relation and mandibular retrognathia with moderate lower crowding and a posterior cross bite (Figs. 1 & 2). The intimate position of the mandibular third molar roots relative to the inferior alveolar nerves was clearly depicted using the AnatoModel (Fig. 3). A narrow pharyngeal shape with reduced total volume was noted using InVivoDental 5.0 software (Anatomage Corp) (Figs. 4 & 5). Also


Fig. 1

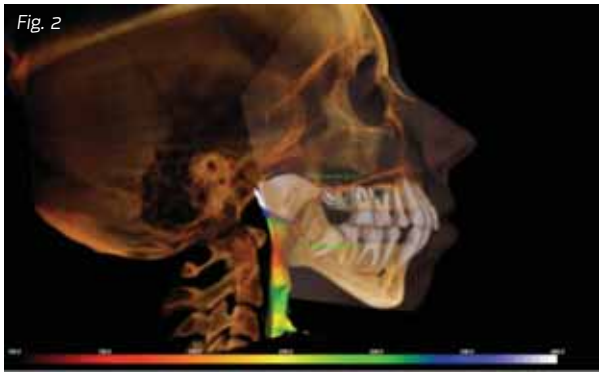
Fig. 2

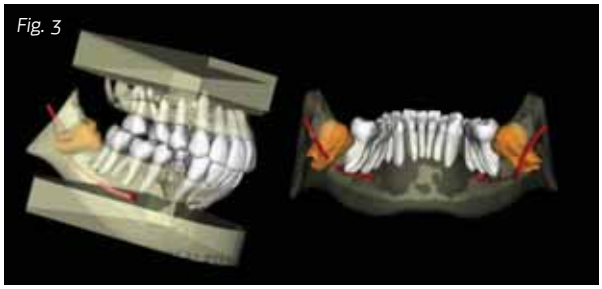
Fig. 3

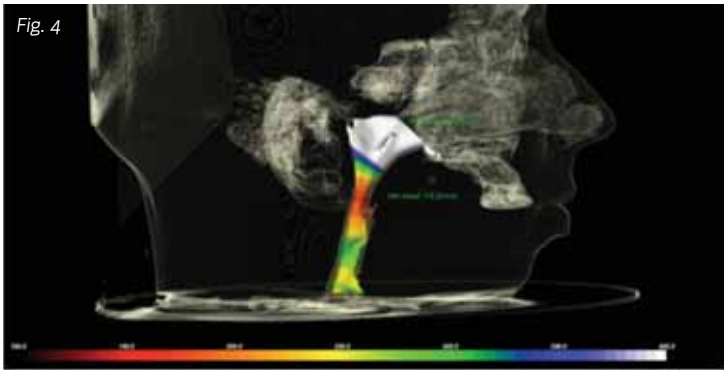
Fig. 4

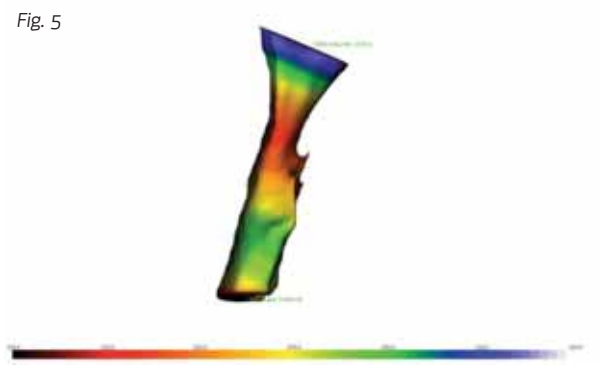
Fig. 5

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Fig. 6

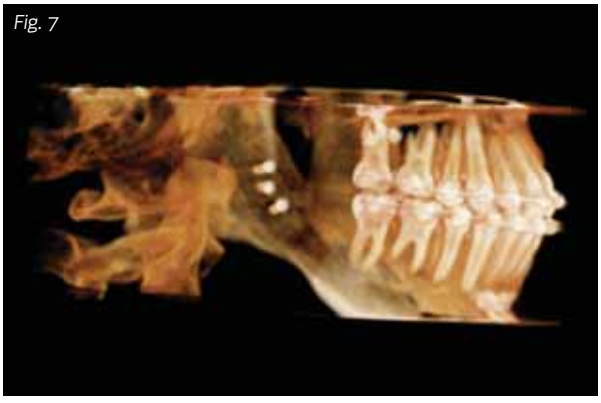
Fig. 7

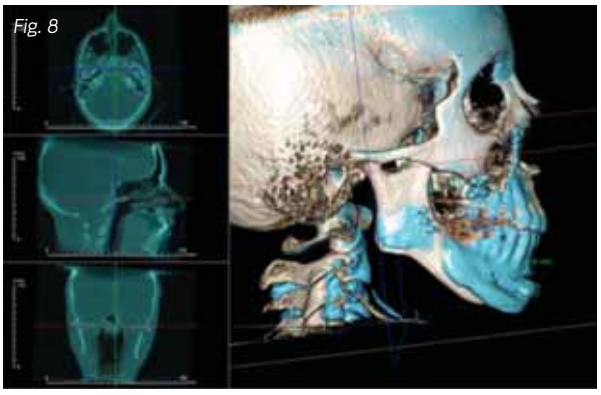
Fig. 8

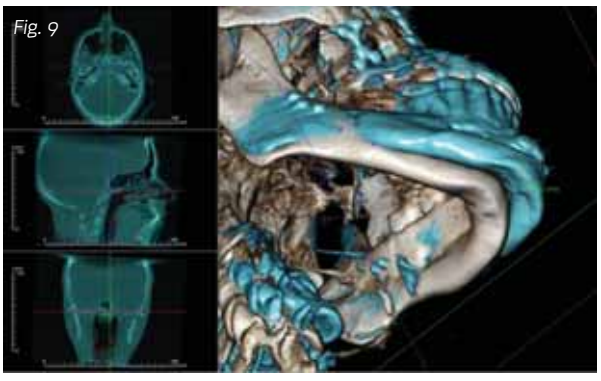
Fig. 9

using InVivoDental software, the total airway volume was measured to be 12.9cc, and the smallest cross-sectional area (aka "the bottleneck") was measured at 9.4mm. Orthognathic surgery is considered as the most definitive and effective corrective surgical means for the treatment or prevention of future obstructive sleep apnea (OSA) caused by an anatomically small airway.[10] The patient was presented several alternative orthodontic solutions including aggressive interproximal reduction with space opening for a dental implant or space closure using a temporary anchorage device. However, given the severity of the reduced airway detected and measured on the CBCT, and a high risk for OSA, retrognathic mandible, and the convex profile, an orthognathic surgical approach was recommended as the most comprehensive treatment. In any case, extraction of lower third molars was recommended prior to initiation of treatment. Tracing of the nerve in 3D proved to be very helpful for the treating surgeon (Fig. 3, previous page).

Treatment

Following a lengthy discussion about the risks, benefits, and alternatives to treatment, the patient choose the orthognathic surgical approach. The pre-surgical phase involved the removal of lower third molars and the lower left first premolar, followed by placement of full fixed appliances (.022 slot, Dentsply GAC In-Ovation C in upper arch and In-Ovation R in lower arch, Roncone prescription) with a pre-surgical goal of closing the premolar extraction spaces bilaterally and decompensating (increase the overjet) the case. The pre-surgical phase took approximately 12 months. Once arches were coordinated, leveled, aligned, placed into 19x25ss surgical arch wires (Fig. 6), and adequate overjet was attained, the patient was ready to have the OMFS procedure which consisted of the following: Le Fort I osteotomy with maxillary advancement of 5mm and superior repositioning of 5mm, mandibular autorotation, bilateral sagittal split osteotomies advancement of 12mm with rigid fixation, and advancement genioplasty of 2mm. Following the surgical procedure, the surgical archwires were removed and replaced with 18x25 NiTi wires and CL I elastics were worn nightly only for eight weeks. Progress records were then taken including a 4.9sec/0.3mm voxel "mini quick scan" using the i-CAT at 16x8cm field-of-view mode. A bracket repositioning appointment was then performed using the quick scan to begin the detail and finishing of the case. These mini-scans are far superior and very useful for bracket resets compared to panoramic films (Fig. 8). The patient's treatment was completed in 24 months, after initial placement of full fixed appliances, and retained using a mandibular lingual fixed retainer and upper and lower vacuum-formed removable retainers to be worn during bedtime only.

Results

After approximately 20 months of orthodontic treatment that involved double jaw orthognathic surgery, the patient received final records, including a final CBCT to assess treatment outcome. Using the 3D volumetric superimposition feature of InVivoDental 5.0, the

pre- and post-CBCT data sets acquired on the same calibrated i-CAT machine were merged and superimposed on the cranial base in 3D using InVivoDental's automated voxel point recognition algorithm on the cranial base and superior orbital rim (Fig. 8). The superimposition showed a mandibular advancement of 8.5mm measured at B point (Fig. 8), and a 12.8mm advancement measured at pogonion (Fig. 9). The final total airway volume was measured to be 38cc, compared to the initial airway volume measurement of 18cc. It is important to note that there is a human element, and as such a degree of inconsistency, in selecting the superior and inferior limits which the software uses for the segmentation of the automated airway volume reconstruction. The smallest cross-sectional area of the final CBCT showed to be 425mm, a significant improvement from the initial 170mm (Fig. 10). Again, it is important to note that the smallest cross-section area was detected to be in a different position altogether (Fig. 10). The final orthodontic result shows a bilateral angle CL I molar and canine relation, with good intercuspation, parallel roots, a balanced canine-guided occlusion, an orthognathic profile, and perhaps most importantly from an overall health and wellbeing standpoint, a much improved airway (Figs. 10-12).

Conclusion

In a previous case report,[8] we showed a dramatic and significant increase in total airway volume and shape on an eight-year-old male, following a combination of ENT surgery and orthodontic Phase I treatment, which arguably created more favorable conditions for improved mandibular *growth* over a two-year time period. The case was diagnosed, treatment planned and measured using CBCT. Similarly, we now present a case of a *non-growing* adult female with mandibular retrognathia, and consequently a reduced airway, which was improved using surgical advancement of her maxillo-mandibular complex.

This case report is again consistent with recent studies correlating airway size and volume with jaw size and position. In conclusion, given the growing concern, consequences and awareness over obstructive sleep apnea (OSA) in both children and adults, it is not just the ability of the orthodontist, but perhaps now the obligation of the orthodontist, to use recent advances in orthodontic imaging (CBCT) to make airway assessment an integral part of diagnosis and treatment in orthodontic cases. ■

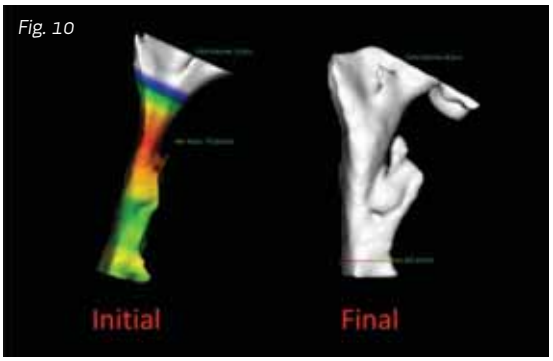

Fig. 10


Fig. 11

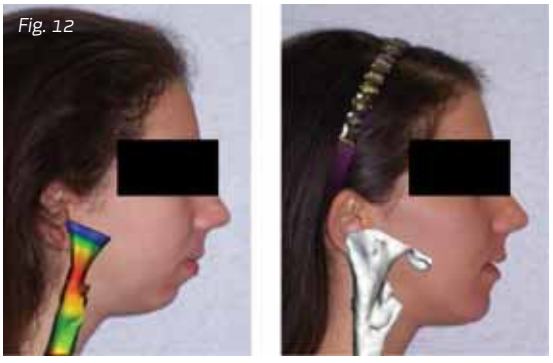
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Fig. 12

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Author Bios

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Dr. Juan-Carlos Quintero is an orthodontist in private practice in South Miami, Florida. He received his DMD degree from the University of Pittsburgh and his degree in Orthodontics and MSc from the University of California at San Francisco. Dr. Quintero holds faculty positions at The L.D. Pankey Institute and Miami Children's Hospital, Department of Pediatric Dentistry. He sits on the Board of Directors of the Baptist Hospital Foundation and Fortis College Advisory Board.