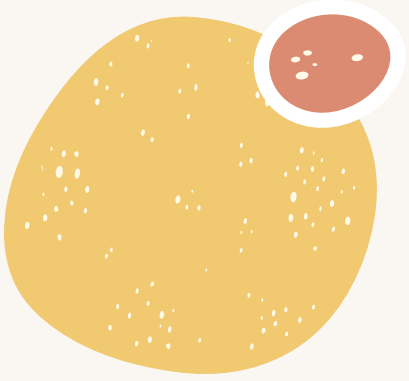
Combination Scan Technique: An Innovative Approach to Diagnosing Altered Passive Eruption

Hesham H. Abdulkarim, BDS, MSD
Akshay Vij, BDS, ACT, FAGD
Dwight E. McLeod, DDS, MS

Abstract

This case report describes the diagnosis and treatment of a patient with altered passive eruption using an innovative combination scan technique to determine the exact location of the alveolar bone crest in relation to the position of the cementoenamel junction and to confirm the diagnosis. Crown lengthening was performed on the upper maxillary anterior sextant to achieve ideal tooth contours and reduce labial bone thickness. On average, 2 mm of crown exposure was obtained, and gingival display when smiling was reduced. The patient was extremely satisfied and reported no complications. This technique can also be used to measure hard and soft tissue thicknesses and postoperative tissue stability.

Key Words: bone sounding, CBCT, crown lengthening, biologic width, gummy smile



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Introduction

Gummy smile, or excessive gingival exposure while smiling,[1] has been described as more than 2 mm of maxillary gingival display below the lower border of the upper lip during a full smile.[2] There are different etiological factors for a gummy smile, including altered passive eruption (APE), which has a prevalence of 12% to 35%.[3,4] To confirm the diagnosis and the subtype of APE,[5] clinicians traditionally use crestal bone sounding with a periodontal probe to determine the positional relationships between the gingival margin (GM), cementoenamel junction (CEJ), and alveolar bone crest and to determine the bone thickness. Once a diagnosis of APE is confirmed, surgical correction of the gingival and osseous architecture generally is required.[6] Since bone sounding cannot be performed on patients without anesthetizing the gingival tissue, many clinicians postpone it until the day of the surgery. However, postponement of this procedure may limit the amount of information about the etiology, proper surgical planning, and the expected outcomes for the clinician and the patient.

Studies have investigated the use of two-dimensional (2D) radiographs to diagnose patients with APE.[7,8] Distortion, calibration issues, and technical complexities, however, make 2D radiographs an impractical option for evaluating multiple teeth and not a reliable tool for determining the subtype of the APE pattern. Another limitation of 2D radiographs is that bone thickness cannot be evaluated.[9]

To address these issues with 2D radiographs and to obtain more information about bone thickness, Januário and colleagues[10] developed a soft tissue cone beam computed tomography (CBCT) technique, wherein two separate CBCT scans were obtained for the same patient so the clinician could measure hard and soft tissue components. Batista and colleagues[11] suggested the use of a single CBCT scan to identify anatomical features of APE.

In the current case report, an innovative combination scan technique (CST) was employed, in which a single preoperative CBCT scan and a digital intraoral scan were obtained at baseline and combined to evaluate the underlying bone. More specifically, the intraoral scans were superimposed and merged with the CBCT scan. This merged combination scan enabled the visualization, evaluation, and measurement of hard and soft tissue topographies of the treatment site **(Fig 1)**. After treatment, postoperative scans can be superimposed onto the previously made baseline combination scan to evaluate tissue stability.

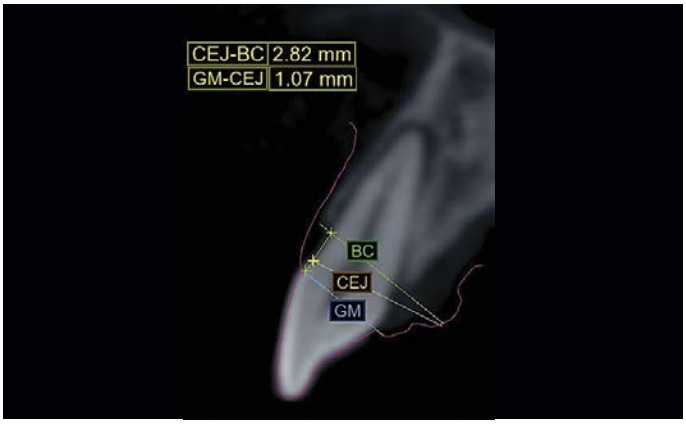


Figure 1: Example image of the CST and the possible measurements that can be made, showing the labial bone crest, cementoenamel junction, and gingival margin.

Case Report

Chief Complaint and Evaluation

A healthy 25-year-old female presented to a dental school clinic with a chief concern of excessive gingival display during smiling. Extraoral and intraoral clinical examinations revealed the following:

- a thick gingival phenotype
- 4 mm of labial gingival display below the lower border of the upper lip at the position of the upper central incisors during full smile
- normal lip length and mobility
- 8 to 12 mm of labial keratinized tissue
- a small diastema between teeth #8 and #9
- a mesioincisal chip in the enamel on #8 **(Fig 2)**.

Her medical and medication history were noncontributory.

Diagnosis

To predict the maximum coronal tooth exposure that could be obtained with esthetic crown-lengthening surgery without root exposure, use of the CST was recommended. A low-dose, limited field-of-view sectional CBCT scan was obtained preoperatively via a digital panoramic system (CS 8100, Carestream Dental; Atlanta, GA), and the resultant image was exported into the Digital Imaging and Communications in Medicine (DICOM) format. A maxillary intraoral scan that included the teeth and gingival tissues was completed with a scanner (CEREC Omnicam, Dentsply Sirona, York, PA) and was exported into standard tessellation language (STL) format. The resultant STL model was superimposed onto the CBCT (DICOM) file using a best-fit algorithm with treatment-planning software (Blue Sky Plan, Blue Sky Bio; Libertyville, IL) **(Fig 3a)**.

The following measurements were performed on the merged file: GM to the CEJ, CEJ to the alveolar bone crest, and bone thickness **(Fig 3b)**. Measurements were made at multiple points on the tooth for all teeth from the upper second bicuspid to the contra-

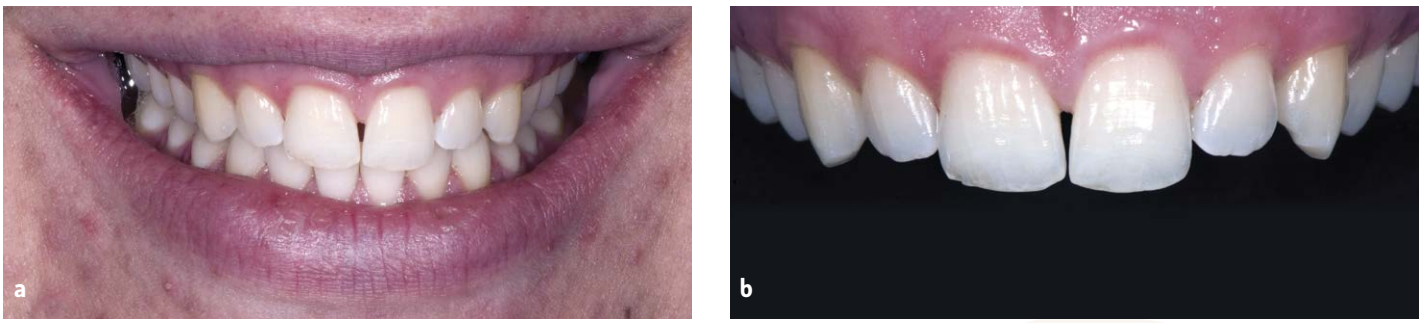
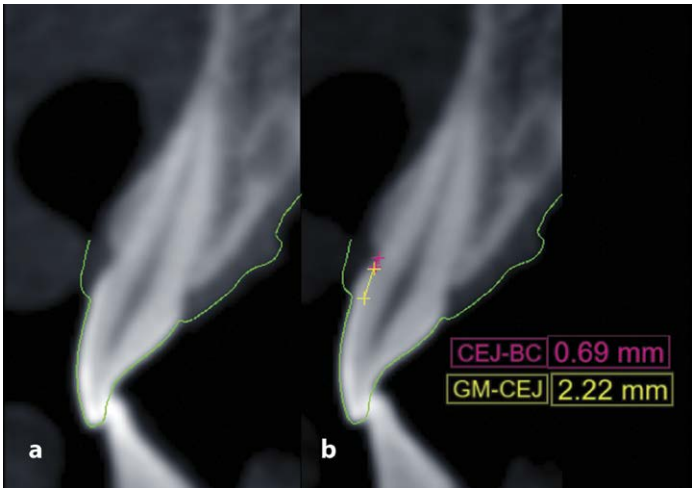


Figure 2: Initial presentation. (a) Frontal smile showing excessive gingival display. (b) Frontal intraoral view. Note the keratinized tissue, midline diastema, and minor mesioincisal chip on #8.



Figures 3a & 3b: Preoperative CST. (a) Tooth #9. (b) Tooth #9 with measurements.

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lateral second bicuspid. After reviewing information obtained from clinical examination and the combination scans, the patient was diagnosed with APE, Type I, subgroup B.[5]

A treatment plan of esthetic crown-lengthening surgery for teeth #4-#13 was formulated. The combination scans were used to discuss the diagnosis and the recommended treatment with the patient. The risks, benefits, alternatives, and long-term stability of treatment were also discussed with the patient, who consented to the proposed plan.

Treatment

From the combination scans, the measurements between the GM and CEJ were transferred to the labial gingiva using a periodontal probe **(Fig 4a)**. The initial submarginal scalloped gingivectomy incision was scored on the buccal gingiva at the level of the CEJ **(Fig 4b)**. Sulcular incisions were placed from the mesial to the distal line angles for each tooth. Split-thickness incisions were placed at the middle third of the papillae area with the papillae tips left intact. A buccal mucoperiosteal flap was raised over the buccal bone, and a split-thickness flap was created in the area of the papillae **(Fig 4c)**.

An osteoplasty was performed to reduce buccal alveolar bone thickness and to produce concave surfaces at interradicular areas **(Figs 4d & 4e)**. An ostectomy was performed to establish the desired 2-mm distance between the CEJ and the bone crest.[12] Sutures (4-0 Vicryl, Ethicon; Bridgewater, NJ) and oral tissue adhesive (PeriAcryl, GluStitch Inc.; Delta, BC, Canada) were used to secure the flap at the CEJ level **(Fig 4f)**.

Follow-up

At the six-month postoperative appointment, the patient's gingival tissue appeared to have healed and matured and reached the final position.[13,14] A direct composite resin restoration was used to close the diastema between #8 and #9 **(Fig 5)**. A final intraoral digital impression was made with the intraoral scanner and overlaid on the preoperative CBCT scan to evaluate the amount of clinical crown exposure gained **(Fig 6)**. Approximately 2 mm of tooth exposure was gained from the esthetic crown-lengthening procedure. The patient was satisfied with the esthetic results and reported no postoperative complications.

Figures 4a-4f: Esthetic crown lengthening for teeth #4-#13. (a) Gingival markings. (b) Scalloping incisions on buccal aspect. (c) Full-thickness flap reflected; note alveolar crest level in relation to the CEJ. (d) After osteotomy and ostectomy. (e) Preoperative and postoperative bone thickness. (f) Flap sutured.

Figure 5: Six-month postoperative views. (a) Frontal smile. (b) Frontal intraoral view

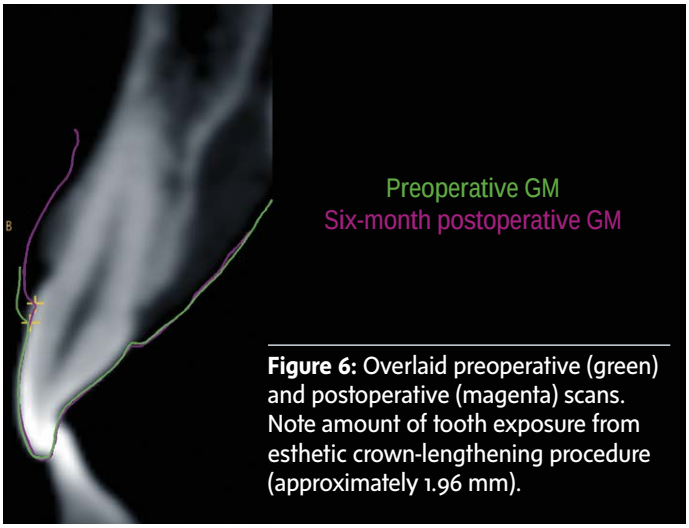

Figure 6: Overlaid preoperative (green) and postoperative (magenta) scans. Note amount of tooth exposure from esthetic crown-lengthening procedure (approximately 1.96 mm).

Discussion

This case report describes the diagnosis and treatment of a patient with altered passive eruption utilizing a combination scan technique. In general, it is difficult to noninvasively establish the relationship between the cementoenamel junction and the alveolar bone in cases of APE because of a tightly attached long junctional epithelium and the CEJ being at the level of, or apical to, the alveolar bone crest.[9] Although previous studies employed radiographic tools to determine the dimensions of dentogingival components,[7,8] 2D radiographs do not allow for three-dimensional (3D) evaluation of the GM, CEJ, alveolar bone crest, and bone thickness.[9]

Several studies have investigated the use of CBCT for 3D evaluation of the dentition.[8,9] Januário and colleagues[10] used two CBCT scans to measure hard and soft tissue components, and Batista and colleagues[11] employed a single CBCT scan to identify anatomical features. The current study utilized a CST, wherein intraoral scans were overlaid on a single CBCT scan with the teeth as common hard tissue landmarks. Including intraoral scans as part of the CST reduces the radiation dose compared to Januário and colleagues' technique, since only a single CBCT scan is needed and it also provides a more distinct and accurate soft tissue surface. This technique is a better alternative than simply altering the contrast/threshold values of a CBCT scan, as an STL file allows for better and more accurate visualization and measurement of hard and soft tissue surfaces. The superimposition and merging of the intraoral STL model on the CBCT scan is accurate and repeatable because common hard tissue landmarks are used for reference. The information obtained from the CST allows for more customized, patient-centered diagnosis and treatment and results in a more predictable outcome that can be evaluated over time for long-term soft tissue stability, and the tissue can be rebound around the surgically exposed crowns because of the crown-lengthening procedure.[13,14] This technique also provides easy visualization of a cross-sectional model that clinicians can show patients to discuss treatment options in an informative and engaging way that reduces patient anxiety and enhances treatment acceptance.

Tips for Combination Scan Technique

Beginner

- Pursue continuing education to master the evaluation of patients using principles of facial esthetics, dental esthetics, dentogingival esthetics, and gingival phenotypes.
- Perform a comprehensive intraoral and extraoral examination that includes obtaining the appropriate photographs, lip and teeth measurements, intraoral digital impression, and complete periodontal evaluation.

Intermediate

- Obtaining an accurate overlay or merge of the intraoral scan and CBCT is paramount to making accurate measurements.
- Highly radiopaque materials such as restorations containing metal, gutta-percha as well as dental implants can cause artifacts and scatter in the CBCT that will make it difficult to obtain an accurate stitch.

Advanced

- Take into consideration the multitude of etiologies that can cause excessive gingival display, including hypermobile lip, vertical maxillary excess, short upper lip, deep bite or dental alveolar extrusion, or altered passive eruption.
- In cases with altered passive eruption, in addition to the vertical positional dentogingival relationship, consider the horizontal soft tissue and alveolar bone thicknesses as confounding factors.
- Accurate transfer of the preoperative measurements and precise surgical execution of the predetermined plan are paramount.

Despite reported positive esthetic and psychological effects of surgical correction of gummy smiles,[15] and compared to studies of functional crown lengthening, there remains a lack of studies investigating treatment planning, surgical outcomes, and prognosis of esthetic crown-lengthening procedures. Perhaps the variability in the distance between the CEJ and the alveolar bone crest limits investigation in this area because it complicates the diagnostic process and the preoperative determination of the amount of ostectomy required to address the APE with current techniques.[16] Use of the CST can address these limitations.

Even though the CST can be beneficial, clinicians should use caution when employing this technique since, unlike traditional bone sounding, it involves exposing patients to additional radiation. The added cost of equipment for the CBCT and intraoral scans may also be a limiting factor for use of this combined technique. Further, if the scans are improperly aligned, there is the potential for measurement errors and subsequent misdiagnosis. When considering the CST for treatment planning, clinicians should discuss the risks, benefits, and alternatives with the patient, and the patient's preferences should be incorporated into the treatment plan.

Summary

The case discussed in this article employed a novel combination scan technique to evaluate and diagnose a patient with altered passive eruption and a chief complaint of a gummy smile. Successful management of the case involved proper identification of the etiologic factors contributing to the APE and the combined use of CBCT and intraoral scans to determine the best treatment plan and application of indicated surgical techniques.

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Dr. Abdulkarim is an assistant professor of dental implants and periodontics at A.T. Still University-Missouri School of Dentistry & Oral Health (ATSU-MOSDOH), in St. Louis, Missouri.

Dr. Vij is the specialty care unit director of esthetic and digital dentistry at ATSU-MOSDOH, in St. Louis, Missouri.

Dr. McLeod is the dean of ATSU-MOSDOH, in St. Louis, Missouri.

Disclosures: The authors did not report any disclosures.