Identification and management of passive eruption

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_C.E. Article_ 1

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Excessive gingival display can affect the total esthetics of a smile, becoming the focus instead of the frame of the smile. This can be the result of passive eruption of the gingival complex as the teeth erupt.1,2

The condition of delayed or altered passive eruption exists when the gingival complex remains positioned coronal to the cementoenamel junction with the attachment on the enamel instead of the cementum of the root, giving the appearance of short clinical crowns.3

Crown lengthening4 is critical to the success of creating a smile that is harmoniously balanced with its surrounding facial features.5

Patients who clinically display too much gingival tissue and short teeth require a thorough diagnosis and treatment plan to provide a predictable esthetic outcome.6

If a patient has altered passive eruption (APE) of the maxillary anterior teeth either secondary to orthodontic treatment or without orthodontic treatment, but the patient has completed facial growth,7 then the practitioner must first correct the gingival levels with either a gingivectomy or esthetic crown lengthening procedure before the placement of veneers or crowns. Thus ensuring that the eventual gingival margins of the maxillary anterior teeth will be at their correct level relative to the adjacent anterior teeth.8

_Understanding altered passive eruption_ 1

In a human mouth absent of periodontal disease, the osseous structure roughly follows the scalloped parabolic contour of the cementoenamel junction (CEJ), from facial to interproximal at an average distance of 2 to 3 mm.9

Fig. 1 Excessive gingival display with pigmented gingiva.

Fig. 2 Wide band of heavily pigmented attached gingiva with passive eruption of the anterior teeth.

Fig. 3 Vacuform stent that has been scalloped at the desired gingival height to act as a surgical template.

Fig. 1

Fig. 2

Fig. 3
In addition, the average interproximal bone height is 3 mm coronal to the facial crest of bone. Because the soft-tissue topography is usually determined by the underlying hard tissue, this osseous "scallop" usually results in a gingival scallop of 3 mm.

Examination of the peri-apical radiographs or periodontal vertical bite-wings will allow the clinician to ascertain the position of the alveolar bone relative to the CEJ of the teeth to determine whether the crest of bone (COB) is 2 to 3 mm apical to the CEJ, allowing for biologic width.

However, where the COB is coronal to the CEJ, a condition results that is referred to as APE. In this situation, the gingival margin will usually be located, on average, 3 mm coronal to the level of the crest of bone, being more coronal on the body of the tooth and creating the appearance of a short, clinical crown. These visual findings are coupled with the clinical information obtained by "bone sounding."

Bone sounding involves using a periodontal probe to locate the CEJ and determine whether it can be felt within the gingival sulcus or only when the probe penetrates through the base of the sulcus.

Additionally, the periodontal probe is also used to feel for the COB. This value is expressed as a numerical distance in millimeters, revealing the distance between the COB and CEJ to ascertain whether there is sufficient biologic width. In a normal, non-diseased human periodontium, the COB is 2 to 3 mm apical to the CEJ.

In addition to the gingival margin on the facial aspect of the teeth, in non-diseased dentition, the interproximal papilla between teeth with no bone loss due to periodontal disease is approximately 4.5 mm coronal to the interproximal crest of bone. The mid direct facial is about 1.5 mm more coronal to the COB.

This additional 1.5 mm, with the 3 mm average osseous scallop from the CEJ, results in the tip of the papilla being an average of 4.5 mm coronal to the facial free gingival margin, where there is a "normal" periodontium, with no loss of bone or periodontal attachment due to periodontal disease.

Anatomic considerations act as parameters when practitioners perform esthetic gingival recontouring. A useful guide can be fabricated by modifying the mounted diagnostic casts so that the waxed modification reflects the ideal tooth proportions desired in the final result, based on the guidelines previously published by Chiche and Pinault.

These guidelines suggest that the average length for esthetically pleasing maxillary central incisors is 10–12 mm. These guidelines for the length of the central incisors, along with the recommended width-to-length ratio of 75 to 80 percent, should be kept in mind when contouring the gingival tissues so as not to leave the teeth too long or too short.
After proportions are achieved on the central incisor proportions, practitioners should focus on the height of contour of the gingival margin on the centrals (zenith). The proper placement of the gingival zenith should be at the peak of the parabolic curvature of the gingival margin, which for the central incisors, cuspids and bicuspids, should specifically be located slightly distal to the middle of the long axis on these teeth. This gives the centrals, cuspids and bicuspids the subtle distal root inclination, which is paramount for the scaffold of a beautiful smile.

The zenith for the lateral incisors is located at the midline of the long axis of the tooth. Furthermore, the height of the gingival crest for the lateral incisors should be 1 mm shorter than the gingival margins of the adjacent teeth (centrals and cuspids).

Finally, the gingival tissues should be manipulated to have a resulting “knife-edge” gingival margin. When the presence of short clinical crowns and crestal bone levels approximating the CEJ has been determined, a diagnosis of APE can be made through the maxillary arch.

The practitioner can then fabricate an esthetic guide that can be placed over the patient’s existing teeth to enable both the practitioner and patient to visualize what the smile would look like with the gingiva in a modified, more esthetic position.

The central incisors should demonstrate midline symmetry, as well as the correct 75 to 80 percent width-to-length ratio. In addition, the incisal smile line follows the curvature of the lower lip. The newly established periodontal smile line should show a reduction of the gummy smile and make the smile more esthetically appealing and harmonious with surrounding facial features.

Gingival levels should be assessed relative to the projected incisal edge position. A predictable method of determining the proper gingival positions is to determine the desired tooth size relative to the projected incisal edge position. The practitioner should remember that the incisal edge should not be positioned using the relative position of the gingival margin to create the proper tooth size. This is because the gingival margin can move with eruption or recession.

It is also paramount when establishing the proper position of the maxillary anterior teeth for an optimal cosmetic outcome to assess the levels of the interdental papillary tissues and their position relative to the crown length of the maxillary incisors.
Gingivectomy and gingivoplasty for esthetic soft-tissue correction

Traditionally, scalpels and periodontal knives (Orban and Kirkland) were utilized to sculpt soft tissue when gingivectomy was the treatment being used to improve esthetics.\(^\text{29}\) These provided precise incisions, but the resulting raw, bleeding surfaces complicated postoperative healing. Monopolar electrosurgery, another option, requires a dry field during treatment and this may increase tissue inflammation during the initial healing period and subsequent tissue shrinkage.

“Charring” of the tissue margins at surgery has also been reported with monopolar electrosurgery and may be a result of the need for operating in a dry field and the high wattage needed to overcome resistance between the cutting tip located intraorally and the grounding plate located a distance away on the body.\(^\text{30,31}\) Bipolar electrosurgery was developed to overcome the obstacles associated with monopolar electrosurgery.

True bipolar electrosurgery as used today in dentistry is a cross over from neurosurgery, which requires delicate incisions in wet fields with no lateral heat generation. The Bident Bipolar surgical unit (Synergetics, King of Prussia, Pa.) transfers those neurosurgical requirements to the dental environment, allowing intraoral soft-tissue surgery in wet fields with char-free, non-bleeding incision margins.\(^\text{32}\) This eliminates marginal shrinkage related to tissue inflammation and provides a more comfortable postoperative period for the patient.

When using the bipolar surgical unit, because the tips have two electrodes that are either straight wires or loops, one must remember that the first electrode to touch the tissue acts as the return and the second electrode does the cutting or coagulating, depending on which foot pedal is depressed. Because the bipolar surgical unit is fully isolated from ground, unlike monopolar electrosurgical units, a ground is not required. Additionally, as no grounding plate is required and resistance through the body is not an obstacle to be overcome, wattage is one-quarter of that used with monopolar electrosurgery.

It is also advised by the author that when you are cutting tissue, your assistant is constantly spraying water from the air/water syringe to keep the field wet while using the high-volume evacuation. This improves efficiency with the handpiece and prevents charring.

Another benefit of the bipolar surgical unit is that even during cutting there is some coagulation that occurs, so the wound edges that result do not ooze and interfere with any restorative procedures being performed during the same appointment.\(^\text{33}\)

Case No. 1: Passive eruption

A 32-year-old female patient presented for treatment of excessive gingival display in the anterior region and requested a restorative option that would provide improved esthetics (Fig. 1). Initial clinical examination revealed a wide band of attached gingiva in the maxillary and mandibular anterior with associated passive eruption (Fig. 2).

Periodontal probing indicated that the depth of the sulcus on the facial of the maxillary anterior teeth was coronal to the CEJ, supporting the presence of passive eruption.
Also noted was the presence of peg-shaped laterals bilaterally, which were tipped both mesially as well as palatally.

A gingivoplasty was scheduled to move the gingival margin to be equal or apical to the CEJ, and perform restorative correction of the lateral incisors.

To aid in the treatment planning, the preoperative smile image was modified using Adobe Photoshop (Adobe, San Jose, Calif.) to indicate the proposed location of the modified gingival margin. This was performed to determine if sufficient attached gingiva would remain following gingivoplasty.

Next, the cervical area of each of the teeth to be treated in the maxillary anterior was altered on the photograph to simulate the cosmetic change in a photographic mock-up.

The patient indicated that the suggested correction of the excessive gingival display would meet her esthetic concerns and she would consider placement of porcelain veneers on the maxillary lateral incisors in the future.

As the mandibular passive eruption of gingiva was not apparent when smiling, the patient declined treatment of that gingival tissue.

**Surgical procedures**

A line was drawn on the maxillary master model indicating the intended position of the gingival margin based on width-to-length criteria.

A sheet of 0.30-inch vacuform material (Raintree Essix, Metairie, La.) was thermoformed over the cast using a Drufomat pressure former (Raintree Essix, Metairie, La.).

After cooling, the thermoformed material was trimmed, scalloping the facial margin to follow the line that had been placed on the master model. The edge was then colored with a black sharpie marker to make it more visible intraorally during surgery (Fig. 3).

Following administration of a local anesthetic, 4 percent Septocaine with 1:100,000 epinephrine (Septodont, New Castle, Del.), a periodontal probe was used to feel the CEJ at the mesial, distal and mid-facial aspect of each of the anterior teeth and the premolars. The vacuform surgical template was inserted and the edge of the tray on the facial was visualized in relation to the mucogingival line.

A 3301 gingivectomy pen was used with a bipolar surgical unit to follow the facial edge of the surgical stent from teeth #4 to #8 (Fig. 4). While the clinician applied the bipolar pen, the assistant sprayed a continuous stream of water over the field, followed by high-volume evacuation to keep the tissue hydrated during the procedure.

The surgical template was removed and the outline of the proposed gingival margin was evaluated. The gingivectomy pen (Bident, Synergistics USA, King of Prussia, Pa.) was used to complete the contouring gingival cut using a semi-lunar shape, sparing the papilla. To avoid a resultant “black triangle,” the papilla was not included in the gingivoplasty cut. A periodontal scaler was used to detach the gingival tissue from the tooth surface and remove any tissue tags remaining on each site.

A 3302 Gingivoplasty pen (Synergistics USA, King of Prussia, Pa.) was used to plane back the thick tissue at the facial aspect of the papilla to achieve normal proportions.
contours and taper in the tissue. Again, water spray was used to maintain tissue hydration and improve postoperative healing. Finally, a 3102 coagulation ball pen (Synergistics USA, King of Prussia, Pa.) was used in the bipolar unit on coagulation mode to seal any bleeding over the gingivoplasty surface. The right quadrant was compared to the left to ensure proper reduction and the process was repeated on teeth #9 through #13 (Figs. 5–7).

**Postoperative instructions**

The patient was dismissed and instructed to avoid spicy foods and to use warm salt water rinses three to four times daily until she presented for the follow-up appointment two weeks later. At the follow-up appointment, the patient indicated that postoperative sensitivity and gingival irritation were not experienced, and the patient was satisfied with the improved smile (Fig. 8).

Clinical examination noted a lack of gingival inflammation except for a small spot on the papilla between the right lateral incisor and central incisor. All areas except this spot were covered with keratinized gingiva that was less pigmented than what was initially present.

At four weeks post surgery, the patient returned and healing was noted as complete (Fig. 9). The patient indicated that she had received comments from friends and family that she appeared to be smiling more. Additionally, she commented that she was no longer self conscious about her smile and was indeed smiling more and would, when finances allowed, proceed with the recommended veneers on the maxillary lateral incisors.

**Case No. 2: Passive eruption with spacing issues**

The patient, a 40-year-old woman, presented with a history of previous direct bonding to correct moderate tetracycline discoloration of the teeth and generalized diastemas. Examination revealed an excess display of gingiva when the patient smiled, as well as bulky, chipped and discolored direct-resin restorations on the maxillary anterior teeth (Figs. 10, 11). The patient expressed a desire for a less gummy smile and an overall improvement in the esthetics.

A full series of radiographs was taken and a periodontal examination was performed. It was noted that a wide band of attached gingiva was present. Examination of the radiographs, coordinated with intraoral probing, determined that removal of 2 mm to 3 mm of gingival tissue would not encroach on the crestal margin of bone and an osseous component to the gingival surgery would not be needed.

After a consultation with the patient and a discussion using the modified photograph, treatment progressed to a wax-up phase on the casts. A duplicate cast of the maxillary arch was altered to give the teeth normal thickness and eliminate the bulky composite that was present.

This was followed by application of a dentin adhesive (Bond 1, Pentron Clinical Technologies, Wallingford, Conn.) to the cast to aid in retention of the wax-up to the cast. Next, composite (Simile®, Pentron Clinical Technologies) was applied to the cast and shaped with composite instruments so that contour and tooth proportions developed.

Material was placed over the gingival aspect of the cast to position the tooth's cervical line where it would be positioned clinically using the modified photograph as a guide. When the contour and position of the composite were finalized, the casts were cured with a handheld curing light (Figs. 12, 13). The modified maxillary model was then placed into Futura floor wax and allowed to soak for five minutes, followed by bench drying for 30 minutes to seal the cast.

Kromopan alginate (Kromopan, Des Plaines, Ill.) was mixed to a runny consistency with more water then normally used and placed into a rubber base former. The modified cast was inserted tooth side down into the material and allowed to set. Upon setting, the model was separated from the alginate and a stone cast was poured.

After the stone cast had completely set, it was removed from the alginate and trimmed to eliminate the palatal area of the cast. This was performed to permit better adaptation of the vacuform material to fabricate stents.

Using a Druformat™ pressure-forming machine (DENTSPLY Raintree Essix, Metairie, La.), two separate stents were fabricated using Tray-Rite sheet material (DENTSPLY Raintree Essix).

The first stent was trimmed to follow the gingival margins on the cast and would act as a guide during gingival surgery. To aid in visualization during surgery, a black sharpie marker was used to color the scalloped gingival margin of the surgical stent. The second stent was trimmed to be used as an intraoral form to fabricate the functional mock-up.

After application of local anesthetic, the first step at the clinical appointment was to strip the old composite using a diamond bur in a high-speed handpiece with water. Care was taken to avoid removal of any enamel at this time. Upon removal of the old composite, it was noted that the teeth had moderate tetracycline staining with a banded appearance.

The maxillary lateral incisors were also noted to be in slight crossbite orientation (Fig. 14). The crossbite situation was mild with no negative overbite, presenting with no contact between tooth #7 and the lower teeth when the teeth were moved into lateral excursions.
The mock-up would be able to determine if during normal function, the resin at the incisal of tooth #7 would chip, which would then require consideration of a full-coverage restoration vs. a labial veneer. When the maxillary tooth is “locked” behind the mandibular tooth, the crossbite would not allow a more normal positioning of the maxillary tooth without drastic preparation of the tooth in crossbite and would require orthodontic intervention to correct.

The surgical stent was inserted and assessment of the new gingival margins was made following the black edge of the surgical stent to ensure that adequate attached gingiva would remain after gingival recontouring (Fig. 15).

Using the bipolar surgical unit, a 3304 gingivectomy pen (Synergetics) was used to follow the edge of the surgical stent while the assistant sprayed a constant stream of water spray with one hand and used the high-volume evacuation device with her other hand. This allowed the tissue to remain hydrated and eliminated any tissue charring during the procedure. This permits improved healing with the lack of inflammatory response often seen with monopolar soft tissue surgery.

Healing time for a gingivectomy is approximately three weeks before the tissue is in a stable position and all associated inflammation is concluded. The Bident Bipolar unit would permit progress to impressions or final restorations immediately, with no healing change in the position of the new margin position because of the lack of heat at the cut margin and lack of inflammatory response.

Osseous surgery requires longer periods of healing because of the manipulation of the osseous crestal position and greater amounts of soft-tissue manipulation before a stable position is achieved. An additional benefit of the Bident Bipolar unit is a lack of tissue bleeding after treatment that could discolor the composite that is being placed.

The stent was removed and gingival margins were further refined with the gingivectomy pen. Tissue was then planed back to develop good papilla contours using a 3302 gingivoplasty pen (Synergetics). Completion of the gingival recontouring did not result in exposure of the crestal bone and non-bleeding gingival margins were noted (Fig. 16). The position of the crestal bone was determined through sulcular sounding with a periodontal probe.

The information gathered indicated that some passive eruption issues were present and with the wide band of attached gingiva present would allow removal of 3 mm of gingival tissue and still provide a normal sulcular depth after healing. The restoration margins were placed at the new gingival margin position.

The functional mock-up stent was tried in, and the gingival position was assessed. Teeth were isolated with cotton rolls and the facial and interproximal of teeth #5—#12 were etched with a 37 percent phosphoric acid-etchant gel for 30 seconds then rinsed and dried. Bond-1 dentin adhesive was applied to all surfaces and light cured for 20 seconds per tooth.

The patient requested a very white bleaching shade and Artiste™ nano composite (Pentron Clinical Technologies) Super Bleach dentin shade and Bleach enamel were selected for the functional mock-up. A thin layer of Bleach enamel shade was placed into the stent in the area of the incisal edge and incisal half of the coronal of teeth #4—#13.

Next, the Super Bleach dentin shade was placed into the stent and the facial aspect of each tooth was filled with material. The stent was then carried intraorally, seated and adapted to the teeth with finger pressure. Each tooth was then light cured for 30 seconds on the cervical followed by 30 seconds on the incisal.

The stent was removed, leaving the bonded functional mock-up on the teeth, and additional light curing was performed. A needle finishing diamond (Brasseler, Savannah, Ga.) was used in a high-speed handpiece with water to remove the cervical flask and provide contours without any overhanging margins. Cervical embrasures were also opened, and definition given to the interproximal line angles.

Occlusion was checked in centric occlusion and lateral excursions and adjusted for proper anterior guidance. Polishing was accomplished using Fini™ polishing paste and a cloth buffer tip (Pentron Clinical Technologies) (Fig. 17).

The patient was recalled 24 hours later to check soft-tissue healing and assess the occlusion. At this time, minor refinement of the esthetics was accomplished and the patient indicated no irritation gingivally where tissue had been treated with the bipolar surgical unit. Slight sloughing of the keratinized layers of the tissue was observed, but a lack of inflammation was noted (Fig. 18).

The patient was next seen at two weeks post-treatment. At this visit, it was noted that the soft tissue had a normal appearance in color and tone and no inflammation was observed. Further refinements in the esthetics were made in the functional mock-up, opening the incisal and gingival embrasures, shortening the incisal edges of the lateral incisors and working with the patient to achieve her view of ideal esthetics that would serve as a blueprint for the final restorations.

Figures 19a and 19b depict the patient before and after correction of the gummy smile and placement of the functional mock-up. After a period of use of the functional mock-up to verify that the anterior guidance was not causing any chipping or damage to the functional mock-up, final restorations would be planned and a determination between ceramic
cosmetic dentistry

Case No. 3: Passive eruption with incisal wear

A female patient presented with the complaint that her teeth appeared short and her smile was gummy. Diagnosis determined that the patient had good periodontal health, with no gingival inflammation nor bleeding and a wide band of attached gingiva (Fig. 20).

Probing depth in the maxillary anterior was within normal limits at depths of 1–2 mm. The gingival margin was positioned, in general, 2 mm coronal to the CEJ. Radiographically, the osseous crest was positioned apical to the CEJ and no bone loss was evident.

Local anesthetic was infiltrated into the buccal vestibule from the second premolar to second premolar. A peri-probe was introduced into the facial sulcus to sound the osseous crest in relation to the CEJ and no bone was noted coronal to the CEJ on the teeth. The Chu instrument for determining width-to-length proportions (Hu-Friedy, Ill.) was used to determine where the gingival margin needed to be placed to have ideal length (Fig. 21).

The Bident Bipolar 3303 gingivectomy handpiece (Synergistics, King of Prussia, Pa.) was used to mark the zenith of each tooth to be altered. Using the gingivectomy handpiece, the gingival margin was sculpted to ideal contours (Fig. 22). The papilla is spared to avoid the potential of creating black triangles interproximally.

The resulting tissue margin after use of the gingivectomy handpiece results in a soft-tissue ledge that needs to be tapered onto the tooth. A Bident Bipolar 3302 gingivoplasty handpiece (Synergistics, King of Prussia, Pa.) was used to sharpen the edge, and also in relation to the adjacent teeth, when evaluating the cosmetic aspects of patients. Passive eruption appears to be infrequently recognized and can affect the final cosmetic result when not addressed as part of the overall treatment.

The teeth were then isolated and acid etched with a 37 percent phosphoric acid gel for 30 seconds then rinse and dried. Bond-1 adhesive was applied to the etched tooth surface then light-cured. Using a stent previously fabricated to the desired incisal length, Artiste nano composite (Pentron Clinical, Orange, Calif.), the length was built using an enamel shade of resin and light cured. The stent was removed and each tooth was then built to full contour of the new length created by lengthening both gingivally and incisally with dentin and enamel shades of Artiste nano composite. Following finishing and polishing of the direct resin restorations, occlusion was checked and adjusted to maintain the anterior guidance that was present before treatment (Fig. 23).

The patient was dismissed and instructed to avoid any alcohol or peroxide containing mouthrinses for the first week and to rinse with warm salt water three to four times daily for the first three days. Additionally, the patient was instructed to continue oral hygiene including brushing the area with a toothbrush and her regular toothpaste. At 24 hours, the patient was called to check on her comfort level, and she indicated no postoperative discomfort nor irritation during normal daily activities.

At one-week post surgery the patient returned for a postoperative examination where a lack of inflammation was noted (Fig. 24). A four-week postoperative examination demonstrated a more esthetic smile with better width-to-length proportions with elimination of excess gingival display.

Conclusions

Practitioners frequently tend to ignore the gingival tissues’ position relative to the tooth’s incisal edge, and also in relation to the adjacent teeth, when evaluating the cosmetic aspects of patients. Passive eruption appears to be infrequently recognized and can affect the final cosmetic result when not addressed as part of the overall treatment.

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