

Altered passive eruption: An etiology of short clinical crowns

Arthur H. Dolt III*/J. William Robbins**

Abstract | *The gingival complex plays a vital role in the overall beauty of a smile. To predictably achieve a successful esthetic and functional result, the dentist must be able to precisely predict the treatment outcome based on biologic determinants. In this article, the biologic requirements for gingival health are discussed. In addition, a differential diagnosis for excess gingival display and treatment options for this condition are discussed. (Quintessence Int 1997;28:363-372.)*

Clinical relevance

Many people with excess gingival display are unhappy with their smile but are unaware of the options available for enhancement of their smiles. It is important for dentists to understand both a differential diagnosis and the available treatment options for excess gingival display.

Introduction

With the increased emphasis on facial esthetics, both patients and dentists are developing a greater awareness of the impact of the gingiva on the beauty of the smile. In the past, the major dilemma related to gingival levels for the restorative dentist was the management of the patient with long teeth secondary to periodontal surgery. However, with the evolution of current periodontal techniques, this problem occurs much less frequently. In recent years, more attention has been given to the problem of excessive gingival display. Previously, the short clinical crown in the anterior maxilla was either ignored or lengthened prosthodontically. However, the short clinical crown is commonly a result of factors other than inadequate

length of the anatomic crown. Common causes of short clinical crowns include coronal destruction resulting from traumatic injury, caries, or incisal attrition, as well as a coronally situated gingival complex resulting from tissue hypertrophy or a phenomenon known as altered passive eruption.

Successful treatment of short clinical crowns requires the practitioner to adequately diagnose the true etiology and to plan an effective course of treatment while giving careful consideration to the biologic width and the dentogingival junction. One of the most commonly overlooked etiologies of the short clinical crown is altered passive eruption. Current concepts of recognition, diagnosis, and treatment of altered passive eruption will be discussed, along with a brief review of eruptive processes and management of other etiologies of short clinical crowns.

Review of eruptive processes

Active eruption has been defined as occlusal movement of a tooth as it emerges from its crypt in the gingiva. This phase ends when the tooth makes contact with the opposing dentition but may continue with occlusal wear or loss of opposing teeth. *Passive eruption*, on the other hand, is characterized by the apical shift of the dentogingival junction. As this occurs, the length of the clinical crown increases as the epithelial attachment migrates apically.¹

The passive eruption process has historically been characterized by four stages¹ (Fig 1):

1. The dentogingival junction is located on enamel.
2. The dentogingival junction is located on enamel as well as cementum.

* Private Practice, Atlanta, Georgia.

** Associate Professor, Department of General Dentistry, University of Texas Health Science Center at San Antonio, San Antonio, Texas.

Reprint requests: Dr J. William Robbins, Associate Professor, Department of General Dentistry, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, Texas 78284-7914. Fax: 210-567-3443.

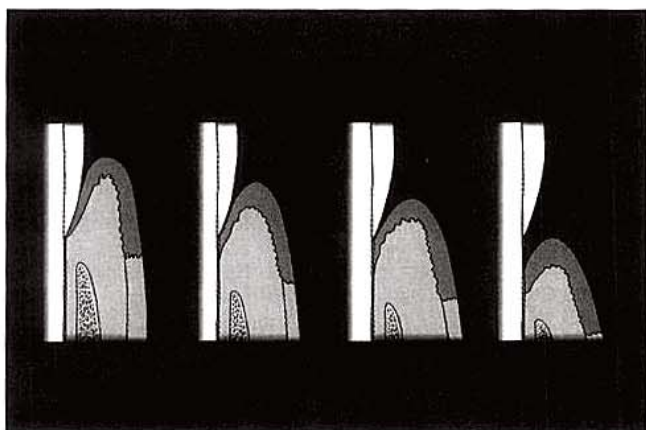


Fig 1 (left to right) Four classic stages of passive eruption.

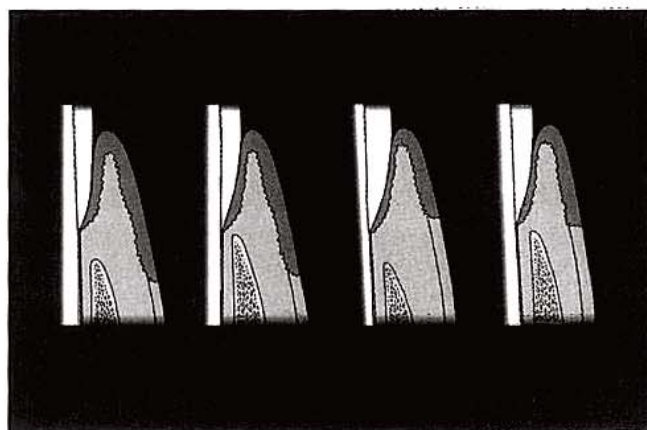


Fig 2 (left to right) Coslet's four types of altered passive eruption: 1A, 1B, 2A, and 2B.

3. The dentogingival junction is located entirely on cementum, extending coronally to the cemento-enamel junction (CEJ).
4. The dentogingival junction is on cementum, and the root surface is exposed as a result of further migration of the dentogingival junction on the cementum (gingival recession).

Although there is debate in the literature as to the limits of what is still considered normal physiologic passive eruption, it is generally agreed that exposure of cementum is considered pathologic. Altered passive eruption (also known as *retarded passive eruption* or *delayed passive eruption*) occurs when the margin of gingiva is malpositioned incisally (occlusally) on the anatomic crown in adulthood and does not approximate the cemento-enamel junction.²⁻⁵ The "normal" relation of the gingival margin to the CEJ is usually considered to be at or near the CEJ in the fully erupted teeth of adults.⁶ Coslet et al² classified cases of altered passive eruption into two main types according to the relationship of the gingiva to the anatomic crown and then subdivided those classes according to the position of the osseous crest (Fig 2).

Type 1 is represented by the presence of the gingival margin incisal or occlusal to the CEJ, where there is a noticeably wider band of gingiva from the gingival margin to the mucogingival junction. The mucogingival junction is usually apical to the alveolar crest in these cases. Type 2 is represented by a gingival dimension from the margin to the mucogingival junction that appears to fall within a normal width. In this type, all of the gingiva is located on the anatomic crown, and the mucogingival junction is located at the level of the CEJ.

Both types 1 and 2 are then subdivided into 1A, 1B, 2A, and 2B. In the A subgroups, the alveolar crest-CEJ relationship corresponds to the 1.50- to 2.0-mm distance accepted as normal. This distance allows for normal insertion of the gingival fiber apparatus into the cementum. In the B subgroups, the alveolar crest is at the level of the CEJ. This relationship, although uncommon in adults, is frequently observed during the transitional dentition that is undergoing active eruption.

The significance of the alveolar crest-CEJ distance is related to the gingival fiber apparatus. In both type 1 and type 2 cases, when the alveolar crest is located at or near the CEJ in the adult, there is a lack of available cementum apical to the CEJ and coronal to the alveolar crest for the insertion of the collagen bundles of the gingival fiber apparatus. This prevents the normal apical movement of the attachment apparatus as the final stage of eruption. It is not uncommon for alveolar bone to approximate the CEJ,⁵ causing a failure of apical migration of the attachment apparatus. Some investigators have coined the term *altered active eruption* to describe this situation, in which a coronally placed attachment apparatus results from coronally placed alveolar bone.⁷ Altered active eruption corresponds to the type 1B altered passive eruption in Coslet's classification. In the authors' experience, type 1B is the most common type of altered passive eruption.

Clinically, a patient with altered passive eruption typically presents with shortened clinical crowns and a smile exhibiting excess gingiva (ie, the so-called gummy smile). However, the characteristic gummy smile in a patient with altered passive eruption may be

mimicked by other conditions, including short or hyperactive maxillary lip, dentoalveolar extrusion, vertical maxillary excess, or a combination of these.

There is no predictable procedure available to correct the short or hyperactive maxillary lip. However, it is important to communicate the diagnosis to the patient, so that treatment expectations are realistic.

Dentoalveolar extrusion generally occurs when the maxillary incisors overerupt. As the teeth continue to erupt, the alveolar bone and gingiva move down with the teeth. This results in gingival levels on the maxillary incisors that are significantly more coronal than the gingival levels on the adjacent canines. Dentoalveolar extrusion is most commonly treated with orthodontic intrusion, although it may be treated with a segmental osteotomy.

Vertical maxillary excess occurs when there is excessive growth of the maxilla. If vertical maxillary excess is suspected, a cephalometric analysis may prove to be a useful diagnostic aid. Even in the case of skeletal maxillary excess, if the clinical crowns are short as a result of altered passive eruption, it is recommended that clinical crown lengthening be accomplished prior to orthognathic treatment. This will help predict the postoperative smile line and the final esthetic outcome.

It has been postulated by Prichard⁸ that an incisally located gingival margin has diminished protection from the trauma of oral function, leading to accelerated gingival pathosis. During initial eruption, the gingival margin is on the convex facial surface of the enamel. In this position, the free gingival margin is not protected from the excursion of food during mastication. Factors such as this movement of food, trauma, and other debris may contribute to chronic inflammation of the bulbous marginal gingiva. This condition may persist until the gingival margin migrates to the cemento-enamel junction, where the free gingival margin is protected by subtle coronal contours. In altered passive eruption, the gingiva does not recede to this normal position and the tissue remains on the convex surface of the crown, where it is subjected to chronic irritation.⁵ It has been reported that gingival hyperplasia may develop in these patients as a result of the chronic irritation.⁸ Although this may occur in rare instances, the gingiva of the patient with altered passive eruption is usually healthy in the absence of plaque.

Restoration of teeth with altered passive eruption poses both functional and esthetic challenges for the dentist. If no attempt is made to lengthen the clinical

crowns, difficulty may arise in obtaining adequate retention and resistance form. In addition, a dilemma may exist regarding optimal placement of crown margins. It has been demonstrated that subgingival placement of crown margins may lead to increased plaque retention and accelerated periodontal breakdown, although improved esthetics may be achieved. Yet, if the clinician places the crown margins equigingivally or slightly subgingivally, the margins may later be unesthetically exposed if passive eruption continues.³ A common restorative error made when patients with altered passive eruption are treated is the placement of margins at what would ordinarily be normal anatomic levels. Such marginal placement in these patients may inadvertently invade the biologic width of attachment because of increased alveolar bone height, resulting in long-term inflammation and compromised esthetics.

Clinical diagnosis of altered passive eruption

The first step in the diagnostic process is to observe the patient both in repose and smiling a natural smile. If there is an excessive display of gingiva during the smile, further diagnostic data are required. First, the length and activity of the maxillary lip must be evaluated. The average length of the maxillary lip, in repose, from beneath the nose to the wet border of the maxillary lip is 20 to 22 mm in females and 22 to 24 mm in males.⁹ If the gummy smile is due solely to inadequate lip length or hyperactivity, no treatment is generally indicated. It is important to discuss this limitation with the patient.

Next, the dentist should attempt to gently locate the cemento-enamel junction using an explorer subgingivally. If the CEJ is located in a normal position in the gingival sulcus, then the patient probably does not have altered passive eruption. In this case, the short teeth are probably due to incisal wear or a variation of normal dental anatomy. To determine the approximate amount of missing incisal edge, the dentist should measure from the CEJ to the incisal edge and subtract this number from 10.5 mm, which is the average length of a central incisor.¹⁰ With this diagnosis, crown lengthening can still be performed; however, this will result in postoperative exposure of the root surface.

When the CEJ is not detectable in the sulcus, a diagnosis of altered passive eruption may be made, and crestal bone sounding is performed. The gingiva is anesthetized and a periodontal probe is placed to the base of the sulcus; the measurement is noted. The

probe is then pushed through the attachment apparatus until the alveolar crest is engaged, and this measurement is noted.

In most instances, the distance from the gingival crest to the alveolar crest will approximate 3 mm; which includes 1 mm for sulcus depth, 1 mm for epithelial attachment, and 1 mm for connective tissue attachment. Because it is usually determined that the CEJ is approximately at the base of the sulcus in altered passive eruption, the measurement can be used to determine the relationship between the CEJ and the alveolar crest. Nature requires approximately 2 mm for both epithelial and connective tissue attachment between the CEJ and alveolar crest; therefore, a determination can now be made regarding whether a gingivectomy and/or gingival flap with osseous resection is indicated.

It is the goal of crown-lengthening surgery to expose virtually all of the anatomic crown. On the completion of the surgery, the marginal gingiva should be situated at or slightly incisal to the CEJ, and the measurement from the gingival crest to the alveolar crest should be approximately 3 mm. Therefore, if it is determined that the CEJ is at the base of the sulcus and, by bone sounding, that the distance from the crest of gingiva to the crest of bone is 3 mm, then ostectomy and an apically positioned flap will be required. However, if the distance from the crest of gingiva to the alveolar crest is measured at 5 mm, and there is adequate keratinized tissue, then approximately 2 mm of gingiva can be simply removed by gingivectomy, leaving the required 3 mm from gingival crest to alveolar crest.

Treatment options

Gingivectomy

When it is determined that the osseous level is appropriate, that greater than 3 mm of tissue exists from bone to gingival crest, and that an adequate zone of attached gingiva will remain after surgery, a gingivectomy is indicated. The initial incision should be lightly scored on the gingiva at the diagnosed level of the CEJ. The initial incision should reflect the normal gingival architecture, so that the highest point of the gingival margin is slightly distal to the center of the tooth.

The initial incision must be precise and symmetric. It is difficult to accurately make the scoring incision while the dentist is sitting behind the patient; it can be best accomplished while the operator stands in front of the patient. A stent made of either acrylic resin or resin

composite may be used as a surgical guide for initial incisions.¹¹ The dentist can then return to the sitting position and complete the beveled, full-thickness gingivectomy incision. Tissue is only removed from the facial surfaces. The papillary tissue is left undisturbed except for minor blending with the gingivectomy incision.

Apically positioned flap

When the diagnostic procedures reveal osseous levels approximating the CEJ, a gingival flap with ostectomy is indicated. The initial incision either can be done as described for the gingivectomy or can be made as a sulcular incision. If the gingival heights of the anterior teeth are asymmetric, the initial incision must be a gingivectomy-type incision so that the final tissue contours will be symmetric. However, if the preoperative tissue contours are symmetric, a sulcular incision can be used and the flap is then apically repositioned. The incision cuts across the facial surface of each papilla, leaving the papilla totally intact interproximally.

A full-thickness flap is reflected beyond the mucogingival junction, and the positions of the CEJ and crestal bone are visually verified. Ostectomy is then performed so that the crestal bone is approximately 2.0 to 2.5 mm from the CEJ. The facial bone is first thinned with a rotary instrument such as a diamond or carbide bur. The remaining bone adjacent to the root surface is removed with an Oschenbein or Weidelstadt chisel. The bony architecture should exactly reflect the desired soft tissue architecture.

The gingiva is then apically repositioned to the CEJ and sutured. It is commonly necessary to thin the facial gingiva and blend the flap with the papillae. The thinning is best accomplished with a rotary diamond or bur, and the blending of the flap and papilla can be performed with a single-wire electrosurgery tip. After the tissue is apically repositioned to the CEJ, the periodontal probe can be inserted through the sulcus to ensure that the distance from the crest of gingiva to crestal bone is 3 mm.

Considerable variation exists in the literature regarding the postoperative time necessary to establish the final gingival levels and scalloping prior to restoration, with estimates ranging from a few months to 3 years.^{4,12-16} Some authors have suggested that after initial healing of the junctional epithelium, a coronal rebound may occur,¹⁴ while others have suggested a postsurgical apical migration.¹⁵ The direc-

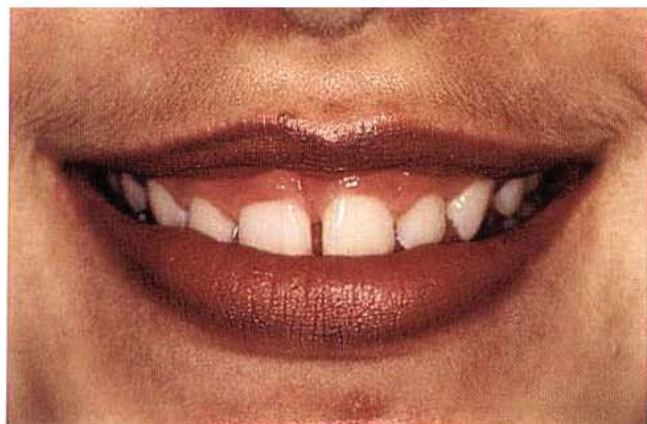


Fig 3a There is excess gingival coverage of the maxillary anterior teeth.



Fig 3b The maxillary right central incisor is 7 mm long.

tion of healing is likely a result of the tissue positioning at the time of suturing. Great care must be made to reposition the tissue with the biologic width of attachment in mind. There is generally minimal movement of the gingival crest during healing if the tissue is sutured in the correct relationship to the alveolar crest. After complete healing has occurred, minor esthetic revisions in the gingival architecture can be accomplished with a scalpel blade, electro-surgery, or a laser.

Orthodontic repositioning

When there is a gingival asymmetry of one or multiple anterior teeth, orthodontic eruption or intrusion can sometimes be utilized. The most common need for orthodontic repositioning is forced eruption of a single anterior tooth because of traumatic fracture of the tooth or because of previous crown margins that have invaded the biologic width. Forced eruption is prescribed when it is determined that crown-lengthening procedures with ostectomy will result in a gingival discontinuity because of asymmetric and/or esthetically unacceptable postoperative gingival levels.

The amount of desired forced eruption, usually 2 to 3 mm, must be predetermined because landmarks change during the eruption process. It should be accomplished quickly, 1 mm every 1 to 2 weeks. After completion of the forced eruption, the tooth is placed in retention for 2 to 3 months to allow the bone and soft tissue to move with the tooth. Conventional crown-lengthening surgery is then accomplished. When the biologic width impingement involves interproximal bone, the interdental papillae must also be reflected. Ostectomy is accomplished so that there is

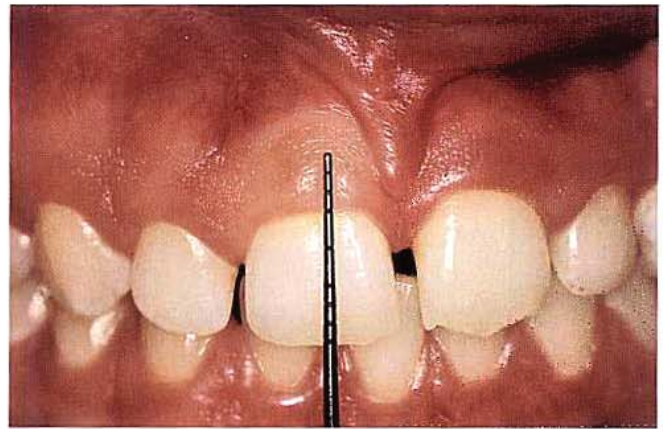
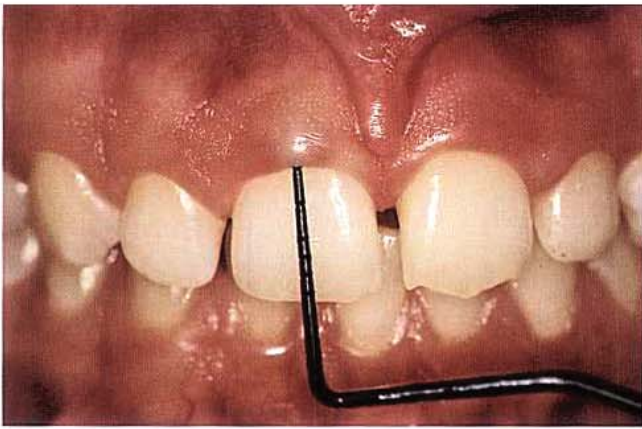
approximately 3 mm from the crest of the alveolar bone to the proposed margin of the final restoration. The tissue is then sutured at the biologically and esthetically correct level. The teeth that have undergone forced eruption should then be placed in retention for 3 to 6 months postoperatively before final restorations are placed.¹⁷

Orthodontic intrusion is accomplished when one or several anterior teeth have overerupted (dentoalveolar extrusion). This most commonly occurs when the maxillary anterior teeth, along with the gingival-alveolar complex, continue to erupt because of a lack of occlusal stops on the lingual surfaces. As the teeth are orthodontically intruded, the gingival alveolar complex moves up with the teeth. The intrusion is completed when the gingival levels are comparable to those of the adjacent teeth. Intrusion is biomechanically more difficult and requires significantly more treatment time. After orthodontic intrusion, the patient must be placed in long-term retention to prevent relapse.

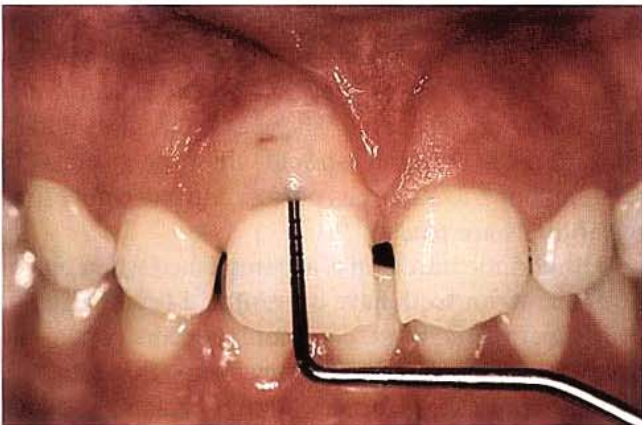
Case reports

Case 1

A 15-year-old girl complained, "I don't like to smile; I show too much gum tissue" (Fig 3a). Examination revealed that the length of her maxillary right central incisor was 7.0 mm and that there was minor incisal chipping but no significant incisal wear (Fig 3b). The gingival sulcus was determined to be 3.0 mm deep (Figs 3c and 3d), and the CEJ could not be detected with an explorer. Bone sounding with the periodontal



Figs 3c and 3d The sulcus depth is 3 mm.



Figs 3e and 3f The periodontal probe is sounding bone to the alveolar crest, which is 5 mm.



Fig 3g The periodontal probe is placed at the mucogingival junction, demonstrating adequate attached gingiva.

probe revealed that the measurement from the gingival crest to the alveolar crest was 5.0 mm (Figs 3e and 3f). The next step was to determine the amount of keratinized tissue. The periodontal probe was placed in the vestibule and moved coronally to determine the position of the mucogingival junction (Fig 3g). It is important to know the width of keratinized tissue to ensure that adequate keratinized tissue remains after the projected periodontal surgery. It was also noted that during a natural smile, the incisal edges of the maxillary anterior teeth were hidden by the lower lip (see Fig 3a).

Based on these findings, it was recommended that the patient have an orthodontic evaluation and diagnosis. However, she chose not to pursue orthodontic treatment. Esthetic crown lengthening was also discussed with the patient. She was told that with a



Fig 3h View after completion of the gingivectomy.

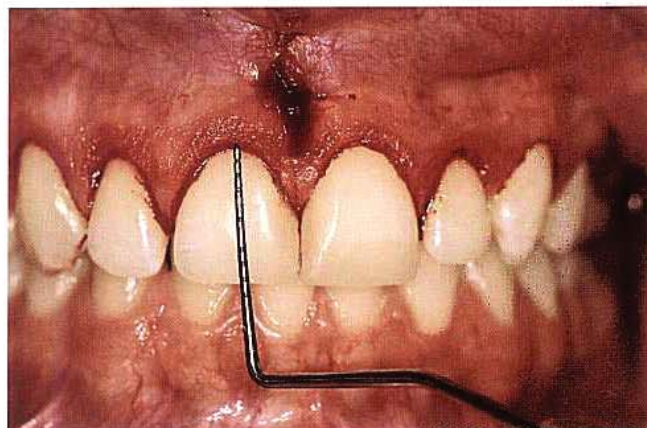


Fig 3i In the gingivectomy procedure, 2 mm of gingival tissue was removed, leaving the required 3 mm from gingival crest to alveolar crest.



Fig 3j Preoperative view.



Fig 3k Postoperative view.

gingivectomy procedure, approximately 2.0 mm of tooth structure could be uncovered. This would result in a 9.0-mm-long maxillary central incisor, which would be 1.5 mm shorter than the average 10.5-mm central incisor. To gain the additional 1.5 mm of length would require an apically positioned flap with osteotomy. After discussing the options with her mother, she chose the gingivectomy procedure, realizing its limitations (Figs 3h to 3m).

Case 2

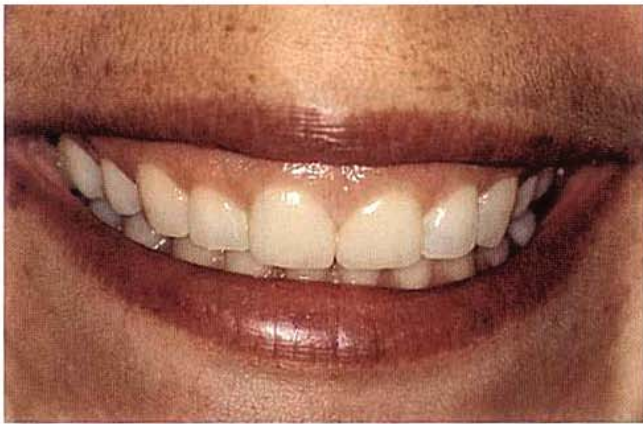
A 30-year-old woman complained, "My front teeth look too short" (Figs 4a and 4b). Examination revealed that the maxillary central incisors were 8.5 mm long, although there was no incisal wear. The periodontal examination revealed that the sulcus was approximately 1.0 mm deep, and the CEJ could not be detected with an explorer. Bone sounding with the



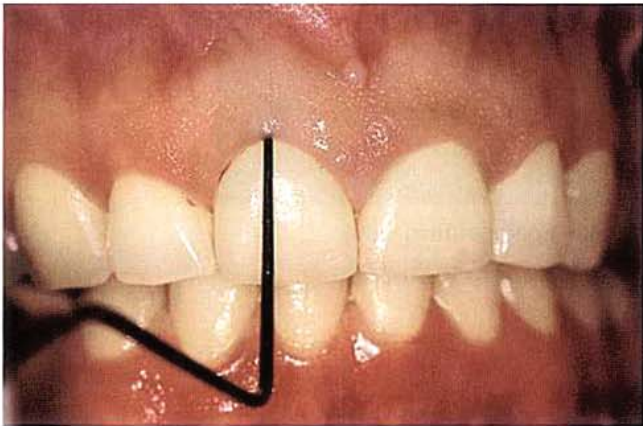
Fig 3l Preoperative view.



Fig 3m Postoperative view.



Figs 4a and 4b There is excess gingival coverage of the maxillary anterior teeth.



Figs 4c and 4d The periodontal probe is sounding bone from the gingival crest, which is 3 mm.

periodontal probe revealed that the measurement from the gingival crest to the alveolar crest was 3.0 mm (Figs 4c and 4d). Based on the diagnostic information, a diagnosis of altered passive eruption was made.

The projected esthetic outcome of the surgery was demonstrated to the patient with resin composite

overlays. The overlays were constructed on a preoperative cast. The projected position of the gingival crest was marked on the cast; the highest point was 10.5 mm (the average length of a maxillary central incisor) from the incisal edge (Fig 4e). The resin composite overlays were constructed in two pieces and placed over the



Fig 4e Resin composite overlays are fabricated (shown on the patient's right side) to demonstrate the approximate amount of tooth that will be uncovered with crown-lengthening surgery.



Fig 4f The resin composite overlays are tried in the mouth (shown on the patient's right side) to demonstrate the projected outcome of the surgery to the patient. These overlays may also be used as guides during surgery.

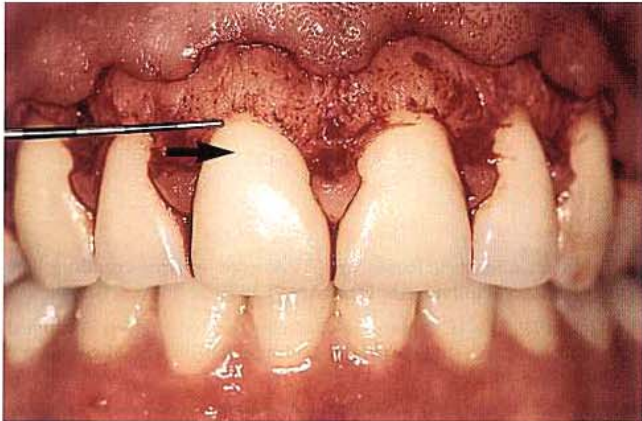


Fig 4g The periodontal probe is pointing to the cemento-enamel junction. The crest of alveolar bone is almost coincident with the CEJ. The margin of a porcelain veneer (arrow) is 2 mm incisal to the CEJ.

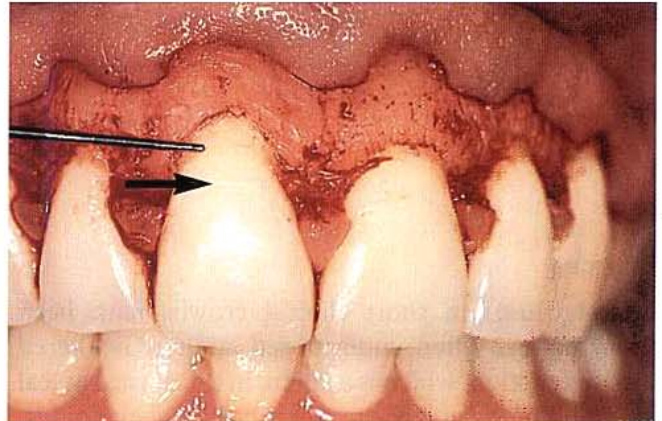


Fig 4h The periodontal probe is pointing to the CEJ after ostectomy. Approximately 2.5 mm of bone has been removed only on the right central incisor. Margin of porcelain veneer (arrow).

patient's maxillary anterior teeth to demonstrate the esthetic benefit of surgery (Fig 4f).

The patient was told that the only esthetic crown-lengthening option was an apically positioned flap with ostectomy. Because of the extent of the patient's smile, the crown lengthening was only accomplished on the maxillary anterior teeth. The patient initially presented with porcelain veneers on the maxillary central incisors. Although the gingival margins were exposed during the crown-lengthening surgery, the esthetic blend was acceptable. Therefore, no additional restorative therapy was required (Figs 4g to 4k).



Fig 4i Immediately postsurgical view.



Fig 4j Preoperative view.



Fig 4k Three-month postoperative view after esthetic crown lengthening. No restorative therapy has been accomplished.

Summary

Several causes of short clinical crowns have been discussed. An often undiagnosed etiology is altered passive eruption, which is a failure in the normal apical migration of the gingiva and/or attachment apparatus. Although Coslet and coworkers² have classified four types of altered passive eruption, at the present time there has been little investigation as to the prevalence of various types of altered passive eruption, and little is known about the specific developmental causes of this phenomenon. This discussion has reviewed current concepts in recognition, diagnosis, and appropriate treatment of patients with altered passive eruption.

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