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Abfractive Lesions: A Bioesthetic Approach to Improve Function and Appearance

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LEARNING OBJECTIVES

After reading this article, the reader should be able to:

- identify the causes of abfractive lesions.
- describe the current treatment options for abfractions and abfractive lesions.
- discuss the theory of "dental bioesthetics."

ABSTRACT

Although described in the literature as early as the 1930s as "erosions," the more specific classification, essence, and etiology of abfractions and abfractive lesions were described in the 1990s by Grippo. Abfractions are the loss of dental substance—ie, chips of enamel and dentin—that break off from a tooth as a result of stress exerted on the teeth. Abfractive lesions are caused by flexture and ultimately material fatigue. Immediate correction of the factors creating the stress and a bioesthetic approach in treating the emerging abfractions at their incipience have become the treatment of choice. This article reviews the literature and defines the role of each element involved in the formation of abfractions. In the case study presented, the author identifies and eliminates the stress-creating factors that resulted in pathologic wear of the tooth structure and the formation of abfractive lesions. The case also shows how the already-existing abfractions were treated, which emphasizes the importance of interdisciplinary cooperation between the clinician and the laboratory technician, using the bioesthetic concept.

Bioesthetic dentistry is a conservative approach to restoring teeth to their natural form and function. This concept requires a complete evaluation of not only the intraoral area and the dentition, but also the patient's mouth, lips, smile, and the entire face as a single collective structure rather than individual units. Harmonious long-term function depends on the cohesive relationship between the anterior and posterior dentition, the temporomandibular joints (TMJ), and the neuromusculature system of the patient. Treatment may involve the entire collective structure, a single unit, or several units contained within the whole.

Abfractions, as defined by Grippo,[1] are the results of stresses produced by biomechanical loading forces and exerted on the teeth. These forces may be static, as in swallowing and clenching, or cyclic, as in chewing. As a result of the stress caused by static and cyclic forces, both enamel and dentin may chip or break away. How this type of loss of tooth substance manifests depends on the magnitude, duration, direction, frequency, and location of the forces. Abfractive lesions are caused by flexure and ultimately material fatigue, which may affect susceptible teeth even at locations on the dental arch that are distant from the point of loading. In a series of articles, Grippo described the etiology of abfractions.[1-5] After clinical observations of a variety of enamel and dentin lesions of different shapes, sizes, loci, and frequency, he determined that the condition warranted a new and distinct classification.[1] This article presents a literature review and the current treatment options of abfractions and abfractive lesions.

LITERATURE REVIEW

Stress resulting from occlusal force was recognized as a factor in the development of cervical lesions more than half a century ago.[6,7] However, no research had been published about the role that occlusal therapy (eg, orthodontics, supragingival occlusal splints, coronaplasty, occlusal adjustments, and restorations) might play in the prevention or arrest of such lesions. In his articles, Grippo expressed hope that adoption of the more accurate terminology proposed will foster research and encourage publication of occlusal therapy in treatment.[1-5]

Davis reviewed the literature of cervical abfractions and concluded that "limiting treatment to only cervico restoration is like repairing a rusted-out automobile with only a tube of Bondo compound. Patchwork and 'make-do' usually are short-term solutions for larger underlying problems. Clinicians must discover and treat overall pathologies, not simply 'plug holes' and hope for the best."[8]

In 1982, Lee[9] stated: "Bioesthetics is the study or theory of the beauty of living things in their natural form and function." Therefore, when creating beautiful and natural-appearing smiles in dentistry, it is important to address not only the esthetic challenges but also any oral functional problems and difficulties that may be present.[10,11]

A clinician must thoroughly understand the function of the ideal human biologic dental system. Applying the observations of the human biologic model (HBM)[12] in patient evaluation allows the clinician to provide restorative care that is both *functional* and *esthetic*.[13-17] The success of functional and esthetic dentistry depends on the clinician's understanding of the morphology of natural dentition, including tooth position, TMJ function, gingival contours, and the influence of these elements on the dental, dentofacial, and facial complexes.[9,10]

Dental bioesthetics also examines the interrelationship of the three complexes—dental, dentofacial, and facial—to transform any functional and esthetic oral defects into a naturally functioning and

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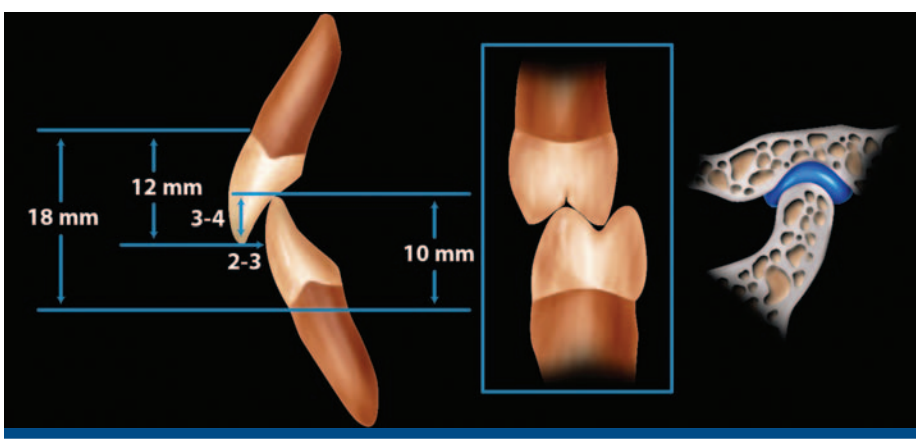

Figure 1 When the condyles are in centric relation, all teeth occlude evenly in intercuspal position. When occlusal contacts are uneven, posterior occlusal interferences in lateral border jaw movements and avoidance patterns will develop. (Reprinted with permission from *Pract Proced Aesthet Dent*.[16])

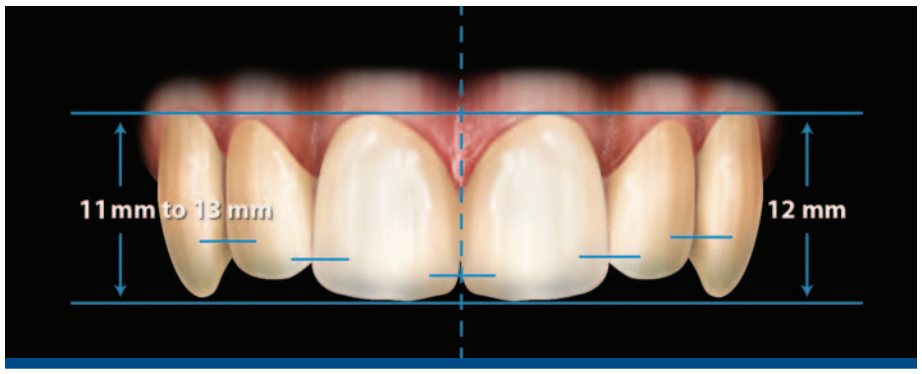

Figure 2 Illustration depicts the position of the maxillary central incisors and canines. Note that the lateral incisors are slightly shorter cervically and incisally. (Reprinted with permission from *Pract Proced Aesthet Dent.*[16])

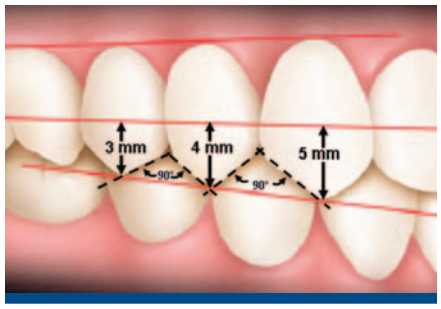

Figure 3 Drawing of distally converging lines (gradation effect) demonstrates the height of the cementoenamel junction (CEJ), interproximal CEJ, interproximal contact points, and buccal cusp tips. (Reprinted with permission from *Pract Proced Aesthet Dent.*[16])

Figure 4 Note that the anatomic shape of the condylar head conforms to the condylar fossae in an upper forward stable condylar position. The black arrow is pointing to the lateral head of the condyle, the red arrow to the mesial.

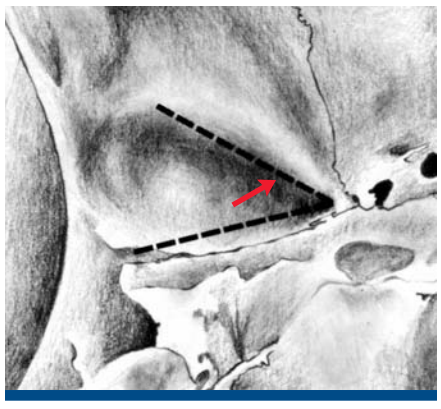

Figure 5 The red arrow is pointing to the mesial condylar head depicting a bone brace relationship in the condylar fossa. (Reprinted with permission from C.V. Mosby Co.[24])

Figure 6 Preoperative view of the patient at presentation. Severely worn maxillary anterior teeth with developing abfractions on teeth Nos. 8 and 11.

Figure 7 Severely worn maxillary anterior segment with abfractions on tooth No. 6.

esthetic whole.[10] The functional goal of bioesthetics is to maximize the anterior guidance and "verticalize" the posterior segment, with the condyles in uppermost stable position (USCP) against the articulator disc in the glenoid fossae (Figure 1). This anterior guidance allows a more natural (ie, sharper) posterior crown form without eccentric occlusal interferences, minimizing the influence of condylar guidance on the morphology of the posterior teeth.

The average length of the maxillary and mandibular incisors is 12 mm (10 mm to 14 mm) and 9 mm to 10 mm, respectively, resulting in a distance of ~18 mm (16.5 mm to 21 mm) between the maxillary and mandibular cementoenamel junction (CMJ) (Figure 1). As a general guide, the length of the maxillary central incisors and cuspids should be approximately 12 mm (Figure 2),[19] 10 mm for the mandibular central and lateral incisors, and 12 mm for the mandibular cuspids. The maxillary lateral incisors are shorter than the central incisors, thereby allowing the mandibular cuspids to pass freely during incisive and retrusive movements (Figure 2).

Measured from the interproximal contact points, the length of the buccal cusps of the canine, first premolar, and second premolar is approximately 5 mm, 4 mm, and 3 mm, respectively. This descending sequencing of the teeth establishes posterior guidance. The mesial and distal embrasures of the canine usually are at approximately 90° moving posteriorly; the maxillary cusp tips and the gingival marginal crest converge. The 90° embrasures allow space for more natural (sharper) cusp forms of the mandibular teeth, both developmentally and restoratively (Figure 3).

Among the clinicians studying nature, several have noted the importance of the presence of cusps on the posterior teeth.[9,10,20-22] These observations, obtained from the healthiest and finest in natural dentition, are known as the "bioesthetic principles" or human biologic model (HBM).[9,10,12] In the healthy dentition, when the teeth of both dental arches are in complete contact, the condyles are in their most superior/anterior/medial (SAM) position by the means of contraction of elevator muscles to seat in the condylar fossa, engaging the thinnest portion of the articular disc: maximum intercuspation (MI) = centric relation (CR). "Centric relation" may be defined as any place along the arch of closure where the condyles are bilaterally in their most superior, anterior, and medial position and in close contact with the thinnest part of the biconcavity of the disc.[10]

However, there are clinical circumstances where there is no intact disc, where the TMJ has remodeled and may function with the same degree of comfort as an intact, properly aligned condylar disc assembly in centric relationship.[23,24] It is important to note that the anatomic shape of the condylar head conforms to the condylar fossae in an upper forward stable condylar position (Figures 4 and 5).

In 1983, Williamson stated that "only when the posterior disclusion is obtained by an appropriate anterior guidance can the elevating activity of the temporal and masseter muscles be reduced. It is not the contact of the canines that decreases the activity of the elevator muscles, but the elimination of posterior eccentric contacts."[25] The occlusal scheme is accomplished through the proper axial inclination of the anterior teeth (Figure 5) and through the correct horizontal overlap of 2 mm to 3 mm and vertical overlap of 3 mm to 4 mm.[9-17] The occlusal scheme facilitates the guidance of the posterior teeth with the condyles in centric relationship.

A proper diagnosis can be made only when the clinician first understands the bioesthetics and physiology of the orofacial dentognathic system. The principal factors in successful long-range occlusal treatments of natural teeth or fixed prosthodontics include the following:

1. Condyles in a comfortable, most stable, upper forward position.
2. USCP = MI position of the teeth.
3. Good anterior vertical and horizontal overlap.
4. Good incisive chewing and nonchewing guidance.
5. Absence of posterior tooth interferences (contacts in excursive pathways), causing abfractions, mobility, functional wear, and fractures.
6. Absence of stress on periodontal membrane, bone loss, or bone gain, ie, tori and buttressing.

By application of these principles, pathologies such as abfractions, mobility, wear, fractures, bone loss, and tori can be avoided.

CASE PRESENTATION

This article presents the evaluation, diagnosis, and treatment of one patient, beginning with the early stages of buttressing, abfractive lesions, and significant wear (Figures 6 and 7). The patient, a 25 year-old woman, presented with a chief complaint of unusual wearing of the anterior dentition. A Panorex full-mouth periodontal series, TMJ examination, and periodontal probing revealed no pathology. A complete series of color photographs and a centric bite record were taken to document the pretreatment condition. The patient did not have proper anterior coupling and exhibited chewing and nonchewing interferences (Figures 8 and 9).[26,27]

Preliminary Restorative Diagnosis

A preliminary centric relation record was made using an anterior compound as an

Figure 8 Anterior view. Note the absence of proper anterior coupling. Arrow depicts chewing side interference.

Figure 9 Anterior view. There is not enough clearance for the canines to pass through the maxillary lateral incisors in incisive guidance.

Figure 10 Casts were mounted in pretreatment centric relation position on a Panadent articulator. Green compound is used as an anterior jig first and then the mandibular posterior is recorded with ZOE paste.

discluder, and an anatomic facebow registration was taken. The casts were mounted in pretreatment CR position on a Panadent articulator (Panadent, Grand Terrace, CA) (Figure 10). The casts of this preliminary relationship were used for the fabrication of a maxillary anterior-guided orthotic (MAGO) device.

An uppermost stable condylar position was created and maintained with the properly constructed, fitted, and adjusted anterior-guided orthotic device.[28,29] This TMJ stabilization splint was worn 24 hours a day, except for brushing, until the uppermost stable condylar position was achieved with no clinical signs or symptoms of TMJ dysfunction. The device allowed time for the entire TMJ complex to attain improved functional health, and it allowed the posterior avoidance patterns of the occlusion to wane. The procedure also ensured that the diagnostic measurements of condylar movements and uppermost stable condylar position were accurately recorded and provided training in anterior-guided chewing cycles (Figure 11).[9]

The anterior portion of the orthosis was adjusted intentionally to provide anterior contact with only the 4 mandibular incisors. There was no canine or posterior contact during the 1-week period. The guidance was developed with the mandibular incisors, allowing an unrestricted movement for the anterior segment. Canine guidance and posterior contacts were added 1 week subsequently. The patient was monitored for several weeks, verifying the uppermost stable condylar position (Figure 12). Black marking paper was used to establish centric stops; red marking paper was used to identify border movements.

Figure 11 At the initial orthotic insertion, only anterior guidance is developed without canine guidance and posterior contacts.

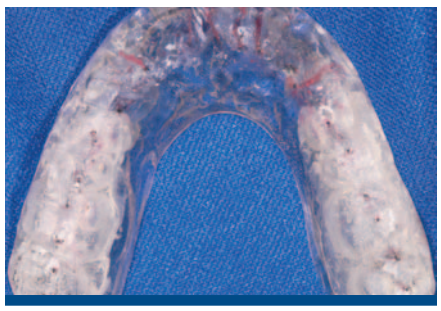

Figure 12 Canine guidance and posterior contacts were added 1 week subsequently. Note red marks indicating incisive and canine guidance, with red mark overlay of posterior stops indicating no posterior interferences.

Figure 13 In uppermost stable condylar position, all contact was on maxillary and mandibular second molars.

Mid-treatment Restorative Diagnosis

After occlusal stabilization, an axi-path recording was used to establish the hinge axis, condylar paths, and the Bennett movement. A new final CR record was made, and a new set of diagnostic casts were mounted with appropriate Panadent Bennett analogs, selected from the axi-path recording (Figure 13). When posterior occlusal disharmonies are present in the closure and border movements, interferences and avoidance patterns will develop, and the patient will function more anteriorly. This forward function, known as the "etiology of the anterior wear," creates unfavorable load, causing early wear of the anterior teeth and loss of adequate anterior guidance.[9]

One of the goals of bioesthetics is to achieve proper anterior guidance using natural, unworn anterior crown forms. Anterior guidance allows the maintenance of more natural (sharper) posterior crown

forms without eccentric occlusal interferences. Successful treatment would result in reduction of the abfractive lesion process and the continuous pathologic wear of the anterior and posterior teeth. Three goals were to be accomplished by coronaplasty: The first goal was to establish the contact of all teeth in both arches at an even pressure, with maximum intercuspation at the uppermost stable condylar position. The second goal was to relegate all eccentric tooth contacts to the anterior teeth, with the most vertical occlusion possible within the limits of the posterior teeth. The third goal was to perform a successful coronaplasty that would preserve or re-create the best possible natural like tooth forms for the posterior teeth.[10]

Figure 14 Postcoronaplasty view of the posterior teeth in occlusion, with anterior open bite.

Figure 15 Lengthening of the maxillary central incisors allows the mandibular canines to pass through the maxillary laterals.

Figure 16 Uppermost stable condylar position of the occlusion after orthotic treatment.

Figure 17 The length of the mandibular central and lateral incisors was 9 mm (the average is 10 mm). Note the deepening the fossae and marginal ridge relationships without adjustment of the cusps.

Figure 18 Postoperative view. Note posterior clearance of 2 mm to 3 mm in the incisive position.

A determination needed to be made on whether or not the anterior teeth could be brought into contact in CR without radical posterior tooth reduction.[30] This procedure was performed on the mounted casts and, in fact, the author was not able to close the anterior open bite without radical reduction of the posterior teeth (Figure 14). Restorative procedures were required to restore biologic occlusion (developing the anterior coupling and posterior intercuspal position in CR) and esthetic harmony.

The next step was to evaluate canine guidance and the incisive edge-to-edge position to note the amount of posterior clearance. Because the incisive position was not attainable using the worn dentition, the treatment plan for the final case was developed from the mounted casts, originally created by the posterior coronaplasty. Anterior maxillary and mandibular teeth were restored to average unworn lengths with normal overlap (anterior guidance) in wax (Figure 15).[9,10] Based on the favorable results of the additive and negative coronaplasty on the models, the decision was made to proceed with the patient treatment. The diagnostic cast wax-ups were subsequently used to design laminate veneers for the maxillary and mandibular anterior teeth to achieve bioesthetic appearance and function.

Final Restorative Treatment

The intraoral centric occlusion was different than that on the mounted casts (Figures 13 and 16). This difference was present because the condyles were seated into the condylar fossa during MAGO therapy (Figure 17), which developed an open anterior bite. Using the bimanual manipulation technique described by Dawson,[23] coronaplasty was performed to establish CR occlusion (Figure 18). Incisive, chewing, and nonchewing excursions were *not* adjusted at this time because the anterior guidance had not yet been established. If eccentric adjustment had been done at this point, the use of the severely worn anterior teeth would have resulted in an extensive loss of good posterior tooth forms. In time, this "flattening" of the teeth would overload the dentognathic system (Figures 7 and 8).

Laboratory Phase

After coronaplasty, the anterior teeth were prepared for porcelain veneers. A hinge bow and a CR interocclusal record was taken, and working casts were mounted. The laminate veneers were fabricated on the articulator in the uppermost stable condylar position using the foil technique. Further occlusal coronaplasty was required on the working casts to develop the final bioesthetic occlusion. It is imperative that the laboratory technician is knowledgeable and understands the principles of the human biologic model.

The porcelain laminate veneers were constructed in accordance with the biologic principles. As a general guide, the length of the maxillary central incisors, cuspids, and the mandibular cuspids is approximately 12 mm; in this case, their length was 11 mm. The average length of the mandibular central and lateral incisors is 10 mm; in this case it was 9 mm (Figure 17). The length of the maxillary lateral incisors was shortened in conjunction with the mandibular cuspids to guide the incisive movement and esthetics. The length of the maxillary and mandibular cuspids was 11 mm, and it was extended to facilitate canine guidance (Figure 18).

Dental Complex

The veneers on the mandibular central incisors were placed first, followed by those of the maxillary central incisors. This sequencing facilitates the development of the anterior occlusion. Final coronaplasty was furthered refined, again with the goal to preserve the cusps of the posterior teeth. The optimal occlusal scheme was accomplished by: 1) creating a proper axial inclination of the anterior teeth; 2) creating an ideal incisor vertical overlap of 3 mm to 4 mm, and a horizontal overlap of 2 mm to 3 mm; and 3) creating a 4-mm vertical and 1-mm horizontal canine overlap (Figure 19). This bioesthetic anterior occlusal scheme, in conjunction with the recorded condyle movements, guides the mandibular teeth to CR without posterior interferences (Figure 20).[11,14-20]

Dentofacial Complex

The lengthening of the anterior segment (central incisors by 1.5 mm) to correct the functional motion (incisive, chewing, and nonchewing) also contributed to the creation of a more pleasing appearance of the smile (Figures 21 and 22). With proper diagnosis and effective treatment, improved function and a more esthetic appearance were achieved in this case, which is the ultimate goal of bioesthetics.

CONCLUSION

The preservation of the dentition from abnormal wear and abfractive lesions should be one of the goals of dentistry today. The need for an interdisciplinary approach was evident in this case. This case demonstrates that by incorporating the bioesthetic principles of esthetics and function, the long-term prognosis for the patient has indeed continued with the rehabilitation performed. The photograph of the patient in Figure 23 was taken 4 years after the initial completion of the case.

The human biologic model has set the standard—an ideal and finite goal for treatment. As Dumont stated, the standard "serves all ages and conditions, and its applicability extends from the smallest interceptive preventative corrections to the most extreme orthognathic surgical or

Figure 19 Postoperative view of the achieved optimal occlusal scheme. Horizontal overlap of the canine is 1 mm to preserve posterior cusp forms.

Figure 20 Postoperative view of the bioesthetic anterior occlusal scheme. Canine guidance with approximately 1 mm to 2 mm on the chewing side and 2 mm to 3 mm on the nonchewing side.

Figure 21 Postoperative view. Note the appearance of a reverse curve from canine to canine.

Figure 22 Final postoperative view. The incisal edge of the teeth conforms to the lower lip.

Figure 23 Four-year postoperative view. Note the quality of long-term prognosis.

restorative rehabilitations. Utilization of the human biologic model will be the standard of dental care in the future. The model is patterned after nature and serves as a framework for unification of all dental disciplines and specialties to a common cause. This paradigm will facilitate the understanding of our magnificent dental system and greatly benefit the quality of care for the patients."[12]

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1. The concept of bioesthetic dentistry requires a complete evaluation of not only the intraoral area and the dentition, but also the patient's:
   - **a.** jaw structure
   - **b.** risk for oral cancer
   - **c.** mouth, lips, and smile
   - **d.** desire for an esthetically pleasing smile
2. Harmonious long-term function depends on the cohesive relationship between the:
   - **a.** anterior and posterior dentition
   - **b.** temporomandibular joints
   - **c.** neuromusculature system of the patient
   - **d.** all of the above
3. Abfractions, as defined by Grippo, are:
   - **a.** severe carious lesions
   - **b.** the results of stresses produced by biomechanical loading forces and exerted on the teeth
   - **c.** the results of years of poor oral hygiene and teeth grinding
   - **d.** the results of severe xerostomia
4. Occlusal therapies can include:
   - **a.** orthodontics
   - **b.** supragingival occlusal splints
   - **c.** coronoplasty
   - **d.** all of the above
5. The success of functional and esthetic dentistry depends on the clinician's understanding of the:
   - **a.** latest generation of restorative materials
   - **b.** patient's medical history
   - **c.** morphology of the natural dentition
   - **d.** pathology of craniosacral pain
6. Dental bioesthetics also examines the interrelationship of which three complexes?
   - **a.** myofacial, craniosacral, and dental
   - **b.** neuromuscular, dental, and myofacial
   - **c.** dental, dentofacial, and facial
   - **d.** facial, neuromuscular, and myofacial
7. The average length of the maxillary and mandibular incisors is what, respectively?
   - **a.** 10 mm to 14 mm and 9 mm to 10 mm
   - **b.** 12 mm to 14 mm and 9 mm to 10 mm
   - **c.** 11 mm to 12 mm and 8 mm to 10 mm
   - **d.** 10 mm to 12 mm and 8 mm to 10 mm
8. Measured from the interproximal contact points, the length of the buccal cusps of the canine, first premolar, and second premolar is approximately:
   - **a.** 4 mm, 3 mm, and 2 mm
   - **b.** 5 mm, 4 mm, and 3 mm
   - **c.** 5 mm, 4 mm, and 2 mm
   - **d.** 4 mm, 2 mm, and 1 mm
9. The occlusal scheme is accomplished through the proper axial inclination of the anterior teeth and through the correct horizontal and vertical overlaps of:
   - **a.** 1 mm to 3 mm and 4 mm to 5 mm, respectively
   - **b.** 1 mm to 2 mm and 3 mm to 5 mm, respectively
   - **c.** 2 mm to 3 mm and 4 mm to 5 mm, respectively
   - **d.** 2 mm to 3 mm and 3 mm to 4 mm, respectively
10. The principal factors in successful long-range occlusal treatments of natural teeth or fixed prosthodontics include:
    - **a.** good anterior vertical and horizontal overlap
    - **b.** good incisive chewing and nonchewing guidance
    - **c.** absence of posterior tooth interfaces causing abfractions, mobility, functional wear and fractures
    - **d.** all of the above

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