Orthodontics: A Review

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Continuing Education Units: 1 hour


Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

Orthodontics, the first specialty in dentistry, emphasizes proper occlusion and tooth alignment as well as ideal dental and facial esthetics. The American Association of Orthodontists estimates that three-quarters of the US population could benefit from orthodontic care, so it's important for dental professionals to understand the basic elements of orthodontics. This course reviews the need for orthodontic treatment, diagnostic procedures and records, biological factors affecting tooth movement, goals of orthodontic treatment, categories of treatment, popular orthodontic devices and oral hygiene considerations.

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• The author reports no conflicts of interest associated with this work.

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Overview
Orthodontics, the first specialty in dentistry, emphasizes proper occlusion and tooth alignment as well as ideal dental and facial esthetics. The American Association of Orthodontists estimates that three-quarters of the US population could benefit from orthodontic care, so it's important for dental professionals to understand the basic elements of orthodontics. This course reviews the need for orthodontic treatment, diagnostic procedures and records, biological factors affecting tooth movement, goals of orthodontic treatment, categories of treatment, popular orthodontic devices and oral hygiene considerations.

Learning Objectives
Upon completion of this course, the dental professional should be able to:
• Discuss the need for orthodontic treatment.
• Describe orthodontic diagnosis, analysis of occlusion and common records.
• Explain the categories of orthodontic treatment.
• Discuss popular orthodontic devices.
• Describe considerations related to oral hygiene and soft tissue.

Course Contents
• History of Orthodontics
• Need for Orthodontic Treatment
• Orthodontic Diagnosis and Records
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  ◦ Oral Exam
  ◦ Analysis of Occlusion
  ◦ Panoramic Radiograph
• Goals of Orthodontic Treatment
• The Biology of Orthodontic Tooth Movement
• Categories of Orthodontic Treatment
  ◦ Elimination of Deleterious Oral Habits
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History of Orthodontics
Orthodontics is the branch of dentistry concerned with the prevention and correction of malocclusions. Appliances for aligning teeth go as far back as the Egyptians. However, formal texts about orthodontics began appearing in the mid-1800s. Published in 1879, Norman Kingsley’s A Treatise on Oral Deformities as a Branch of Mechanical Surgery was one of the first textbooks that dealt with orthodontics. Kingsley introduced extra-oral force to move teeth.

However, it was Edward H. Angle who first declared orthodontics a specialty. He founded the American Association of Orthodontists (AAO) and started the first independent school of orthodontics. In addition, he originated the classification of malocclusions.1 In the early years, the goals of orthodontic treatment were to attain ideal occlusion without the extraction of teeth. Angle believed that if the teeth were placed in ideal position, good facial esthetics would result. Angle opposed the extraction of teeth; consequently all of his cases were treated non-extraction.

As time went on, and with the introduction of cephalometrics, a number of orthodontists emphasized the importance of the relationship between the teeth and bones as well as soft tissues. In the 1930s, controversy erupted when Calvin S. Case advocated the use of extraction in treatment.2 Case also recommended the use of retainers to maintain the achieved results. More recently, implant supported anchorage provides the opportunity to make dental changes not previously possible (Figure 1). Finally, in conjunction with oral and maxillofacial surgery, skeletal problems in adults can be treated to provide optimum occlusal relationships and facial esthetics.

Need for Orthodontic Treatment
Orthodontic need and demand varies with social and cultural conditions,3 sex, race, orthodontic status, socioeconomic status, and availability of specialist treatment services4 Wheeler et al.4 observed orthodontic need to be less in black (35.3%) than in white children (47.2%) and
demand in the higher socioeconomic groups greater (11.7%) than in the lower groups (1.8%). Findings from the National Health and Nutrition Examination Survey (NHANES III) show the average overbite to be 2.9 mm, with 8% of the population having severe overjet of 6 mm or more. Excessive overjet has been associated with increased risk of incisor injury.\(^5\)

**Orthodontic Diagnosis and Records**

**Orthodontic Diagnosis**

Orthodontic diagnosis begins with the elucidation of the patient chief complaint. Typical orthodontic records include a medical history, oral exam, facial and intraoral photographs, study casts, a panoramic and a lateral cephalogram head film supplemented by intraoral views as needed. Most of these are now in the digital format, including the casts. In addition to their diagnostic value, the pre-treatment records are used as a baseline to evaluate treatment results.

**Medical History**

Typically there are only a few conditions that would prevent a person from receiving orthodontic treatment (e.g., cardiovascular disease due to need for SBE coverage, nonsteroidals that inhibit prostaglandins, diabetes). Patients should be asked if they have any cardiovascular problems that require pre-medication before any dental procedure. In general, there are few drugs that may complicate treatment, including Dilantin and bisphosphonates. Antiepileptic drugs such as Dilantin may produce gingival hyperplasia, which may slow down tooth movement. Although the mechanism of action of bisphosphonates is not fully understood, these drugs tend to slow down bone turnover; consequently, teeth may move very slowly. A young patient taking Ritalin for Attention Deficit Hyperactivity Disorder (ADHD) may have social-behavioral problems and consequently compliance may be a problem. Some reports also suggest that Ritalin affects growth rates. Patients with growth disorders and growth manipulation should be considered potential problem patients. Lastly, any allergies should be noted. The most common allergies that may complicate treatment are to nickel, since it is found in most wires, and latex, which is found in some elastic material. As with any condition, it should be followed up with the patient's physician.

**Dental History**

One should inquire if the parents received orthodontic treatment, and if so, what the nature of their problem was. There are some indications that there are genetic influences in many dental and occlusal characteristics, especially missing and displaced teeth.\(^6\) It is important to ask if the patient is receiving regular dental care. This might reveal the family awareness of dental health. A question should be asked about whether the patient ever had any traumatic injury involving the teeth or jaws. Trauma to permanent teeth may produce devitalization and/or ankylosis, in which case the tooth will not move or will be subject to resorption or asymmetric facial growth if condylar morphology has not been restored by remodeling or the mandible cannot translate.

**Facial/Dental Photographs**

Standard orthodontic photographs include two frontal views of the face – one with lips at rest and another while the patient is smiling. A lateral view of the face is also taken. Five intraoral views are taken: occlusal views of the upper and lower arch and a frontal right lateral and left lateral view while occluding. Frontal and profile views of the

**Figure 1.** A retromolar implant is being used to distalize the first molar in order to alleviate the premolar crowding.
patient's face provide identification of problems in the primary planes of space. A frontal view of the face provides a general outline of the face as well as transverse proportions.

Ideal facial symmetry in the transverse dimension is depicted in Figure 2 but is seldom a reality since all patients have some degree of asymmetry. Asymmetries should be noted on the transverse facial examination as well as deviations of the nose or chin from the facial midline (Figure 3). If large deviations from normal are noted, this may be indicative of an underlying developmental abnormality and should be documented with a pa cephalometric radiograph.

A profile view of the face provides antero-posterior discrepancies of the maxilla and mandible. A slightly convex or Class I profile indicates a balance between the maxilla and mandible (Figure 4). Discrepancies between the two jaws can produce a convex profile indicating a skeletal Class II jaw relationship (Figure 5) or a straight to concave profile indicating a skeletal Class III jaw relationship (Figure 6).

Ideal facial proportions in the vertical dimension can be determined by the profile view and are depicted in Figure 7. Typically the face is divided into equal thirds: the upper third is the forehead; the middle third is the area between the bridge of the nose and the base of the nose; and the lower third runs from the base of the nose to the undersurface of the chin. Within the lower face, the ratio of upper lip to lower lip should equal 1:2. Facial assessments are made with the patient at rest and in full smile. At rest, a patient will be lip competent (have lips naturally touching) or have a small amount of maxillary incisal display and no gingival display. Decreased interlabial gap is found with vertical maxillary deficiency or anatomically long upper lip (natural change with aging, especially in males). Increases in interlabial gap are seen with anatomic short upper lip or vertical maxillary excess. This becomes obvious upon full smiling. Ideally, a patient will have full maxillary incisal display with up to 2-3 mm of gingival display above the gingival margin of the maxillary incisors. Additional gingival display, often referred to as a "gummy smile" is a condition that detracts from facial esthetics (Figure 8).
Oral Exam
This includes: a) level of oral hygiene; b) the opening, closing, and translation function of jaw and range of motion and temporomandibular joint as well as pain or tenderness of the muscles of mastication; c) the health of the teeth and of the supporting tissues; and d) the intra and tetrarch relationship of the teeth and the teeth to the bones in both the antero-posterior, transverse and vertical planes.

Study Models
Good alginate impressions are obtained of the upper and lower arch. A bite registration is taken with the occlusion in centric occlusion (and centric relation if there is a CR-CO discrepancy) so that the models are properly oriented. The impressions are poured in stone and trimmed with the bite registration in place. An alternative to stone models is digital models. The alginate impressions are sent to various companies (OrthoCAD or Emodels) who scan the impressions and produce a digital image. From these models, the orthodontist will validate occlusal characteristics from the intraoral examination, tooth size and available space (Figure 9).

Analysis of Occlusion
The occlusion is evaluated in the three planes of space: antero-posterior; transverse; and vertical. Many methods have been devised to record malocclusion. Probably the most used comprehensive method is the Ackerman and Proffit method, which evaluates the malocclusion...
in the three traditional planes of space as well as arch perimeter and alignment and facial proportions and esthetics. However, Angle’s classification of malocclusion is by far the most commonly used for the molars and incisors and can be generally descriptive for categorizing of malocclusion. A sagittal evaluation of the dentition focuses on the molar Angle classification and the amount of overjet. Angle’s molar classification is based on the relationship of the first molars as follows:

A. **Class I or Neutroclusion** – The mesiobuccal cusp of the permanent maxillary first molar approximates the groove between the buccal cusps of the permanent mandibular first molar (Figure 10). This type of malocclusion is by far the most common.

B. **Class II Division 1 or Distoclusion** – The maxillary mesiobuccal cusp falls forward to the buccal groove of the mandibular molar (Figure 11). If the malocclusion is unilateral, the term subdivision is used (i.e., Class II, Division 1, Subdivision).

C. **Class II Division 2** – The molar relationship is Class II, however the upper central incisors are retroclined, the upper laterals are proclined and there is increased incisal overbite (Figure 12).

D. **Class III or Mesiocclusion** – The maxillary mesiobuccal cusp falls distal to the buccal groove of the mandibular molar (Figure 13). This type of malocclusion is least common (1-2%) in whites. However, it is more common in Asians.

Increments are sometimes added to this classification in an attempt to quantify the severity of the relationship by approximating the fraction of a cuspal width. Typical classifications are one half cusp class III and etc. In the mixed dentition, one half cusp class II (flush terminal plane) is normal since as the primary molars are replaced by the permanent premolars, which have a smaller mesio-distal dimension, the extra space allows the permanent mandibular first molars to drift anteriorly to reach a class I relationship. Overjet is measured as the distance between the facial surface of the mandibular incisor and the maxillary incisor and typically measures 1-3 mm. Excessive overjet and a class II molar are indicative of a class II skeletal and dental relationship whereas an anterior crossbite (negative overjet) combined
with class III molars are indicative of a class III skeletal and dental relationship.

Vertical evaluation (Figure 14) of the dentition focuses on overbite or the amount of overlap of the incisors and is usually expressed as percent. Ideal overlap is 10-30%. Anterior open bite (no overlap of the incisors vertically) can be indicative of habits such as thumb sucking or of a more serious skeletal imbalance (Figure 15). On the contrary, deep bites (overbite 80-100%) are found in developing malocclusions and the patient may actually be impinging on their palate with the mandibular incisors causing the palate to become irritated. This may be serious to the point of causing periodontal concerns on the lingual aspect of the corresponding maxillary incisors. Many times a patient presenting with deep bite will have accompanying pronounced Curve of Spee, decreased lower facial height, with or without an associated sagittal component of excessive overjet, all of which are indicative of potential severe problems. Determining whether the problem of deep bite is caused by extrusion of the maxillary anterior teeth or a deep curve of Spee is important in planning treatment.

Transverse evaluation of the dentition focuses on midline (Figure 16) discrepancies and posterior crossbites (Figures 17 and 18). A midline discrepancy, in the absence of any mandibular shifts, is typically due to unequal crowding in each quadrant. Alternatively, a mandibular shift due to a posterior crossbite will produce a midline shift. This condition is typically treated early to eliminate the potential for soft tissue facial asymmetry, improve space, simplify diagnosis and reduce attrition of anterior teeth. Another consideration in the development of a diagnosis is the examination of the maxillary and mandibular arches for crowding and overall position of teeth. In the primary dentition, the best indicator of potential crowding is the lack of spaces between the primary teeth.

The threshold for noticing a discrepancy varies among lay people, general dentists and orthodontists. Although all three groups were able to distinguish a 2 mm incisor crown angulation, only orthodontists found that a 4 mm midline discrepancy was anesthetic whereas general dentists and lay people where unable
to detect it. In general, orthodontists are able to
detect smaller discrepancies than lay people and
general dentists.

**Panoramic Radiograph**
The panorex provides information on the number of
teeth present, eruption problems, root form
and length, quality of alveolar bone and other
pathological conditions.

**Lateral Cephalometric Head Film**
Cephalometrics is the study of the measurements
of the head with relation to specific reference
points, used for evaluation of facial growth and
development and treatment including soft-tissue
profile. Cephalometric roentgenographs enable
the orthodontist to determine craniofacial and
dentofacial relationships. Lateral cephalograms
(Figure 19) are obtained by positioning the
patient's head so that the median sagittal plane
of the head is parallel to the plane of the film and
perpendicular to the central ray of the radiation
tube. The distance of 60 inches from the anode
to the median sagittal plane of the patient's head
is standard. Because of the distance between
the patient's head and film, there is usually
approximately 8-10% magnification of the image
on the film. A translucent plastic sheet of acetate
paper is placed on the film and skeletal structures
are identified and measured, or the image is
digitized and the points stored for analysis.

**Cephalometric Analysis**
One of the first cephalometric analyses to be
developed was the Downs analysis. This
analysis was based on facial and skeletal
proportions of 25 untreated adolescent
Caucasians because of their ideal dental
occlusion. Since then many other analyses
have been developed. Cephalometrics provides
information about the maxilla to the cranial base;
the mandible to the cranial base; the maxilla to
the mandible; vertical skeletal relationships; lip
protrusion and vertical facial proportions; and the
teeth to the underlying jaws and their interarch
relationships. The radiographic information
together with study casts and the clinical
examination indicate to the practitioner what type
of occlusal correction is necessary.

**Goals of Orthodontic Treatment**
According to Roth, orthodontic treatment goals
can be divided into five categories: facial
esthetics, dental esthetics, functional occlusion,
periodontal health, and stability. There is no
one standard that can be used to determine ideal
facial esthetics. Current desirable characteristics
among Caucasians include a slightly convex
profile, nasolabial angle of 90-110º and some
circumoral prominence, a symmetrical face, lip
closure without stain, 1-2 mm of visible gingiva on
smile, and high cheekbones.

Dental esthetics are captured by Andrews' "six
keys" class I occlusion. This includes adequate
tip and torque on teeth, no rotations, crowding
or spacing, as well as central and lateral incisors
with flat incisal edges and a pointed cusp tip on
the canine. Vertically, the central incisor and
canine are at the same level and the lateral
incisor is 1 mm shorter. The gingival margins
should be symmetrical on the anterior teeth.
Recently the esthetics of the smile indicate that
buccal corridors (the dark space between the
dentition and the corners of the lips) should be
modest or reduced, and the arch of the smile
(first premolar to first premolar) is most esthetic
when following the curvature of the lower lip upon
smiling.

In a functional occlusion, the following criteria
should be met: centric occlusion (CO) that
coincides with centric relation (CR), cusps that
are interdigitated, equal magnitude of posterior
forces present, cuspid guidance in lateral
excursions (Video 1), and anterior guidance with
posterior disclosure on protrusion (Video 2).
The Biology of Orthodontic Tooth Movement

Orthodontic tooth movement is composed of three phases: initial tipping, lag phase and progressive tooth movement. Initial tipping occurs when a force (tipping) is applied to a crown of a tooth. The periodontal ligament (PDL) is compressed near the alveolar marginal on the side toward which the tooth is moved. On the opposite side, the PDL is widened or is under tension. The amount of tipping is dependent on the PDL width, root length, anatomical configuration, force magnitude and periodontal health.12

The lag phase represents a delay in movement, which reflects recruitment of cells and the establishment of a microenvironment that will allow the PDL and bone to remodel. This is when osteoclasts are recruited to the area and osteoblasts are activated.

The final phase represents tissue turnover, which allows reduction of the applied strain terminating in tooth movement and appliance deactivation. Bone resorption is dominant in pressure areas, and bone formation is dominant in areas of tension. The length of each phase is partially dependent on the amount of force applied. If excessive forces are applied, the root approaches the alveolar wall effectively to reduce vasculature to the area. As a result, a cell-free zone or hyalinized area is formed. The hyalinized tissue must be removed for tooth movement to occur. This occurs by a process termed undermining resorption, where osteoclasts present within the adjacent bone marrow spaces begin bone resorption on the underside opposite the cell free area. This lag phase can last from several days to several weeks. The use of light forces can minimize the appearance of hyalinized tissue.

An acute inflammatory response is typically present in the early phase of orthodontic tooth movement. Cytokines, which are secreted by mononuclear cells, are chemical mediators that may interact directly or indirectly with bone cells. Cytokines, such as IL-1, can evoke the synthesis and secretion of numerous substances, including prostaglandins (PGs) or a variety of growth factors. Prostaglandins have been shown to stimulate bone resorption and increase the rate during orthodontic tooth movement.12

Periodontal goals include adequate alveolar bone support without dehiscences or fenestrations, good gingival crest height, no pocketing or inflammation of the attachment apparatus, adequate thickness of the attached gingiva, no frenum pulls, and optimum crown-root ratios (JCO).10

Most orthodontic cases exhibit some form of change or settling once the braces are removed. These changes are due to a rebounding of tissues and continued facial growth. Unwanted changes in the occlusion can be minimized by avoiding overexpansion of the mandibular arch, overcorrecting rotations, flattening interproximal contacts and eliminating undesirable neuromuscular habits. Stability in the occlusion can be maximized by adequate retention.
Interceptive Orthodontics
Interceptive orthodontics involves guiding dental and facial development and is typically attempted in the mixed dentition or very early in the permanent dentition. For space problems, some lost space can be regained using fixed or removable appliances to reposition teeth to their original positions. This is usually limited to...
Crossbites where multiple teeth are involved and the cause is skeletal or dental in young children. Posterior crossbites in the near or adolescent age groups are typically corrected using a rapid or slow palatal expander (RPE or SPE) (Figure 23). Most of these appliances consist of a midline screw or spring, which is attached to the molars and premolars. The appliance is typically activated twice (RPE) or once per day (SPE) and produces force, causing the opening of the midline suture.

Perhaps the greatest challenge in interceptive orthodontics is the early correction of skeletal disharmonies. By far the most common problem is the correction of a skeletal class II malocclusion. Typically these patients present with a class II molar relationship due to a retrognathic mandible or a prognathic maxilla. The goal with these skeletal problems is to redirect the growth of the offending jaw. Using early headgear and functional appliances can make changes in the skeletal positions, but these changes are just as effective if produced in the late mixed dentition. Therefore, this type of treatment is probably best suited for those with esthetic complaints or increased risk of trauma to the anterior teeth. Early correction of class III problems due to maxillary retrusion is also a possibility in moderate cases when treated prior to age 10. Unfortunately, early treatment for mandibular protrusion is not recommended.

Corrective Orthodontics
Corrective orthodontics is the use of full orthodontic appliances in the permanent dentition to treat a malocclusion in either adolescents or adults. Typical corrections in AP plane include
In 1998, Align Technology, Inc. (San Jose, CA) invented the most recent esthetic orthodontic appliance system, called Invisalign®. This system uses computer-aided scanning and imaging techniques to manufacture a series of custom made, clear, removable appliances to sequentially move teeth. These appliances (called aligners) are made from a 0.030" clear plastic that adapts to the anatomy of the teeth, and extends to the gingival margin. Each aligner incorporates a small amount of tooth movement to some or all of the teeth within the arch (according to the projected stages of tooth movement), allowing for a maximum displacement of 0.15 to 0.25 mm per tooth. The number of stages necessary to complete the treatment dictates the number of aligners per patient; generally, a mild malocclusion will require fewer aligners than one that is more severe.

Recent advances in orthodontic therapy have focused on designing new appliances that fulfill the patient's esthetic demands. Plastic and ceramic brackets were introduced in the 1970s and late 1980s, respectively, offering improved esthetics over traditional metal brackets. However, these bonded appliances still require metal wires and clear ligatures, which tend to discolor over time. Many patients choose to whiten their teeth after orthodontic treatment with a bonded appliance as the tooth color may become uneven during the course of the treatment.
formed. These plastic devices are esthetic and usually well accepted by the patients. The tooth positioner appliance can be used for minor detailing of the occlusion as well as retainer. Cooperation is difficult since these appliances are bulky and unaesthetic.

An alternative to the removable retainer is the direct-bonded lingual retainers often referred to as permanent retainers. These are typically used when rotations are present in the mandibular anterior teeth or if a diastema is present in the maxillary arch. Patient acceptance of the bonded retainers is excellent. The patient appreciates that the stability of the treatment result does not depend upon their cooperation, as is the case with removable retainers. However, increased oral hygiene measures need to be implemented since they are a food trap.

Tissue Considerations and Oral Hygiene During Orthodontic Treatment
Oral hygiene is of paramount importance during orthodontic treatment. The role of dental plaque accumulation in the development of dental caries and periodontal diseases is well documented. While orthodontic appliances do not cause dental caries, they provide increased possibilities for the retention of food debris. The unwanted effects of enamel decalcification and gingival inflammation can be prevented if good hygiene is followed. Maintaining good oral hygiene is difficult since bands, brackets, ligature wires, and elastics encourage accumulation of microbial flora and food residues. Various toothbrush devices, chemotherapeutic rinses and other home care products are available to help the patient achieve the desired level of oral hygiene.

Ideally, each aligner is worn 20-22 hours per day for two weeks and is removed only for eating and oral hygiene procedures.

Retainers
Once the malocclusion is corrected and the braces are removed, stability is a major concern of orthodontics. Retainers are appliances that are worn full- or part-time to hold the teeth and prevent them from drifting or moving after treatment has been completed. Retainers are generally removable, but not always. Cooperation in prescribed retainer wear is very important in maintaining the results of orthodontic treatment after braces are removed. The Hawley-type retainers are preferred by most of the orthodontists for retention. They seem to be suitable and well-adapted by the patients in the aspect of speech articulation. Clear or Essix are another type of retainer, which are vacuum-
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1. **Who first declared orthodontics a specialty?**
   a. Calvin S. Case
   b. Norman Kingsley
   c. Stuart Proffit
   d. Edward H. Angle

2. **Findings from the National Health and Nutrition Examination Survey (NHANES III) show the average overbite in the U.S. to be _______.**
   a. 1.2 mm
   b. 2.9 mm
   c. 3.8 mm
   d. 4.6 mm

3. **Typical orthodontic records include a __________.**
   a. medical history and oral exam
   b. facial and intraoral photographs
   c. panoramic and a lateral cephalogram head film
   d. All of the above.

4. **A profile view of the face provides __________ discrepancies of the maxilla and mandible.**
   a. antero-posterior
   b. midline
   c. Both A and B.
   d. Neither A nor B.

5. **Discrepancies between the maxilla and mandible can produce a convex profile indicating a skeletal Class II jaw relationship or a straight to concave profile indicating a skeletal ______ jaw relationship.**
   a. Class I
   b. Class II
   c. Class III
   d. None of the above.

6. **Within the lower face, the ratio of upper lip to lower lip should equal ______.**
   a. 1:1
   b. 1:2
   c. 2:1
   d. 1:3

7. **Additional gingival display, often referred to as a __________ is a condition that detracts from facial esthetics.**
   a. gummy smile
   b. overbite
   c. underbite
   d. overjet
8. Which type of malocclusion is the most common in the United States?
   a. Class I
   b. Class II
   c. Class III
   d. None of the above.

9. Vertical evaluation of the dentition focuses on overbite or the amount of overlap of the incisors and is usually expressed as a percent. Ideal overlap is __________.
   a. 5-10%
   b. 15-25%
   c. 10-30%
   d. 20-30%

10. In general, orthodontists are able to detect __________ discrepancies than lay people and general dentists.
    a. fewer
    b. smaller
    c. greater
    d. None of the above.

11. Angle's classification of malocclusion is the study of the measurements of the head with relation to specific reference points used for evaluation of facial growth and development and treatment including soft-tissue profile.
    a. True
    b. False

12. Which of the choices below is one of the five categories for orthodontic treatment goals?
    a. Periodontal health
    b. Stability
    c. Functional occlusion
    d. All of the above.

13. During the "lag phase" of orthodontic tooth movement, tissue turnover occurs, which allows reduction of the applied strain terminating in tooth movement and appliance deactivation.
    a. True
    b. False

14. Bone resorption is dominant in __________ areas, and bone formation is dominant in areas of __________.
    a. pressure / tension
    b. tension / pressure
    c. tension / turnover
    d. gingival health / subgingival calculus

15. A prime example of __________ treatment involves space maintenance from premature loss of teeth.
    a. interceptive
    b. corrective
    c. retention
    d. preventive
16. An example of interceptive orthodontics is _______________.
   a. elimination of thumb and finger sucking
   b. correction of anterior or posterior crossbite
   c. an adult wearing aligners
   d. None of the above.

17. Single-tooth crossbites are typically corrected with which of the following appliances?
   a. Rapid palatal expander
   b. Slow palatal expander
   c. W-arch
   d. Retainer

18. Many patients choose to whiten their teeth after orthodontic treatment with a bonded appliance as the tooth color may become uneven during the course of the treatment.
   a. True
   b. False

19. An alternative to the removable retainer is the _______________ often referred to as permanent retainers.
   a. direct-bonded lingual retainers
   b. aligners
   c. band and loop space maintainer
   d. Hawley-type retainer

20. Home care products that help patients achieve the desired level of oral hygiene include _______________.
   a. colored rubber bands
   b. chemotherapeutic rinses
   c. in-office bleaching
   d. retainers
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About the Author

Calogero Dolce, DDS, PhD

Dr. Dolce is an Associate Professor in the Department of Orthodontics at the University of Florida. Dr. Dolce completed his DDS and PhD at SUNY-Buffalo and a certificate in orthodontics at the University of Florida. He is a diplomate of the American Board of Orthodontics. Currently, Dr. Dolce is a co-investigator on NIDCR-funded research that examines the timing of treatment for Class II malocclusion. In addition, he is involved in a clinical trial funded by Align Technologies and BAS medical. His other research interest is on the biology of tooth movement.

Dr. Dolce serves as a reviewer for various journals including the Journal of Dental Research and the American Journal of Orthodontics and Dentofacial Orthopedics. Dr. Dolce is involved in teaching orthodontic residents and is part of Faculty practice.