ESSENTIALS OF

Orthodontics

Diagnosis and Treatment

1 Orthodontic Diagnosis and Treatment Planning

Normal and Ideal Occlusion

To recognize a malocclusion, a clinician needs to understand ideal and normal occlusions. People with **ideal occlusions** have all 32 adult teeth in superb relationships in all three planes of space. The tip of the mesiobuccal cusp of the upper first molar fits into the buccal groove of the lower first molar, and the tip of the upper canine crown fits into the embrasure between the lower canine and first premolar (Fig. 1.1, Class I ideal occlusion). **Overbite**, the extent that the upper central incisors overlap the lower central incisors in the vertical plane, is approximately 20%. **Overjet**, the distance along the anteroposterior plane between the labial surfaces of the lower central incisors and the labial surfaces of the upper central incisors, is approximately 1 to 2 mm. Teeth, moreover, are normally angled in the mesiodistal plane, normally inclined in the buccolingual plane, and aligned without being spaced, rotated, or crowded along the crests of the alveolar processes (Andrews 1972). Ideal occlusions are rare in the United States.

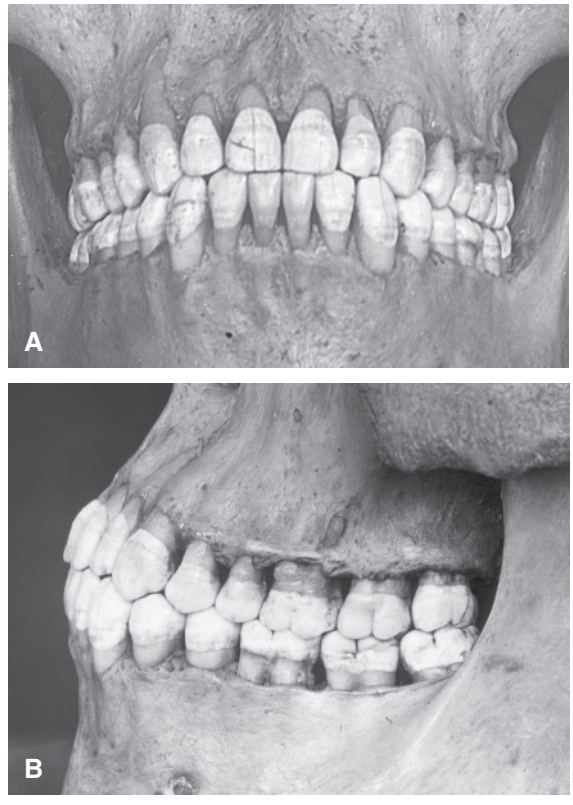

Figure 1.1. A, B, Ideal occlusion in the skeletal remains of a human adult. (Skull "secretum apertum," courtesy of Dr. Richard Summa.)

Essentials of Orthodontics: Diagnosis and Treatment
by Robert N. Staley and Neil T. Reske

Figure 1.2. **A–E,** Normal occlusion in a female adult.

Normal occlusions have minimal rotations, crowding, and/or spacing of the teeth. More variability is observed in overbite and overjet in normal occlusions (Fig. 1.2). Normal occlusions are much more frequently observed in the United States than are ideal occlusions.

Normal Occlusion in the Primary Dentition

As a child approaches the age when the normal primary dentition transitions into the mixed dentition, spaces develop between the incisors in

Figure 1.3. **A–E,** Normal occlusion in the primary dentition of a 5-year-old boy.

both arches with growth of the maxilla and mandible (Fig. 1.3). The spacing of primary incisors is needed to accommodate the erupting permanent incisors that are much larger than their primary counterparts.

Centric Occlusion and Centric Relation

Occlusion is observed and classified when the teeth are in **maximum intercuspation,** the definition for **centric occlusion. Centric relation** is

defined as the most retruded occlusal position of the mandible from which opening and lateral movements can be performed (Moyers 1973). Centric occlusion deviated on average 0.7 mm from centric relation in 18 Class I normal occlusion subjects, with a maximum of 2.5 mm; however, in 28 Class II patients, the discrepancy averaged 1.2 mm, with a maximum of 4 mm (Williamson, Caves, Edenfield, and Morse 1978).

Angle Classification of Malocclusion

Angle classified malocclusions on the basis of the **anteroposterior** relationships of the upper and lower teeth (Angle 1899). He concentrated on the relationships between the upper and lower first molars and canines. His observations on the different classes remain valid and useful today. His classification system also enhances communication between clinicians.

Angle Class I Malocclusion

Class I malocclusions have mostly normal anteroposterior tooth relations combined with a discrepancy between tooth size and dental arch length (Fig. 1.4). The discrepancy is usually crowding and less often excessive spacing between the teeth. Patients with Class I crowded malocclusions have larger-than-normal teeth,

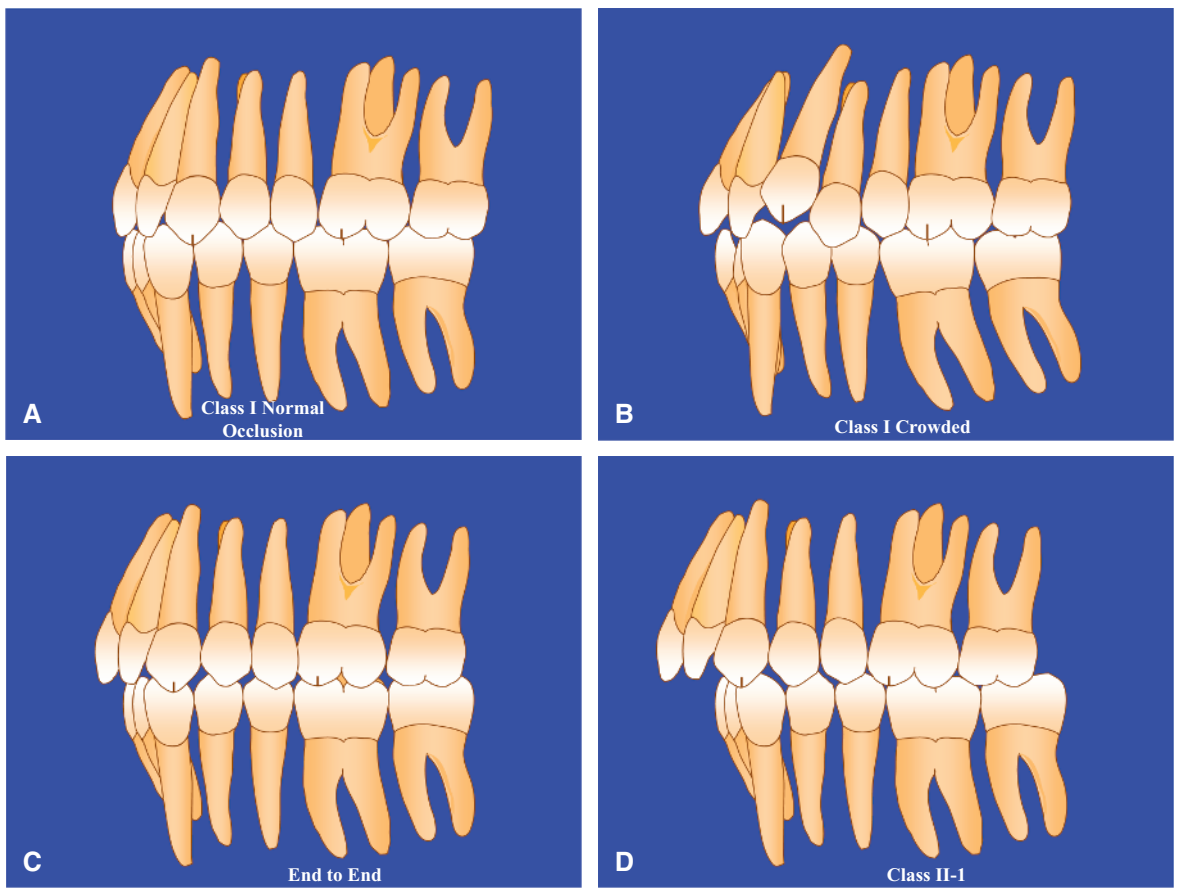

Figure 1.4. **A–D,** Schemata of Class I normal occlusion and Class I crowded, end-to-end, and Class II division 1 malocclusions.

smaller-than-normal arch lengths, and smaller-than-normal arch widths (Kuntz et al. 2008). Overbite and overjet vary in Class I malocclusions. Anterior and posterior crossbites appear in this type of malocclusion.

Class I Malocclusions in the Primary and Mixed Dentitions

Primary second molars are considered to be Class I normal if a **mesial step** is present between the distal surfaces of the upper and lower molar crowns when viewed from the buccal surfaces (Fig. 1.5). A **mesial step** occurs when the distal surface of the lower primary second molar is mesial to the distal surface of the upper primary second molar.

Crowding problems are rarely found in the primary dentition. If no spacing is seen between the primary incisors, dental crowding can be expected. Crowding is first apparent in the mixed dentition when the permanent incisors begin to erupt. In a crowded dentition, incisors can erupt lingual and labial to the line of arch. The **line of arch** is located along the crest of an alveolar process where the anatomic contact points of the teeth should be located ideally on a given alveolar process. Rotated and displaced incisors are commonly seen in the developing crowded malocclusion.

Angle Class II Division 1 Malocclusion

In Class II-1 malocclusions, the lower teeth are distal to the upper teeth, usually resulting in larger-than-normal overjet. The upper incisors often have increased labial inclination, making the incisor crowns susceptible to accidental fractures. The distobuccal cusp of the upper first molar occludes with the buccal groove of the lower first molar (Fig. 1.4, Class II-1). The maxillary canine crown tip is located near the mesial surface of the mandibular canine (Fig. 1.4, Class II-1). Patients with these malocclusions may or may not have crowded arches and vary in the degree of overbite from openbite to deep

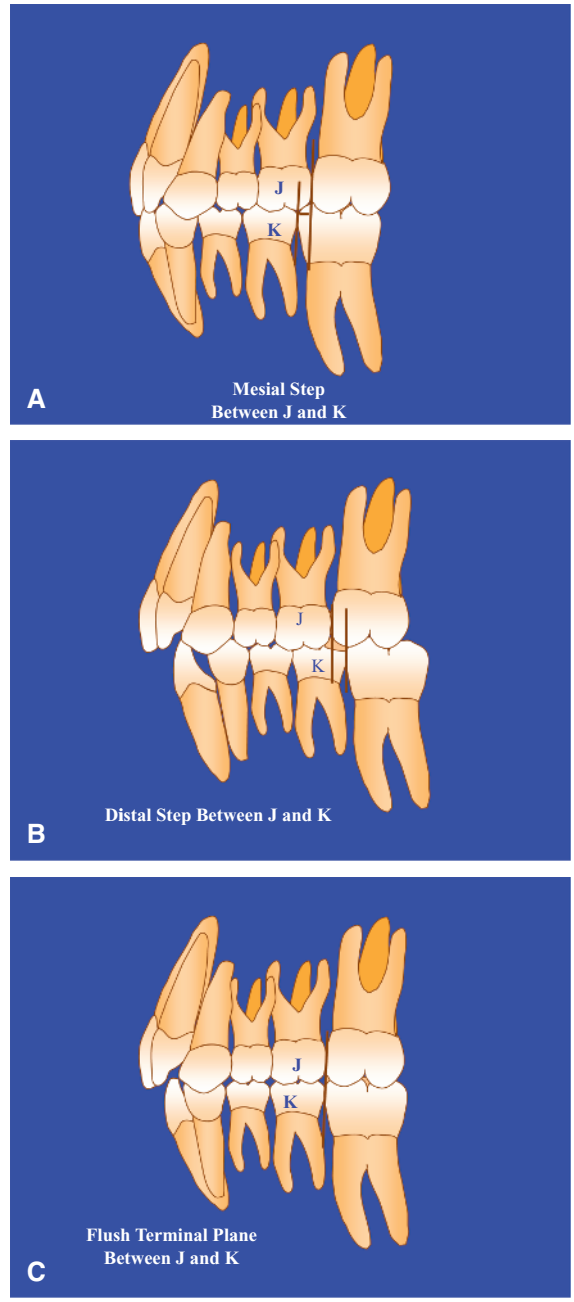

Figure 1.5. **A–C,** Schemata of the mixed dentition showing second primary molars with mesial step, distal step, and flush terminal plane occlusions.

overbite. On average, maxillary arch widths are narrower in Class II-1 patients than in persons with normal occlusion (Staley, Stuntz, and Peterson 1985).

Angle Class II Division 2 Malocclusion

In Class II-2 malocclusions, the upper incisor crowns, especially those of the upper central incisors, are inclined to the lingual, in contrast to the excessive labial inclination observed in many Class II-1 malocclusions (Fig. 1.6). The number of maxillary incisors with lingual inclination varies from one to four. The lingual inclination of the upper central incisors results in small to moderate overjet measurements. Overbite is often deeper than normal, because of the lingual inclination of the upper incisors. The **collum angle** between the long axis of the crown and the long axis of the root in maxillary central incisors has been shown to be larger in a sample of Class II-2 patients compared with other occlusion groups. Class II-2 patients with large collum angles are predisposed to larger-than-normal overbites (Delivanis and Kuftinec 1980). The maxillary arches of patients with this malocclusion are narrower than normal but significantly larger than the widths observed in Class II-1 patients (Huth et al. 2007). Few of these patients have posterior crossbites.

Class II Malocclusions in the Primary and Mixed Dentitions

Primary second molar crowns are considered Class II when a **distal step** is observed between the distal surfaces of the upper and lower second primary molar crowns (Fig. 1.5). In this situation, the distal surface of the lower second primary molar is positioned distal to the distal surface of the upper second molar crown.

End-to-End Occlusion

When molars and canines are positioned between Class I and Class II, the relationship is considered

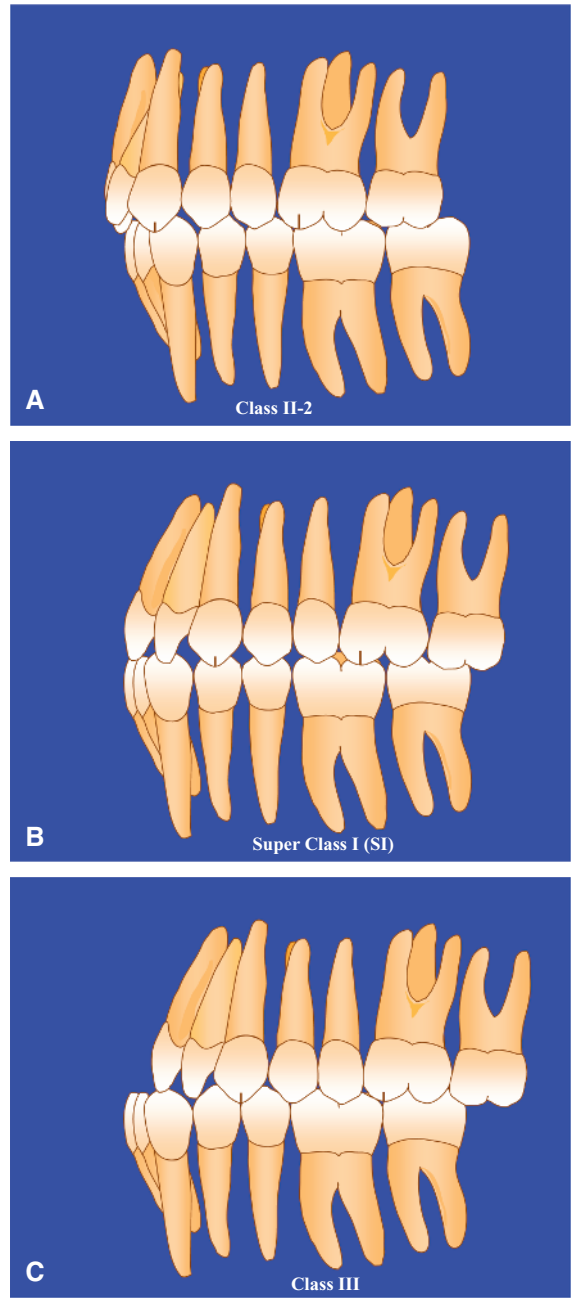

Figure 1.6. **A–C,** Schemata of Class II division 2, Super Class I, and Class III malocclusions.

to be end to end. These Class II malocclusions are less severe versions of the full Class II occlusion (Fig. 1.4) and are considered Class II malocclusions when assigning Angle Classification. End-to-end occlusions appear in both Class II-1 and Class II-2 types.

In the primary molars, the end-to-end relationship is expressed by what is called a **flush terminal plane** (Fig. 1.5). In a flush terminal plane, the distal surfaces of the upper and lower primary second molars are vertically coincident.

Angle Class III Malocclusion

In this class of malocclusion, the lower teeth are mesial to the upper teeth, usually resulting in anterior crossbite (Fig. 1.6). The mesiobuccal cusp of the upper first molar occludes with the embrasure between the lower first and second molars. Overbite varies from openbite to deep overbite. Alignment of the teeth in the arch varies from good to severe crowding, with the upper arch being more prone to crowding than the lower arch. On average, the maxillary arch widths of these patients are narrower than those in normal occlusions (Kuntz et al. 2008). The narrowness of the upper arch and the anteroposterior displacement of the arches are often associated with posterior crossbites.

Class III Malocclusions in Primary and Mixed Dentitions

Class III malocclusion in the primary dentition is expressed in an exaggerated mesial step between the distal surfaces of the upper and lower second molars. Often, in younger patients, a Class III occlusion is less severe than it will eventually become, because the mandible usually grows forward for a longer time than the maxilla.

Super Class I Malocclusions

When the mesiobuccal cusp tip of the upper first molar occludes distally to the buccal groove of the lower first molar in a position between Class I and full Class III, the malocclusion is termed Super Class I (Fig. 1.6). A Super Class I malocclusion is a mild version of Class III malocclusion and is considered a Class III malocclusion when assigning an Angle Classification to the patient.

Super Class II and Super Class III Malocclusions

These are more severe versions of Class II and Class III malocclusions and are seen only rarely. They can occur in patients who have lost teeth through extraction that permitted first molars to spontaneously move through the alveolus mesially or distally. Excessive or diminutive growth of the mandible can also result in these severe malocclusions.

Subdivision Malocclusions

Class II Subdivision Malocclusions

Class II subdivision malocclusions occur when the first molar relationship is Class II on one side of the arches and Class I on the other side. A Class II-1 subdivision is written as follows: Class II division 1 subdivision right when the Class II molar relation is on the right side of the arches and Class II-1 subdivision left when the molar relation is Class II on the left side of the arches.

The written form for Class II-2 subdivision malocclusions follows the same pattern as given earlier.

Class III Subdivision Malocclusions

Class III subdivision malocclusions occur when the first molar relationship is Class III on one side of the arches and Class I on the other side. Class III subdivision malocclusions are written as Class III subdivision right or left to indicate the Class III side.

Class II-III Subdivision Malocclusions

When the first molar relation is Class II on one side and Class III on the other side, the malocclusion is classified as a Class II-III subdivision right or left to indicate the class that appears on each side of the arch. For example, a malocclusion is defined as Class II R, Class III L. These malocclusions are rare and usually caused by the loss of posterior teeth and resultant shifting of teeth into extraction sites. Angle did not include Class II-III malocclusions in his classification system. This addition to the classification system includes patients with this rare malocclusion.

Incisor Dental Compensations in Class II and Class III Malocclusions

The tendency for the upper and lower incisors to remain near one another as the maxilla and mandible diverge in the anteroposterior plane during growth is called **dental compensation**. As the anteroposterior discrepancy between the upper and lower arches increases, the inclination of the incisors in both arches compensates for the discrepancy. In the Class II patient, compensation is expressed as increased lingual inclination of the upper incisors and increased labial inclination of the lower incisors. In the Class III patient, the compensation is expressed by increased labial inclination of the upper incisors and increased lingual inclination of the lower incisors.

Iowa Notation System for Angle Classification

Clinicians record the Angle relationships of the first molars and canines with an abbreviated notation. For example, a Class I malocclusion is written from the patient's right side to left side as I, I, I, I. A Class II malocclusion is written as II, II, II, II, and a Class III malocclusion is written as III, III, III, III. The term "end-to-end" is used for molar and canine relationships that are intermediate between Class I and Class II. The symbol E is used for end-to-end in the notation. The symbol E is equivalent to Class II when classifying the malocclusion. The term "Super I" (SI) is used to describe molar and canine relationships falling between Class I and III. The symbol SI is equivalent to Class III when classifying the malocclusion. When a canine or molar cannot be classified because it is missing or not erupted, a dash is put into the notation. The notation system alerts the clinician to the presence of asymmetries in the dentition.

When the distobuccal cusp of the upper first molar occludes somewhere mesial to the buccal groove of the lower first molar or the crown tip of the upper canine is located mesial to the lower canine, the Class II occlusion is exaggerated. The term "Super II" (SII) is used to describe this exaggeration. When the mesiobuccal cusp of the upper molar is located distal to the embrasure between the lower first and second molars or when the tip of the upper canine occludes distal to the embrasure between lower first and second premolars, the Class III malocclusion is exaggerated. The term "Super III" (SIII) is used to describe this exaggeration.

Rules for Assigning Angle Classification

Examples of classifications are given next for molar and canine relations that are either the same or similar:

1. I, I, I, I = Class I
2. II, II, II, II = Class II, division 1 or 2
3. II, E, E, II = Class II, division 1 or 2
4. E, E, E, E = Class II, division 1 or 2
5. III, III, III, III = Class III
6. III, SI, SI, III = Class III

Examples of classifications are given next for three similar molar and canine relations. The Angle Classification is based on the most frequent notation, **with molar relationships taking precedence over canine relationships.**

1. I, II, SII, II = Class II, subdivision left
2. I, I, E, I, = Class I

3. E, E, E, I = Class II, subdivision right
4. III, I, III, III = Class III
5. I, I, I, II = Class II, subdivision left
6. I, I, I, III = Class III, subdivision left

Examples of classification are given next for combinations of two similar notations, of which some are Class I and others are Class II or Class III. Molar relationships take precedence over canine relationships in the assignment of Angle Classification.

1. I, E, E, I = Class I
2. I, II, II, I = Class I
3. I, SI, SI, I = Class I
4. E, I, I, E = Class II
5. SI, I, I, SI = Class III
6. I, I, II, II = Class II, subdivision left
7. SIII, SIII, I, I = Class III, subdivision right
8. I, II, I, II = Class II, subdivision left
9. I, III, I, III = Class III, subdivision left

The following principles are useful guides in assigning Angle Classification:

1. The notation E is equivalent to II.
2. The notation SI is equivalent to III.
3. Neither E nor SI is equivalent to I.
4. Normal occlusion must be differentiated from Class I malocclusion.

Rating the Severity of a Malocclusion

The severity of a malocclusion is related to the number of problems observed within the dental arches and to the relationship of the malocclusion with the face. Within the arches, problems can occur in all three planes of space: anteroposterior, transverse, and vertical (Akerman and Proffit 1969). The severity of a malocclusion increases when it involves two or three of the planes of space. Malocclusion also increases in severity as the maxilla and mandible become more involved in anteroposterior, transverse, and vertical skeletal deviations from normal. An accurate assessment of severity will be beneficial to the patient and clinician as the treatment is planned (Proffit and Akerman 1973).

Orthodontic Records

The data collected from the patient prior to treatment provide essential information on which the treatment plan, treatment, and retention plan are based. The care taken in collecting records will be reflected in the diagnosis and treatment of the patient. Records are essential for the medicolegal protection of the dental clinician.

Records taken at the initial appointment of a patient with a minor malocclusion problem include a clinical examination of the face and oral cavity, impressions for plaster casts of the teeth, facial and intraoral photographs, and a panoramic radiograph. In the mixed-dentition patient, periapical radiographs of the premolars and canines are needed for the mixed-dentition tooth size–arch length analysis. A cephalometric radiograph may be needed in some patients to determine whether the malocclusion problem is minor or complex. Patients with a suspected facial growth problem, such as a mixed-dentition patient with an anterior crossbite, may need a cephalogram to determine whether the mandible has a normal relationship to the maxilla. The cephalogram of the patient with a Class III pattern of growth can be used to assess future facial growth.

After treatment begins, a written chronologic record of treatment becomes an essential part of the patient's records. Oral hygiene practices of the patient and other compliance issues are recorded. Periodically during treatment, additional records may be gathered to assess the progress of treatment. Photographs are often taken to describe important stages and appliances used in the treatment of the patient. When appliances are removed at the end of active treatment, records also are taken. These records establish what was accomplished by the treatment. Post-treatment or retention records may be taken to evaluate the stability of the treatment and the success of the retention plan.

Records are the primary means by which a clinician can understand how the appliance corrected the malocclusion and how facial and dental growth affected the treatment outcome.

Records should be maintained for a reasonable time after treatment to help the patient during the time that retainers are worn and to protect the clinician in the event questions arise about the treatment.

Clinical Examination

A form is used to record the findings of a chairside clinical examination (Figs. 1.7, 1.8, and 1.9). Forms such as these can be digitized for paperless record keeping. In addition to demographic information, the patient is asked to describe his chief concern for seeking orthodontic treatment. A medical history is taken, including an examination of nasal airway competence. A dental history is taken. Habits involving the teeth are recorded. Habits commonly seen are thumb sucking, tongue thrusting during swallowing, and lip biting and sucking. The patient is asked if he has had previous orthodontic treatment.

A temporomandibular joint (TMJ) examination is undertaken to record any abnormal symptoms during mandibular movements and to obtain the history of any abnormal symptoms. Although orthodontic treatment has not been shown to be the cause of TMJ symptoms, these symptoms or lack thereof must be elicited and recorded at the initial examination. If significant symptoms are discovered, refer the patient to a TMJ disorder (TMD) specialist. TMDs can prevent orthodontic patients from wearing elastics or chin cups during treatment.

In viewing the face from the front, a clinician evaluates facial height and bilateral symmetry. Face height in normal adults is divided into three approximately equal parts: (1) *upper,* hairline to radix nasi [root of nose] (2) *middle,* radix nasi to basis nasi [base of nose], and (3) *lower,* basis nasi to base of chin (Fig. 1.10). Children have a smaller lower face height that gradually lengthens to adult proportions during growth. Patients with bilateral facial asymmetry usually have a noticeable deviation of the chin to the right or left of the facial midline. These patients need to be treated by a specialist. Lip position at rest is noted. The presence of a gummy smile can be evidence of excess vertical growth of the face, a shorter-than-normal upper lip length, or vertically short teeth. Face profiles fall into three types: (1) straight, (2) convex, and (3) concave. Convex profiles are often associated with Angle Class II malocclusions, whereas concave profiles are often associated with Angle Class III malocclusions (Fig. 1.10).

The dentition is then examined. The stage of development of the dentition is recorded. Early mixed dentitions have only the permanent first molars and/or incisors erupted. In the late mixed dentition, at least one permanent canine or premolar has erupted. Interceptive orthodontic procedures are initiated in the primary, mixed, and early permanent dentitions.

Periodontal status is important in all adult patients. Periodontal disease must be treated before orthodontic treatment can proceed. Adequate attached (keratinized) gingiva is needed on the buccal and labial surfaces of teeth that are planned to be moved in those directions during treatment. Gingival recession prior to treatment requires a periodontal consult before starting orthodontic treatment. Abnormal maxillary frenum attachments may be associated with a diastema between the upper central incisors. Restorative status must be assessed. Untreated nonvital teeth must receive endodontic treatment before initiation of orthodontic treatment. Prosthetic restorations have an important impact on the choice of an orthodontic appliance and its ability to move teeth. Oral hygiene status is extremely important and should be excellent before starting orthodontic treatment. All caries must be treated before beginning orthodontic treatment.

Anteroposterior relationships include the Angle Classification for molars and canines, overjet, and anterior crossbites. Vertical relationships of the upper and lower teeth are recorded. Patients with anterior and posterior openbites and deep overbites are not good candidates for minor orthodontic treatment. Transverse relationships include dental midline discrepancies with the face, posterior crossbites, and asymmetry in the

ORTHODONTIC EXAMINATION, DIAGNOSIS AND TREATMENT PLAN

Date of Examination _____

Patient's Name _____Birthdate____Gender____
(last) (first) (initial)

1. **Chief Concern** _____

2. **Medical History and Airway Exam**
   a. General health_____
   b. Significant conditions (e.g. requiring antibiotic premedication)_____
   c. Prescribed drugs _____
   d. Tonsils and adenoids normal _____ enlarged _____
   e. Nasal airway: open _____ obstructed _____mouth breathing_____

3. **Dental History**
   a. Habits: finger _____tongue _____lip _____
      Bruxism _____ musical instruments_____
   b. Trauma to face and teeth: _____
   c. Previous orthodontic treatment _____

4. **TEMPEROMANDIBULAR JOINT EXAM:** symptoms _____
   pain _____ history _____

5. **Facial Form**
   a. Frontal:
      1) Vertical: Face height: normal _____ long _____ short _____
      2) Bilateral: symmetry _____asymmetry _____
      3) Lips: Position at rest: touching_____ apart (mm) _____
      4) Gummy Smile: Yes_____ No_____
   b. Profile: straight _____convex _____concave_____

6. **Dentition**
   A. **Stage of Dentition:** Deciduous _____Mixed (Early) _____ (Late)_____ Permanent _____
   B. **Periodontal status:** (All adults **must have** recent periodontal probings). _____
      Gingival Recession _____Abnormal Frenum _____
   C. **Restorative Status:** Caries_____ Endodontics _____
      Prosthetic restorations_____
   D. **Oral Hygiene:** Good _____ Poor _____ White Spots_____
   E. **Vertical**
      1. Overbite (%) _____Anterior Open bite (mm) _____Posterior Open bite (mm) _____

Figure 1.7. Page 1 of an orthodontic clinic record form.

F. **Transverse**

1. Dental midlines to face (mm): Upper _____ Lower _____
2. Posterior Crossbite: Unilateral _____ Bilateral _____

U/L Molar inclination: Lingual_____ Buccal_____Intermolar width difference (mm) _____

3. Asymmetry in dental arches _____

G. **Anteroposterior**

1. Right Molar _____ Right Canine _____Left Canine _____Left Molar_____

Choices: III, SI [Super I], I, E, II)

Angle Classification: Class I _____Class II-1 _____Class II-2 _____ Class III _____

2. Incisor Overjet:(mm) _____ Edge to Edge_____ Anterior Crossbite_____

H. **Functional Shifts on Closure:** Anteroposterior _____Transverse _____

Premature loss of deciduous teeth: _____

Toothsize/Arch Size:	Excess Space	Adequate	Crowding
Maxilla	_____	_____	_____
Mandible	_____	_____	_____

K. **Radiographic Analysis:**

Ectopic Eruption _____ Short Roots _____

Missing Teeth _____ Supernumerary Teeth _____

Impacted Teeth _____ Root Resorption _____

Root Dilaceration _____ Periapical Pathology _____

Alveolar Bone Height _____ Ankylosis_____

Caries _____ Other _____

Summary of Diagnostic Findings and Problem List

1. **Chief Concern** _____
2. **Medical History** _____
3. **Dental History** _____
4. **Facial Form** _____
5. **Dentition:**
   - a. **Perio status** _____
   - b. **Restorative status** _____
   - c. **Oral Hygiene** _____
   - d. **Angle Class:** _____; **RM**_____ **RC**_____ **LC**_____ **LM**_____
   - e. **Overbite (%)**_____ **Overjet (mm)** _____
   - f. **Crossbites (anterior)**_____ **(posterior)** _____
   - g. **Functional Shifts**_____
   - h. **Crowding/Spacing (mm)** U____ L ____ **Molar Width Difference (mm)**_____
   - i. **Radiograph Findings**_____
6. **Diagnosis:**

1. Anter-oposterior

2. Transverse

3. Vertical

4. TSALD

Figure 1.8. Page 2 of an orthodontic clinic record form.

TREATMENT PLAN

1. Goals (in response to problem list):

2. Anchorage Source(s):

3. Complicating Factors:

APPLIANCE PLAN

1. Draw Picture Of Removable Appliance:

2. Describe Fixed Appliance:

RETENTION PLAN

1. Describe Appliance:

2. Recommendation To Patient Regarding Wear Time For Retainer(s):

EVALUATION OF TREATMENT

COMMENTS:

Figure 1.9. Page 3 of an orthodontic clinic record form.

upper and lower arches. The presence or absence of a functional shift on closure is important information for all patients who have anterior and posterior crossbites.

Premature loss of primary teeth can lead to mesial drifting of the permanent first molars and impaction of second premolars. Intercepting this problem before it occurs with use of a space

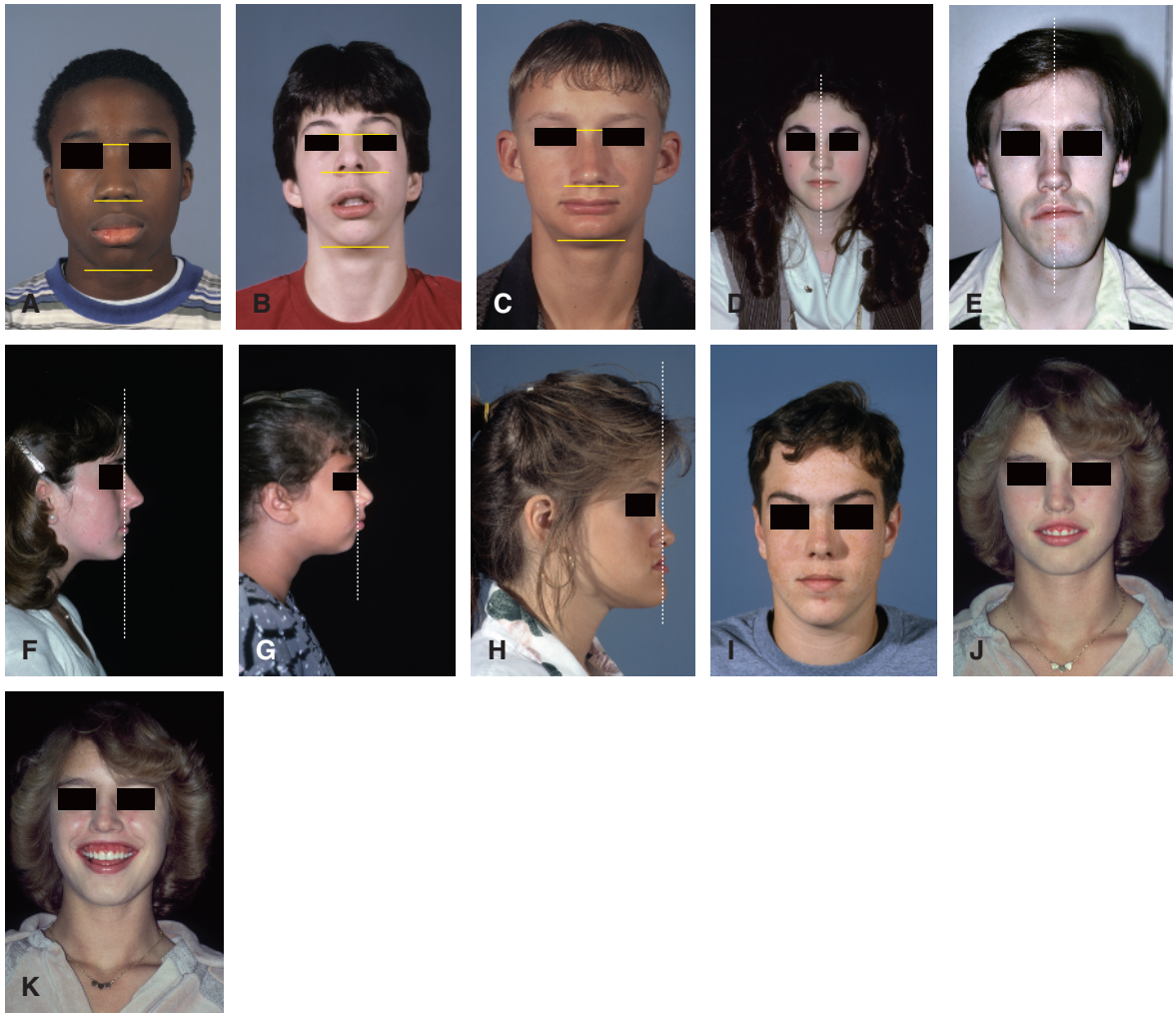

Figure 1.10. **A–K,** Facial form in vertical, transverse, and profile views and lip postures. **A,** Vertically normal face. **B,** Vertically long face. **C,** Vertically short face. **D,** Bilateral symmetry. **E,** Bilateral asymmetry. **F,** Straight facial profile. **G,** Convex facial profile. **H,** Concave facial profile. **I,** Normal relaxed lip position. **J,** Lips apart at rest. **K,** Gummy smile.

maintainer or with an orthodontic appliance after a premolar has been impacted is an important service to the patient.

Tooth size–arch length relations are recorded. Detailed analysis requires measurements on the dental casts.

Radiographic findings are recorded after images are examined. Several important findings are listed in the clinical examination form.

Summary of Findings, Problem List, and Diagnosis

After the clinical examination, important findings are summarized by the clinician. From this information, a diagnostic summary is developed (Fig. 1.8). The Diagnostic Summary is divided into four sections: (1) anteroposterior findings, (2) vertical findings, (3) transverse findings,

and (4) tooth size–arch length discrepancy [TSALD].

A treatment plan is based on the diagnosis and problem list (Ackerman and Proffit, 1969). The treatment plan addresses the problems (Fig. 1.9). Some problems, such as compromised nasal breathing, require referral to a physician. Appliance and retention plans are also developed for the patient. Alternative appliance plans can be formulated, to fully inform and educate the patient about how the malocclusion problem can be corrected. This preparation enables the clinician to meet with the patient to describe his malocclusion problem and reach an agreement with the patient on the best treatment plan and appliance for him based on informed consent.

Consultation with Patient and/or Parent

After the treatment and appliance plans are developed, the next step in the process is to meet with the patient and parents of a minor to discuss the diagnosis and plans for treatment, the appliance(s), and retention phase. The records serve as tools to educate the patient about his malocclusion problem. Informed consent must be obtained from the patient and/or parent before starting treatment.

The patient must be informed about the risks of orthodontic treatment. Hazards that must be mentioned are **root resorption** and **enamel demineralization.** Apical root resorption usually involves a small loss of root structure in one or more of the teeth. Teeth rotate around the center of resistance located approximately at the junction of the middle and coronal thirds of the root. Take a ballpoint pen and hold it with two fingers at the "center of resistance of the root" and rotate it to show how movement of the "crown" causes a great deal of movement of the "end of the root." This will illustrate the vulnerability of the root apex to attack by osteoclasts that remodel alveolar bone but can also resorb part of the root. In 12 studies published since 1970, orthodontic patients experiencing root resorption ranged from 0% to 100%, with a mean of 44.8% for the 12 studies (Brezniak and Wasserstein 1993). Resorption ceases when the orthodontic appliance is removed from the teeth. A very small percentage of patients experience abnormally large amounts of root resorption during orthodontic treatment. If a patient exhibits root resorption on pretreatment radiographs, this is a strong indicator that root resorption will occur during orthodontic treatment. A routine mid-treatment panoramic radiograph will identify patients who are susceptible to excessive root resorption. In these patients, orthodontic treatment is completed as quickly as possible to arrest the resorption process. Root resorption caused by orthodontic treatment does not require endodontic treatment, unless the teeth are diagnosed as nonvital. Root resorption of 2 or 3 mm caused by orthodontic treatment is not thought to compromise the longevity of the involved tooth.

Enamel demineralization can occur in patients treated with a fixed orthodontic appliance who do not follow good oral hygiene and healthy dietary practices. Increase in the frequency of white spot lesions of 25.6% has been reported for patients who received orthodontic treatment (Gorelick, Geiger, and Gwinnett 1982). Cooperative patients do not usually experience demineralization. A clinician must give the patient hygiene and dietary recommendations at the consultation appointment before the beginning of treatment, and at any later time during treatment when poor oral hygiene is observed. Careful brushing after eating, the use of fluoridated toothpaste and rinses, floss, and water irrigation devices all will help the cooperative patient avoid enamel demineralization. Bonding brackets with resin-modified glass ionomer cement may reduce demineralization of the enamel surrounding the bracket (Schmit et al. 2002).

Patients who present for treatment with poor oral hygiene, active caries, and fillings are associated with white spot development during treatment (Lenius et al. 2009). Topically applied fluoride varnishes and sealants should be used in patients who present with these factors to prevent or at least reduce the impact of poor hygiene

practices (Buren, Staley, Wefel, and Qian, 2008). After the appliances are removed and white spots are observed in a patient, the patient's use of low fluoride–containing toothpastes and products that deliver calcium, phosphorous, and fluoride (in low concentration) have the best potential to remineralize the white spots.

The ankylosis of a tooth root to the alveolar bone is a rare occurrence that may become apparent when an orthodontic appliance cannot move a tooth. This risk should be emphasized before the treatment of nonerupted and partially erupted teeth.

Finally, successful orthodontic treatment requires an obedient patient who will follow the instructions given by the clinician. The patient must come to appointments on time and at regular intervals to receive orthodontic treatment in a timely manner. Failures in patient or parent compliance can lead to a request by the clinician for consent to remove the orthodontic appliance.

At the consultation appointment, agreement on the treatment plan is required before proceeding with the treatment. An informed consent document should be given to the patient and/or parent to read and sign before orthodontic treatment begins.

REFERENCES

Ackerman, J. L., and Proffit, W. R. 1969. The characteristics of malocclusion. A modern approach to classification and diagnosis. Am. J. Orthod. 56:443–454.

Andrews, L. F. 1972. The six keys to normal occlusion. Am. J. Orthod. 62:296–309.

Angle, E. H. 1899. Classification of malocclusion. Dental Cosmos. 41:248–264.

Brezniak, N., and Wasserstein, A. 1993. Root resorption after orthodontic treatment. Part I. Literature review. Am. J. Orthod. Dentofac. Orthop. 103:62–66.

Buren, J. L., Staley, R. N., Wefel, J., and Qian, F. 2008. Inhibition of enamel demineralization by an enamel sealant, Pro Seal™: an in vitro study. Am. J. Orthod. Dentofac. Orthop. 133:S88–S94.

Delivanis, H. P., and Kuftinec, M. M. 1980. Variation in morphology of the maxillary central incisors found in Class II division 2 malocclusion. Am. J. Orthod. 78:438–443.

Gorelick, L., Geiger A. M., and Gwinnett, A. J. 1982. Incidence of white spot formation after bonding and banding. Am. J. Orthod. 81:93–98.

Huth, J. B., Staley, R. N., Jacobs, R. M., Bigelow, H. F., and Jakobsen, J. R. 2007. Arch widths in Class II-2 adults compared to adults with Class II-1 and normal occlusion. Angle Orthod. 77:837–844.

Kuntz, T. R., Staley, R. N., Bigelow, H. F., Kremenak, C. R., Kohout, F. J., and Jakobsen, J. R. 2008. Arch widths in adults with Class I crowded and Class III malocclusions compared with normal occlusions. Angle Orthod. 78:597–603.

Lenius, J., Staley, R. N., Qian, F., McQuistan, M., Marshall, T. A., and Wefel, J. S. 2009. Factors associated with white spot lesion occurrence in orthodontic patients. J. Dent. Res. 88(Spec Issue A).

Moyers, R. E. 1973. Handbook of orthodontics for the student and general practitioner. Chicago: Year-Book Medical Publishers.

Proffit, W. R., and Ackerman, J. L. 1973. Rating the characteristics of malocclusion: a systematic approach for planning treatment. Am. J. Orthod. 64:258–269.

Schmit, J. L., Staley, R. N., Wefel, J. S., Kanellis, M., and Jakobsen J. 2002. Effect of fluoride varnish on demineralization adjacent to brackets bonded with RMGI cement. Am. J. Orthod. Dentofac. Orthop. 122:125–134.

Staley, R. N., Stuntz, W. R., and Peterson, L. C. 1985. A comparison of arch widths in adults with normal occlusion and adults with Class II Division 1 malocclusion. Am. J. Orthod. 88:163–169.

Williamson, E. H., Caves, S. A., Edenfield, R. J., and Morse, P. K. 1978. Cephalometric analysis: comparison between maximum intercuspation and centric relation. Am.J. Orthod. 74:672–677.