Setting It Straight - Advanced Orthodontics

Lori Garland Parker, CDA, COA, RDAEF, BS, MAOM
Continuing Education Units: 3 hours


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.

The goal of this continuing education course is to familiarize dental professionals with the more advanced aspects of orthodontics.

Conflict of Interest Disclosure Statement
• The author reports no conflicts of interest associated with this work.

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Overview
This course extends beyond what is covered in “Wired for Learning – Orthodontic Basics” and includes information on the six keys to occlusion, orthodontic bonding materials and techniques, instrumentation, archwire alloys, early treatment considerations, risks and limitations of treatment, and the latest technological innovations in orthodontics. The goal of this course is to familiarize dental professionals with the more advanced aspects of orthodontics.

Learning Objectives
Upon completion of this course, the dental professional should be able to:
• Define orthodontics.
• Recognize the parts of orthodontic appliances, including brackets, bands, buccal tubes, archwires, and ligating modules.
• Understand Andrews' "The Six Keys to Normal Occlusion."
• Identify the ten potential risks and limitations to orthodontic treatment.
• Learn the advantages and disadvantages of early orthodontic treatment.
• Recognize and know the uses for typical orthodontic instrumentation.
• Understand five conditions that require orthognathic surgery for correction.
• Learn about self-ligating brackets, including their advantages and disadvantages.
• Describe three types of orthodontic adhesives.
• Identify the steps involved in bonding brackets using light-cure adhesive.
• Identify the advantages and disadvantages of indirect bonding.
• Learn the advantages and disadvantages of three different wire alloys.
• Understand five ways computer technology is being used in orthodontics.

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Glossary
abut – Adjacent to.
active triangulation – Technique that allows for precise three-dimensional scans without the need for a fixed point of reference.
**a-lastic** – Small round elastic tie used to hold the archwire into the bracket slot; also known as “O” ring, “O” tie, elastomeric tie, or ligation module.

**alloy** – Two or more metals mixed together to form a new metal.

**buccal tube** – Small metal part welded onto the outside of a molar band or bracket; it contains slots to hold archwires, lip bumpers, facebows, and other auxiliaries.

**classification (dental)** – System of classifying the relationship of the upper teeth to the lower teeth.

**classification (skeletal)** – System of classifying the position of the maxilla in relation to that of the mandible (this system does not reference the teeth).

**dentofacial** – Involving the teeth and face.

**gnathic** – Pertaining to the jaws.

**Keys to Occlusion** – Characteristics shared by individuals with both optimal occlusion and balanced faces, as identified by Dr. Lawrence F. Andrews.

**maxillofacial** – Pertaining to the jaws and the face, particularly with reference to specialized surgery of this region.

**ortho** – Prefix meaning straight or correct.

**orthognathic surgery** – Procedure combining orthodontic treatment with surgery of the jaw to correct or establish a stable functional balance between the teeth, jaws, and facial structures.

**root resorption** – Shortening of the roots; resorption of cementum and underlying root dentin.

**spee, curve of** – Curvature of the occlusal plane of the teeth.

**tangent** – Line or plane that touches a given curve or solid at a single point.

**torque** – Movement of the crown of a tooth in one direction and its root in the opposite direction.

**transillumination** – The shining of a light through a tooth.

**white light** – Non-invasive light that can be used repeatedly without adverse effects on patients during bonding procedures.

**Definition of Orthodontics**
Orthodontic treatment involves movement of malpositioned teeth to orthodontically straighten or correct their positions. In traditional orthodontics, small orthodontic appliances, known as brackets, are connected to exterior surfaces of the patient’s teeth, and an archwire is placed in a slot of each bracket to move the teeth. The archwire forms a track that guides movement of the teeth to the desired positions for correct occlusion. End sections of the archwire are placed through appliances known as buccal tubes. The buccal tubes are welded to bands and cemented onto the patient’s molar teeth (Figure 1).

In recent years it has become common practice to bond orthodontic appliances to the labial or lingual surfaces of the tooth, using either direct or indirect methods. Although bands are still used, bonded appliances are becoming more common (Figures 2a & b).

**Andrews Six Keys to Normal Occlusion**
In September of 1972, Lawrence F Andrews published an article in the AJO-DO titled *The Six Keys to Normal Occlusion*, where he shared his observations of 120 casts of non-orthodontic patients with normal occlusion. His contributions form the essential basis of orthodontic treatment today.

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Figure 1. Parts of Orthodontic Appliances
(Note: The Ligating Module also is commonly known as an elastic tie, or a-lastic.)
Andrews Six Keys to Occlusion

- Key I – Molar Relationship
- Key II – Crown Angulation (tip)
- Key III – Crown Inclination (torque)
- Key IV – Rotation
- Key V – Tight Contacts
- Key VI – Curve of Spee

**Key I – Molar Relationship**
According to Andrews' definition, normal occlusion exists when the mesiobuccal cusp of the maxillary first permanent molar occludes in the groove between the mesial and middle buccal cusps of the mandibular first permanent molar (Figure 3, also known as Class I dental occlusion).

**Key II – Crown Angulation (tip)**
The gingival portion of the crowns of all teeth is more distal than the incisal or occlusal portion of the crowns. The long axis of all crowns of the teeth (with the exception of the molars) is considered the main mid-development ridge of the facial surfaces of the teeth. The long axis of the crown of the molar teeth is considered to be the buccal groove and its extension to the gingiva (Figures 4a & b).

**Key III – Crown Inclination (torque)**
This refers to the labio-lingual axial inclination of the anterior teeth and bucco-lingual axial inclination of the posterior teeth. This is measured from a perpendicular to the occlusal plane to the crown long axis tangent to the mid-
point of the middle of the crown. If the crown is facial to the tangent, it is said to have positive torque. If the crown is lingual to the tangent, it has negative torque. The upper incisors usually have positive torque; the lower incisors usually have slight negative torque. From the upper canine distally, the torque becomes progressively negative. Figure 5 shows crown inclination before and after orthodontic treatment.

Key IV – Rotation
The fourth key to optimal occlusion is absence of tooth rotations (Figures 6a & b).

Key V – Tight Contacts
There should be no spaces between the teeth. Contact points should abut unless a discrepancy exists in a mesiodistal crown diameter.

Key VI – Curve of Spee
The depth of the curve of Spee should be fairly flat ranging from 0.5mm to 1.5mm at its deepest point. An average curve of Spee is 1mm. Figure 7 illustrates curves of Spee before and after treatment.

Potential Risks and Limitations of Orthodontic Treatment
As with any medical or dental procedure, there are risks and limitations of orthodontic treatment. Before orthodontic treatment is initiated, the following topics should be discussed with the patient and/or parent.

Decalcification
Decalcification is the white chalky marks on teeth caused from the patient leaving plaque on the teeth for an extended period of time. To prevent decalcification from occurring, good oral hygiene must be performed. Stress the importance of home care at the exam appointment and ensure that the entire dental team supports this philosophy. Monitor toothbrushing at each appointment, and keep the patient/parent informed of the status. Chart any pretreatment decalcification, evaluate oral hygiene, and review techniques as needed at each visit.

Root Resorption
When moving teeth orthodontically, it is common to have some shortening of the roots. The
Figure 6a. Maxillary Arch Alignment

A well aligned arch.

Figure 6b. Mandibular Arch Alignment

An apparently well aligned arch, but a careful examination shows some small rotations.

Figure 7. Curve of Spee

Before Treatment  After Treatment
Impaction
Impaction refers to teeth that are having difficulty erupting. The orthodontist should discuss any potential impaction concerns with the patient/parent.

Growth Patterns
Growth patterns can change, and they vary with each individual during and after orthodontic treatment. As these changes are controlled by nature, the orthodontist should explain that the patient’s growth must be monitored, and if necessary, treatment adapted accordingly. Note any remarkable family history in the chart.

Treatment Time
Duration of treatment can be estimated based on the type and difficulty of the required treatment. Patient cooperation also plays a role in the length of orthodontic treatment. Emphasize the importance of keeping regular appointments, maintaining proper oral hygiene, and avoiding foods and habits which can cause loose or broken bands, brackets, and wires.

Relapse
Relapse refers to the shifting of teeth following treatment. Stress the importance of retainer wear and follow up appointments.

Early Treatment
As noted in Wired for Learning – Orthodontic Basics, the American Orthodontic Association recommends that children have their first orthodontic examination by age 7, or earlier if an orthodontic problem is detected by parents, the family dentist, or the child’s physician. In some cases, early intervention that utilizes the patient’s growth can make corrective treatment faster and easier.

Some young patients can benefit from a two-phase approach to orthodontic correction. Early treatment, sometimes referred to as Phase I, can correct major orthodontic problems early and guide jaw growth. In some cases, such treatment can reduce the need of orthognathic surgery as an adult and/or reduce the time required in traditional orthodontic appliances.

Early treatment can include expansion appliances that widen the arch, making room for the permanent dentition. In other cases, orthopedic
Orthognathic Surgery
Orthognathic surgery combines orthodontic treatment with surgery of the jaw to correct or establish a stable functional balance between the teeth, jaws and facial structures. The goal of maxillofacial surgery is to treat any jaw imbalance and the resulting malocclusion, which could adversely affect the cosmetic (esthetic) appearance as well as the proper functioning of the teeth. To correct musculoskeletal, dento-osseous, and soft tissue deformities of the jaws and associated structures, this approach involves diagnosis, treatment planning, and execution of

Typically, patients are given a “rest period” between phases, and once the patient has full permanent dentition, Phase II treatment is initiated to fine tune correction. This approach reduces the time in treatment during the most critical teenage years.

**Table 1. Advantages and Disadvantages of Early Treatment**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Possible Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interception of orthodontic problems before they become more severe.</td>
<td>1. Possible longer total time in treatment.</td>
</tr>
<tr>
<td>2. Improve a child’s outlook and attitude by increasing self-identity and pride.</td>
<td>2. Potential patient burnout with more time spent in the orthodontic office.</td>
</tr>
<tr>
<td>3. Treat certain problems when a child is most cooperative instead of during the teenage independent years.</td>
<td>3. Extra cost.</td>
</tr>
<tr>
<td>5. Improve chances of avoiding extraction and surgical procedures.</td>
<td></td>
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<tr>
<td>7. Orthopedic intervention when skull sutures are actively adjusting (e.g., the use of rapid palatal expanders).</td>
<td></td>
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<tr>
<td>8. Guiding eruption of permanent teeth and regulating space where needed.</td>
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<tr>
<td>9. Early correction of rotated teeth, both for esthetics and to reduce relapse tendencies.</td>
<td></td>
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<tr>
<td>10. Avoid fracture of protruding teeth.</td>
<td></td>
</tr>
<tr>
<td>11. Eliminate adverse habit patterns (e.g., tongue, thumb, etc.).</td>
<td></td>
</tr>
<tr>
<td>12. Improve chances of good speech development.</td>
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</tr>
<tr>
<td>13. Change functional factors (e.g., lip pursing, tongue posture, etc.) that could otherwise change and morphologically alter and worsen the problem.</td>
<td></td>
</tr>
<tr>
<td>14. Early expansion can help eliminate some breathing problems, and early maxillary orthopedics can help increase the nasal airway.</td>
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</tbody>
</table>
treatment that combines orthodontics and oral/maxillofacial surgery.

The term “orthognathic” was coined by an oral/maxillofacial surgeon to mean “straight jaws” just as orthodontics means “straight teeth.” Prior to that time, the terms “surgical orthodontics” and “facial orthopedics” were used to describe the field.

Orthognathic surgery is appropriate when the jaws do not meet correctly and/or teeth don’t seem to fit with the maxillary and mandibular jaws. The teeth are straightened using orthodontics, and corrective jaw surgery repositions the malaligned jaws. This not only improves the facial appearance but also ensures that teeth meet correctly and function properly.

Many different types of abnormalities of the jaw structures can result in facial deformity and malocclusion. These abnormalities in the jaws and facial bones may be congenital (present at birth) or surface during growth and development. They also may be acquired after birth as a result of hereditary, environmental influences, or trauma/illness to the face.

It has been estimated that dentofacial deformities affect up to 20 percent of the population. Any individual with difficulty in the following areas should be evaluated for possible orthognathic surgery:
- difficulty in chewing, biting or swallowing
- speech problems
- chronic jaw or TMJ pain
- open bite
- protruding jaw
- breathing problems

Goals
The specific goal for orthognathic surgery varies from patient to patient, depending on the actual diagnosis. In general, the team will address:
Function: Restore normal chewing, speech, ocular (eye) function, respiratory function;
Esthetics: Establish facial harmony and balance;
Stability: Avoid short and long term relapse; and
Minimizing treatment time: Provide efficient and effective treatment.

Evaluation and Diagnosis
The most important aspect of overall patient management is thorough evaluation and diagnosis. Patient evaluation for orthognathic surgery can be divided into four main areas:
1. Patient concerns or chief complaints
2. Clinical examination
3. Radiographic and imaging analysis (x-rays)
4. Dental model analysis

After an examination by each of the orthognathic surgery team members (dentist, orthodontist, and maxillofacial/oral surgeon), a diagnosis and coordinated treatment plan is prepared. The complete treatment plan usually is implemented in several stages over the course of one to two years.

Treatment Process
Any general dental maintenance, prevention, or restoration procedures should be performed prior to orthodontic and surgical intervention. The first stage of orthognathic treatment is the alignment of the teeth into a stable relationship with the underlying jaw by orthodontics. This step, which prepares the dental arches for the surgical repositioning, usually takes the longest amount of time, averaging from a few months to over a year. At this stage, the abnormal bite (malocclusion) may become more noticeable. Once ready for the surgical procedures, the orthodontist and maxillofacial surgeon review photographs, x-rays, and dental models to finalize the surgical plan. The operation may involve a single jaw or both the maxilla and mandible. The surgery also may be combined with other procedures, such as rhinoplasty (nose correction) or genioplasty (chin correction) to improve the general appearance of the face.

The surgical procedure may take two to four hours, depending on the complexity of the case. Most patients are kept in the hospital for two to five days, again depending on the specifics of the procedure and post-operative condition. Most patients return to their normal activities within a week or two of their surgery. The surgeon monitors healing and reviews the changes in the facial structures and occlusion (bite). The orthodontist adjusts the braces to fit the patient’s new repositioned jaw. Orthodontic treatment may continue for several months to ensure optimal positioning of the teeth.
Orthognathic Surgery Cases
The following cases depict situations that lend themselves to orthognathic surgery:

Case 1. Apertognathia
Apertognathia is a situation when the posterior teeth meet but the anterior teeth do not touch. This space causes difficulty in biting with the anterior teeth. Surgical correction of open bite occlusion with maxillary jaw surgery.

Before:

After:

Case 2. Prognathia
Prognathia is when the mandible is too large and grows too far forward. Surgery can be used to slide the mandible back. Surgical correction of Class III occlusion (underbite) with mandibular surgery.

Before:

After:
Case 3. Retrognathia
Retrognathia is when there is a severe overbite. Retrognathia is managed with a combination of surgery and orthodontics. Surgical correction of Class II occlusion (overbite) with maxillary and mandibular jaw surgery.

Before:

After:

Case 4. Vertical Maxillary Excess
Vertical Maxillary Excess is also known as the “gummy smile”. In this case the Maxillary jaw has grown too far down. Surgery can move the jaw upward to create a much nicer looking smile. Surgical correction of gummy smile and weak chin with maxillary jaw surgery and chin surgery.

Before:

After:

Diagram of Maxillary and Mandibular Jaw Surgery

Case 5. Jaw Asymmetry
Jaw Asymmetry – Surgical correction of Class III occlusion (underbite) and asymmetric (crooked) mandible using maxillary and mandibular jaw surgery.
best treatment plan. A virtual study model can be utilized to prevent the need for taking study model impressions (Figure 8).

**Basic Orthodontic Instrumentation**
As with any dental specialty, orthodontics has a series of instruments that makes delivery easier. Table 2 describes common orthodontic instrumentation.

**Self-ligating Orthodontic Brackets**
New bracket designs are continually being introduced to entice orthodontists, each promising increased control, easy placement, and an aid to finishing. A popular variation of the traditional bracket is a reduced-friction, ligatureless design that does not require the typical elastic or metal tie to engage the archwire into the bracket. Instead, this type of bracket contains a clip that opens and closes. When closed, the clip holds the archwire in place. Although the concept of a ligatureless bracket was introduced in 1935 the design essentially laid dormant for the next 40 years or so. Since the 1970s, however, several ligatureless designs have emerged and are becoming a popular choice in orthodontics (Figure 24).

**Orthodontic Records**
Cone beam, 3D dental imaging is becoming more popular to gather information needed to evaluate and diagnose a case. 3D views are used to analyze teeth, roots, TMJ, airway, and sinuses without magnification or distortion. Practice efficiency can be enhanced by capturing a complete workup in less than 10 seconds. This is especially helpful when the practitioner intends to place TADs or when knowing the exact position of teeth is important to determine the
### Table 2. Common Orthodontic Instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band Pusher or Seater</td>
<td>To seat bands.</td>
</tr>
<tr>
<td>Bite Stick</td>
<td>To seat a band (patient bites on the stick to seat).</td>
</tr>
<tr>
<td>Band Removing Plier</td>
<td>To remove bands and banded appliances.</td>
</tr>
<tr>
<td>Bird Beak (139)</td>
<td>To place bends in a wire.</td>
</tr>
<tr>
<td>Bracket Removing Plier</td>
<td>To remove brackets.</td>
</tr>
<tr>
<td>Distal End Cutter</td>
<td>To cut and hold the end of an archwire.</td>
</tr>
<tr>
<td>Edgewise Plier</td>
<td>To make 90-degree bends.</td>
</tr>
<tr>
<td>Hemostat</td>
<td>To place elastic ties and power chain.</td>
</tr>
<tr>
<td>Howe Plier</td>
<td>To place and remove archwires.</td>
</tr>
<tr>
<td>Ligature Cutter</td>
<td>To cut ligature ties (up to 0.014 only), chain, and elastic thread.</td>
</tr>
</tbody>
</table>
Because no elastic ligature is required, ligature decay (Figures 25a & b) also is not a problem. However, security of ligation depends on the clip/slide being robust and not inadvertently opening. Until very recently, this requirement for security of performance was not fully met by self-ligation designs. Secure, full-archwire engagement maximizes the potential long range of action of modern wires and minimizes the need to regain control of teeth when full engagement is lost during treatment.

**Rapid leveling and alignment of the dentition has been observed in many patients treated with self-ligating appliances.** It should be noted that finishing may be more difficult with these brackets than with standard pre-adjusted edgewise brackets.

**Advantages of Self-ligating Brackets**
Theses advantages apply to all self-ligating brackets, although different brands can vary in their ability to consistently deliver these benefits in practice.

**Secure, full-archwire engagement**
Full engagement is a feature of self-ligation. The bracket’s clip/slide is either fully shut or it is not; unintentional partial engagement is not possible.

Because no elastic ligature is required, ligature decay (Figures 25a & b) also is not a problem. However, security of ligation depends on the clip/slide being robust and not inadvertently opening. Until very recently, this requirement for security of performance was not fully met by self-ligation designs. Secure, full-archwire engagement maximizes the potential long range of action of modern wires and minimizes the need to regain control of teeth when full engagement is lost during treatment.

**Low friction**
During orthodontic tooth movement with the preadjusted edgewise system, friction generated at the bracket-archwire interface tends to impede the desired movement. The method of ligation is an important contributor to this frictional force. Traditionally, elastic ties have been used to secure the archwire into the slot (Figure 26), which created significant friction. The friction generated by a self-ligating bracket is dramatically lower than for elastomeric rings with conventional brackets. This seems to be an inherent characteristic of self-ligating brackets.
Secure archwire engagement and low friction as a combination
The combination of very low friction and very secure full archwire engagement is likely to be the most beneficial feature of self-ligating brackets. This combination enables a tooth to slide along an archwire with lower and more predictable net forces, and yet under complete control, with almost none of the undesirable rotation of the tooth that can result from deformable modes of ligation (such as elastomeric tie).

Alignment of severely irregular teeth
The combination of low friction and secure full engagement also is particularly useful in the alignment of very irregular teeth and the resolution of severe rotations. In these cases, the capacity of the wire to slide through the brackets of the rotated and adjacent teeth significantly facilitates alignment. Low friction facilitates rapid alignment and more certain space closure; secure bracket engagement permits full engagement with severely displaced teeth without compromising control as the teeth slide teeth along an archwire. Modern archwires substantially enhance our ability to harness these benefits.

Less chairside assistance and faster ligation/archwire removal
The original motive in developing earlier self-ligating brackets was to speed ligation. Time saved depends on the bracket and the experience of the operator.

Disadvantages of Self-ligating Brackets
As with any new system, operators experience a learning curve with a different bracket design and movement system. Self-ligating brackets require a different mind set in bracket placement, archwire selection, and finishing techniques.

Bracket Placement
Proper placement of the orthodontic brackets and bands is essential to achieving optimum treatment results within the projected treatment time. Accurate bracket placement has long been recognized in orthodontics as the single most critical determinant of efficient tooth movement. Until the late 1970s, orthodontists placed nonprescription brackets on the teeth, and archwires were carefully fabricated by the orthodontist for each patient. The development of straight-wire appliances greatly reduced the amount of archwire bends required.

Dimensions of Bracket Slots
The archwire fits into a slot machined into the orthodontic bracket. The two most common dimensions of traditional orthodontic bracket slots are 0.018-inch and 0.022-inch. Separated by four thousandths of an inch, these sizes present a somewhat unusual description in a metric modern world, where the scientific community measures in millimeters and micrometers. The size indicates the largest round, square, or rectangular archwire that can be used. Smaller wires have more “play” in the slot as compared to a full-size archwire (Figure 27).

The 0.022-inch slot was the first to be introduced, and it suited the gold wires that were commonly used in the early 1900s.

Bonding
Since the inception of direct bonding, composite resins have been the most widely used adhesives...
for orthodontic bonding procedures. Several types of adhesives are available today, two of the most common being light-cure and chemical-cure adhesives.

**Two-part Chemical Cure**
Two-part (A&B) chemical-cure adhesives are base and catalyst systems that polymerize when the two A & B paste components are mixed, the two A & B resins are mixed, and the resulting mixtures are brought into contact.

**Advantages of two-part chemical cure materials include:**
- strong bonding material,
- good working times (1.5 to 2 minutes), and
- no curing light required. These adhesives cure five minutes after the correct working time is utilized.

**Disadvantages of two-part chemical-cure materials include:**
- A & B materials must be mixed for both tooth and bracket, and
- bonding can be compromised if materials are mixed insufficiently or disproportionately.

**No-mix Chemical Cure**
Two-part primer and paste no-mix chemical cure adhesives are base and catalyst systems that polymerize when the liquid primer and paste are brought into contact. The primer is placed both on the tooth and bracket base; the paste is placed on the bracket.

**Advantages of no-mix chemical-cure materials include:**
- easy, no-mix formula and
- no curing light required. These adhesive systems cure five minutes after the correct working time is utilized.

**Disadvantages of no-mix chemical-cure materials include:**
- lower bond strength (although adequate for long-term bond strength) and
- short working time (typically 30 to 45 seconds).

**Light Cure (light-cured system)**
The most common adhesive system today is the light cure system where a resin is placed on the tooth and a paste is placed on the bracket. A rapid polymerization of the bonding material occurs when visible light is applied. The bonding material is cured under brackets by direct illumination from different sides as well as by transillumination when tooth structure transmits visible light. In recent years, alternatives to conventional halogen lights offering reduced curing time have emerged. Light-emitting diodes (LEDs), and plasma arc lights are becoming more popular, however studies have shown that there is no statistical difference in the quality of bond strength.

**Advantages of light cure materials include:**
- good bond strength,
- ample working time (depending on ambient light situation), and
- fast curing time, especially for re-bonds.

**Disadvantages of light cure materials include:**
- longer curing time compared to chemical cure systems on full-mouth bondings,
- care is required when working in ambient light, and a curing light is required.

**Bonding Using Light Cure Adhesive**
Light cure adhesives are one of the more popular methods of bonding brackets today. The basic steps involved are summarized in Table 3.

**Advances in Bonding Brackets**

**Indirect Bonding**
Indirect bonding is a method of placing brackets on dental models in the laboratory (Figures 33 and 34), then making a transfer tray (Figure 35) that is used to bond the brackets onto the patient’s teeth, an entire arch at a time (Figure 36). Because this approach offers improved access and time availability in the laboratory, it has been suggested that this technique may allow more precise bracket location.

**Advantages of Indirect Bonding include:**
- increased accuracy of bracket placement (working on a model, there are no lips or cheeks to obscure the operator’s view),
- less repositioning needed,
- major reduction of doctor time,
- ergonomically healthier,
- better staff utilization,
- shorter chair time,
**Table 3. Steps for Using Light Cure Adhesives**

<table>
<thead>
<tr>
<th>If using traditional phosphoric acid etchant:</th>
<th>If using a self-etching primer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Completely dry teeth to be etched.</td>
<td>Mechanical adhesion is achieved through a unique adhesive chemical process in which the etchant chemical compound converts to a primer. It creates an etched, primed surface without rinsing. This delivery system is fast and easy to use, allowing you to etch and prime in a single step.</td>
</tr>
<tr>
<td>2. Quickly yet completely cover the surface of the teeth to be bonded with etchant, avoiding contact with gingival tissue. (Etchant can irritate tissue on contact.)</td>
<td>1. After teeth have been pumiced, rinsed, and dried, apply the self-etching primer using a swirling motion for 3-5 seconds per tooth or as per manufacturer’s instructions.</td>
</tr>
<tr>
<td>3. Leave the etchant on place for 20 to 40 seconds depending on manufacturer’s instructions.</td>
<td>2. “Air thin” each tooth with a gentle one- to two-second burst of dry air to thin the primer.</td>
</tr>
<tr>
<td>4. Using an air-water spray combination, rinse thoroughly for at least 5-10 seconds per tooth to remove all etchant and demineralized material. Use a high speed evacuator to collect rinse solution and prevent etchant from contacting tissue. Avoid salivary contamination of the etched surface. If the tooth surface is contaminated, isolate, re-etch for five seconds, and rinse.</td>
<td>3. The operator places and positions the brackets with adhesive, then compresses and removes excess adhesive.</td>
</tr>
<tr>
<td>5. Dry tooth surfaces thoroughly with a tooth dryer or air syringe. Dry toward the gingiva to avoid salivary contamination from the gingiva. The tooth should have a dull, chalky appearance. If not, re-etch for 15 seconds, rinse completely and dry. (Note: Appearance alone does not confirm ideal surface preparation.)</td>
<td>4. Light cure the brackets.</td>
</tr>
<tr>
<td>6. Place a thin coat of sealant on the tooth, avoiding the gingival and interproximal areas.</td>
<td>5. After the adhesive has fully cured, archwires are placed.</td>
</tr>
<tr>
<td>7. Do not touch the bracket with hands or gloves. With a plastic spatula, press a thin layer of adhesive onto the bracket and pass to operator.</td>
<td></td>
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<tr>
<td>8. Operator will press the bracket firmly onto the tooth surface and clean away excess adhesive.</td>
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<tr>
<td>9. If using light-cure system, place the light cure wand as close to the bracket as possible without touching it. Light cure times vary from 3 to 20 seconds total per tooth, depending on the type of bracket (clear or metal), material, light cure unit, and manufacturer’s directions. Do not move the light during the curing process.</td>
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</tr>
<tr>
<td>10. Wait five minutes after curing before applying any pressure (such as archwire engagement) on the bracket.</td>
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</table>
These resilient metal wires are more flexible and retain their pre-formed shape.

Three Common Wire Alloys Used Today
Three alloys, Nickel Titanium, Copper Nickel Titanium, and Stainless Steel are most commonly used on orthodontic archwires today, each with its own advantages and disadvantages.

Nickel Titanium
Nickel titanium (NiTi) wires are very flexible but cannot be deformed. The alloy has “memory,” meaning that it wants to return to its original shape. This wire is most commonly used in the initial alignment phase of orthodontic treatment.

Advantages:
• The small, round diameter wires can be “bent,” but not deformed, so they can be placed in each bracket even when the brackets do not align.
• As the wire returns to its original shape, it moves the teeth in that direction via the bracket tie (or closed slot in a self-ligating bracket).

Disadvantages:
• These wires cannot be bent unless they are heated, at which time they become “dead soft” and cannot move teeth.
thread into position, depending upon the size of the archwire.

**Copper Nickel Titanium**
The addition of copper to the nickel-titanium mix gives a wire the advantage of changing properties with changes in temperatures. This type of archwire is most commonly used in the initial alignment phase.

**Advantages:**
- Chilling the archwire can simplify ligation. Using “endo ice” spray, an ice cube, or even cold air from the air syringe temporarily “dead softens” the archwire, allowing the operator to passively place it in each bracket while tying it in place.
- As the wire warms with exposure to body temperature, it exerts more and more force, thus moving the teeth like the traditional NiTi archwire.

**Disadvantages:**
- These archwires cannot be bent unless heated, and then the material becomes “dead soft” and will not move teeth.
- Copper-nickel-titanium is a brittle alloy. These wires break if repeatedly flexed.

**Stainless Steel**
This alloy has tremendous strength and the capacity to exert or resist great forces.

**Advantages:**
- When used to close spaces between teeth, stainless-steel wires resist the tipping forces of chain, allowing tooth roots to move together in a more parallel fashion.
- A large-diameter stainless steel wire can allow the full expression of the bracket prescription and tip/torque roots into their ideal positions.
- Because stainless steel can accept a bend, these wires can be used to “detail” a case, that is, they can be bent to allow specific movements of specific teeth to improve their position.

**Disadvantages:**
- Stainless steel can be distorted (for example, if the patient bites on something too hard, it can permanently deform the archwire).
- Stainless steel also is not very flexible. The bracket slots must be closely aligned for it to

**Banding**
Bands can tolerate more force than brackets and as such, are most commonly used in the posterior, where most chewing occurs, however more and more practitioners are bonding all teeth.

When bands are needed, band selection requires the ability to visualize the size and shape of a tooth. Once the appropriate size band is determined, a final adaptation of the band to the patient’s tooth is necessary (Figure 38).

There must be enough space between the teeth to fit the band. If the contacts are tight, separators are typically placed for one week to slowly make just enough space for a band to slide between the contacts. If the contacts are too tight, proper size determination may be difficult and the procedure may be unnecessarily uncomfortable for the patient and the operator.

**Computer Technology in Orthodontics**
As in all facets of dentistry, technology is helping to take orthodontics to the next level.
Brackets are then manufactured to the patient's specific prescription needs. Research in this area has progressed over the past 10 years, fine-tuning the technique in preparation for the mass market.

**Computer-Aided Bracket Placement**
To enhance the accuracy of bracket placement, a company has designed a bracket placement wand that includes a miniature video camera. The camera transmits real-time images from the patient's mouth to the screen (Figure 40), and when the software detects a match between the projected image and the clinician-prescribed position (Figure 41), an audio-visual signal is delivered so the doctor can accurately bond the appliance.

**Completely Customized Lingual Orthodontic Brackets**
A new lingual orthodontic technique is available in which the brackets are completely customized and fabricated one at a time with each patient's unique prescription built into the bracket. All the archwires required for the patient's treatment are bent by a robot and are included as part of the system.

**Sequential Plastic Aligners**
Sequential Plastic Aligners (Figure 42) are a series of clear, precision polymer aligners that

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**Robots in Orthodontics**
Intraoral scanning and the use of robots to fabricate patient-specific archwires is now being introduced to the orthodontic profession (Figure 39). The scanner is an intraoral three-dimensional (3-D) imaging device based on white light and active triangulation. The software allows for interactive 3-D viewing of the malocclusion and a fine tuning of diagnostic set-ups to customize occlusion goals. The robot customizes the patient's archwires per the orthodontist's virtual treatment plan.

**Patient-Specific Brackets**
Another new technology for orthodontics is patient-specific bracket design and fabrication using CAD-CAM (Computer-Aided Design/Computer-Aided Manufacturing) technology. A three-dimensional model of the patient's malocclusion is produced, and software is used to indicate where the orthodontist wants the teeth to be positioned.
incrementally straighten teeth. Using a precise three-dimensional analysis of the patient's teeth and adjacent tissue, personalized aligners are crafted for each patient. Each aligner is worn for two to three weeks, and can be removed to eat, brush, and floss as well as on special occasions. During wear, the patient's teeth are gently moved to their ideal position. The length of the process depends on the patient's specific situation.

Digital Models
With digital models (Figure 43), clinicians can easily store, retrieve, diagnose, and communicate cases electronically, eliminating the storage and retrieval issues associated with plaster casts.

State Dental Practice Acts
Most state dental practice acts define conditions under which a dental auxiliary may perform specific duties. Several orthodontic procedures in many states can be delegated to dental assistants, for example, placement or removal of archwires, preparation for bonding brackets, fitting orthodontic bands, and in some cases, bonding of orthodontic appliances. Laws vary from state to state, ranging from delegation of nearly all reversible procedures to minimal delegation. For more information on individual state laws, contact the State Board of Dental Examiners for the state of interest.

Conclusion
During the last decade, the specialty of orthodontics has undergone a technological revolution. New materials and techniques have been developed that can make braces less noticeable, improve patient comfort, and in some cases, reduce treatment time and help control costs. Like any area of health care, orthodontic theories and techniques are constantly being improved. In today's health-conscious society, where physical appearance is important, advancements in care continue to popularize orthodontics.
### Table 4. Facts about State Dental Practice Acts

<table>
<thead>
<tr>
<th>Common terms used in dental practice acts include:</th>
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<tbody>
<tr>
<td><strong>Patient of record</strong> – One who has been examined and diagnosed by a licensed dentist and whose treatment has been planned by that dentist.</td>
</tr>
<tr>
<td><strong>Assignment/delegation</strong> – The dentist appointing a dental auxiliary to perform a specific procedure on a designated patient of record. The dentist need not be physically present in the office or in the treatment room at the time the procedure is being performed.</td>
</tr>
<tr>
<td><strong>Direct supervision</strong> – The dentist has designated a patient of record upon whom services are to be performed by an auxiliary while the dentist is in the office. The dentist has described the procedure to be performed, examines the patient before prescribing the procedures, and examines the patient again when the procedure is completed.</td>
</tr>
<tr>
<td><strong>General supervision</strong> – The dentist has authorized and delegated specific procedures that may be performed by a qualified dental auxiliary for a patient of record. The dentist need not be physically present in the office at the time the procedures are being performed.</td>
</tr>
</tbody>
</table>

As noted above, the laws, licensure, and delegation requirements vary significantly from state to state. For more information on individual state laws, contact the State Board of Dental Examiners for the state of interest.
Course Test Preview
To receive Continuing Education credit for this course, you must complete the online test. Please go to: www.dentalcare.com/en-US/dental-education/continuing-education/ce326/ce326-test.aspx

1. In Andrews’ Six Keys to Occlusion, normal occlusion exists when the ________________.
   a. canines on both sides interdigitate properly between the mandibular canine and first permanent premolar
   b. mesiobuccal cusp of the mandibular first permanent molar occludes in the groove between the mesial and middle buccal cusps of the maxillary first permanent molar
   c. mesiobuccal cusp of the maxillary first permanent molar occludes in the groove between the mesial and middle buccal cusps of the mandibular first permanent molar
   d. distobuccal cusp of the maxillary first permanent molar occludes in the groove between the mesial and middle buccal cusps of the mandibular first permanent molar
   e. None of the above.

2. In Andrews’ Six Keys to Occlusion, the gingival portion of the crowns are ideally more distal than the ________________.
   a. occlusal portion of the crowns
   b. buccal or occlusal portion of the crowns
   c. facial or occlusal portion of the crowns
   d. incisal or occlusal portion of the crowns
   e. lingual or occlusal portion of the crowns

3. Choose the correct letter for this appliance:

   a. archwire
   b. bracket
   c. band
   d. buccal tube
   e. ligating module

4. Choose the correct letter for this appliance:

   a. archwire
   b. bracket
   c. band
   d. buccal tube
   e. ligating module
5. Choose the correct letter for this appliance:

![Image of an appliance]

a. archwire  
b. bracket  
c. band  
d. buccal tube  
e. ligating module

6. Choose the correct letter for this appliance:

![Image of an appliance]

a. archwire  
b. bracket  
c. band  
d. buccal tube  
e. ligating module

7. Choose the correct letter for this appliance:

![Image of an appliance]

a. archwire  
b. bracket  
c. band  
d. buccal tube  
e. ligating module

8. Crown Angulation indicates tooth ____________.

a. torque  
b. tip  
c. inclination  
d. tooth length  
e. None of the above.

9. The average Curve of Spee in normal occlusion is ____________.

a. 0.5 mm  
b. 0.5 mm-1 mm  
c. 0.5mm-1.5mm  
d. 1-2 mm  
e. None of the above.
10. ______________, is/are advantages of early orthodontic treatment.
   a. Treatment is less expensive
   b. Interception of orthodontic problems
   c. Improves chances of avoiding extractions
   d. Always shorter treatment time
   e. Both B and C

11. Choose the correct letter for this instrument:

   a. Ligature Cutter
   b. Weingart
   c. Bird Beak
   d. Tweed Loop
   e. Distal End Cutter

12. Choose the correct letter for this instrument:

   a. Ligature Cutter
   b. Weingart
   c. Bird Beak
   d. Tweed Loop
   e. Distal End Cutter

13. Choose the correct letter for this instrument:

   a. Ligature Cutter
   b. Weingart
   c. Bird Beak
   d. Tweed Loop
   e. Distal End Cutter
14. Choose the correct letter for this instrument:

[Image of a dental instrument]

a. Ligature Cutter  
b. Weingart  
c. Bird Beak  
d. Tweed Loop  
e. Distal End Cutter

15. ____________ is designed to place and remove archwires.

a. Bird beak  
b. Weingart  
c. Tweed Loop  
d. Ligature cutter  
e. Distal end cutter

16. ____________ is used to make loops in archwires.

a. Howe plier  
b. Weingart  
c. Tweed Loop  
d. Ligature cutter  
e. Distal end cutter

17. ____________ is used to cut ligature ties.

a. Bird beak  
b. Weingart  
c. Tweed Loop  
d. Ligature cutter  
e. Distal end cutter

18. ____________ is used to cut and hold the end of an archwire.

a. Bird beak  
b. Weingart  
c. Tweed Loop  
d. Ligature cutter  
e. Distal end cutter

19. When using light-curing bracket adhesive, cure each tooth for ____________.
   a. 10-30 seconds  
   b. the time listed in the manufacturer's instructions  
   c. the time listed on the light curing unit used  
   d. Both A and B  
   e. Both B and C
20. **What is rhinoplasty?**
   a. Chin correction
   b. Nose correction
   c. Cheek implants
   d. Lip contouring
   e. Both A and B

21. **Choose the correct letter for this drawing:**

   ![Diagram](image)

   a. Vertical Maxillary Excess
   b. Apertognathia
   c. Retrognathia
   d. Prognathia

22. **Choose the correct letter for this drawing:**

   ![Diagram](image)

   a. Vertical Maxillary Excess
   b. Apertognathia
   c. Retrognathia
   d. Prognathia
23. Choose the correct letter for this drawing:

![Drawing of maxillary jaw with vertical and horizontal arrows]

a. Vertical Maxillary Excess  
b. Apertognathia  
c. Retrognathia  
d. Prognathia

24. Choose the correct letter for this drawing:

![Drawing of maxillary jaw with vertical and horizontal arrows]

a. Vertical Maxillary Excess  
b. Apertognathia  
c. Retrognathia  
d. Prognathia

25. The maxillary jaw is routinely moved upward in a patient with ________________.

a. retrognathia  
b. vertical maxillary excess  
c. maxillary jaw asymmetry  
d. apertognathia  
e. prognathia

26. Two-part chemical-cure adhesives ________________.

a. use a curing light  
b. have a working time between 1.5 and 2 minutes and are affected by ambient light  
c. have a base and catalyst  
d. use a no-mix formula  
e. None of the above.

27. No-mix chemical cure adhesives ________________.

a. have a lower bond strength compared to two part chemical cure.  
b. use a two paste system  
c. have a short working time  
d. Both A and C  
e. Both B and D
28. **When bonding orthodontic brackets, etch the teeth for _____ seconds.**
   a. 20
   b. 30
   c. 40
   d. 20-40
   e. 10-20

29. **When etchant contacts gingival tissue______________.**
   a. nothing happens unless it is left on for 60 seconds or longer
   b. the tissue becomes irritated
   c. the tissue appears chalky
   d. All of the above.
   e. None of the above.

30. **If the tooth does not look chalky after etching_______________.**
    a. continue the bonding process
    b. re-etch for 15 seconds
    c. repeat the etching process
    d. rub etchant onto affected teeth
    e. Do all of the above.
References

About the Author

Lori Garland Parker, CDA, COA, RDAEF, BS, MAOM

Lori Garland Parker is a clinical consultant and co-founder of Consulting Network, a leading orthodontic management and training organization. She coaches orthodontic practices on maximizing the talents of the clinical team, implementing systems to enhance clinical efficiency and productivity along with continuity of care, and teaches communication skills and patient motivation. She also designed and teaches the “Train the Trainer” program, lectures extensively in the U.S. and abroad, and has written a line of customizable procedure manuals to support successful new employee integration into the practice. Lori holds Bachelors in Business and a Masters in Organizational Management. She is also a CDA, COA and is an RDAEF in California.