Contemporary Edgewise Appliances

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Introduction

The contemporary edgewise appliance, known commonly as ‘braces”, is the mainstay of orthodontics. These appliances are bonded securely to tooth enamel and when used in concert with the proper archwire, provide highly precise, three-dimensional control of both crown and root position. In orthodontics, three dimensional control of tooth movement is further defined

- Labio-lingual crown position, first order, (in-out position)
- Mesio-distal crown tip, second order, (tip)
- Labio-lingual root inclination, third order, (torque)

The contemporary edgewise appliance has a number of common design features that differentiate it from the simple edgewise appliance that dates back to the early 1900’s. The early edgewise appliance was a simple slot welded to a band that was fitted and cemented to each individual tooth. The slot in the appliance accepted a rectangular archwire, with the wider dimension (surface) of the rectangle parallel to the occlusal plane. While the archwire provided the basic archform, individual bends at each tooth were placed in the archwire to position each tooth to ideal occlusion.

Dr. L. Andrews is widely credited with the development of the contemporary edgewise appliance in the early 1980’s. This was termed "The Straight Wire Appliance". The contemporary edgewise appliance has numerous modifications in the slot and in the base of the appliance that reduce the number and complexity of the archwire bends required in obtaining an ideal finished occlusion. In order to take full advantage of the design features incorporated in the appliance, two conditions must routinely be met:

1. Brackets must be bonded in an ideal position
2. A large enough finishing wire must be utilized that takes full advantage of the slot size.

Multiple improvements have been made as bracket design has evolved from the 1980's. New materials, indirect bonding, cad-cam technology and self-ligation have changed the way braces are placed and adjusted in everyday practice. But the basic premise of the contemporary archwire remains constant. It is the interaction between wire and bracket that provides predictable, controlled tooth movement in all three planes of space.

The following article will outline the common design features of the contemporary edgewise appliance, the clinical process of direct bonding and the placement of the initial archwire.

Design Features

Contemporary edgewise appliances come in two slot sizes: 0.018x025" and 0.022x028". While each slot size has its advantages and disadvantages in clinical practice, most practitioners have adopted the .022" slot size. Regardless of the slot size of the bracket, the incorporated design features are consistent. The extent of the design features are identified in the appliance prescription.

First Order

In the original edgewise appliance, labiolingual bends in the archwires (first-order or in-out bends) were necessary to compensate for variations in the contour of the labial surfaces of individual teeth as well as the labio-lingual thickness.[1] The most common first order variations are seen in the maxillary lateral incisors and the maxillary first molars where these teeth are routinely stepped in and rotated out 10 degrees facially respectively. In the contemporary edgewise appliance, variations in the thickness of the bracket base allow for alteration in faciolingual position of the teeth.[2] The base of the maxillary lateral incisor bracket is thicker than the maxillary central or cuspid bracket, in order for the maxillary lateral incisor to be positioned slightly lingual upon final finishing. Similarly, the mesial aspect of the maxillary first molar bracket is thinner than the distal aspect, resulting in increased mesial facial prominence of the first molar at case completion. Alteration in bracket base thickness reduces, but does not eliminate the need for finishing bends in the archwire, because of wide variation found in tooth thickness within any given population.

Second Order

In order to achieve an ideal occlusion with proper interdigitation, the roots of the upper and lower teeth must have a given degree of mesio-distal tip. All teeth in the maxillary arch have varying degrees of distal root tip, with the maxillary lateral incisor and canine characteristically having the greatest amounts. Mandibular teeth also have varying amounts of distal root tip, with the possible exception of first and second bicuspid teeth depending on

the prescription. Second order, or mesio-distal root tip is incorporated into the modern edgewise appliance by angulating the bracket or bracket slot relative to the long axis of the tooth.2

Third Order

The facial surface of teeth varies significantly in inclination to the true vertical. As a result of this variation, the original edgewise appliance required varying degrees of twist in each segment of rectangular wire in order for the wire to sit passively. The twist bends, also known as third order or torque bends, were required in every patient for every tooth to avoid inadvertent movement of properly positioned teeth. The bracket slots in the contemporary edgewise appliance are inclined to compensate for the inclination of the facial surfaces so that third order or torque bends are less necessary, and are usually only incorporated in finishing when additional or reduced levels of third order position is required. Teeth requiring the greatest levels of torque are commonly the maxillary central incisors, while mandibular second molars commonly require the least.[2]

Clinical Procedure

The direct bonding of orthodontic brackets is a precise, technique sensitive process. The clinical steps include:

1. *Preliminary tooth preparation and moisture isolation*
2. *Primary enamel preparation*
3. *Bracket preparation*
4. *Bracket placement, positioning and cure*
5. *Archwire insertion*
6. *Post bonding instruction*s.

1. *Preliminary tooth preparation and moisture isolation*

Prior to the placement of bonded orthodontic appliances, the patient should be caries-free and demonstrate a consistently high level of oral hygiene. The teeth must be prophied just prior to bracket bonding to remove the pellicle that if left will reduce overall bond strength. Mix a small amount of unflavoured pumice with water to the consistency of wet sand. Using a webbed prophy cup in a slow speed handpiece, pumice the buccal and labial surfaces of the teeth you are about to bond. Run the handpiece slowly and use deliberate motion. Have the patient rinse thoroughly to remove the residue.

Proper isolation is the key to maximum bond strength. A well fitting cheek retractor, a saliva ejector, cotton rolls and dry angles are routinely used to prevent salivary contamination while bonding orthodontic brackets. With the patient properly positioned, insert the cheek retractor so it sits comfortably just inside the mouth. The edges of the retractor should not impinge on

the soft tissue. The patient's lips will be stretched, but it should not be painful. Work efficiently, the retractor places pressure on the lips that can cause fatigue over time. Cotton rolls and dry angles can be added if additional isolation becomes necessary. Keep the saliva ejector close at hand for regular evacuation.

2. *Primary enamel preparation*

The recent availability of all-in-one etch-primer solution has significantly simplified the enamel preparation process. Each all-in- one etch-primer stick provides enough material to prepare one arch. Thoroughly mix the contents of each well by folding one into another according to the manufacturer's instructions. It is important to hear a slight 'pop' as the contents of each well mix. The material, once mixed should appear slightly yellow in colour and the brush should be thoroughly saturated prior to placement on the tooth surface.

Air-dry the surface of the enamel with a light burst from the air-water syringe tip. Rub the brush tip against the enamel with pressure and motion similar to that of a pencil eraser on a sheet of paper. Rub in a circular pattern for approximately 5 to 10 seconds. Re-dry the tooth with a light oil-free burst of air. Proceed to bracket placement when bonding teeth that are susceptible to moisture contamination. For teeth that are predictably isolated, repeat the preparation procedure, replenishing the brush tip for each tooth.

3. *Bracket preparation*

Check that you have the proper bracket for the intended tooth. Brackets can easily be inadvertently mixed up. The bracket should be held securely in the appropriate bracket holding forcep. Anterior brackets are most securely held with the beaks contacting the mesial and distal surfaces of the bracket, while posterior brackets are secured from the mesial, with the beaks of the forcep contacting the occlusal and the gingival. With your hand securely braced, apply the bonding resin to the mesh surface of the bracket, applying just enough material to cover the base 0.5 mm thick. Ensure that the entire base is covered. Tamp the resin into the mesh base using an instrument to ensure a solid resin-bracket interface. If the bonding material is light-cured, shelter the resin from the overhead light.

4. *Bracket placement, positioning and cure*

Place the bracket firmly on the tooth. It is advisable to start bracket placement from the most posterior tooth and move anteriorly, so that bracket height remains constant. Ensure that the bracket does not pull away from the tooth surface as the bracket holding forcep is released. Should it pull away and the bracket end up loose in the mouth, never lose sight of the bracket at any time. Remove the bracket from the mouth, remove the resin from the base and re-prepare the bracket base. As the bracket is pressed against the enamel surface, a moderate amount of flash should be expressed.

Proper bracket positioning is the key to the case. Once the bracket is placed, using a mouth mirror, observe your placement from the occlusal and from the facial. Although specific bracket systems will have idiosyncrasies with regards to individual teeth, most contemporary edgewise systems are consistent in their positioning. Brackets should be positioned as follows:

- Centered mesio-distally.
- The mesio-distal borders of the bracket base parallel the long axis of the tooth.
- The occulsal margin of the bracket base parallels the incisal edge or occlusal surface of the anterior or posterior teeth respectively.
- The gingival surface of the bracket is curved and parallels the gingival margin of the toot.
- Bracket heights are determined by the heights of the marginal ridges. In the maxillary arch, the central incisor bracket height and the height of the cuspid bracket should be the same, while the maxillary lateral incisor is 0.5 mm more incisal in order to slightly intrude this tooth.

Once the bracket position is finalized, any remaining flash is removed and the bracket is light-cured for 30 to 60 seconds (10 seconds mesial, 10 seconds distal with Transbond). The process is repeated until the entire arch (or arches) is completed.

5. *Archwire insertion*

There is any number of archwires that may be selected for initial alignment and leveling. The most common initial archwire selected is a 0.014” nickel titanium archwire in the 0.022” slot. This wire provides a light, gentle continued force, yet does not overpower the brackets nor does it routinely cause significant discomfort to the patient.

Once you have selected the archwire, estimate how long you think it needs to be by measuring against the study model or by lightly placing it in the mouth. Trim the ends using a distal end-cutter. Place the wire through the terminal tubes and centre the midline of the archwire to the midline of the dental arch, all the while taking care not to poke your patient in the cheek with the end of the wire. Trim the ends using the distal end-cutter until they emerge 1 to 2 mm out the end of the terminal tube. Remove the archwire.

Flame the ends of the archwire using a match or lighter until it glows red hot. Heating the wire anneals the nickel titanium so the wire loses its shape memory in the heated area and can be bent to a set position. Cool the wire and reinsert it to the predetermined position. Secure the wire into the brackets using elastomeric ligatures of the proper colour taking care not to pull too hard on the newly bonded brackets. Rotate the elastomeric ligatures onto the tie-wings using a Mathieu plier or small hemostat. Finish the procedure by cinching the ends of the archwire securely towards the gingival using a Howe or Weingart plier. Ensure there are no sharp ends before you dismiss the patient.

6. *Post bonding instructions*

Sit the patient up in the chair and allow them to visualize their new appliances with a hand mirror. Post bonding instructions can be divided into the following sections:

Diet - Patients should be instructed not to eat anything hard for the next 24 hours as the bonding resin cures. After 24 hours, a regular diet can resume, with the patient taking extra care when chewing.

Certain foods and items must be avoided at all times. Patients should be instructed not to chew on pens or pencils, ice, hard candies, or hard breads. Patients need to know that by biting on hard objects, their braces will flex and ultimately fail.

Oral Hygiene Instruction - Patients should be instructed to brush a minimum of three times per day. Using a hand mirror, they must be shown how to access all surfaces of their teeth and appliances. Instruct your patient on the technique and have him or her demonstrate it back to you.

Patients should also be shown how to floss with braces using a floss threader or ‘superfloss’. They should floss a minimum of once per day. Warn them that flossing with braces is a skill and that it can initially take a great deal of time to perfect.

Pain - Warn your patients that they can expect both hard and soft tissue pain for up to two weeks post bonding. Soft tissue pain can be addressed using a small amount of orthodontic wax applied to the appliances in the areas of abrasion. Hard tissue pain can be addressed using a mild analgesic such as Advil or Motrin. Should pain persist beyond a mild ache, the patient should be instructed to contact his or her orthodontist.

Research and Clinical Implications

The contemporary edgewise appliance is ever-evolving. While the simplest appliance system has been presented, it is still the most widely used appliance in clinical practice throughout North America. The system has inherent weaknesses. Not one prescription is applicable to all patients. Almost every case requires some bending of the archwire to achieve the desired outcome. The traditional method of ligation can fail and be less than efficient.

Research is ongoing to address these inherent weaknesses. CAD-CAM technology and the use of chair-side clinical scanners are advancing the idea of individualized custom brackets for each tooth. Robots exist to bend wires to a greater tolerance than the orthodontist. The process of self-ligation, although in itself not a new concept has of late become the method of choice for the majority of recently graduated orthodontists.

The contemporary edgewise appliance, is the mainstay of clinical orthodontics. It will remain the mainstay of orthodontic research.

References:

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