

Aesthetic Orthodontics : An Overview

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ABSTRACT

Through the influence of the media and increasing awareness amongst the people aesthetic concerns regarding orthodontic treatment have risen up. The adult orthodontic patients put higher demands for aesthetic results not only after the treatment but also during the treatment phase. Not only adults but all orthodontic patients give importance to their appearance and for social or work reasons would probably refuse visible orthodontic treatment therapy. This article describes some of the effective solutions to these problems that will not impair the patient from an aesthetic point of view during the treatment phase.

INTRODUCTION

Webster's dictionary defines "esthetic" as "appreciative of, responsive to, or zealous about the beautiful; having a sense ...of beauty or fine culture." Each of us has a general sense of beauty. However, our own individual expression, interpretation, and experience make it unique, however much of it is influenced by culture and self-image. Esthetics is not absolute, but extremely subjective.¹

Esthetic concerns continue to remain at the forefront for a significant segment of patients seeking orthodontic treatment. Appearance is undoubtedly the most important motivating factor for adults whether it is termed "facial appearance", "dental appearance" or "straight teeth".²

Not so long ago, orthodontic therapy was for children and young adults. With the increase in awareness regarding oral health and developments in armamentarium and biomechanics in orthodontics, new field of adult orthodontics have opened. However the adult orthodontic patients put higher demands for aesthetic results not only after the treatment but also during the treatment phase. Not only adults but all orthodontic patients give importance to their appearance and for social or work reasons would probably refuse visible orthodontic treatment therapy. A large population belonging to categories like public personalities, teachers, actors, advocates, models, social workers, TV news readers etc fall in this group. Lingual orthodontics, clear plastic aligners

(Invisalign) and tooth coloured brackets represents some of the effective solutions that do not impair the patient from an esthetic point of view.

TOOTH COLOURED BRACKETS

PLASTIC BRACKETS

During the early 1970s, plastic brackets were marketed as the aesthetic alternative to metal brackets. These polycarbonate brackets quickly lost favour because of discoloration and slot distortion caused by water absorption.

To compensate for the lack of strength and rigidity of the original polycarbonate brackets, high-grade medical polyurethane brackets and polycarbonate brackets reinforced with ceramic or fibreglass fillers and/or metal slots have been recently introduced and are becoming increasingly popular. Polycarbonate brackets with metal reinforced slots demonstrate significantly less creep than conventional polycarbonate brackets although torque problems still exist.³

The addition of ceramic and fibre glass in the plastic brackets also failed to improve the torque stability of the polycarbonate brackets and pure polyurethane brackets showed no significant difference from pure polycarbonate at optimal torque. A comparison with stainless steel brackets illustrated that plastic brackets are only suited for clinical application if they have a metal slot.



Figure 1: Plastic orthodontic brackets

Self-ligating aesthetic brackets are a further recent development. Polycarbonate self-ligating brackets have been shown in vitro to generate significantly greater static and kinetic frictional forces than stainless steel self-ligating brackets but are comparable to conventional stainless steel brackets. (Figure 1)

CERAMIC BRACKETS

In the mid 1980's, the first brackets made of monocrystalline sapphire and polycrystalline ceramic materials came into the field of orthodontics.⁴ They were introduced as an esthetic appliance which, unlike plastic brackets, could withstand most orthodontic forces and resist staining. Ceramic brackets provide higher strength, more resistance to wear and deformation, better colour stability and, most important to the patient superior aesthetics (Figure 2). Ceramic brackets are available in a variety of morphologies including true Siamese, semi-Siamese, solid and Lewis/Lang designs and also various appliance systems including Begg and variable force ligation brackets.



Figure 2: Monocrystalline ceramic brackets

Ceramic bracket composition

All currently available ceramic brackets are composed of aluminium oxide in one of two forms: polycrystalline or



Figure 3: Polycrystalline ceramic brackets

monocrystalline,⁵ depending on their distinct method of fabrication. The first brackets were milled from single crystals of sapphire (monocrystalline) using diamond tools⁶. These were closely followed by polycrystalline sapphire (alumina) brackets, which are manufactured and sintered using special binders to thermally fuse the particles together^{7,8} (Figure 3). The most apparent difference between the two is their optical clarity; monocrystalline ceramic brackets being noticeably more translucent.

Polycrystalline zirconia brackets (ZrO₂), which reportedly have the greatest toughness amongst all ceramics,^{9,10} have been offered as an alternative to alumina ceramic brackets.⁷ They are cheaper than the monocrystalline ceramic brackets but they are very opaque and can exhibit intrinsic colours making them less aesthetic.

However, disadvantages of ceramic brackets are:

1. Bonding and bond strength
2. Frictional resistance
3. Bracket breakage and fracture resistance
4. Iatrogenic enamel damage
5. Debonding

1. Bonding and bond strength

Ceramic brackets cannot bond chemically with acrylic and diacrylate bonding adhesives due to their inert aluminium oxide composition. Consequently, the early ceramic brackets used a silane-coupling agent to act as a chemical mediator between the ceramic bracket base and the adhesive resins. This chemical retention resulted in extremely strong bonds that caused the enamel/adhesive interface to be stressed during debonding, risking irreversible enamel damage in the form of crack and delamination that often required dental restorations. Numerous mechanical base designs are now available ranging from microcrystalline, mechanical ball, dovetail, dimpled chemo/mechanical, silane coated buttons and polymeric bases with many manufacturers claiming

consistent bond strengths and debonding characteristics comparable to that of stainless steel mesh.

2. Frictional resistance

Unlike stainless steel brackets, ceramic brackets can vary in fracture toughness and strength depending on the extent of the surface roughness.⁵ This, in turn affects the overall frictional properties of the bracket. Polycrystalline ceramics, due to their rougher more porous surface, have a higher coefficient of friction than monocrystalline ceramics and stainless steel. Polycrystalline ceramic brackets are manufactured either by an injection moulding process, which produces a smooth surface texture, or by milling or machining with diamond tools, resulting in a rougher final surface texture.

In an attempt to improve the frictional characteristics of polycrystalline ceramic brackets, manufacturers have introduced metal lined/reinforced archwire slots⁸ (Figure 4). They claim to provide smoother sliding mechanics and additional strength, to withstand routine orthodontic torque forces, whilst preserving the aesthetic appeal.

3. Bracket breakage and fracture resistance



Figure 4: Ceramic bracket with metal slot

The low fracture toughness of ceramics leads to a higher incidence of bracket breakages than with stainless steel brackets. Injection moulded brackets have a much smoother finish than machined brackets thus reducing the number of surface flaws. Refined manufacturing techniques including boron carbide tumbling process (Inspire Ice™) and surface heat treatments may produce ultra-smooth surface finishes and rounded facial contours to improve frictional resistance and patient comfort.

4. Iatrogenic enamel wear

Ceramic brackets, being second in hardness only to diamond, are significantly harder than enamel. Rapid and severe enamel wear to the opposing dentition has been reported when ceramic brackets are placed in the lower arch. The use of polycarbonate brackets in the lower arch has been recommended if overbite is a concern as they are less abrasive to the opposing dentition.

Alternatively, most patients will accept metal brackets on the lower arch, particularly when shown that they will display little if any of the lower brackets during normal function.

5. Debonding

Rigid ceramic brackets present a debonding challenge, with enamel damage more likely from debonding ceramic as opposed to metal brackets. The sudden nature and the degree of force required to achieve mechanical bond failure of the early chemically bonded ceramic bracket,

often resulted in enamel fractures and delamination. Grinding ceramic materials from the tooth surface generates heat, resulting in potential pulpal damage especially if low speed grinding without a coolant is used.

CLEAR PLASTIC ALIGNERS (INVISALIGN)

Clear plastic tooth moving appliances (Figure 5) are excellent options for adult or responsible adolescents who might be reluctant to wear the fixed appliances and who will follow clinicians' directions, and whose chief complaint centres around mild to moderate alignment problems. The aim of the tooth positioner developed by Kesling in 1944 was to allow case to be debanded earlier than they otherwise would. Active movements frequently achieved with tooth positioners are:-

1. Alignment of teeth in overcorrected position
2. Closing of band spaces
3. Canine crown positioning
4. Correct the occlusal plane angle, if it is tipped during treatment
5. Correct the balancing side interferences
6. Correct the horizontal and vertical slant of incisors
7. Change the canine-premolar relationship, so that premolars are not obvious when patient smiles
8. Reduce the overcorrected teeth to their correct position

Fabrication of clear aligner

Impression materials like silicones are used to accurately



Figure 5: Invisalign aligner

record the dimensions and spatial relationships of oral tissues. The impressions are put through a CT scan from which a computer creates a three-dimensional model. The information is sent to laboratory and is manipulated by non-dentist and non-orthodontist lay persons who individualize the teeth in the computer model and move them to their final position as prescribed by the orthodontist. Custom software then simulates the movement of the teeth in stages. The orthodontist reviews the simulation online using Align Technology's ClinCheck via a web browser and approves or modifies the treatment. Once approved, a plastic resin aligner is manufactured for each stage of the computer simulation and sent to the orthodontist.¹¹

Tooth coloured attachments (also called buttons) are sometimes bonded to teeth that need to be rotated or moved more than other teeth. Elastic wear (rubber bands) are also used to move the teeth forward or back relative to the jaw, thus accomplishing anterior or posterior corrections. Reproximation, (also called Interproximal Reduction or IPR and colloquially, filing or drilling), is sometimes used at the contacts between teeth to allow for a better fit.^{12,13}

Average treatment time is about one year,¹² again depending on the complexity of the treatment. Simple treatments (minor crowding, minor spacing) may be as short as twenty weeks—this is known as the "Invisalign Express" program. Although the aligners are removable, they must be worn at least 20 to 22 hours per day to avoid delaying the treatment process. If they are not worn consistently, treatment time will increase.

After the regular aligner or braces treatment is complete, retainers composed of a similar plastic material are usually required to be worn, at least at night.

Like other orthodontic systems, the patient has some flexibility. The final position of the teeth is not completely determined by the last aligner. If the patient wants to change the end position because the actual position is not optimal, new aligners are ordered.

Advantages

1. Cosmetic: The aligners are completely transparent, therefore far more difficult to detect than traditional wire and bracket braces. This makes the method particularly popular among adults who want to straighten their teeth without the look of traditional metal braces, which are commonly worn by children and adolescents.¹²
2. Due to the removable nature of the device, food can be consumed without the encumbrance of metallic braces.
3. Lesser root resorption and demineralization: Almost all other types of orthodontic treatment will cause

the roots of teeth to shorten (root resorption) for most patients¹⁴ and demineralization or tooth decay occurs in up to 50% of patients¹⁵ because (unlike Invisalign) they cannot be removed for eating and cleaning.

4. Lesser force: The aligners give less force per week and less pain than do fixed appliances (traditional metal braces). Fixed appliances are adjusted approximately every six weeks and apply greater forces.¹⁶
5. No restrictions on foods: Aligners should be removed to eat, drink, to clean the teeth, or to have them checked by the clinician. Because patients are able to remove the aligners, there are no restrictions on foods that could damage the appliances.
6. Computerized treatment planning: Computerized treatment planning is compulsory as part of the Invisalign protocol. As with other forms of orthodontic treatments that incorporate a computerized plan, this allows the prospective patient to review the projected smile design, learn how long the treatment is likely to take, compare different plans, and make a more educated decision about whether or not to use Invisalign.

Disadvantages

1. Patient compliance: Like traditional fixed braces, they are largely dependent on a patient's habits and their cooperation. The success of the Invisalign aligners is based on a patient's commitment to wear the aligners for a minimum of 20–22 hours per day, only removing them when they are eating, drinking, or brushing their teeth.
2. Expensive: The system is also somewhat expensive, as conceded by the Align company and can be more expensive than traditional wire and bracket systems.
3. Could be lost or damaged: Because the aligners are removed for eating, they could be lost. Invisalign recommends that the patient keep the previous aligners in case this happens.
4. Rotation corrections: Certain teeth are slightly problematic for Invisalign aligners to rotate. Some lower premolars with their rounded shape can be difficult for the aligners to grasp and apply a rotational force to.
5. Not suitable for vertical movement: Also, due to the nature of the design, Invisalign treatment is not suitable for teeth that require vertical movement, such as teeth that are higher in the gingival line than other teeth. The aligners work by applying pressure on teeth, whereas teeth that are too low or too high require pulling to be moved into place.
6. Lipping: Also, similar to traditional metal braces, aligners may cause a slight lip at the beginning of

treatment. This usually disappears as the patient becomes used to the treatment.

7. Allergic: The aligners are constructed of implantable-grade polyurethane, there may be cases of allergic and toxic sensitivity reactions to Invisalign.¹⁶

LINGUAL ORTHODONTICS

In lingual orthodontics brackets are placed over the lingual aspect of teeth and therefore the appliance is inconspicuous (Figure 6). Over the years, the lingual appliance and the techniques have improved dramatically and as a result, a reliable system has emerged. It has now undergone many years of clinical experience and has been shown to consistently produce satisfactory results.



Figure 6: The lingual appliance

Favourable cases for lingual orthodontics are as follows:¹⁷

Non extraction cases

- Deep bite, Class I with mild crowding, good facial pattern
- Deep bite, Class I with spacing or diastema, good facial pattern
- Deep bite, mild Class II, good facial pattern
- Class II Div 2 with retruded mandible

Extraction cases

- Class II upper 1PM and lower 2PM
- Class II upper 1PM extractions
- Mild bimaxillary protrusion with 4 PM extraction
- Class III tendency with deep bite

Unfavourable cases

- Surgical cases
- Open bite cases and high angle cases
- Poor oral hygiene and periodontal involvement with reduced bone level
- Cases with multiple restorative work
- Short clinical crown
- Mutilated posterior occlusion and acute TMJ dysfunction

During the past 20 years, various lingual brackets have been designed and modified for patient control, mechanical efficiency and precise tooth positioning. Some of the brackets used in lingual orthodontics are Conceal, Fujita lingual bracket, Scuzzo –Takemoto bracket, Forestadent, Stealth brackets, Philippe self-ligating bracket, Kelly bracket, Kurz lingual bracket, Adenta bracket, in-ovation L bracket, ibraces (incognito).¹⁸

Amongst all these bracket systems, the incognito or ibraces are totally customised and very comfortable for patients. They have lower profile, and exact finishing¹⁸. This bracket system differs fundamentally both in designing and in manufacturing methods for existing appliance. Using the state of the art CAD/CAM technology, the two normally separate processes of bracket production and bracket positioning are fused in to one unit. In this process, the demand for maximum individuality with simultaneously minimized space requirements is put consistently in to practice. This system is based on digital registration of the malocclusion situation. The brackets are then individually designed and optimally positioned in the computer. Each bracket body is designed independently of the bracket base, on which it is optimally positioned.

BONDING IN LINGUAL ORTHODONTICS

In order to fully exploit the potential of the device used in lingual orthodontics, it is imperative that the brackets be positioned with 100% accuracy. The importance of bracket positioning is due to difficulty of direct vision, variation in morphology of lingual surfaces of teeth, wide range of labiolingual thickness, transfer of labial and buccal torque on to lingual surface, and smaller inter bracket distances makes indirect bonding an essential procedure for high quality lingual orthodontics. To improve the accuracy in bonding various indirect bonding techniques such as the CLASS system, TARG machine, slot machine, HIRO technique, lingual bracket jig, lingual plain wire mushroom bracket positioner, Kis bracket positioner, Ray set, transfer optimised positioning (TOP), Orapix system are available.

Advantages of lingual therapy^{19,20}

1. As the appliance is placed on lingual tooth surface it is inconspicuous.
2. Facial surfaces of the teeth are not damaged from bonding, de-bonding, adhesive removal, or decalcification from plaque retained around labial appliances.
3. Facial gingival tissues are not adversely affected.
4. The position of the teeth can be more precisely seen when their surfaces are not obstructed by brackets and arch wires.
5. Facial contours are truly visualized since the contour and drape of the lips are not distorted by protruding labial appliances.

6. The bite plane effect in brackets will allow the intrusion of the incisors and a limited extrusion of the molars.
7. The lingual appliance system allows both arches to be treated simultaneously, while maintaining the effects of the splint.
8. It is possible that molar distalization through lingual techniques produce more bodily movement of the tooth and less distal tipping.
9. Clinically we obtain more remarkable dento-alveolar expansions through lingual mechanics than through labial mechanics.
10. The lingual patient will have a significant increase in salivary flow rate, decreasing the risk of caries during treatment.

Disadvantages of lingual therapy^{19,20}

1. Tissue irritation and speech difficulties: The earlier brackets placed on the lingual surface of teeth were irritating to the tongue and impeded normal speech.
2. Gingival impingement: Access for adequate oral hygiene and the self cleansing nature of the oral cavity are compromised.
3. Difficulty in oral hygiene
4. Decreased arch radius, decreased interbracket distance, a compound lingual geometry, highly variable tooth morphology, and limited access and

visibility all combine to make accurate compensating bends exceedingly difficult with a lingual appliance.

5. Non economic
6. Difficulty in rotation correction
7. Technique sensitive
8. Transverse and vertical control is less.
9. Anteroposterior and vertical changes become immediately evident upon bonding lingual brackets to the maxillary teeth. The bite plane built into the maxillary anterior brackets usually causes disocclusion of the posterior segments. So this exacerbates patients with a high mandibular plane angle.

DISCUSSION

In this era of 21st century, the number of adult patients seeking orthodontic treatment are increasing day by day. Fixed orthodontic appliances have been the backbone of orthodontic biomechanical technique. However, adult patients seeking orthodontic treatment are increasingly motivated by aesthetic considerations. This radical concept of aesthetic orthodontics for comprehensive orthodontic treatment provides a viable option for the orthodontist as well as to the patient.



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