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ORTHODONTIC BRACKETS
(A Literature Review)

Yrd. Doc. Dr. Selim ARICI*

ÖZET:

Bu yüzyıl boyunca dental malzemelerle ilgili bilim dalındaki en önemli eğilimlerden birisi, ortodontik apareylerin fonksiyon ve estetiğini geliştirmek olmuştur. Bu nedenle, farklı materyallerden birçok tipte ortodontik braketler dizayn edilmiş ve üretilmiştir. Bütün bu braketlerin ortodontik uygulamalarda bazı avantaj ve dezavantajları vardır. Bu yüzden, bir klinisyen braketlerden en fazla performansı alabilmek için onların mekanik, kimyasal ve klinik özelliklerini bilmelidir.

Anahtar Kelimeler: *Ortodontik braketler, braket materyalleri.*

SUMMARY: ORTHODONTIC BRACKETS

Throughout this century, one of the main trends of progress in the science of dental materials has been the improvement of both the function and aesthetic of orthodontic appliances. For this reason, many types of orthodontic brackets have been designed and manufactured from different materials. All these brackets have some advantages and disadvantages for orthodontic applications. Therefore a clinician should know the mechanical, chemical and clinical properties of the brackets in order to get best performance out of them.

Key words: *Orthodontic brackets, bracket materials.*

INTRODUCTION

By the late 1970s, the acid etch bonding technique and the mesh-based metal bracket had produced bond strengths adequate to consistently withstand intraoral forces and the direct bonding of brackets became an accepted clinical procedure in orthodontics (68, 83-87).

Although orthodontic patients preferred the direct bonded stainless steel brackets to bands, the metal brackets were still quite visible (65). The development of brackets which would combine both satisfactory aesthetics for the patient and an adequate technical performance for the orthodontist has remained an elusive goal. Attempts at an aesthetic appliance have included; altering the appearance of or reducing the size of stainless steel brackets, bonding the appliance on the lingual surface of the teeth, changing the material from which brackets are made.

Early attempts to coat the surface of metal brackets with a tooth coloured material were unsuccessful due to lack of translucence, discoloration of the coating in intraoral fluids and failure of the coating to adhere. Plastic brackets were aesthetically satisfactory in the early stages of treatment but deteriorated in appearance with time. They were also prone to deformation and fracture under applied orthodontic forces (1, 2, 21, 79). Manufacturers returned to stainless steel but began designing brackets with increasingly smaller bracket dimensions, thereby reducing the amount of visible metal and improving the appearance of the appliance. These brackets offered a worthwhile, but necessarily limited, aesthetic advantage over their predecessors.

More recently, ceramic reinforced plastic brackets have become available but while these seem more durable than plastic brackets, their ability to maintain their integrity and appearance over long treatments remains suspect (5, 29).

The continued quest for an aesthetic and durable bracket led to the use of ceramics, which are translucent or transparent whilst also being hard and strong. Ceramic brackets are aesthetically more pleasing and better suited to the oral environment than their metal, coated

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* Ordokuz Mayıs Üniversitesi Dişhekimliği Fakültesi Ortodonti Anabilim Dalı

metal and plastic predecessors. However, ceramic brackets introduced the problems of bracket and enamel fracture, friction, enamel wear and problems during debonding (34-37).

To understand the proper use of a bracket material, it is necessary to be familiar with its mechanical and chemical properties. With such knowledge, one can better predict how the bracket will react under conditions of actual use. Therefore, the aim of this study is to review the basic mechanical and chemical properties of the materials from which orthodontic brackets are made. The effect of these properties of the bracket materials on their clinical performance is also reviewed.

BRACKET MATERIALS

Materials may be classified into metals, ceramics and plastics according to their prevalent bonding forces (metallic, ionic/covalent, van der Waal's) and their atomic structure (18). All these three materials, usually single but sometimes in combination, have been used for the manufacture of orthodontic brackets. Their properties differ widely and all the materials currently used have advantages and disadvantages.

The mechanical properties of a material relate to its response when it is loaded or deformed, that is, when it is subjected to stress (load/cross-sectional area) or strain (extension/initial length). The load may be tensile, compressive, or shear and its magnitude may be constant with time, or it may fluctuate continuously (18, 77, 103). The application time may be for only a fraction of a second or many years. Orthodontic forces under occlusion are particularly variable. The response of a material to such loading conditions will be elastic strain (recovered on unloading), or plastic strain (not recovered on unloading) or fracture (18,103). These may develop immediately on applying stress, or over a period of time. The important mechanical properties are strength, hardness, ductility, and stiffness.

The tensile and compression tests measure the resistance of a material to a static or slowly applied force (the resistance of materials to gross plastic deformation). Tensile strength testing is typically used for characterising ductile metals and plastics (18, 24). Compressive strength is the crushing strength of a material. It is rarely measured for metals, but is commonly measured for ceramics (55, 88).

Fracture toughness (K_{IC}) is the stress intensity required to cause a fracture in a material. In other words, it is a measure of the material's ability to resist damage or fracture (55, 93).

The environment may be air at high, ambient, or low temperature; or it may be one of a great number of possible fluid combinations (saliva or ingested fluids), many of which are potentially corrosive. The oral environment is an aggressive environment. The fluctuating acidity (pH) and temperature in the mouth can adversely affect the chemical stability of the materials (50). Materials may dissolve in the water (saliva) or release soluble components; they may erode due to the presence of acids; they may discolour due to absorption of substances from saliva; or they may corrode (22, 103).

Discoloration does not cause a deterioration of the material itself, but can be unsightly. In contrast, corrosion is a chemical reaction between the material and its environment and is therefore a potentially much more serious problem. The products released during corrosion may have an adverse effect on the biological environment, both locally and systemically (103).

Stainless Steels

Stainless steels are ferrous (iron-based) alloys. Their predominant alloying element is chromium; a concentration of at least 11 wt % Cr being required. They are resistant to corrosion in a variety of environments, especially the ambient atmosphere. Corrosion resistance may also be enhanced by nickel and molybdenum additions (18).

Stainless steels are divided into three classes on the basis of their microstructure-martensitic, ferritic, or austenitic at normal temperature (18, 24). The stainless steel used for orthodontic brackets is an austenitic alloy, which is nonmagnetic and is highly corrosion resistant to all media, except hydrochloric acid and other halide acids. In addition, it may be polished to a mirror finish and thus is relatively easy to keep clean (60, 110).

Most commercially available stainless steel brackets are made from AISI classification (American Iron and Steel Institute) type 303, 304, 304L, and 316L steels in which the amount of carbon decreases as the numerical nomenclature increases (41). The suffix "L" denotes low carbon. The reduction in carbon contributes to increased passivating properties, rendering the austenitic alloy less susceptible to corrosion. Type 304L steel contains 18 to 20 per cent chromium and 8 to 10 per cent nickel, with small amounts of manganese and silicon and low carbon content, typically less than 0.1 %. Elements, such as silicon, phosphorus and sulphur are added to improve specific properties such as machinability. The type 316L steel, which has a higher nickel content, includes 2 to 3 per cent molybdenum, and a still lower carbon content for better welding characteristics and improved corrosion resistance (60, 103).

The first generation of stainless steel brackets were fabricated by machining (metal cutting), which is the removal, usually by milling, of the unwanted metal from a blank in the form of chips so as to obtain a finished product of desired size, shape, and finish (65). Brackets made by milling are, however, too expensive and at the same time too prone to human error, and the method has been superseded by sophisticated precision investment casting and sintering techniques. Sintering involves the compaction of powdered metal, followed by heat treatment (below their melting point) to produce a dense bracket. Currently, some companies use metal injection moulding (MIM) to manufacture their stainless steel brackets.

Plastics

The term of "plastic" includes fibrous, rubber-like, and resinous or hard, rigid substances. From a technical viewpoint, the term is applied to a group of engineered materials, characterised by large molecules, that are built up by the joining of small molecules. On a more practical level, these materials are natural or synthetic resins, or their compounds, that can be moulded, extruded, cast or used as thin film coatings. They offer low density, low tooling cost, and design versatility. From a chemical viewpoint, most are organic substances containing hydrogen, oxygen, carbon, and nitrogen (24, 110).

Plastic materials may be either thermoplastic (such as acrylics or nylon) or thermosetting (such as epoxies or silicones). In thermoplastics, all bonds within the molecules are strong primary bonds. The attraction between neighbouring molecules, however, is only by the much weaker van der Waal's forces. Because these secondary bonds are weakened by elevated temperature, plastics of this type soften with increasing temperature and become harder and stronger when cooled (18, 24, 110).

Thermosetting plastics, on the other hand, are those with a three dimensional framework structure in which all atoms are connected by strong covalent bonds. These materials generally result from condensation polymerisation, in which elevated temperature tends to promote an irreversible reaction, hence the term thermosetting. Deformation requires the breaking of primary bonds, so that these plastics tend to be strong, but brittle (24, 110).

Several plastic families, such as acrylics, nylons, epoxies, polyphenylene, and polycarbonates, have been investigated in attempts to select a suitable plastic for a direct bonding orthodontic attachment. At the present time, plastic brackets are generally manufactured by using acrylic moulding powder (Plexiglas) or polycarbonate which is a clear, very tough, amorphous plastic (29, 110).

Moulding is the most common method for forming plastic brackets. The techniques used include compression, transfer, and injection moulding. For each, a finely palletised or granulised plastic is forced, at an elevated temperature and by pressure, to flow into, fill, and assume the shape of a mould cavity (24).

Ceramics

Ceramics are inorganic non-metallic materials. Most ceramics are compounds of metallic and non-metallic elements for which the interatomic bonds either totally ionic or predominantly ionic but having some covalent character (52).

Ceramics are well known for their hardness and resistance to high temperatures and to chemical degradation. The atomic structure that imparts these advantages also accounts for their most glaring fault, which is their brittleness. They show very little elastic or plastic deformation. The crystalline structure of ceramics does not permit the shifting of bonds and redistribution of stresses, so when stresses reach critical levels the interatomic bonds break and material failure occurs (56, 88).

Because of their strong interatomic bonding and high shear resistance, ceramic materials tend to have low ductility and high compressive strength, which is 10 to 15 times higher than their tensile strength. Theoretically, ceramics could also have high tensile strength, but generally they do not because small cracks, pores, and other defects act as stress concentrators, whose effect can not be reduced through ductility and plastic flow. Due to this atomic structure they are also susceptible to crack propagation caused by minute imperfections or material impurities (45, 69, 88).

Although one manufacturer uses zirconia in its ceramic bracket processing, the currently available ceramic brackets are mostly made from alumina (aluminum oxide). Alumina is a ceramic on which much development work has been carried out in order to purify the material and to improve the processing technique, so as to obtain a fine grained structure, free of porosity (56, 69). There are two types of alumina ceramic bracket available;

- Polycrystalline alumina brackets are the most common type available and are translucent, thus they match tooth colour. They are manufactured by blending aluminum oxide particles with a binder so that the mixture can be moulded into a shape from which a bracket can be cut. An alternative method of making polycrystalline alumina brackets is injection moulding. This process does not require the brackets to be machined and thus eliminates structural imperfections created by the cutting process (99).

The advantages of polycrystalline brackets include their ability to be moulded and therefore produced in large quantities, resulting in lower manufacturing costs. The disadvantages of polycrystalline brackets are mainly related to the fact that they consist of several crystals of alumina, all orientated along different axes, with grain boundaries between each crystal. Such imperfections, or impurities at these grain boundaries, can lead to crack propagation (55-57, 69, 99).

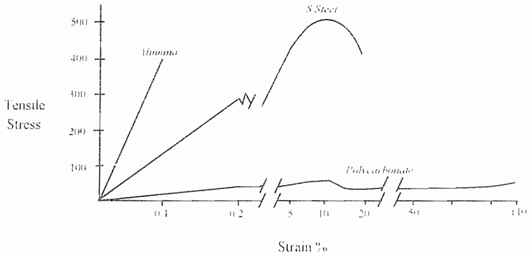
- Single-crystal alumina or sapphire brackets are clear and manufactured from single-crystal man-made alumina by an entirely different process. Single crystals of man-made sapphire are produced by making a molten mass of aluminum oxide at temperatures in excess of 2100°C. These large single crystals are milled into the shapes and dimensions required for the various brackets using ultrasonic cutting techniques, diamond cutting, or a combination of the two (99).

The disadvantage of the monocrystalline brackets are that they are expensive both to produce and to machine. The advantage is that the virtual elimination of grain boundaries reduces the stresses generated by imperfections and impurities, so theoretically reducing the chances of bracket fracture (56, 57, 99).

Comparison of the Bracket Materials

Typical stress-strain curves for ceramics, metal, and plastics are compared in Figure 1 using as examples a stainless steel, an Al_2O_3 ceramic (alumina) and a polycarbonate plastic. A typical ceramic fractures in a brittle mode with only minimal elastic deformation prior to fracture. The typical steel fractures in a ductile mode with initial elastic deformation followed by a yield point and plastic deformation, fracture occurring when the cross section decreases to such a degree that the applied stress can no longer be sustained. To demonstrate the widely differing properties of the compared materials, the elongation for stainless steels is approximately 20 % when it finally fails (24), but the elongation for the ceramic at fracture is less than 1 % (52), this latter material being much more brittle.

Figure 1. Stress-strain behaviour of selected materials.



As a general rule, the mode of fracture in thermosetting plastics is brittle. For thermoplastics, both ductile, as in the Figure 1, and brittle modes are possible (24, 110). Many of these materials are capable of experiencing a ductile-to-brittle transition, when their temperature is reduced. Glassy thermoplastics are brittle at relatively low temperatures; as the temperature is raised, they become ductile in the vicinity of their glass transition temperatures and experience plastic yielding prior to fracture (110).

The tensile strength of metals and many plastics is a bulk material property that can be very appropriate indicator of performance in orthodontic applications, with little or no regard to the surface conditions. The tensile strength of ceramics, however, is not a simple bulk property (69, 99). It is, as stated before, so very dependant on the surface of the ceramic that tests on bulk samples of the material can be irrelevant and misleading (93). The presence of localised stress concentrations (i.e., scratches, notches, and sharp raised flaws) will propagate the fracture failure. Even a shallow scratch on the surface of a ceramic material will drastically reduce the load for fracture whereas the same scratch on a metal or many plastic surface will have little, if any, effect on fracture under load. Therefore, the fracture toughness is the physical property that most distinguishes ceramics from other materials (Table I). Theoretically, this property is of particular relevance in orthodontic brackets (92, 93, 99).

Table I. Comparison of some properties of three commonly used bracket material.

Property	S. Steel	Polycarbonate	Alumina
Density (g/cm^3)	8	1.20	3.97
Tensile Strength (MPa)	552	65	440
Elongation at Break (%)	50	110	0.1
Fracture Toughness (MPa√M)	80-95	1.7-2.5	2-4.5 MC* 3-5 PC**
Hardness (Rockwell)	5-35		97.5 MC 82.5 PC

* Monocrystalline **Polycrystalline

Typical values of fracture toughness for stainless steel are in the 80-95 MPa √M range, while values reported for polycrystalline alumina ceramic are down in the 3.0-5.3 MPa √M range (92). Sapphire single crystal alumina fracture toughness were reported to be in the 2.4-4.5 MPa √M range (48). Polycarbonate plastic has a fracture toughness around 1.7-2.5 MPa √M (18).

None of the plastics possess strength properties that remotely approach those of the stainless steels, although their low density allows them to compete effectively on a strength-to-weight (or specific strength) basis. Many have low impact strength, although several (such as polycarbonate, polyethylene) do have good impact properties. The dimensional stability tends to be greatly inferior to those of metals and ceramics, and the coefficient of thermal expansion is rather high (24, 110).

When chemical properties of materials are considered, in general, it can be said that plastics tend to suffer from water absorption and loss of soluble components, metals are prone to corrosion, and ceramics may be subject to erosion (18, 22, 24, 48, 52, 53, 56, 110).

Although the corrosion resistance of plastics is generally good, they often absorb moisture, and this absorption, in turn, decreases strength and can result in discoloration. Some thermoplastics can exhibit a 50% drop in tensile strength as the humidity increases from 0% to 100% (24, 53).

Ceramics are chemically stable under most circumstances, and aluminum oxide ceramics (particularly sapphire) resist discoloration and corrosion well. In acid solutions, some ceramic types, such as alumina products, should have good resistance, while those with a calcium aluminate and glass bond will have less. Attack by alkaline solutions would have slightly greater effect on the properties (52, 56, 69).

All metals (even stainless steels) are prone to corrosive attack when the environment is aggressive enough. The corrosion process for metals is driven by a decrease in the free energy as the metal reacts with a liquid or a gas. Corrosion is highly undesirable, as it weakens materials and may lead to fracture (53, 63, 103).

TYPES OF BRACKETS

A wide variety of bracket types are commercially available for clinical use and a considerable amount of development has taken place to improve their clinical properties.

Stainless Steel Brackets

Metal brackets (first gold, but then exclusively stainless steel) were in routine use for banded cases when adhesive bonding was originally suggested and were thus already available. In the first reported *in vitro* study with bonded metal brackets, sectioned siamese edgewise brackets were rejoined to form retentive facing wings in the bracket base (70).

Stainless steel does not form a chemical union with any of the available adhesive resins. A micro-mechanical interlock must be obtained between the bracket base and the adhesive. Therefore several designs of bracket base have been devised to gain the maximum bond strength by interlocking. These bases are perforated, foil-mesh (gauze), milled (undercuts), cast, photo-etched and polymer coated. Recently metal brackets with laser structured bases has also been marketed.

Comparison studies of bond strengths of stainless steel orthodontic brackets have shown the foil-mesh base to be superior to the perforated, milled, cast, photo-etched and polymer coated bases (25, 30, 61, 62, 82, 87, 95, 96). Further studies indicated that fine foil-mesh bases allows the best resin penetration and the strongest bond strength (54, 100). It has been generally accepted that foil-mesh based stainless steel brackets are the standard by which other types of bracket attachments are judged (42, 43, 62).

Investigators who have attempted to develop an optimal method of removing orthodontic metal brackets have concluded that application of a force that peels the bracket base away from the tooth and causes bond failure at the bracket/adhesive resin interface is the most consistently atraumatic debonding technique (10, 73). The elastic and plastic deformation characteristics of the stainless steel has been shown to contribute to the lower bond strength that exists between metal bracket bases and the adhesive resin compared to that between the adhesive resin and enamel (96, 107). Therefore, the debonding of metal brackets exhibit no problem in clinic.

Several studies (4, 28, 58, 59, 78, 89) reported that the archwires in stainless steel brackets generate lower frictional forces than the archwires in ceramic and plastic brackets, although several variables, such as bracket-slot size and angulation, ligature type, archwire diameter and shape, and salivary lubrication have been demonstrated to affect the magnitude of friction between bracket and wire (47, 74, 102).

Investigations into the effects of oral environment on the corrosion of stainless steel brackets has been limited. It has been reported that corrosion of alloys in the oral environment might decrease the strength of stainless steel brackets leading to a widening of the slot and to alterations in torque and angulation (66). There has also been concern about adverse biological effects of the corrosion products on the patient (41, 63, 64, 76). Therefore, gold and titanium coated metal brackets have been marketed for those patients who are allergic to nickel and chromium ions. On the other hand, the release rates of nickel and chromium ions from full-mouth orthodontic appliances have been reported to be less than 10 % of the average daily dietary intake for nickel and 0.25 % of those for chromium (6).

Tooth staining is another phenomenon that accompanies metal bracket corrosion. A study showed that one cause of staining was the diffusion of metal ions into resin, which in turn remained ingrained in the enamel (41).

Stainless steel brackets are very commonly used in direct bonding because they exhibit adequate strength to withstand the torquing and retraction forces applied to the teeth, although they have aesthetically unpleasant appearance.

Plastic Brackets

Plastic brackets, generally made from polycarbonate, were initially well received and the aesthetic advantage of them in orthodontic treatment is well documented (1, 38, 71, 85). However, their popularity decreased by the time due to the several problems they exhibit. These included distortion following water absorption, fracture, wear, discoloration and an inability to withstand the torquing forces generated by rectangular wires (2, 21, 26, 79, 80). They do also not form a strong chemical bond with diacrylate adhesive resins. The use of an acrylic resin monomer as a primer is necessary to enhance bonding between the diacrylate resin and the polycarbonate bracket (8, 72, 79).

There have been some attempts to improve the physical properties of plastic brackets. It was suggested that a combination of metallic and plastic materials might improve bracket strength (111). Plastic edgewise brackets with a metallic edgewise slot are commercially available. Another hybrid type, which is now commonly used, is the ceramic reinforced plastic bracket which consists of ceramic particles in a plastic matrix to improve the resistance to creep and deformation - in effect a composite bracket. This reinforcement comprises ceramic whiskers, platelets and dispersions (29). However, ceramic reinforcement does not appear to have any significant effect on strengthening the polycarbonate matrix (5, 17, 42).

The torque-deformation characteristics of four types of polycarbonate brackets (one pure, and three reinforced) in comparison with stainless steel brackets were investigated in a recent study (29). It was found that, when compared with the stainless steel bracket, all polycarbonate brackets showed significantly higher deformation and lower torque. Within the polycarbonate group the metal slot reinforced polycarbonate produced the highest torque and lowest deformation values followed by the metal slot and ceramic reinforced polycarbonate, ceramic reinforced polycarbonate, and pure polycarbonate. It was also concluded that only the metal slot reinforced brackets are clinically capable of applying a sufficient torquing force to teeth.

It has to be born in mind that the Edgewise bracket was designed to be constructed in metal. Attempts to construct satisfactory plastic brackets have always tried to ape the metal bracket and some of the disadvantages of the plastic bracket might be overcome by designing a fixed appliance system suitable for plastic components rather than metal ones. Generally speaking, plastic brackets are not strong enough to withstand the heavy torquing forces applied by a rectangular wire and should be used with those cases which require little torquing, minimal movement and a short treatment.

Ceramic Brackets

The introduction ceramic brackets was a much-heralded development in orthodontic technique especially in cases where the aesthetics of the appliance were important. Although ceramic brackets, unlike polycarbonate brackets, resist staining and discoloration and are the most aesthetic brackets commercially available, they have disadvantages such as, bracket fracture, abrasion of opposing tooth enamel, higher frictional resistance of the bracket, and enamel fracture during debonding (3, 7, 9, 13, 14, 16, 19, 20, 23, 40, 44, 46).

Bracket fracture, which is due to low fracture toughness of the aluminum oxide ceramics often affects bracket wings and usually occurs when tying-in an archwire with steel ligatures (31, 57, 93). A recent survey also showed that nine out of ten "ceramic operators" had experience of bracket fracture during debonding (37).

Wear of opposing enamel surfaces in juxtaposition with ceramic brackets can happen very quickly if there is any occlusal interference between the bracket and the opposing tooth surface (23). This problem is due to the fact that ceramic brackets are seven times harder than enamel The results of an *in vitro* experiment showed that it was possible to get clinically visible enamel abrasion after only 15 chewing cycles, which is less than one meal (104). Therefore manufacturers introduced elastic "cushions" to cover the bracket occlusal surface to reduce abrasion (75).

Another problem which is related to the hardness and roughness of ceramics is higher frictional resistance of these brackets. The sliding resistance of the archwire in the bracket slot is increased by abrasive wear of the archwire by the hard ceramic (4). Several *in vitro* studies showed that wires in ceramic bracket slots generated significantly stronger frictional forces than did wires in stainless steel brackets (4, 58, 59, 74, 78, 102).

Enamel fracture and flaking on debonding is related to the low elastic deformation and high bond strength of ceramic brackets. Two different mechanisms are used for bonding ceramic brackets: Mechanical retention via indentations and/or undercuts in the bracket base, or alternatively chemical bonding using a silane coupling agent as a chemical mediator between the adhesive resin and the bracket base, or a combination of thereof (32, 39, 67, 72, 81, 91). In several studies, it has been demonstrated that bonded ceramic brackets fail primarily at the enamel/adhesive interface, thus endangering enamel continuity (34, 42, 72, 105, 108). Since ceramic brackets have become commercially available, several articles have been published dealing with enamel fracture during the debonding procedure (37, 49, 81, 97).

The potential for creating enamel fractures and cracks following debonding raises questions about the safety of the procedures used to remove these attachments. As a result, manufacturers have been continuously introducing various debonding techniques (mechanical, electrothermal, ultrasonic and laser aided) and modifying the bonding characteristics of ceramic brackets. Evaluations of the effectiveness of these bracket-removal techniques with respect to bracket failure rates, bracket types and quality of the enamel surface after initial bracket removal have all been reported in the literature (9-12, 15, 27, 33, 51, 90, 94, 98, 101, 106, 109). Summarising the findings of these studies, it may be said that clinicians still encounter problems during the debonding procedure and this has been identified as a major disadvantage of ceramic brackets.

The general clinical properties of orthodontic brackets were summarised in Table 2.

Table II. Clinical properties of orthodontic brackets.

Property	Bracket Type		
	Stainless steel	**Plastic**	**Ceramic**
Aesthetic	Bad	Good	Excellent
Discoloration	No	Yes	Not usual
Corrosion	Yes	No	No
Deformation (Torquing)	No	Yes	No
Adhesion (to composite resin)	Mechanical	Chemical	Chemical and/or Mechanical
Friction (Arch wire)	Low	Low	High
Debonding	No problem	Easy	Problematic

In summary, there has been rapid progress in the science of dental materials during the last two decades, and the introduction of direct bonding brackets in orthodontics was one of the results of this development. Although the direct bonding procedure has been welcomed by clinicians and used worldwide, the profusion of orthodontic brackets causes problems in selecting proper type to give the desired performance in the oral environment. Therefore clinician should be aware of the basic properties of the brackets in his use.

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YAZIŞMA ADRESİ :

Yrd. Doç. Dr. Selim Arıcı
OMÜ Dişhekimliği Fakültesi
55139 Kurupelit / SAMSUN
Tel: 0362 4576000/3006
Faks: 0362 4576032