International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Review Article

Brackets Mesh Changing Trends: A Review

V.A.Afsal[1], Pradeep Philip George[2], Sandeep Mathew[3], Nishad V M[3], Shabeer Ali P[3], Soumya K M[3*]

[1]Professor & HOD, [2]Reader, [3]Senior Lecturer,
Department of Orthodontics and Dentofacial Orthopedics, Al-Azar Dental College, Thodupuzha, Kerala, India

[*]Correspondence Email: drsoumyakm@gmail.com

Received: 11/06//2013 *Revised: 05/08/2013* *Accepted: 10/08/2013*

ABSTRACT

Clinicians have an extensive selection of bracket bases and bonding materials at their disposal so that their choices can be tailored to the patients' specific needs, their own clinical experience. Research works on orthodontic bracket materials has led to the use of advanced manufacturing methods like injection molding, improved bracket base designs for retention purposes. This article overview the changing trends in the bracket design and bases.

Key words: Bracket mesh, orthodontics, bonding.

INTRODUCTION

Orthodontic brackets bonded to enamel provide the means to transfer the force applied by the activated arch wire to the tooth. Before Angle began his search for new materials, orthodontic attachments were made from noble metals and their alloys. In 1887 Angle tried replacing noble metals with German silver which were actually copper, nickel, and zinc alloys that contained no silver. Plastic brackets were introduced in late 1960s mainly for esthetics but their tendency to undergo creep deformation when transferring torque loads and discoloration led to their unpopularity. Ceramic orthodontic brackets were first introduced in 1987 as a more esthetic alternative to the traditional stainless steel brackets.

There are various bracket base designs all in an attempt to optimise the mechanical bond between the bracket and the adhesive. The design of the bracket base adhesive pad has been found to be a significant factor in mean shear bond strength.[1] Seventy five percent of brackets with a simple foil mesh base undergo bond failure at the bracket adhesive interface.[2] Presently most stainless steel orthodontic brackets have a fine mesh design on the adhesive surface of the bracket base.[3-5] It has been reported that mesh based brackets with larger mesh spaces (apertures) provide a greater shear bond strength than do bases with smaller mesh apertures.[6] The number of openings per unit of area of the bracket base is determined by the wire diameter and the mesh spacing. For resin to penetrate the base effectively air needs to be able to escape and this is determined by the free volume between the mesh and the bracket base.[7] As far as the mesh design is concerned, Matasa claimed that the mesh number and the wire diameter of the mesh are the most important influencing factors.[8] The two areas in which improvements have taken place are in the design of the mesh as well as the use of bond enhancing metal surface treatments applied to the mesh. The various types of treatment applied to bracket bases have entailed micro-etching, sandblasting, polymer coating or a spray with fine particles of molten metal. The current trend is for a less dense mesh to be used so as to ensure a larger aperture or open area in the base.

MANUFACTURING METHODS FOR METAL BRACKETS

Various methods used for manufacturing metal brackets were,

1. Milling→ one-piece attachment is milled on the lathe
2. Casting→ where one-piece brackets are made by casting
3. Sintering→the partial welding together of metal particles below their melting point
4. Metal injection molding (MIM) →Metal and ceramic injection molding are derivatives of powder metallurgy. Powders can be shaped in a semi-fluid state, but after heating to high temperatures the particles bond into strong, coherent masses. This technique requires the use of computer-aided design, along with computer-numerical controlled machines tools.

METAL BRACKET BASE TYPES

The sizes of the wire mesh used in the manufacturing of the various single mesh type bases were 40, 60, 80, and 100 meshes.[9] The finest mesh used on metal brackets is 100 gauge, which can accommodate up to a 155-micron particle size of filler.[10] In 1969 Mizrahi and Smith introduced the earliest technique of welding mesh to stainless steel band material and directly bonded the orthodontic attachments to the enamel. Nominal area of bracket base is measured by a method called Planimetry where enlarged photographs of bracket base are examined and mesh size is also calculated by counting wires per linear inch.

Mesh Type Bases:

1. Foil mesh base
2. Mini mesh base
3. Micro mesh base
4. Laminated mesh base
5. Dyna bond base
6. Ormesh wide central
7. Supermesh MB base.

Non-Mesh Type Bases:

1. Micro-loc base
2. Dyna lock integral base
3. Micro etch base
4. Laminated perforated base
5. Peripheral perforated base
6. Laser structured base.

Perforated Bases

When first introduced metal brackets had perforated bases in order to mechanically attach to cements.[11] When bonding these brackets the cement was free to flow through the holes, that were not obliterated by the bracket. The major problem associated with this type of base was plaque retention and poor aesthetics. Brackets with perforated bases are no longer used in orthodontics.

Foil-mesh Bases

Foil-mesh bases replaced perforated bases. The foil-mesh is either welded or brazed on to the bracket base. Compared to a perforated base foil mesh provides a smoother, less plaque retentive and thus more hygienic surface.[12] It has also been shown that foil-mesh bases provide better retention than perforated metal bases.[13, 14] Weld spots used to secure the foil mesh to the bracket are thought to reduce the retentive area and as a result reduce the bond strength by obliterating distinct areas of the foil-mesh. Author's haves also suggest that these weld spots act as "stress concentrators" in composite resin, thus leading to a weakened bond between the base and the cement. However, using a laser for welding or mesh attachment by brazing yields better tensile and shear bond strengths

Integral Bases

Metal brackets with integral bases are fabricated in a manner that both the bracket and its base are cast as an integral unit. As a result, the bracket cannot be separated from its base.[15] The integral base brackets are divided to two types: machined integral brackets and cast integral brackets (Fig 1). In machined integral brackets a milling process is used for imparting mechanical retention on to the bracket base, whereas for cast integral base brackets a casting process is used. The bases of integral brackets have horizontal undercut channels, which open at the mesial and distal extremities. The Time bracket (American Orthodontics) is an example of a machined integral, microetched base with mechanical undercuts.

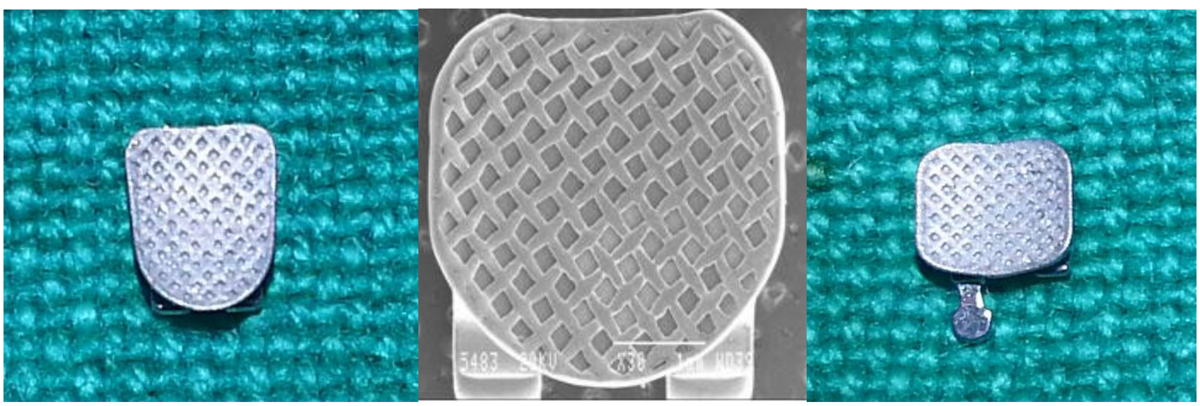

Fig 1: Brackets Mesh.

Sintered Bases

Sintering is a process that is used to improve the mechanical retention of the cement on metal base brackets and it involves fusion of metal or ceramic particles onto the bracket base. This process creates a porous layer with increased surface area into which the cement material can penetrate. These bases are shown to yield higher tensile bond strengths than conventional foil-mesh bases.

Photo-etched Bases

An alternative to foil-mesh metal bracket bases is photo-etching. Photo-etched bracket bases are retained through small indentations in the base that are microscopically roughened by an etching process. The bond strength achieved by using this type of base design is greater than perforated bracket bases but less than the foil- mesh bases. The inferior bond strength compared to foil-mesh bases is attributed to poor penetration of resin cements which results in air inclusions that inhibit polymerization of uncured resin.

The *Supermesh type* base consists of a pad with a dense (200 gauge) mesh beneath a standard (100 gauge) mesh. Double mesh or dual mesh type bases have 80-gauge layered on a 150-gauge microetched foil mesh base. David Hamula introduced titanium brackets whose retentive base pads were done by a computer-aided laser (CAL) cutting process, which generates micro- and macro-undercuts. Olivier Sorel (2002) used a new type of laser structured base retention (Discovery bracket, Germany).The smooth surface of injection molded single piece bracket base is treated by a sufficiently powerful Nd: YAG laser, melting and evaporating the metal and burning hole-shaped retentions.

Base Morphology of Ceramic Brackets

Three types of bracket base retention in ceramic brackets:

a. Mechanical retention employing large recesses.
b. Chemical adhesion facilitated by the use of a silane layer.
c. Micromechanical retention through the utilization of a number of configurations, including protruding crystals, grooves, a porous surface, and spherical glass particles.

A. ***Mechanical Interlock:*** Large grooves are cut in the base of the bracket where the edge angle is 90° to provide mechanical retention. Further, there are crosscuts to prevent the bracket from sliding along the undercut grooves.
B. ***Silane Coating of Ceramic Bracket Bases:*** The coupling agent γ-methacryloxypropyl-trimethoxy-silane (γ-MPTS) has been used for promoting chemical adhesion between surfaces. The γ-MPTS is hydrolysed to the corresponding silanol. A limited number of silanol groups per silanol molecule are hydrogen-bonded to the water layer adsorbed on the base surface. Side chain silanols are condensed, establishing a siloxane network that stabilizes the structure. Owing to the silanol orientation toward the bracket base, methacrylate groups are placed in a configuration that favours cross-linking with the methacrylate-based adhesive.
C. ***Micromechanical Retention of Ceramic Brackets****:* Polycrystalline alumina brackets with a rough base comprised of either randomly oriented sharp crystals or spherical glass particles. These brackets provide only micromechanical interlocking with the orthodontic adhesive. The different types of spheres found on the base of the bracket may imply a different manufacturing process, perhaps involving the spray atomization of melted glass that is fused onto the ceramic base, generating the spherical shape as a result of surface tension.

Methods of Attaching Mesh to Bracket Base

Spot Welding: Originally, the strands within the mesh backing were welded to each other and to the back of the bracket. Spot-welding appears to cause damage to the mesh base where the mesh is completely obliterated by the spot-welding, causing the wire to fracture and leaving sharp areas exposed. Spot-weld damage not only decreases the nominal area available for retention but also produce an area of stress concentration which can initiate the fracture of the adhesive at the adhesive-base interface. Inadequate spot-welding may lead to separation of the bracket from the base.

Braising / Brazing: Instead of welding the mesh strands, they are united by a special process called braising (brazing) that does not flatten the wires (Sidney Brandt 1977).Brazing is a process where metal parts are joined together by melting a filler metal between them at a temperature below the solidus temperature of the metal being joined and the melting point of the filler is above 840° F (450° C). The brazing layer usually contains a combination of silver, gold or non-precious alloys such as AgCu, AuNi, or NiFeCu. Thus an attempt is made to maximize the area for interlocking potential by making more room for the bonding agent.

Improvements in Bracket Base Design

Studies were shown were improved mechanical retention of metal brackets by fusing metallic or ceramic particles onto the bracket base.[16] Particulate-coated bases were prepared by sintering stainless steel or cobalt-chromium beads of various mesh sizes onto the bases at approximately 1,100° C for 4 hours in an inert atmosphere. Ceramic coatings were applied by similar sintering techniques or with a chemical bonding agent to the stainless steel. One advantage of a porous-coated base is that ready penetration of bonding resin occurs through capillary action and strong mechanical interlocking results, with concomitant high bond strength if the porous coating is firmly bonded to the base. Hanson and Gibbon used bracket bases coated with porous metal powder and compared its bond strength with foil mesh base.[17]

Siomka and Powers used following methods to improve bracket base retention.[18]

1. Etching→ An acid solution is used to roughen the surfaces of the bases chemically to create a larger surface area for mechanical retention of the adhesive
2. Silanation→ Process where a silane-coupling agent dissolved in methanol to promote an increase in wetting of the mesh base to allow better penetration of the resin into undercut areas.
3. Surface activation→ It is an electrochemical process used to remove oil, dust, and thin oxidation films from alloy surfaces that might inhibit bonding.
4. Etching plus silanation
5. Etching plus surface activation

CONCLUSION

As we know that treatment principles are mainly based on science but art is also a part of it. Through the years, the advent of new system of brackets has been pounded into the field of orthodontics, which has guided the clinician in his planned mechano therapy. The changing trends in the brackets design and the mesh also plays an important role during bonding of brackets. Future development in bracket materials relies on orthodontist's technical requirements, patient's esthetic and functional demands.

REFERENCES

1. Sharma-Sayal SK, Rossouw PE, Kulkarni GV, Titley KC. The influence of orthodontic bracket base design on shear bond strength. Am. J. Orthod. Dentofacial Orthop. 2003; 124: 74–82.
2. Sorel O, El Alam R, Chagneau F, Cathelineau G. Comparison of bond strength between simple foil mesh and laser-structured base retention brackets. Am. J. Orthod Dentofacial Orthop. 2002; 122: 260–266.
3. Cucu M, Driessen CH, Ferreira PD. The influence of orthodontic bracket base diameter and mesh size on bond strength. S. Afr. Dent. J. 2002; 57: 16–20.
4. Wang WN, Li CH, Chou TH,. Bond strength of various bracket base designs. Am. J. Orthod Dentofacial Orthop. 2004; 125: 65-70.

5. Maijer R, Smith DC. Variables influencing the bond strength of metal orthodontic bracket bases. Am. J. Orthod .1981; 79: 20-34.
6. Matasa CG. In Search of a Better Bond: State of the Art. Orthod Mat Insider. 2003b; 15: 1.
7. MacColl GA, Rossouw PE, Titley KC, Yamin C. The relationship between bond strength and orthodontic bracket base surface area with conventional and microetched foil-mesh bases. Am. J. Orthod Dentofacial Orthop. 1998; 113: 276-281.
8. Matasa CG. Do Adhesives and Sealants Really Seal the Brackets' Pad? II. Surface Tension. Orthod Mat Insider. 2003a; 15: 4-8.
9. Dickinson PT, Powers JM. Evaluation of fourteen direct-bonding orthodontic bases. Am J Orthod. 1980. 78:630-63.
10. Paul Gange on the Present State of Bonding.Journal of clinical orthodontics.1995:29:429-436.
11. Thanos CE, Munholland T, Caputo A. Adhesion of mesh-based direct bonding brackets. Am J Orthod. 1979:75:421-430.
12. Maijer R, Smith DC. Variables influencing the bond strength of metal orthodontic bracket bases. Am J Orthod: 1981:79:20-34.
13. Reynolds IR, von Fraunhofer JA. Direct bonding of orthodontic attachments to teeth: the relation of adhesive bond strength to gauze mesh size. Br J Orthod. 1976:3:91-95.
14. Lopez JI. Retention shear strengths of various bonding attachment bases. Am J Orthod. 1980. 77:669-678.
15. Mahal RS. A standardized approach to determine the effect of thennocycling and long- term storage on the shear bond strength of orhodontic brackets cemented to bovine enamel. Masters Thesis. Facultv of Dentistrv. Universitv of Toronto. Canada. 2000
16. Maijer R, Smith DC. Crystal growth on the outer enamel surface: An alternative to acid etching. Am J Orthod. 1986. 89: 1 83- 193.
17. Hanson GH, Gibbon WM, Shimizu H. Bonding bases coated with porous metal powder: a cornparison with foi1 mesh. Am J Orthod. 1983. 83: 1 -4.
18. Simoka LV, Powers JM. In Vitro bond strength of treated direct-bonding metal bases. Am J Orthod. 1985.88: 133- 136.

How to cite this article: Afsal VA, George PP, Mathew S et. al. Brackets mesh changing trends: a review. Int J Health Sci Res. 2013;3(9):97-102.

****