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A quarterly dedicated to orthodontic professionals, and to the renewal of their habits and tools by ORTHO-CYCLE, A COMPANY THROUGH WHICH YOU CAN RECONDITION, BUY AND SELL ORTHODONTIC APPLIANCES.

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Self-ligating brackets vs. the conventional ones: no difference ?

Audiatur et altera pars (Latin: hear the other side)

For decades, this newsletter has been considered by its readers both trustworthy and independent, as shown by some of the many related letters received.* While from the materials point of view we disagree with the following message (see our comments), we feel that it is our duty to present below the view of one our readers:

“Dear Prof. Matasa:

I enjoy receiving and reading your Orthodontic Insider newsletter and your posts in ESCO also. I read your latest newsletter regarding Self-ligating brackets and your initial comments I could not let go by;

“The patient is pleased as they are less conspicuous and more comfortable, clinicians because they get the job done in less time.....”

Unfortunately you are repeating the marketing doctrine rather than the evidence in the literature. Currently a number of prospective clinical trials demonstrate no significant difference during initial alignment between a SL bracket and a conventional bracket and mode of ligation.

The only prospective trial finding in favour of a SLB (Pandis) used different wire sequences (round in the conventional bracket versus rectangular in the SLB) which would explain the improved alignment/reduced irregularity they found regardless of the bracket used.

All other prospective studies used identical wires and found no difference. The only two studies existing on space closure [one en-masse (Miles) and the other using canine retraction (Burrow)] also found no difference or in fact a slight advantage with the conventional bracket, likely due to the greater width of the conventional bracket resulting in less binding due to tipping as the canines retract.

Discomfort studies are less clear but also seem to show little difference in reported discomfort. I am not meaning to preach but to clarify this issue. Orthodontics has had attempts in the past such as Begg, Tip Edge, Universal Technique, Twin Wire, etc. to reduce force levels and achieve more rapid movement and SL is no different – you give up a little control for less classical friction, but you cannot overcome binding and notching, or the main factor, the patients biological response.

Their main advantage, that they save some clinical time

for ligation and hygiene, is also unclear in the research at present. Not much else is currently supported in the literature apart from some authors opinions which at best offer case reports and not evidence and unfortunately is repeated by others as fact.

Sorry for the sermon as I do enjoy your input.

With kindest regards, Dr. Peter Miles, 10 Mayes Avenue, Caloundra QLD 4551, Australia; pmiles@beautifulmiles.com.au.

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Our comments



For Ortho-Cycle Co. at least, SLBs are a financial blessing: despite the the extra labor they require for ensuring that their sliding part works, they are both pricy and in high demand. Every year, at least for the last 5 years, their proportion has increased 4-6%, reaching today almost half brackets processed. Far from assuming the point of view of the clinician, we believe that these events are a step further from the ligature wires or the cytotoxic elastomers, Fig. 1.^{1,2} The worn, old elastomers used along with the conventional ones become loose and increase friction by creeping within the slot's wall and the arch wire, Fig. 2.³, impairing the arch wire's sliding.

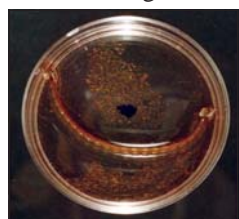


Fig. 1. Cytotoxicity of polyurethane elastomers on fibroblastic embryonic cells. Dead cells surround the elastomer

A supplementary source of friction in their case is the bracket's configuration, Fig. 3⁴: the sharper the angle of the elastomeric ligature over the arch wire, the higher is the pressure exerted on the arch wire.

Contra-intuitively, the apparently fragile and higher profile SLBs survive better the debonding process than do the conventional brackets. The alloys are not only superior, but their void-containing, flexible and resilient structure, Fig.4⁵ better withstands mechanical solicitations.

If processed using the temperatures well under that of the complex alloys sensitization, as in Ortho-Cycle's case,⁶ the percentage of the recoverable brackets is higher, an advantage that adds to the company's elimination of the metal-removing electro-polishing.⁶

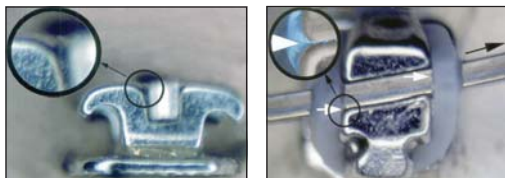


Fig. 2. Gaps at the interface arch wire-chamfered slot allow old, loose creeping there impairing sliding



Fig. 3. The sharper the angle of the elastomeric ligature over the arch wire, the higher the friction.

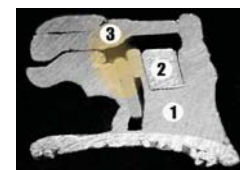


Fig.4 Buccal and sectional views of two SLBs, In-Ovation R and Damon 3MX. Their empty spaces render them resilient.

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Can you trust Ortho-Cycle and its "Insiders" ? Others did...

From the "Insider", December 2001 (http://orthodonticmaterials.com/insider/insider_2001/december_2001.pdf)

- KJS, Lakewood, CO: "It's great to have a medium to cut through the ad hype !"
- BWE, Fort Dodge, IA: "I heartily believe in your company and all you stand for -honesty and excellence, a great combo..."
- SBF, Professor, Univ. of Pennsylvania, Philadelphia, PA: "It gives a different perspective than the manufacturers would like and exemplifies the old saying that "there are two sides to every question.""
- AWA, Oak Brook, IL: "With manufacturers interested in selling their products, not in testing them, and the journals willingness in spreading the disinformation about these products, an alternative source of information is needed."
- PN, Lefebvre, Quebec, Canada: "It is one of the only places where the truth is more important than making a sale."
- KCJB, Bedford, UK: "It gives a fascinating, independent and impartial view of the materials I use."

From the "Insider", December 1997 (http://orthodonticmaterials.com/insider/insider_1997/december_1997.pdf)

- D.V., San Luis Obispo, CA: "I am a strong admirer of both your integrity and expertise."
- M.H.S., Cote St. Luc, Quebec, Canada: "Your newsletter is most informative and honest."
- A.P.C., Durham & Roxboro, NC: "Written in a scientifically accessible way, your articles have been well documented, open-minded, and show no allegiance to unfounded beliefs or so-called "sacred elephants.""

ORTHO-ARMAMENTARIAN, OR JUST A VAIN OCTOGENARIAN?

Claude Matasa's *Insiders*: exercises in futility or substantial contributions?

After working for 30 years in chemistry (books and chapters in English, French, and Romanian; 23 patents in 12 countries including US, Germany, UK, Switzerland), he dedicated another 30 to orthodontic materials research—well over 100 specialty papers and posters.¹ While in the past his contributions were praised by luminaries,* with the occasion of his 80th birthday, his company's employees believe it's time to sum up what *The Insider* has contributed to the science of orthodontic materials. No grants, advertisements or other incentives have ever been received! Your critical assessment of his contributions will help them decide this newsletter's future: no more accolades, but clinicians' blunt assessment ...

Ortho-Cycle's employees believe that deserve this, as they send for two decades, for free, four times a year, tens of thousands of copies throughout the world, the company newsletter, *The Orthodontic Materials Insider*. Grateful for observations regarding *Insider's* articles lacking originality or imparting wrong information, they will compensate the informant (hopefully with the "boss's" approval) by sending the writer, pending availability, a case of his or her preferred recycled brackets, the value of which may exceed \$100.

Those interested can visit this article at www.OrthodonticMaterials.com, April 2010: to reach the desired topic, click on the related reference (*Insider*, year, quarter or month, page) and send your thoughts to OrthoCycle@aol.com.

A modest launching pad: attachment recycling

It all started with Claude's bewilderment at seeing clinicians discard undamaged, previously used attachments: made with more skill and better alloys, these were better than the commonly reused instruments. Being an environmentalist and having business acumen, he founded Ortho-Cycle in 1976 which generated a base strong enough to support his life passion, materials research.

T.M. Graber's assessment of Claude's contribution to recycling is frank: "*He (C G Matasa) has developed an elevated but practical recycling process for orthodontic appurtenances that has saved millions of dollars for practitioners (and patients) in the cost of their armamentaria. By replacing adhesive's charring with its dissolution, and metal electro-polishing with a method used by manufacturers, burnishing, he has allowed his company, Ortho-Cycle, to be both ISO and CE certified by the prestigious Scandinavian Institute for Dental Materials. Aside from its economic effect, the recycling of stainless steel devices reduces the amount of harmful chromium and nickel ions which, if dumped, pollute our groundwater. Today, even the intrusive and comparatively difficult-to-sterilize pacemakers and catheters are often recycled. I have personally read the manufacturer letters sent to Professor Matasa, some with grudging recognition of his avant-garde discoveries*" (*Insider*, 2006; 3: 4).

Fighting stainless steel's (SS) sensitization. Years before Majier,² Park,³ and Wheeler⁴ described the damaging effect of heat on SS brackets subjected to adhesive removal, Buchman⁵ tested attachments recycled by several companies and found that only Ortho-Cycle "*did not alter their mechanical properties.*"

The company's "secret", revealed after a decade (*Insider*, 1990; 4: 3) was not unknown in industry⁶: "*Austenitic steels are metallurgically unstable when heated in the temperature range of 350-800°C (650-1500°F). After heating in this temperature range, they become subject to severe attack at the grain boundaries by even mild corrosive media. This attack is referred to as intergranular corrosion, and is so severe that the steel literally disintegrates*

*W. R. Proffitt, U. N. Carolina (*Insider*, 1993; 1: 1); T. M. Speidel, U. Minnesota (*Insider*, 1993; 1: 3); H. P. Bimler (*Insider*, 1993; 4: 3); G. E. Palade, U. C. San Diego, Nobel Prize, 1974 (*Insider* 1997; 4: 5); M. M. Kufninec (*Insider*, 2005; 1: 4); T. M. Graber, U. Illinois (*Insider*, 2005; 1: 1); T. Eliades, Aristotle U., Thessaloniki (*Insider*, 2009; 3: 4); N. Wahl, Orthodontic historian (*Insider*, 2006; 3: 3); S. Bishara, U. Iowa (*Insider*, 2007; 4: 1); J. P. Moss, U. London (*Insider*, 1994; 3: 3); L. White, Baylor Dent. College (*Insider*, 2009; 3: 1).

into separate grains, losing substantially all its properties."

Protecting the metal. After being exposed to sensitization temperatures or higher, attachments made of SS become tarnished and require polishing. Unfortunately, "*the electro-polishing step, with its removal of not only tarnish and surface oxidation but also metal, may be an important variable affecting bracket tolerance.*"⁷ After mitigating this effect for decades using "*solvent stripping combined with high frequency vibrations and only flash electro-polishing,*"⁸ Ortho-Cycle switched in 2002⁹ to a process already used by orthodontic manufacturers: metal burnishing (*Insider*, 2002; 3: 1).

Decontamination. Although removal of the cured adhesive at lower temperatures was a major accomplishment, a manufacturer raised doubts if the mild processing can indeed kill harmful micro organisms.¹⁰ His assumption was malevolent because the breakage of the C-C bonds in the polymer (needed to free and remove the filler's composite), will occur also in every living creature. To such attempts at frightening clinicians, AAO's counsel, Sally Bowers, answered:¹¹ "*Even if a bracket could become detached and the patient could swallow it, this will not result in an injury to the patient*".

Attachment identification. Perhaps the most difficult part of providing the clinician with reusable attachments is the ability to classify them. Indeed, today's orthodontists use brackets having two slots, a variety of in-outs, torques and angulations. In addition, every few years manufacturers come up with new lines of attachments. This has led to the existence of thousands of brackets for each tooth. In contrast, orthodontists demand only the attachments they are accustomed to. This obstacle was partly overcome when he introduced to clinicians worldwide the 0.018" and 0.022" slot gauges to check bracket widths (*Insider*, 1988; 1: 4). After developing sophisticated means to differentiate them, Ortho-Cycle was able to provide clinicians with what they needed. The best proof of Ortho-Cycle's success is the fact that it has been buying since 1979 used attachments for resale, as advertised in the *American Journal of Orthodontics*.¹² Starting its recycling service before companies like Esmadent, Vector, Ortho-Bonding, Century 21 and Lancer Orthodontics (*Insider*, 1999; 2: 3)—which after a few years had to quit—Ortho-Cycle grew soon enough to be considered by a major manufacturer as "*a very significant competitor.*"¹³ After being unsuccessfully sued by the OMA (Orthodontic Materials Association, an organization comprising at that time 12 of the largest orthodontic manufacturers),¹⁴ and after repeated attacks by NBC-TV's *Dateline*, the AAO had to take a stand: according to its 1997-1998 *Bulletin*, the NBC's broadcast "*generated little consumer interest,*" as the recycled attachments are "*safe and effective.*" (*Insider*, 1999; 2: 7).

Metal characteristics

Miniaturization vs. strength. “Mini” has its price. As attachments become smaller and thinner, and adhesives become stronger and stronger, something’s got to give in: the stronger the steel, the more brittle it is. For evaluation, both the Ames Rockwell hardness (*Insider*, 1988; 3: 4) and the Vickers/Hanemann micro-hardness¹⁵ testers (*Insider*, 1994; 3: 6) give conclusive results, relating performance to the pores, gaps, grain, and carbide separation, as well as to the intergranular corrosion found in some commercial brackets (*Insider*, 1998; 3: 5).

Chemical resistance. Having miniaturization as a goal, many manufacturers have switched over the years from corrosion-resistant, austenitic SS to the stronger but less resistant martensitic types. Fabricated initially from several parts (bracket, brazing, foil, and mesh) brackets became one piece only to return today to multi-component, self-ligating ones. The exposure to a corrosive environment of their different alloy constituents led not only to leaching out of harmful ions but also to malfunctions.

To evidence differences in galvanic corrosion susceptibility, conventional brackets with laminated foil mesh and brazed bases were subjected to dilute muriatic (hydrochloric) acid (*Insider*, 1992; 2: 5) while measuring the volume of hydrogen released. The test revealed incredible differences, such as a single lower incisor bracket of AISI 303 alloy (Ormco Diamond) releases 10 times the volume of hydrogen as that of 10 larger ones of 316L alloy (upper central, “A”-Co.) (*Insider*, 1994; 1: 6).

Corrosion resistance in general and in improvements such as by coating brackets can be evaluated either by using the above method or by the color reaction of the iron ions that leach out in an acid potassium ferrocyanide gel (*Insider* 1999; 3: 6). The test was further simplified (*Insider*, 1999; 4: 4) by adding these chemicals to an ISO-recommended standard for accelerated corrosion. Made of lactic acid and sodium chloride, it can identify the corrosion-susceptible areas of both brackets²¹ and expansion screws. The same works when detecting leached nickel: the color reaction is given by an alkaline solution of dimethyl glyoxime (*Insider*, 2000; 3: 2 and 4: 4).

While the base metal is SS, self-ligating brackets usually contain other alloys. This leads to “tight-place” corrosion and galvanism which affect the brackets’ sliding movement, even after exposure to a mild acid such as salad dressing (*Insider*, 2007; 4: 3 and 4: 4). Dilute acids such as lactic and nitric can, however, be helpful in allowing clinicians to test and then improve their attachments’ chemical resistance (*Insider*, 2009; 4: 4).

Brazing alloys. Some attachments are still joined with brazing alloys, despite the galvanism and the human errors that are involved (*Insider*, 1991; 2: 4). Few of the currently used brazing alloys wet well SS or exhibit the same electric potential. Because of galvanism, the least noble component of the joint will corrode. While the best joints use gold alloys, these are plagued by the yellow traces left behind, often confused with food debris.

Titanium alloys. The difficulties encountered in shaping titanium attachments translate into poor adhesive retention. To the latter contributes also the metal’s relatively thick oxide layer which repels the hydrophobic (water-hating) adhesives. To improve adhesion, efforts in Eastern Europe have succeeded to laser-sculpt the bracket’s bases: related SEM images show a higher roughness than that of the German Rematitan (Dentaurum) (*Insider*, 2005; 4: 5).

Magnets. The use of magnets in orthodontics has been associated with a controversial or misunderstood decrease in pain. The

latter can really occur because in aqueous environments, magnetic fields generate oversized Ca⁺⁺ hydrated ions (extra hydration layers) The difference from the common ones allows their separation: in Scandinavia thousands of homes have installed upstream magnet-based traps to prevent the formation of hard deposits in pipes (water descaling). In our body, these increased size ions find difficulties in traversing the nerve’s bi-lipid-layered channels, i.e. in transmitting pain (*Insider*, 2003; 3: 5).

Ceramics

Ceramic brackets. Difficult to detect, these often hide pores and cracks. Such defects lead to debonding fractures, leaving behind fragments that are difficult to remove without harming the enamel. A device used to test the impact resistance of ophthalmic lenses can disclose such problems (*Insider*, 1997; 2: 2), thus helping in their design.¹⁶

Unfortunately, most friction tests are performed on new brackets. Tests should deal with the used ones, as the friction which smoothes surfaces moving against each other is exacerbated in ceramics; the peaks are removed, while the valleys become clogged with metal debris from the arch wire¹⁷ (*Insider*, 1997; 2: 6).

Polymers

Harmful components. For tooth bonding, dentistry needs strong, rigid polymers made of monomers known as “molecular rods.” Instead of seeking alternatives, the profession has focused only on benzene cycles-containing, cross-linked polymers, documented to generate health problems¹⁸ (*Insider*, 2004; 4: 4). The future of composites should be tied instead to harmless, nonaromatic molecular rods (*Insider*, 2005; 1: 7).

Fashioned from 2 parts of which one is volatile, the strong acrylates used today are thermoset, i.e., they cannot be remolded or adjusted. In addition, acrylates are attacked by microorganisms: fortunately, they can be immunized by adding biocides such as quaternary salts of ammonium.^{19, 20} (*Insider*, 1992; 3: 2)

The leaching of these polymers (toxic monomers or additives) can be evidenced with the help of the Permanganate Index.²¹ Made of a mixture of water, sulfuric acid and potassium permanganate, this purple reagent becomes discolored as it oxidizes soluble ingredients (*Insider*, 2004; 1: 3 and 2002; 1: 5). The test can be used not only to detect dissolved monomers or additives but also to test polymers, either as such (*Insider*, 2006; 2: 1) or after exposure to liquid air and crushed (*Insider*, 2004; 4: 3).

Polycaprolactone. To replace harmful polymers, another weaker—but harmless—polymer, polycaprolactone, can be successfully used in orthodontics. One part and nonvolatile, it melts at 60°C (140°F), after which it remains for a while in an extended softened state. In that stage, it can be molded either by hand or be pressed in direct contact with tissues (*Insider*, 2009; 2: 5). In addition to its use to support/embed samples for testing bond strength, it can be used to make or mold an array of polymer or metal-polymer orthodontic attachments that are not exposed to too high forces or high temperatures (as will be shown in our next Insider issue).

The myth of 2-paste adhesives. Since the first day of their commercial launching, 2- part, paste adhesives have been cautiously kept separated, using jars with nonexchangeable lids to avoid premature setting. In fact, this cannot happen because a solid, thin film will be quickly generated at their interface, hindering the initiation of extended setting (*Insider*, 2006; 1: 1). It is strange that such beliefs persist, despite the general knowledge that a good cure is not possible without fully dispersed pastes.

Elastomers' challenge. Latex gloves are known to have killed wearers (anaphylactic shock). The use of Permanganate Index (see above) allows to evaluate the amount leached; the less leached ingredients, the better (*Insider*, 2004; 3: 5).

While less dangerous, polyurethanes may be cytotoxic due to their additives²² (*Insider*, 1996; 4: 6). Difficult to notice, old or worn elastomers can leave behind adherent particles on the surface with which they get in contact, increasing friction (*Insider*, 2002; 3: 3). Metal ions, such as those leached in the mouth from corroded attachments, significantly accelerate the aging of elastomeric ligatures (*Insider*, 2003; 2: 7).

Chemical bonding vs. water resistance. Cyanoacrylates bond chemically well, but lack water resistance. In contrast, acrylates offer poor bonding (just mechanical interlocking) but acceptable water resistance. In special *in situ* situations and with particular acrylates, the 2 can act together to provide chemical affinity to the enamel and the necessary water resistance. (*Insider*, 2007; 1: 4).

Brackets and tubes, properties

Faulty attachments. Their weakness is usually the result of either a poor microstructure generated within the alloys used during the thermal treatment (*Insider*, 1998; 3: 3), or by human- or machine-generated flaws²³⁻²⁵ (*Insider*, 1989; 1: 4 and 1990; 1: 1).

Bracket bases vs. bond strength. Once disregarded (*Insider*, 1994; 1: 3), some of today's one-piece brackets (*Insider*, 1994; 2: 3; 1998; 3: 3; 2006; 2: 3; and 2008; 2: 3) and tubes (*Insider*, 2009; 2: 1) have been found, as we predicted 20 years ago,²⁶ to provide higher bond strengths than those having mesh.

Contra-intuitively, in contrast with conventional brackets, the apparently flimsy self-ligating ones debond with less chances to get damaged. First, however, it is necessary to find and take advantage of the brackets' flexible, resilient structure (*Insider*, 2009; 2: 8). Brackets and tubes having the same nominal mesh size may also offer surprises, as these can show significant differences in bond strength due the mesh's depth, i.e., its adhesive's locking ability (*Insider*, 2009; 1: 7).

Because of higher chances of stress concentrations, the bond strength of large, but not thickly supported bases is far from being proportional to their surface (*Insider*, 2009; 1: 7). If bond strength is referred to the surface of the base, sometimes smaller, single brackets may withstand forces twice as big as those double their size.

Corrosion susceptibility. Complete enamel sealing is a myth. Oral fluids—the main source of bracket corrosion, nickel leaching and premature debonding—can better penetrate the bases with indentations and grooves than those based on mesh (*Insider*, 2002; 4: 5).

The corrosion susceptibility of conventional (*Insider*, 2004; 2: 6) and self-ligating (*Insider*, 2007; 4: 3) brackets can be evaluated using reactive gel chromatography (*Insider*, 2000; 3: 4). The attack can be influenced/aided by microorganisms: it occurs not only in commercial SS tanks (which are attacked by freshwater microorganisms), but also on bracket bases (*Insider*, 1992; 4: 3).

Self-ligating brackets are in particular subject to tight-places corrosion, which hinders “sliding doors” movement. It occurs due to the fact that the lack of oxygen (needed to regenerate SS's protective chromium oxide layer) is exacerbated by the galvanism exhibited by the contact of different alloys (*Insider*, 2009; 3: 4 and 4: 4).

Friction

Metal/metal. While common, worn slot surfaces offer less friction, previous studies on friction have dealt only with these of new brackets. As the interlocking peaks and valleys found at the in-

terface bracket/arch wire slide one against the other, the friction generated diminishes (*Insider*, 1993; 3: 1 and 1998; 4: 6).

Bracket shapes and the way of ligating dramatically influence friction^{27, 28} (*Insider*, 2001; 2: 2). In elastomeric-ligated brackets, friction increases proportionally with the pressure the ligature exerts over the arch wire. In other words, with the distance between the bottom of the slot and the highest point of the under-the-tie-wing ligating area (*Insider*, 2001; 4: 3). Ligated brackets having the same slot depth and width, but exhibiting differences in shape, show major differences when made to slide along the same straight wire (*Insider*, 1995; 3: 1; 2001; 2: 1 and 4: 2; 2009; 2: 4). The same procedure, but using a force gauge or even a tubular scale worth few dollars, allows to compare the friction exerted by self-ligating brackets (*Insider*, 2009; 2: 2).

Atomic force microscopy studies¹⁷ (*Insider* 1997; 2: 6 and 1998; 4: 6) show that even the relatively little cold work to which steel attachments are subjected during orthodontic treatment, is enough to increase the metal's hardness. Based on this, Ortho-Cycle has switched from flash electropolishing to burnishing, a mechanical treatment commonly used by orthodontic manufacturers to polish attachments (*Insider*, 2002; 3: 7).

Metal vs. ceramic. Several studies of ceramic brackets' friction show it to be higher than that opposed by their metal counterparts. This is in contrast to physical principles, which teach that the harder the material, the less friction it opposes. The worn ceramic attachments exhibit lower friction because of the leveling effect generated by the gradual removal of the ceramic peaks and clogging of the valleys with metal debris from the arch wire¹⁷ (*Insider*, 1997; 2: 8).

Surface phenomena

Etching. As wear, previous inadequate processing (electropolishing), or original manufacture can deter an attachment's base bonding ability because of reduced roughness, an adequate topical acid treatment can reverse this by improving the damaged surface. Although SS is “stainless” because it is corrosion resistant, its surface can be roughened by aqua regia (a mixture of nitric and hydrochloric acids) (*Insider*, 1989; 2: 2). Rinsed after with adequate surfactants, this treatment improves the subsequent adhesive wetting (*Insider*, 2004; 2: 6).

Adhesion/adhesives. Dentists, who have to bond hydrophobic polyacrylates to hydrophilic substrates (teeth, metals, ceramics) should take advantage of industry's longer experience²⁹. As SEM images of bonded brackets show, hydrophobic adhesives do not wet the hydrophilic chromium oxide layer that covers the SS surface (*Insider*, 2003; 4: 3).

While fluid, adhesives do not properly penetrate tight places. Added to this is the Trommsdorff (or Gel)-effect, according to which an apparently fluid adhesive prematurely becomes viscous (*Insider*, 2005; 2: 6). Adequate volatile solvents help penetration, allowing viscous composites to reach tight places (*Insider* 2005; 4: 5).

Surfactants. Bis GMA, the main component of many resins, does not penetrate an SS 100 mesh except in the presence of surfactants. The addition of surfactants to etching gels causes these to leave behind, after rinsing, an oil-loving film with affinity for adhesives (*Insider*, 2004; 2: 6 and 2003; 1: 4).

Silanation. Long before silanating the bases of metal brackets became common, Mascia & Chen confirmed receiving such attachments from us.³⁰ Along with silanation (*Insider*, 1988; 4: 3), we found that etching leads to significantly increased bond strength³¹

(*Insider*, 1989; 2: 2).

Silanated and then polymer-coated glass fibers/cloth significantly increase acrylates' (and other compatible polymers') bulk strength, rivaling with metal composites. Fragile only when bent, fiber-reinforced composites offer great resistance when subjected to tensile forces (*Insider*, 2006; 2: 5).

Affordable evaluations

Force testers and gauges. A simple device used to test coatings, Gardner's Elcometer F106/1, can be used to measure the bond strength between brackets and mesh plates (*Insider*, 1993; 1: 6). Using the same Elcometer, Artun's Adhesive Remnant Index (ARI)³² can be used to compare the strengths of different brackets bonded to the same etched ceramic tile or, conversely, various adhesives while using the same brackets and tile. This can be easily done just by reading the traces of adhesive left after bracket removal (*Insider*, 2001; 1: 1).

A simple arrangement of pulleys can translate the weight of water dripping into a container into a force capable of debonding brackets. At the breaking point, the water is automatically redirected to another container (*Insider*, 2001; 2: 1), allowing thus to assess the force used by weighing the initial container. Easier to handle, SS balls are even better weight substitutes than water (*Insider*, 2006; 4: 5; 2007; 1: 6 and 2008; 2: 3). This system has helped determine the adhesives' Trommsdorff (Gel-) effect (*Insider*, 2005; 2: 6).

Deadened scale The simple insertion of a calibrated spring in a scale (deadened scale) allows measuring tensile forces. Using the same adhesive, it is feasible to evaluate the forces needed to debond different brackets from an etched ceramic tile, or the strength of different adhesives using the same brackets and tile^{27, 28} (*Insider*, 2001; 2: 3 and 2005; 2: 3).

Force gauges. Universal testing machines (UTM) used today to measure the forces involving small orthodontic attachments are disproportionately large and expensive. Today, commerce provides relatively inexpensive, digital, hand-held force gauges (similar to these built in the UTM) that can measure up to 110 lbs (50 kg), enough for most tests. Such gauges have been used to measure the friction exerted by self-ligating brackets (*Insider*, 2009; 2: 1) and potentially for *in vivo* bond strengths (*Insider*, 2008; 4: 4)

A misnomer: "shear-peel." Often used, this hedge word masks the uncertainty of the researcher who reaches for a real tensile measurement that require verticality of the pulling wire over the bracket's base. In the common conditions encountered in practice, bracket debonding cannot be performed except as a "peel" at a certain angle (*Insider*, 2007; 2: 1). The highest bracket debonding force is shear, followed by tension and torsion, the lowest being peel.

Geometric evaluation of slot sizes. Neither the mechanical or electronic gauges cannot seize their behavior, as these cannot take in account the slot's inner features. In contrast, a long enough SS wire conveniently inserted into a fixed bracket allows to accurately calculate its slot size: if one end is moved, the other will provide the data by playing free across a ruler.³³ (*Insider*, 2001; 3: 4 and 2005; 2: 2).

Methodology

Polishing substitute. Needed to remove tarnish, both abrasion and polishing remove metal. Images of electro-polished bracket bases obtained by scanning electron microscopy (SEM) show not only missing roughness, but even portions of missing wire (*Insider*, 2002; 3: 4). Burnishing (used by manufacturers to shine rough attachments made by injection molding) does not remove metal, but

peens the surface. In the process, the leveled, more compact surface of the attachment acquires a higher light reflectivity (*Insider*, 2002; 3: 7).

Accelerated aging. As used today in the orthodontic literature, the attempt to find alterations in time is discretionary, leading to aleatory approximations. Following Svante Arrhenius' law (Nobel Prize, 1903), a 2-week exposure of any orthodontic system in a pressure cooker, maintained thermostatically at 100°C, would duplicate accurately an exposure of 2 years in the mouth (*Insider*, 2008; 1: 1).

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Colleagues' "biased" voice:

Theodore Eliades, DDS, MS, Dr. Med., PhD, U. Thessaloniki, Greece, editor of *Self-Ligation in Orthodontics*, New York: Wiley-Blackwell, 2009; editor-in-chief, *Journal of Dental Biomechanics* (Sage-Hindawi) and associate editor, *European Journal of Orthodontics* and *American Journal of Orthodontics and Dentofacial Orthopedics*. Entrusted to be C. G. Matasa's successor as contributor ("Orthodontic Materials") to T. M. Graber's *Orthodontics: Current Principles and Techniques*, 5th ed.)

"The text is much shorter than it would have been required to portray your work. Actually I would like to bring out another perspective of your contribution through the Insider: that of its role as an educational tool. Through the topics you presented, and which I often discussed with residents, you managed to illustrate several tests in a simplified way such as the backed test for bond strength (where you filled a container with water until the specimen failed and by the volume of the water you estimated the weight), or the wonderful martensite-austenite transformation (which I incorporated in some of my slides for the NiTi course); or the color marker for the identification of substances in adhesives. This wealth of information introduced the clinician to aspects of materials testing which could only be attained by a hands-on seminar in a laboratory, not to mention that the text provided information which could never be found elsewhere in the accessible orthodontic literature, the product of your background on physical sciences together with your deep understanding of clinical orthodontics, particularly the mechanics (a superb theoretical but more importantly practical analysis of friction), surface properties (an astonishing AFM section), corrosion and metallurgy of orthodontic alloys (beautifully-illustrated NiTi crystallographic structures), organic and inorganic chemistry of orthodontic materials (electro-chemistry and composite/adhesive research). Actually, you could bind the Insider issues and group similar topics to make a sound, detailed and thorough treatise of orthodontic materials for the engineer and clinician. (Note: some information are already on the e-book <http://orthodontic-biomaterials-risk-prevention.com>). All best wishes for your birthday and congratulations for your life achievements."

E-mail: teliaades@ath.forthnet.gr.

Mladen M. Kuftecin, former Chairman of NYU's Orthodontic Dept, *Edward H. Hatton Research Award* from the International Association of Dental Research, San Francisco, CA, and the *Doc McNulty Memorial Award* for Research.

"The proverbial 'little birdie' from Ortho-Cycle company informed me [in confidence, naturally!] that Claude is getting close to another significant number in his age – 80 years young. Furthermore, I was appraised that they, the very people who work daily along side Claude, were preparing a summary style report, summarizing the most important topics or areas of Claude's experimentation.

I've known Claude Matasa for many years. It was a short time after I became the Chair at Louisville that I was introduced to him. Didn't take me very long to realize that Claude understood my language of orthodontics much better than I understood his language of chemistry and biomaterials. When he showed me the very first issue of his "Phoenix without Ashes" and timidly asked me if I thought he should continue writing in that style, I give myself a lot of credit by encouraging him and even predicting that his "stuff" would even-

ually become the bible of orthodontic materials for clinicians and educators alike. Fast forward some 35 years, to the present times. How accurate was my prediction? In all fairness I must admit that I was not the only one who was impressed with Claude's writings. Several prominent academic orthodontists, among them Tom Graber, Bill Profitt, Mike Spiedel, Hans Bimler and others, have also recognized the value and timeliness of Claude's contributions to our basic knowledge and understanding of often used orthodontic materials.

What was so good about the "stuff" that Claude wrote about? Very simple: it was filling a large void in our literature. We were all recognized experts in our specialty of orthodontics, yet we knew patetically little about materials we used on a daily basis. There really were very few and some times no sources of information about our materials. With every new issue of the "Phoenix" and later of "Insider", the gap was narrowing. Now, we, the educators, had some references, could read about the "stuff" and even teach it to our students. Didn't take long before more biomaterial topics were found in various orthodontic journals. Similarly, we were not very surprised that in the most widely used textbooks, Graber's *Orthodontics. Current Principles and Techniques*, a new chapter was added, the chapter on biomaterials. Who wrote that first chapter? Claude Matasa, who else?

Now, some 35 years from the beginning, I was offered a look at the summary report. Certainly a bit of nostalgia, but also the "who is who" of orthodontic materials. Reading though it, I was tacitly asking myself what impresses me the most. What topic or chapter, if you will, proved to be most significant?

I cannot find the answer. I can, however, reflect on several topics that I personally either liked the most or believed had the greatest impact on the -hows- and -whys- of clinical orthodontics. I'll start with an area that for too often I, rather than Claude, receive the credit for. This is the story in brief. One day I had a call from Florida and after my secretary directed me back to my desk I realized that Claude was waiting to talk to me. He said that he read a program of a large national meeting and saw that I was speaking on certain characteristics of preadjusted appliances [the "straight wire appliances", SWA]. He continued with a statement and a question: if the idea of the SWA is to fully engage the bracket slot in order to place all teeth in optimal position within the arch or to control the tooth movements in all three dimensions, how come that most of the cases show that the arch wire, with the stripped brackets still attached, is far from being "straight wire" and more, the wire very often is not even rectangular? That comment intrigued me enough to accept Claude's invitation to have one of my graduate students do her research in Florida, in the Ortho-Cycle facility. Our findings were shocking. Fewer than 10% of all finished cases were finished with large dimension rectangular arch wires. The great majority of cases were finished in round wire and many had compensatory bends, most commonly the 2nd order bends (up and down adjustments.) That study led to a series of publications, national and international talks and a lot of discussion on the topic of the "straight wire appliances".

As a side conclusion, two additional topics were better ex-

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plained and adopted in clinical practice. One was the well known concept of “one shoe does not fit all of preadjusted appliances. The other, much less known, is that it limits the miniaturization of attachments. On one hand we demonstrated that bonding strength suffered when the size is reduced to a certain degree. The other that precision of placement of attachments was greatly affected by reducing their sizes. One call from Claude, several interesting implications!

One additional example, out of many, of my learning by interacting with Claude will be mentioned. Some 20 or 25 years ago I took a great interest in the possibility of magnets to exert the forces needed to achieve orthodontic tooth movements. The reigning guru of the time in using non-ferrous magnets, Eugene Dellinger, developed his Active Vertical Corrector, demonstrating that the chromium cobalt magnets could be smartly used to correct one of the more challenging clinical problems, anterior open bites. In spite of very promising clinical results, the use of the AVC has not delivered on its initial promise, largely because of the large size of these devices. My idea, and I know that I was not the only one considering this

possibility, was to produce devices that would have much smaller pieces of non-ferrous magnets, such that the bulk issue would have been resolved. Even the extension of the idea to grind the magnets into the “magnetic powder” that could coat a particular surface of the tooth, in order to create the needed magnetic field and cause tooth movement was entertained. I made a call to Claude, intending to ‘pick his brain’ on how to prepare this -magic- magnetic powder. It took less than 3 minutes to learn another important lesson: magnetic properties, in addition to metal selection, also depend on the size of the magnets, pretty much killed that idea.

A regular reader of the *-Orthodontic Insider-* knows much more about magnets than I, the “expert” at the time, knew. Finally, the question that Claude’s office staff asked was: is Claude Matasa an Ortho-armamentarian, or just a vain octogenarian? An interesting, yet easy question for me to answer.

You, the reader, were you a clinician, a teacher or a researcher, need to answer it for yourself.”

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