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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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DREAM AND REALITY

To dream ... the impossible dream ...
To fight ... the unbeatable foe ...
To bear ... with unbearable sorrow ...
To run ... where the brave dare not go ...
(Man of La Mancha)

A third of a century ago, Ortho-Cycle, the company that introduced orthodontic recycling, launched the first periodical dedicated to "the renewal of orthodontist's habits and tools." Initially named *Phoenix without Ashes*, its name was changed in December 1994 to better reflect its new direction: *The Orthodontic Materials Insider*. Some of the topics researched and published in the first 10 years were cytotoxicity, chelates, adhesives, and microbial attack of adhesives. Some of the testing methods used were microhardness, atomic force microscopy, and accelerated corrosion. The profession heartily received both the business and the challenge: When we were sued by manufacturers, AAO's president defended Ortho-Cycle's activities with FDA's own key words— "safe and effective." On the newsletter's 10th anniversary, over 250 clinicians, professors—even a Nobel Prize laureate—showed their appreciation. The diversity of commentators can be explained by the variety of topics addressed.

Spurred on by the conviction that "the world needed his immediate presence" (Cervantes, *Don Quixote*, Book 1, Part I). Ortho-Cycle's initiator, another dreamer, instead of doing it just to make money, focused his outsider's experience of a doctor in chemical engineering and technical sciences to improve orthodontic materials. There was enough room, as even today clinicians are forced to use harmful materials because there are no acceptable alternatives.[1]

As Ortho-Cycle's means were limited, simple but illustrative do-it-yourself methods were described in the hope that they could be used by concerned clinicians all over the world (out of an average 20,000 copies printed every trimester, some 12,000 are sent within the US, the rest to other countries). The publication was, and still is, sent free of charge, and anybody interested can receive it. While it is difficult to determine whether the newsletter's message and content has succeeded enough to renew orthodontists' "habits and tools," it has opened new vistas and raised concerns that have inspired many articles, scholarly theses, and dissertations. Those interested in the way their contributions have been appreciated are invited to read Prof. T. M. Graber's laudatory review in the March 2005 *Insider*.[2] The review ends with the statement: *"Professor Matasa's activity isn't limited to publishing his research and reviews in specialty journals. He launched almost twenty years ago* Phoenix without Ashes, *aptly renamed in 1994 the* Orthodontic Materials Insider, *a publication he has personally fostered for the good of the profession. This, alone, shines like a scientific beacon for the orthodontic community."*

"The stomach carries the heart, and not the heart the stomach" (Cervantes, *Don Quixote*, Book 2, Part 13). Today, most clinicians want to have the best materials without giving a thought to how to modify or improve them to fit their needs. At least this was the conclusion we drew in the article, **"**Where are the Edward Angles and Rafael Bowens of Today?"[3] *"The longevity of Angle's and Bowen's contributions is that much more remarkable in light of the fact that, every 10 years, half the existent products disappear. The contrast is even more poignant when one realizes that our markets offer perhaps a million raw materials that can be put to good use. Unfortunately, clinicians' interest in this domain now seems to be lower than ever, the task resting with manufacturers who may not have the same vision. Progress in the number of raw materials now available for dental and orthodontic products is impressive, as one can glean from the fact that 2 decades ago, Freeman Chemicals was the only manufacturer I could find willing to sell bis-phenol A–based resins (e.g., bis-GMA); another one claimed that its production was "captive."* After showing that today, when the raw materials and instruments needed for research are readily available, the article admonished the profession's indifference: *"Isn't it a pity that, having such material-related opportunities, most clinicians prefer to be chained to their chairs instead of embarking on product development?"*

Definitive proof of this new attitude recently came to light when Ortho-Cycle offered free of charge and postage paid, an ounce of polycaprolactone along with enough primer to bond it to most plastics. The offer was preceded by a description showing that, for less demanding attachments, caprolactone or Nylon O can replace the classical acrylic liquid-and-powder mixture.[4] (The offer was limited to US practitioners, as many countries, in their attempt to protect their citizens, go overboard in restricting chemicals.)

The offer was made with the sole purpose of encouraging orthodontists and their lab technicians to explore an useful and less costly material. Although polycaprolactone is a strong, thermoplastic solid that can be reshaped and remolded ad libitum, the cured acrylic powder-liquid mixture is thermoset and cannot be readjusted or reprocessed. A far more important difference resides in toxicity: while the former is a well-established biologically inert material, the worst health offender among dental resins, based on the number of reported cases, is methyl methacrylate.[1]

"My judgment is now clear and unfettered, and that dark cloud of ignorance has disappeared, which the continual reading of those detestable books of knight-errantry had cast over my understanding." (Cervantes, *Don Quixote*, Book 2, Part 16). What the knight told his family at the end of his life matches well the feeling of one of his enthusiastic followers.[If Of those 12,000 subscribers to the June issue, by mid-August only 12 had asked for the free samples. Thousands, at least, didn't care about a material and technique that could offer them new options. While it is true that it could have been worse, should our modern Don Quixote remain captive to their imaginations and continue wasting their money?

References

1. Matasa CG, Dental plastics: Masters of deceit, in Schmalz G, Eliades T, eds, Risks in Dental Materials, Berlin, Heidelberg: Springer, 2010

2. www.orthodonticmaterials.com/insider/insider_2005/march_2005.pdf

3. www.orthodonticmaterials.com/insider/insider_2009/september_2009.pdf

4. www.orthodonticmaterials.com/insider/insider_2010/june_2010.pdf

Changing mechanical paradigms

A recent interview with Mladen M. Kuftinec, retiring professor and former chair of NYU's orthodontic department

CGM: The most frequent topics or titles of presentations at national and international meetings deal with self-ligation or temporary anchorage devices (TADs). As outsiders, we are impressed especially by other changes, primarily dealing with the mechanics of treatment: final archwires are becoming straighter and straighter. It is quite different from some 17 years ago when, in another interview (Preadjusted appliances: One shoe fits all? *Phoenix without ashes*, April 1993; 6 [1]: 1-5; http://orthodonticmaterials.com/insider/insider_1993/april93.pdf), you showed that most orthodontic cases treated with preadjusted appliances receive finishing arch wires with first-, second-, and third-order bends incorporated into their respective arch forms.

Can you comment on this?

MMK: You may be onto something here, and what is happening probably does not have much to do with the brackets or the "specialty arch wires." In my opinion, it has to do with the clinicians' thinking and his comfort in dealing with various clinical situations.

CGM: The changes we observed seem to coincide with the popularization of various lines of self-ligating. As an experienced international speaker on this subject, could you shed some light on this observation?

MMK: Perhaps I could, but at the onset I want to stress a variety of other factors, not related to a specific appliance or specific, named treatment philosophy.

A major movement toward self-ligation started in the mid to late 1990s. Let's remember that this was about 2 decades after Andrews introduced and Roth and others popularized concepts of the straight wire appliances [SWA]. This is important, because the major self-ligating brackets, both in the so-called passive and the active [better: interactive] groups were "born" as *preadjusted appliances.*

CGM: What is the connection between the SWA and self-ligation?

MMK: This is what I want to explore.

You will remember that in the early 1990s we conducted, with your assistance, a major study, where we systematically analyzed the finishing sets of arch wires. We were not evaluating treatment outcomes and, in fact, had no idea how good [or bad!] respective treatment results were. We examined the finishing wires, the ones that clinicians tend to remove together with the fixed appliances at the end of active treatment.

The power of our study was in numbers: we evaluated over 40,000 finishing arch wires. The great majority, or well over 80%, of all finishing arches did not meet the criteria of the SWA. They were either not "straight" (containing a variety of compensatory bends) or—to our great surprise— not rectangular, but undersized, round arch wires. This indicated to us that orthodontists around the globe either did not understand the basic premises of the SWA [as promoted by Andrews and his followers, and even more so by Roth and his followers] or that they looked at their work and smartly made the needed wire adjustments prior to finishing their treatments.

At the time we liked to think that it was the latter situation, and we have, in fact, encouraged clinicians to look at their work, not only by looking at their patient's mouth, but to take a routine before-the-end-of-treatment Panorex, in order to evaluate the position of the roots.

At the time, it was believed that many clinicians switched to preadjusted appliances to "keep up with the Joneses" and, based on many presentation titles at various large orthodontic meetings, additional learning of Andrews' or Roth's concepts was quite prominent. I myself had been invited several times to large meetings to discuss both the advantages and limitations of the SWA.

CGM: We recall that situation, but how is this connected to the present observations?

MMK: By now we've had almost 40 years to "digest" the SWA concepts and to learn to not only live with them, but to take advantage, while overcoming their disadvantages. An important outcome of this learning period is that we have substantially improved our ability to place attachments more precisely and more correctly, which, in turn, has cut down on the need for placing adjustment bends in all of our arch wires, initial and final.

I would predict that if we were to reproduce our study of finishing arch wires with today's materials, the new results would be significantly different, showing much less compensatory wire bending.

CGM: I would agree on this prediction. However, do you think that factors, other than learning more about the SWA, contribute to substantially less wire bending?

MMK: Of course there are other factors. Let me elaborate on the more important ones. When a clinician looks at his work in later stages of treatment and sees some discrepancies or problems, he typically faces the two possibilities. He can either place one or more compensatory bends in his arch wires, which is not easy and requires certain wire bending skills that some orthodontists simply don't have.

The other possibility is to remove and rebond the tooth or the teeth that need to be corrected. This intentional rebonding, that is to say, replacing an attachment not because the patient broke the bond, but we remove the "faulty" bracket[s], planning to replace it at the same appointment, became significantly easier [and technically better!] with popularization of the laboratory sandblasting apparatus. It is currently very popular for the clinician to remove the attachment, hand it to his assistant, who goes to the office lab, while he prepares the tooth. The same attachment [cutting the cost and on the possible selection of attachment errors] is replaced, cured, and engaged in a very short time, probably not more than 3–5 minutes. If such "incorrectly placed" attachments are repositioned, it follows that an appropriate arch wire will not need to be bent. It should be noted that we frequently recommend stepping down the size of the wire used after such intentional rebonding.

CGM: While the bond strength of such a rebonded bracket is known to be poor, skilled clinicians often take chances and live with it. What would you estimate is the frequency, or in what percentage of treatments, do you think this rebonding is being done?

MMK: I and all of my students do it routinely, perhaps not 100%, but surely over 80% of our cases. My guess is that, for the worldwide orthodontic population, this is a lower percentage, perhaps in the 30% or 40% range, but there is no doubt that it is on the increase!

CGM: You and your team may have special tools and skills that others do not have... Of the brackets we receive at Ortho-Cycle to be reconditioned, many are "incorrectly placed." You have also indicated that there may be some additional factors at play that contribute to your original observation, mainly that the treatments are finished differently?

MMK: Yes, and I'm coming to this important point.
In my opinion, the popularity of self-ligation produced much more than just not needing to tie in arch wires, which—we sometimes forget—was the original idea and purpose. It also produced various positive side effects in the area of mechanics and in the biology of orthodontic tooth movement [OTM]. Some of these good effects actually came from a rather intense but, generally speaking, healthy competition between the two chief schools, or philosophies, of self-ligation, namely, the passive and the interactive systems.

First, we have generally accepted that in both of these systems we can and should use lower-level forces. Practically, this means that we do substantial parts of our treatments on smaller-diameter arch wires. These, in turn, deliver much lower forces for a given wire deflection. To carry this idea a bit further, it also means that the smaller diameter straight, or unbent, wire will be able to engage a more misplaced tooth. This clearly favors Andrews' SWA and it additionally leads us toward more biologically oriented OTM.

CGM: As we understand it, in order to get the full expression of the bracket slot preadjustment, eventually one would have to use the full-size arch wire that would fill the slot size 3-dimensionally. Is this not so?

MMK: To a degree it is, but not entirely. Here comes one of the basic differences between the passive and the interactive systems. In passive systems, because the "gate" essentially closes the bracket slot and thus converts the slot into a short tube, one does not have other options but to fill the slot, in order to gain the characteristics of preadjustment. In contrast to this, interactive systems have an interactive clip, capable of making the slot functionally smaller. In terms of arch-wire-to-bracket slot interaction, this is nearly equivalent to using heavier, more controlling arch wires. The net benefit is that most of the OTM is achieved while using smaller-diameter and lower-force-producing wires.

You would undoubtedly observe that in many cases treated and finished in an interactive system, the finishing arch wires are routinely undersized, relative to the bracket slot size. This is not because clinicians do not know better or are lazy, but because of the inherent characteristics of interactive self-ligation.

CGM: One final question. When we started Ortho-Cycle, the typical fixed appliance treatment duration was somewhere between 2 and 3 years. Now we are observing shorter treatment times. Is this a direct result of increased usage of self-ligating appliances?

MMK: Probably yes to some degree. There are other factors contributing to our shortening treatment times. The chief among these, again in my opinion, is our better knowledge of mechanics and of biological responses to OTM.

Let us also give due credit to office automation and to better practice management regimes. Getting back to what I said earlier in this interview: the typical orthodontic practice looks and functions differently than it did just a single generation ago. Not only differently, but better!

CGM: Even as an outsider, I can vouch for this: left on their arch wire after debonding, most brackets of today slide along it; as the width of the slot approaches that of the wire, a jam occurs, often pointing to too narrow a slot. Thank you for presenting to our subscribers the general context of progress we all see, but few understand.

SPACERS, A MUST FOR DENTAL PHOTO-CURING

Patent pending

Introduction

The present research relates to the dental photo-curable adhesive used for bonding opaque or semiopaque articles to tooth structure. After the adhesive is placed on either the dental article or tooth structure, these adherends must be pressed one against the other before the cure takes place. Pressure is necessary not only to improve contact between the adherends (precluding voids and bubbles by displacing air), but to help the hydrophobic adhesive penetrate the hydrophilic surface of the adherends. As the adherends come closer together due to pressure, the interfacial layer of adhesive becomes thinner and uneven, and therefore less exposed to the curing light.

Materials and method

Typical application of this research can be found in direct bonding whenever the adhesive should fill the space between the enamel and the attachment. Of importance is the degree to which the shape or contour surfaces match: adhesive layers that are too thick do not borrow the strength of the supports— as is desirable—and the "starved" areas do not contribute to the bond strength. As pressure generates tight places between adherends, most of the curing light is wasted by being absorbed by the poorly reflective, opaque surfaces. The longer the distance from the application of radiation, the higher the chances of finding uncured or insufficiently cured adhesive. While empty spaces between adhesive areas do not transmit radiation, the photo-curable adhesive does; the thicker the layer, the more light transmitted. In contrast, the higher the pressure, the thinner the layer, the longer the light exposure, and the higher the electric bill.

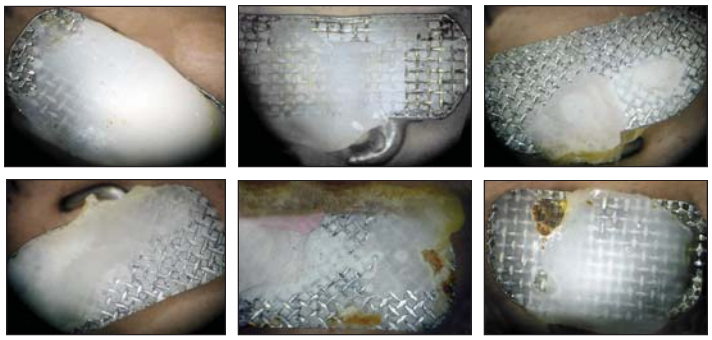


Fig. 1.Tube bases showing uneven thickness of adhesive layer. Spaces attract microorganisms that dine on acrylics

Applications of the above can be found in both dentistry and orthodontics. The unevenly filled spaces contribute, in the first case, to the veneer's debonding and discoloration due to food debris penetration, while in the second, to the bonded attachment's poor bond strength. Whereas the phenomenon occurs often, it is better illustrated when larger bonding surfaces are involved, as in the case of tubes (Fig. 1).

To control and substantially improve dental photo-cured bonding, we recommend using spacers, i.e. particles which can maintain the desired distance between the adherends when these are pressed one against the other. Fairly evenly distributed throughout the composite in minute quantities, these particles should maintain that distance between 0.1 to 0.5 mm. As they are hard, chemically inert, and insoluble in the composite's mononomers, spacers generally do not interfere with the adhesive's aspect or behavior.

Appropriate spacers can be ceramic or polymer particles or common adhesive fillers such as metal oxides, glasses, and metal salts. Larger particles of these fillers can also be used; when this is done, then their uncommon size easily permits detecting the purpose of their addition.

Results and discussion

Among the best spacers are the microspheres of polymers such as polystyrene. Practically colorless, they are ideal for improving veneers' bond strength. Red polystyrene microspheres, as sold by Micro Particles GmbH (City of Science, Technology and Media; Berlin-Adlershof, Germany), can be used to evaluate the spacer's efficiency in ensuring the adhesive layer's continuity, thickness, and distribution (Fig. 2a and b). Fig. 3 shows how an adhesive layer sandwiched between adherends cures when subjected to light. In the first case, the spacers allow the light to pass, and the adhesive is evenly cured (purple). In the presence of the adherend's

Fig. 2 a. Distribution of colored spacers in a photocured adhesive

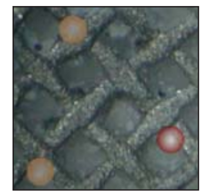


Fig. 2 b. Spacers even up the thickness of an adhesive

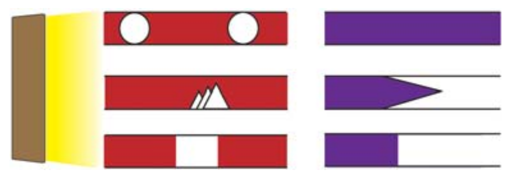


Fig. 3. Light transmission through a layer of adhesive sandwiched between adherends. Uncured (red) and cured (purple)

surface unevenness, marked in Fig. 3 with multiple triangles, the cure is impeded or ceases to take place. In tight places, in addition to adhesive layer discontinuity, there is no cure at all.

Conclusions

Pressure enhances good bonding. Adhesives randomly applied on uneven surfaces generate some layers that are too thick, as well as "starving" others, both undesirable. Adhesives designed for photo-curing are good transmitters of light, and their layers' conductance can be optimized with the help of appropriate spacers.

OPINION: AREN'T YOU FED UP WITH MOLAR BANDS? II

(Second take, after years!)

In an article with this title we published **18** years ago,[1] we expressed our amazement that, faced with a viable alternative, many orthodontists still use bands. As engineers, our amazement has turned to bewilderment as molar bands continue to be popular. To add to our confusion, there are clinicians who use, in an impression that assaults the eye of the beholder, sophisticated, state-of-the-art self-ligating brackets accompanying bands and even attached thereto.

Ortho-Cycle long ago ceased to follow the path of easy money and, based on the trust and understanding of our readers, allows itself to keep an eye on its neighbor's yard and tell what it sees, even if this goes against its interests. While we make money by reconditioning molar bands, orthodontists' persistence in using them is all but inexplicable. Having the above in mind (and trying to be free of bias after over 30 years in the field), Ortho-Cycle feels compelled to share its comparison criteria with *Insider* readers, hoping to receive some comments.

The first typical orthodontic band was described by Angle. His device included "a metallic circularly shaped band with a relatively small portion of the circumference being thicker than the remainder thereof. A hook for engagement by a wire or the like is fixedly secured to the band."[2] In contrast to brackets, patents on bands are being issued in steadily decreasing numbers, as the pos-

Fig. 1 Recent patent for molar bands. A strip of flexible material can be locked at each end of the strip

sibilities for innovations are limited. To appreciate this, it suffices to look at one of the most recent patents in the field (Fig. 1).[3]

Advantages of bands. Important for adhesion, properly fitted bands offer a larger surface area and anatomical shape matching that of the involved molars. Bands can receive more attachments than a tooth with a bonded tube and can be successfully used when dental restorations are present. Bands are commonly advocated to protect posterior teeth against fracture during endodontic treatment and before final restoration. Banding with temporary cement allows for easy tooth cleaning after treatment.

Disadvantages of bands. Of importance to both patient and clinician is their unsightly appearance (tin grin). As molars have different diameters, not only is a large inventory necessary, but so are time and patience. The tables of size conversion occupy many pages, which shows the complexity with which the clinician must deal when trying to switch manufacturers. Statistics also show that it is far more common for orthodontic bands to come loose than tubes to debond.

"Don't eat hard or sticky foods" is a song sung by generations of orthodontists to avoid loose bands. As the space needed to accommodate the band usually closes in a few days, the clinician often sacrifices valuable time by promptly recementing the band. Because bands have a high possibility of poor marginal fit and are intimate with the gingivae, meticulous oral hygiene is needed to prevent dental plaque accumulation. Dental procedures that go below the gum line provide an opportunity for bacteria to enter the blood stream. To fit bands comfortably, irritating separators must be placed between the teeth to slightly separate them. A poorly fitting band may lead to a compromised coronal seal and gingival irritation.

Bonded teeth are more subject to corrosion phenomena, while banded teeth have higher chances of incurring decay. Patients at risk of developing infections from dental procedures need antibiotic coverage during band placement and removal. A banded tooth with a large cement void can be prey to decalcification, which is frequently not detected until decay is already extensive. White-spot formation under orthodontic bands cemented with glass ionomer is quite common. As much of the banding today is performed with thermoset adhesives similar to those used in bonding, the presence of a larger amount of these cytototoxic adhesives increases the chances of harmful leaching.[4]

Conclusions

While bonding has problems, they pale when compared with those of banding. Bonding is much faster and easier for both the patient and the dentist. Today's improved adhesives, along with resilient wires have allowed clinicians to use direct-bonded tubes on all molars. Brackets, compared with bands, reduce inventory requirements, afford more comfort, are more hygienic for the patient, and bond and debond quickly and easily.

Thousands of spent appliances received by Ortho-Cycle with attachments left in place on the arch wire do not include bands. Considering that only few of these were removed for impression-taking (retainers), it is obvious that clinicians can do without them, and this since quite a while.. Back in the early '90s, clinicians such as Dr. James Layport were treating patients sans bands.[1] As an outsider, it seems strange to me that some of today's clinicians, who for sure are trying their best to save time, effort, and money, continue to extensively use bands—devices that fail in all these directions. Aside from self-ligating brackets, bands with tubes are more expensive both when new and after recycling (service or purchase). Years ago, in the inner circle of a major orthodontic manufacturer, there was a complaint that the sale of orthodontic bands with tubes wasn't profitable. Management's answer was that the company should continue that particular business to prevent its customers from dealing with the competition. As for the recycler who doesn't have to manufacture bands, just the effort to transform them from scrap to good, reusable attachments is a difficult task. As will be shown in the following article, the money and energy received for this endeavor hardly compensates us. To solve this riddle that has annoyed us for years, we are willing to offer our readers a prize for letting us know their reason (except routine) for the extensive use of molar bands.

References

1. Matasa CG, Aren't you fed up with molar bands? *Insider,* April 1992, www.orthodonticmaterials.com/insider/insider_1992/april92.pdf
2. Angle EH, US Patent 1,204,114, 1916.
3. Munro DM, Soon PS, U.S. Patent 6,059,568, 2000.
4. Malkoc S et al, Cytotoxic effects of resin-modified orthodontic band adhesives, Angle Orthod. 2010: 80 (5): 890-895.

Send us an e-mail with your answer: For the authors of the 3 most convincing arguments we will recycle free 100 brackets or 50 bands with tubes ("Quality" in both cases). Deadline: December 10, 2010.

A THRIVING SURVIVER: THE MOLAR BAND

Introduction

In the preceding article, we showed the disadvantages of the molar bands. We are therefore so surprised that the latter survive that we were willing to award prizes to those who can explain what we consider a miracle, see above. To help our readers understand our position, we are offering them a description of how hard we fight to transform stainless steel scrap into sought-after attachments. The last time we did anything similar was 20 years ago, the topic being the recycling of direct-bonding brackets (Matasa CG, You are forcing us to disclose, Mr. Horowitz, *Insider*, December 1990, www.orthodonticmaterials.com/insider/insider_1990/dec90.pdf)

Materials and method

Assessment. Bands with triple tubes taken randomly from orders sent by Ortho-Cycle customers were first steam-decontaminated at 121°C using one of the autoclaves shown in Fig. 1. The

Fig.1. Autoclaves

Fig. 2. Worn band, as removed

bands were then photographed to evidence the transformation suffered when going from scrap (Fig. 2), to reusable attachments. All the band images were taken with a Nikon 3DX digital camera connected to a microscope (Fig. 3).

Fig. 3. Digital camera and microscope

Fig. 4 Used, clean band

Adhesive removal/decontamination. Composite or cement, the adhesive is removed using the procedure already described for brackets. Subjected to hydrolysis and pyrolysis, both types are completely removed at a temperature above that of sterilization but way under that of stainless steel sensitization. The band maintains its general aspect.

A microscopic evaluation of the bands' inner surface after the treatment does not show any deposit (Fig. 4).

Burnishing. To remove oxides and scratches, a centrifugal, high-energy "Ferris wheel" is used along with proprietary polishing media. Unlike manufacturers, who all use this type of machine, Ortho-Cycle doesn't need it for heavy-duty purposes (the commonly used powder metallurgy leads to bad-looking surfaces). Widely used in jewelry manufacturing, burnishing has the advantage of avoiding loss of precious metal.

A standard installation comprises 4 centrifugal, planetary barrels mounted in a Ferris-wheel turret (Fig. 5). While the turret spins, the evenly spaced barrels rotate in the opposite direction, at its periphery. Rotation of the turret and barrels causes the mass (parts, media, compound, and water) to slide to the farthest wall of the barrel, the centrifugal force adding weight to lightweight media.

Fig. 5. Centrifugal high-energy machine.

Fig. 6. Burnished

Peening the stainless steel surface increases light reflectivity, making the parts appear polished (Fig. 6). At the same time, peening induces hardening through compressive stress and reduces residual tensile strength. Roughness finishing measuring less than 1 μ renders the attachment as shiny as after 50 μ metal removal.

Sizing and measurement. Once cleaned and burnished, the bands are checked for integrity and size by being pulled on appropriate, tightly calipered mandrels (Fig. 7).

Fig. 7 Shaping rods, a. bicuspid; b. anatomical molar; c, round molar

The bands are forced along till their advance is stopped; at that point the size marking is recorded. As notations vary from manufacturer to manufacturer, each brand requires a specific tapered-ring measuring rod (Fig. 8), which leads to an evenly rounded band (Fig. 9).

Fig. 8. Calibrated molar rod

Fig. 9. Sized circular band

First shaping. Another type of rod, this time quasi-rectangular (Fig. 10), is used to provide the necessary anatomical shape, allowing the band to better fit the molar's crown (Fig. 11).

Fig 10. Anatomical (square) rod

Fig. 11. Anatomically shaped band

Second shaping. The inwardly directed flange at the top of a band is necessary not only to stabilize its position but also to host the adhesive. The so-called occlusal rollovers can be successfully made with the help of pliers. The rounded ends of the plier, shown in Fig. 12a, create the bands' inner curvature by forming it within 2 hard surfaces, while those shown in Fig. 12b press the walls outward. With the help of the plier shown in Fig. 12c it is feasible to apply both types of forces.

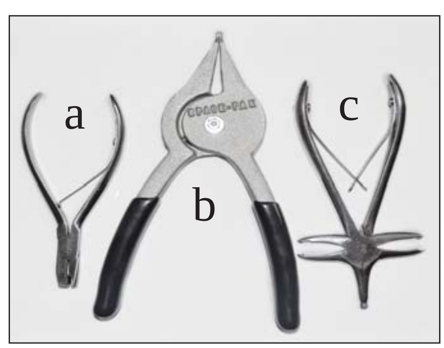
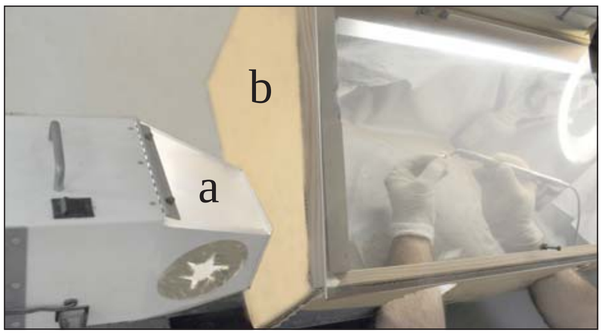


Fig. 12. Band wall-curving pliers

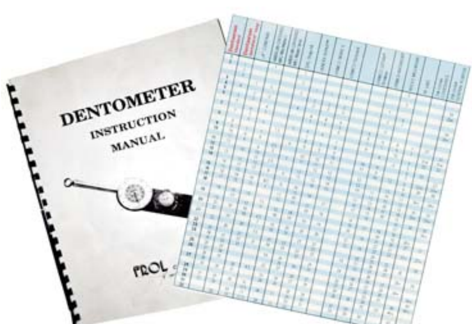
Sandblasting, etching. The roughness of the bands' inner wall promotes cement adhesion while providing additional stabilizing friction between tooth and metal. Mesh or metal melt additions having the purpose of increasing adherence change the bands' inner diameter. In contrast, both etching and sandblasting provide a homogeneous microroughness. With etching, a gel of aqua regia (3 vol conc HCl to 1 vol conc HNO_3) is left for 5–10 minutes on a stainless steel surface: the resulting roughness is extended and homogeneous. The sandblasting uses a jet of alumina (corundum) particles (70–100 μ) which is directed where needed. To avoid media loss and protect the operator, sandblasting is performed in closed cabinets provided with dust collectors (Fig. 13a and b). Compared with the methods that add mesh or imprintable alloys on the bands inner wall, sandblasting doesn't lead to a change in diameter, i.e. to less "try-ins"



Fig, 13 Sandblasting cabinets: a Direct, b. Hand-controlled jet

Fig. 14. Inner wall of a band that has been subjected to 50 μ alumina sandblasting.

Marking. To serve its purpose, the band must match the molar to which it was dedicated in both shape and diameter. Using only a dentometer or a band conversion chart (Fig.15) is not enough for accurate matching. Only experience and, in the case of Ortho-Cycle, replacing electropolishing with burnishing helps. Indeed, after wear and polishing, the original marks, either laser burned or engraved, are likely to vanish.



Fig, 15. Dentometer manual and just one of the ight Dentaurum's molar band conversion charts

In contrast, burnishing leaves enough readable marks in a given lot to allow comparisons and adjustments. The marking can be done on bags, the method preferred at Ortho-Cycle, or engraved directly on bands using a tungsten carbide bur (Fig. 16).

Fig.16. Carbide tip-marked band

Tube (sleeve) testing. Bands can have several sleeves for arch wires and a sleeve for headgear traction; as all of these can be damaged during debonding, testing them is a must. In contrast to bracket-slot testing, which should always be done with blade-type gauges, tubes are checked with calibrated arch wires partly embedded in plastic (Fig. 17a). For testing the headgear sleeve, a .045" round wire (Fig. 17b) suffices.

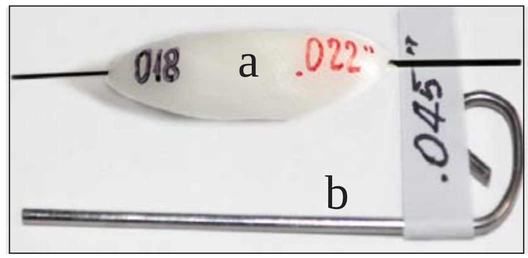


Fig 17. Sleeve-measuring wires: a. For the rectangular sleeves, .018" and .022" arch wires; b. For the headgear sleeve, round .045"

Sorting, decontaminating, and packaging. After sizing, the bands are sorted and marked. Their last decontamination is performed in sterilizable polypropylene bags. As shown in Fig. 18, strips of sterilization-temperature tape are placed along the bags before inserting the whole in the autoclave shown in Fig.1. If the right conditions are met, one can read on the tape the word: "sterilized".

Fig.18. Marked bags with bands

Results

Starting its orthodontic appliance recycling activity in the midseventies, Ortho-Cycle had to include bands. While processing brackets was high-tech but simple, providing reusable bands was difficult and complicated.

To assess the impact of the changes in band processing on Ortho-Cycle's business, it is useful to consult the company's ISO compliance record (No. 13485:2003, 4.3, Control of Nonconforming Product).

A first observation is related to the substitution of electropolishing, associated with metal removal, by burnishing. As the electropolished bands became thinner each time, the num-

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ber of reuses was limited. Starting in 2002, when Ortho-Cycle started burnishing, the thickness of the bands not only remained unchanged, but the metal surface got harder due to the peening involved.

A second observation is that in time, customers' interest in both bicuspid and molar band recycling dropped as many switched to direct bonding. In contrast, interest in band purchases grew as a result of increased quality, ie, our efforts to reduce clinicians' try-ins in attempting to fit a particular molar.

Discussion and conclusions

Many bands are considered undesirable by some clinicians just because they look deformed and twisted—in other words, because they are not deemed to be reusable ...

In fact, our statistics show that, with the exception of tube detachment or a broken ring, most worn molar bands are only deformed after being used for treatment. Quite often, the band even maintains its original marking, of course, needing rechecking and resizing.

While years ago bands were cemented temporarily, the quest for less effort and a stronger bond has led clinicians to use the same crosslinked, thermoset composites as used in direct bonding. In general, the latter development restricts the bands' reuse, because the heat needed to char the polymer softens their walls and renders them dark. Whereas electropolishing can bring back the original shine, it results in a further softening of the band's wall due to metal removal.

This situation changed when Ortho-Cycle started to apply to bands its unique method of dissolving polyacrylate adhesives from direct bonding brackets. Combined hydrolysis and pyrolysis not only preclude the metal's exposure to sensitization temperatures, but, as the degree of shine is a little lower, also allows burnishing to be an acceptable replacement for electropolishing.

Once the metal's strength is assured, its shape can be restored; its raison d'être being that of approximating a body varying in shape.