Patient-Specific "Damon**-Compatible" Archwires

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While orthodontic treatment planning for anterior dental esthetics is multifaceted, the methods and materials we use to precisely achieve treatment goals remain largely limited and generic with regards to the variability in tooth size. Visual balance and harmonious gradation in smile design are highly dependent on the collective width of anterior teeth, as well as their distribution along a specific archform. Although most orthodontists give considerable effort to the precise placement of brackets on teeth, few give the same consideration to where the bracketed teeth will land on the curvature of the archform selected for their patient. As a result of this limited focus, many apply their treatment mechanics equally to patients with widely varying anterior tooth size, with no accounting for the total dimensions.

For Damon doctors, lateral development with passive self-ligating brackets is the hallmark of the system where a progression of broad archwires helps the muscles of the tongue and face develop a patient's upper and lower dental arches beyond that of traditional tapered archforms, resulting in the signature "Damon smile." Most practitioners following the Damon Suggested Treatment Protocols are successful in consistently producing broader arches due to the effective lateral forces delivered in the defined "High Tech stage" through careful use of rectangular NiTi wires. Despite their best intentions, some practitioners deal with some inefficiencies of broadened archforms in patients with small to medium sized teeth. Spacing, root prominence, and occlusal discrepancy are among the top inefficiencies found. Moreover, the general guidelines for bracket placement in the Damon System were among the first to move away from a traditional mid-facial position to a more mesial placement in the canine regions to compensate for the larger archforms. Most orthodontists are not aware, however, that the mesial compensation is largely unnecessary for larger width teeth and, conversely, are progressively more important for patients with smaller width teeth. Because of the additional inefficiency often introduced by lateral changes and because of the inconsistencies in bracket placement, the continued use of a single high tech archform for all patients regardless of tooth size must be addressed.

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WIRE SLOPE AND BRACKET PLACEMENT

I now recommend a new treatment protocol that offers the option of selecting wires that have the more rounded anterior Damon shape, but in a wider variety of paired and coordinated sizes to provide appropriate lateral changes for individual patients with smaller teeth (Fig. 1)*. Reduced-size versions of the Damon wire thus keep the canines at the "corners" of the archforms and enhance the functional fit and esthetic display of patients' smiles. Furthermore, the consideration of canine position on the turn of the dental arch and the canine bracket position as it relates to the slope of the wire ultimately allow for more consistent bracket placement closer to the mid-facial (Fig. 2). Most importantly, selecting the appropriate size archwire set reduces the risk of too much lateral arch development. For patients with a variety of tooth sizes, this seems to be a more appropriate and consistent way to develop a balanced display of anterior teeth.

Since general treatment protocols demand a progression from beginning with light round flexible wires to intermediate rectangular flexible wires, we have to consider the stage of mechanics that has the most influence on the arch shape. When using Damon compatible wire sizes and sequences, lateral development seems most greatly affected by the broad rectangular high-tech wires, beginning with the 14x25 NiTi and ending with the 18x25 NiTi. Because NiTi wires cannot be shaped by the practitioner, a "one-size-fits-all" approach applies for all

patients. Thus, flexible NiTi archwires, broader in the transverse dimension than most patients' dental arches -- are inserted through the molar tubes and actively constricted where brackets are engaged at the corners of the mouth. Arches begin to broaden laterally by the wires pushing on the inside of bracket doors, creating many desirable changes for patients with crowded dentitions and lingually inclined buccal segments. As wire sizes progress torques are expressed and begin to upright canines. Finally, with all crowding resolved, customized and coordinated steel or TMA wires are inserted and are rarely altered, "cementing" the final archform for a patient as heavier mechanics and the detailing phases follow. On occasion, stainless steel wires are expanded in order to affect a broader arch form that previously limited the high tech rectangular wires.

FORCES IN THE LATERAL DIMENSION

I have been aware for many years that the lateral development in Damon mechanics due to the wires begins when wire forces exceed the facial muscle forces. While biological principles dictate to the clinician to be patient and cultivate arches in light round wires, orthodontic mechanics often win out, resulting in the placement of heavier force rectangular NiTi wires. In retrospect to me, it seemed kinder to periodontal tissues when I was able to correct crowding by placing the lightest force wire that would tip the muscle equilibrium in favor of the tongue and begin laterally developing my patient's dental arch. More recently, I have resolved that most of my cases unravel quickly in the rectangular high-tech wires and that my protocols have evolved into systematically progressing through a graduated wire sequence with changes being made at each visit. More appropriately labeled the "working wires," I have received the most patient complaints of discomfort at the point of transitioning from round to rectangular wires, specifically in the regions of the canines and the first bicuspids, theoretically due to these higher forces.

In early 2006 I conducted a study with the help of the orthodontic residents at The Medical College of Georgia School of Dentistry to study the differences in resultant forces in the canine and the first molar regions when Damon wires of various sizes were compressed four millimeters in each region. In theory, this would be comparable to the forces felt when a stock Damon wire was constricted two millimeters per side (4 mm total) and engaged in a patient with a narrow arch to the canines or molars only. The results consistently showed more force delivered to the canines than to the molars. More specifically, the high-tech rectangular series were the first wires to show forces above one ounce (28 grams) of force in the canine region, the approximate value of mean capillary pressure. Since these NiTi wires cannot be customized by the doctor, I concluded that they exceeded mean capillary pressure in the periodontium and adjacent bone and introduced traditional orthodontic tooth movement by

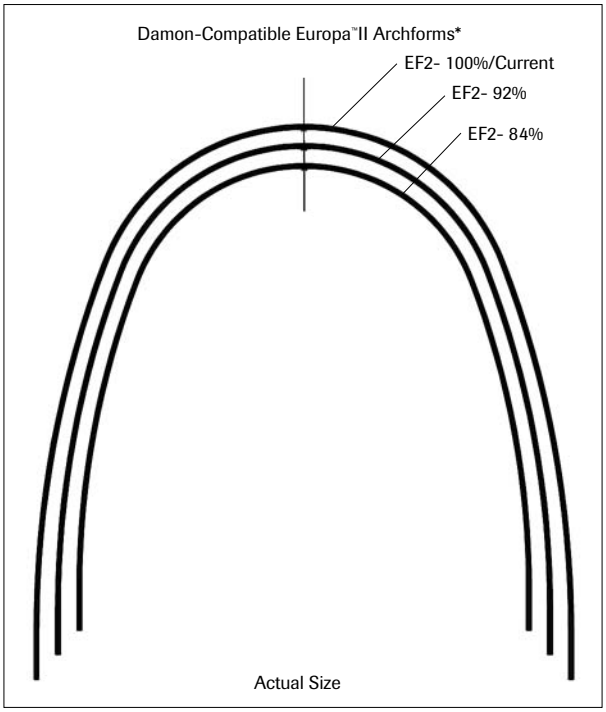

Fig. 1

*Europa™ II Archform: G&H® Wire Company
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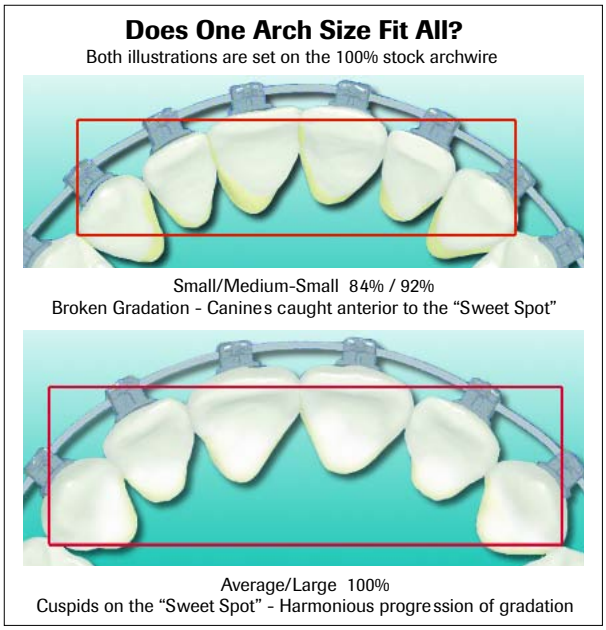


Fig. 2

way of hyalinization and undermining resorption. My rationale was that this was a necessary level of force, since I wanted a certain treatment outcome broader than what the patient currently displayed. Because the level of force measured in the canine region was linear with respect to the degree of constriction, I have always been diligent to carefully customize my steel and TMA wires in the regions of the canines and first bicuspids to avoid these iatrogenically introduced high forces. I am always careful also to not leave 18x25 NiTi wires in for more than six weeks to avoid excessive lateral development and resultant spacing. My attention at this point was to create a more logical wire progression.

ADVANCED TREATMENT PROTOCOL – COORDINATED SETS

Applying this thinking to my current rationale for graduated wire shapes in the "High-Tech" wire phase simply gives me the ability to reduce the lateral forces received by an arch by more closely matching the wire to the existing dental arch and concomitant tooth sizes. Consequently, I have been impressed when introducing these wires with more modest levels of lateral force, patients do not complain about the transition from round to rectangular wire when the transverse forces are minimized both through customizing and coordinating the wires and by using reduced-size NiTi wires. I am getting far less iatrogenic spacing when a more appropriate wire selection is made, which uncomplicates treatment and dramatically shortens treatment time. I can now theoretically provide a patient with smaller teeth a wire sequence that creates no lateral changes for cases requiring a transitional wire for leveling and slot alignment. And, with this variety of wire sizes we have a more specialized selection that better addresses transverse needs when working with bilateral crossbites and telescopic bites.

49.8mm Upper Six m/d Widths
Cuspids on the "Sweet Spot" harmonious progression of gradation

43.5mm Upper Six m/d Widths
Broken gradation - canines caught anterior to the "Sweet Spot"

Fig. 3

Most Damon practitioners would agree that, on careful analysis and study, their most esthetic smiles are achieved when treating patients with average- to large-sized teeth when 100% stock Damon archforms are used. In these cases, bigger teeth mean broader archforms can be cultivated. However, these same protocols do not usually apply to cases with small teeth.

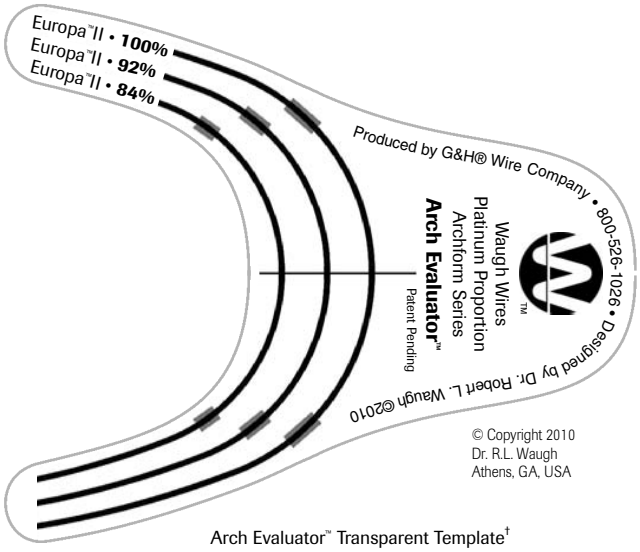
The cultivation of broad archforms without regarding tooth size and crowding may complicate certain cases by creating unwanted spacing through too broad of an archform for patients with smaller teeth. While the smaller width teeth might then be consolidated on the anterior aspect of the large archform, they could never be distributed to the point where the canines would properly turn the corner in the dental arch; in many cases the smallest teeth end up grouped on the anterior segment of the wire well ahead of the turn. While traditional tapered orthodontic archforms achieve at least classic Golden Proportion (62% gradations) and Damon enhances this with what I term "Platinum Proportion" (75%+ gradation), I ask myself this question: "What comes after Platinum Proportion?" In fact, I am convinced that there are diminishing returns in esthetics and function when the first bicuspid instead of the canine turns the corner of the dental arch.

Over the last three years, my well-trained staff helped me measure the mesio-distal tooth widths of the upper and lower anterior teeth for every patient in treatment. I historically put more energy into solving Bolton's ratio problems than thinking about how the upper anterior total tooth widths distribute along the curve of the Damon wire. The most revealing moment came when I summarized the statistics of these measurements which range in upper anterior tooth widths between 37 mm and 57 mm on review of 325 cases. It was surprising to see how different the cases with small teeth appeared on frontal center view compared to patients on the larger end of the range (Fig. 3). The distribution of the large teeth on the 100% Damon stock archform filled the wire nicely and created the most esthetic smiles. The cases with smaller teeth showed loss of torque and flatter anterior displays. In the most extreme cases of small teeth (i.e., less than 40 mm total mesial-distal width), the first bicuspids were distributed along the wire where the canines would normally be seen creating unwanted dynamic interferences. In many cases of smaller teeth (less than 43mm), the anterior esthetics appear compromised when cultivated on the stock Damon archform.

METHODOLOGY OF WIRE SELECTION

The current method I use for selecting the appropriate wire size is to first evaluate the degree of lingual canine inclination, along with the amount of anterior dental crowding. I initially make an effort to view the patient from the front or, better yet, look at a current center dentition intraoral photo. Viewing a patient from the front allows the orthodontist a clear view of the labial or lingual inclination of all canines, which should be carefully combined with the presence or absence of crowding or, alternately, spacing. For crowded cases with lingually-inclined canines, it should be obvious that an increase in transverse dimension would be desired; thus, selecting a broader wire would help increase needed arch width. Conversely, smaller teeth with spacing would not benefit from the use of a broader wire and archform, so a reduced wire would be selected.

Next, a transparent template (aka Arch Evaluator™) of the proposed archform size is positioned over the lower arch in order to visualize the lateral changes needed for a patient, if any (Fig. 4) †. If none is needed, then clearly the closest sized wire to that archform would prevail. However, from my experience most cases entering the "High Tech" phase need a broader archform. Simply holding the Medium archform template over the lower brackets, centered on the midline, provides a diagnostic tool to select the 100%, 92% or 84% size for the lower arch. With only three size choices, the best selection is easily made. For example, if the 92% template looks too wide for a patient's needs, the 84% is selected for the lower arch.



Arch Evaluator™ Transparent Template†

Fig. 4

†Europa™ II Archform: G&H® Wire Company
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Finally, the total mesial-distal tooth widths of the patient's upper anterior six teeth is considered before making the final wire selections for the upper and lower arches. I have come to classify total upper anterior tooth sizes as 84% (less than 43 mm), 92% (43-47 mm) and 100% (greater than 47 mm). In categorizing these patient groups it seems logical that a simple method might exist whereby a reduced archform could be appropriately sized and applied to meet the relative needs of a patient. Additionally, a coordinated set of wires would be helpful to promote the upper and lower arch shapes coordinating throughout the High Tech phase. In this way, a patient with small-to-medium width teeth would predictably receive a small lower wire grouped with a medium upper wire. The medium upper wire is manufactured so it is coordinated, or 2 mm beyond the small lower wire in all measures when laid concentrically beside it on a flat surface or when in the mouth. Similarly, a large upper wire and medium lower wire would be appropriate for patients with medium-to-large sized teeth. Extremely large teeth would need a pair of large wires, while extremely small teeth would ideally receive a pair of small wires. Bilateral posterior crossbite cases might receive a large upper wire and a small lower wire. The beauty of these wires is that they give the practitioner a chance to avoid unwanted forces in the transverse dimension and consequently, the patient has fewer negative side effects. Additionally, the patient's anterior rotations are allowed to round out unrestrained by coil or ties, all-the-while without the concern of too much lateral development.

DISCUSSION

A variety of archwire sizes that relate to the needs of a patient can simplify the approach to archform cultivation. Because the broad Damon archform creates an appealing smile for patients with average to large width teeth, a reduced version of this archform is more appropriate in creating the same gradation for patients with smaller width teeth. A host of benefits are realized when patient specific archforms are selected using a simple assessment technique. When properly selected, the simultaneous insertion of coordinated upper and lower wires throughout all mechanical treatment phases promotes efficiency and coordinated lateral development of both arches.

In Part Two of this Educational Series, the relationship of tooth size to anterior wire dimension will be further explored along with clinical techniques in the uses of the reduced "Damon-Compatible" archwires.

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