

FAST-TRACK GUIDE FOR SELECTING

THE BEST WIRES

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In much of what we do, the wire is supreme. One can hardly imagine orthodontics without wires. Selection can be difficult, but the following guide will help.

Of all the advancements in the profession, including adhesives, cements and bracket design, nothing seems to go as unnoticed or underappreciated as the wires used in treatment. The purpose of the archwire is to transfer elastic energy through work, resulting in tooth movement.

As the first dental specialty and the third medical specialty to be recognized, orthodontics has a history of scientific innovation in addition to the demands of clinical practice. To be a recognized specialty in the healing arts, it is imperative that clinicians, educators and researchers

continually challenge the status quo for improvements in the profession, clinical results, and products—including wires.

Patients also have an interest in improvements, as—generally speaking—these improvements allow the benefits of straight teeth and corrected malocclusions to reach more of the population, hopefully at a reduced fee.

Orthodontic appliances have been central to the expansion of the marketplace for more than 100 years. Constructed of attachments to the teeth (brackets) and moved with wires and auxiliaries, the appliance is constantly being revisited for efficiency, comfort and cost-effectiveness. Wires are a huge part of that, and for such a simple item, there is a lot to consider.

Three ways to evaluate wires

Soon after finishing our educational programs, when we begin the daily routine of orthodontic practice, we immediately begin to rate wires clinically. Put another way: how does it feel, and what evidence exists—however anecdotal—that the wire is performing?

The second way to measure a wire's effectiveness is empirically. I would call this "bench-testing," or "expected results." Usually performed in laboratories, this method gives a somewhat standard measurement to an otherwise subjective performance metric.

Thankfully, many researchers, scientists and others are responsible for the atomic or metallurgical level of understanding. They help others with new advances in performance that we, at the clinical level, can appreciate—and our patients reap the benefits.

Basic behavior of wires

As you know, in the world of wires various metals provide forces of varying intensities and durations across different sections of the dental arch. We'll discuss those factors at the end of this article in the history section, but for now we'll look at the basics of metal properties to help select the archwire sequence best for treatment.

In years past, since most wires were made of stainless steel, the properties changed with diameter and dimension. With the advent of thermal control and varying types of wire, different wire shapes can be used during various phases of treatment with good results.

Resilience is the property of the wire to release stored energy when unloaded. In other words, how much will a wire spring back when it is loaded to a less than permanently deformed state?

Modulus of elasticity defines the amount of force required to deflect a metal. This is a property inherent in the metal itself.

Elastic limit is the amount of work—or "bend"—that may be applied to a wire before a permanent bend takes place. This property is essential to understand when

placing finishing bends in archwires that allow for fine amounts of tooth movement.

The shape memory effect is the ability of a wire, previously deformed by exceeding its elastic limit, to return to its original shape after heating or deformation. This is why nickel titanium alloys are popular in orthodontics. When these wires are deflected—as when tying to brackets—they deform and gradually return to their original shape.

When to use

Stainless-steel wires offer excellent corrosion resistance, high elastic limits and high moduli of elasticity. Very affordable, they are weldable and can be utilized in small sizes in the initial phases of treatment if loops and bends are incorporated into them. They have minimal friction and maintain shape for space closure and arch-shape development.



resilient; however, they have a low elastic limit, meaning they may have a tendency to deform easily.

Beta-titanium wires are a great compromise between stainless steel and nickel titanium when the best of each metal's properties are desired. The wires have greater resilience than stainless steel and twice the stiffness of nickel titanium. They may be welded, but with some difficulty. They are very useful for applications requiring stiff and bendable wires. One of the benefits is that they work well for patients who have allergies to chromium and nickel.

Nickel titanium varieties offer metallic properties well suited to aligning and leveling of the dentition. They have high elastic limits, low moduli of elasticity and high resilience. Their favorable physical properties make them well suited for systems requiring light, continuous forces, and are utilized in many of the self-ligating treatment prescriptions. However, they are not weldable and have higher friction than comparable stainless-steel wires.

Aesthetic wires of varying materials and sizes are utilized for patients desiring the ultimate tooth-colored solution. Many manufacturers offer some sizes—but not all—for the suggested treatment prescriptions. The coatings on some of these wires tend to chip or ding after several weeks. Some manufacturers are coating only the labial surface of the wire, which reportedly cuts down on this disadvantage and allows

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Braiding many small stainless-steel wires together allows for elimination of bends in the initial and finishing stages of treatment when placing a straight simple wire. Multi-stranded wires are considered

for less friction.

So how do you select the best wire for your purposes? When working clinically, you'll need to address three properties in order to select the correct wire for the

situation at hand. They are cross-section, wire type, and shape-memory effect.

Common prescriptions

For reference, three commonly accepted methods of treatment were selected to highlight the types and sizes of wires utilized by select authors for “ideal situations.”

The MBT system

The first is the popular MBT system, which has been published and in use for close to 20 years. In this system, the importance of leveling and aligning is stressed and nickel titanium wire is suggested.

Stainless steel is suggested for working wire, thanks to its ability to weld and maintain arch form during space closure,

which is probably more common due to the advocacy of tooth removals in certain situations.

Initial aligning

.014 or .016 heat-activated nickel titanium

Leveling

.019 x .025 heat-activated nickel titanium

Working

.019 x .025 stainless steel with hooks

Finishing

.019 x .025 beta titanium

Settling

.019 x .025 braided stainless steel

The Damon system

The second is a popular self-ligating bracket system developed by Dr. Dwight

Damon, which also has been available for a number of years.

Initial aligning

.013 or .014 copper nickel titanium

Leveling

.014 x .025 or .018 x .025 copper nickel titanium

Preformed reverse curve wires of the same metal may be used for severe overbites.

Working

Space closure on .016 x .025 or .019 x .025 stainless steel with posts

Optional beta-titanium sizes would be .017 x .025 or .019 x .025 if no posts are needed

Finishing

Beta-titanium wires are recommended for finishing with elastics.

Settling

There is no specific wire suggestion for settling.

Carriere self-ligating bracket system

A third developing system is based on the newer, larger-footprint self-ligating bracket. The wire sequence used is based on superelastic wires, with thermally activated wires being utilized towards the end of treatment.

Initial

.014 copper NiTi

Leveling

.014 x .025 copper NiTi
.017 x .025 copper NiTi

Working

.019 x .025 copper NiTi

Finishing

.019 x .025 beta-titanium

Settling

There is no specific wire suggestion for settling.

Arch forms

Worthy of note is the difference in philosophy between the edgewise and self-ligating treatment prescriptions.

Central to the MBT philosophy is the selection of archwires based on the patient’s existing arch form.

Central to the self-ligating philosophy is the ability to expand to the

Test your wire knowledge

(Answers are on page 47.)

1. Which is not a way to evaluate archwires?

- Clinically
- Atomically
- Organically
- Performance

2. The first wires were...

- Gold
- Silver
- Copper
- Ceramic

3. Elgiloy was first introduced for what purpose?

- Auto brakes
- Watches
- Orthodontics
- Sports

4. Which metal is missing from Beta Titanium?

- Nickel
- Titanium

5. The M stands for which metal in TMA?

- Mercury
- Molybdenum

6. All esthetic wires on the market have similar properties to their metal counterparts.

- True
- False

7. Specific arch form needs to be incorporated into the Damon system.

- True
- False

8. In the MBT system, multistrand wires are utilized for settling.

- True
- False



“patient-specific biologic response,” or PSBR. This PSBR is addressed in literature and videos by manufacturers and is key to using thermally activated archwires.

In these situations, a standard archwire is selected and activation occurs until this muscular limit is achieved. Once the archwire exceeds the .018 x .025 size, the PSBR may be exceeded.

Wire history

Gold was probably the most commonly utilized material during the infancy of the profession. Other materials, such as nickel, silver and other alloys, were used before practitioners settled on gold, primarily due to its availability and ease of use. Gold is heat-malleable and also boasts a lack of corrosion. These are the same properties that made gold the ideal restorative choice.

Stainless steel was introduced into the orthodontic market in the late 1920s and quickly became the standard. The early 1930s brought numerous publications and lecturers promoting stainless-steel products, and the claims of fewer instances of breakage and easier workability helped the alloy take hold. While gold was still being utilized for orthodontic brackets and auxiliaries in the 1940s, wire made of stainless steel was beginning to gain ground.

Chrome cobalt also was introduced in the 1940s, at first in the watch industry and eventually in orthodontics. Rocky Mountain Orthodontics presented Elgiloy, a cobalt-base alloy wire, to the profession. The wire performed similarly to stainless

steel, but with enhanced properties following heat treatment. It is probably because of this extra clinical step that the wire never gained widespread traction in clinics across the country.

Beta-titanium alloy is named for the physical properties in the beta stage of wire development. Utilized in industry since the 1950s, these wires became available for orthodontics in the 1980s. Beta-titanium archwire is often known as TMA, so designated because of its titanium and molybdenum elements.

Nickel titanium has been as much of an agent of change in the orthodontic profession as adhesives have been for the dental profession. Developed by the U.S. Naval Ordnance Laboratory for defense and space use, its most valuable property for the orthodontic market is its shape-memory effect.

The Unitek Corporation was the first to market this wire, under the name Nitinol, in the early 1970s. The main advantage of this wire is its ability to generate light but continuous forces over a long period of time.

Superelastic wires were the next generation, developed by the Chinese for use in orthodontics. Offering greater elastic recovery and less stiffness than conventional nickel titanium wires, the wires were rebranded by the Japanese in the late 1980s under the name Sentalloy.

Thermodynamic archwires were the next advancement in wire technology, possessing the ability to deform at low temperature and activate at mouth temperature. The creation of a wire that can selectively alter its properties depending on its position in the mouth was a most exciting advancement.

The Ormco Corporation introduced copper nickel titanium to the orthodontic

market in the 1990s. This wire offers increased specificity to temperature activation and better overall stability than other nickel titanium wires. Currently, many manufacturers offer this type of archwire.

Aesthetic wires, of course, are under constant development due to the popularity of tooth-colored brackets or clear attachments on teeth. The wires feature a coating of Teflon or other resin. Wire manufacturers have struggled to give them the same properties as their “non-aesthetic” counterparts. Polymers and other composites have also been utilized to provide the “activation” of the orthodontic appliance, with physical properties not quite equal to stainless, or nickel-titanium wires.

As you see, wires have come a long way in a profession that continues to evolve. ■

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