Orthodontic Slot Size: It's Time to Retool

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Recently on these pages, Dr Robert Rubin[1] made a reasoned plea for orthodontists and manufacturers to agree on 1 standard for the slot size of orthodontic brackets. His logic was welcome. Often, as a university teacher, I field inquiries from curious postdoctoral orthodontic students on differences in bracket slot sizes for the edgewise appliance. The neophyte usually would ask for explanations on the advantages and disadvantages of the 0.018-inch and the 0.022-inch standard slot widths in use today. Students should not be the only ones searching for a sound rationale behind the 2 slot choices offered by edgewise bracket and tube manufacturers. This ''double standard,'' separated by 4 thousandths of an inch, could easily appear arbitrary to anyone unfamiliar with the historical basis of the edgewise appliance, the most popular fixed mechanical system in orthodontic use today.

To evaluate and compare critically the 0.018- and 0.022-inch slot standards for the edgewise orthodontic appliance, we must look back to the early applications of wires in the mechanical treatment of malocclusion. The middle of the 19th century was the time when ''orthodontia'' was beginning rapid evolution as a biomechanical discipline. In orthodontics, as in most other emerging fields, American progress was becoming an important global force. By midcentury, the flourishing manufacturers of America were eager to set their own technical and industrial standards apart from those used in the ''Old World.'' A few decades later, innovative American orthodontists, such as Kingsley, Farrar, and Angle, developed tooth-moving appliances using wires or bars made of gold alloys and sometimes platinum or silver alloys. These pioneers in clinical orthodontics described the wire sizes they employed according to the newly established American Standard Wire Gauge, a die-tool for the precise measurement and drawing of round wires. The American Standard Wire Gauge was introduced in 1857 as an improved measurement system for wire diameters based on a ''regular geometrical progression,'' according to its developer Joseph R. Brown, cofounder of the Brown & Sharpe Manufacturing Company in Rhode Island, a leader in measurement instrumentation for 150 years. Brown, a member of the family who founded the eponymous university in Providence, broke away from the British and Continental measurement standards of the time. This was a bold move for his fledgling tool company serving industrial United States, which had yet to establish its Bureau of Standards.

The thousandths-of-inch wire diameters customarily associated with present-day orthodontic wires and appliances are easily recognized in this early ''American standard'' formulation (Table 1). Angle's 23-gauge slot (0.022 inch) might have been 0.024 inch under the old British Imperial Standard were it not for the introduction of this 19th century American system. Even surgical specialties today cling to the inch-based, traditional American wire gauge numbers to describe needles and fixation wires at the same time surgeons record their operative results in millimeters, the metric standard long practiced by the international scientific community.

The earliest slotted-bracket appliances relied on precious-metal wires for activation. Gold wires, used singly or twinned in a slotted bracket, were efficient and resilient in the first standardized slot size, 0.022 inch. In the 1930s, chrome steel alloys called ''stainless steel'' were introduced as orthodontic materials. Orthodontists soon replaced their precious-metal wires with the cheaper stainless steel ones, despite the realization that the steel wires were less flexible than their equivalent sizes in precious metal. Stainless steel orthodontic wires proved to be about 50% stiffer than equally sized wires of the earlier spring-tempered gold. Many orthodontists worried about tissue damage from the increased forces delivered by the new stainless steel wire materials. However, economically, orthodontists showed little enthusiasm in turning back to gold orthodontic hardware. Instead, nontraditional clinicians in the 1950s began employing smaller sized stainless steel wires in the 0.022-inch slot, and some innovators introduced new ''light wire'' treatment techniques. Begg's new appliance, dependent on 0.016-inch round wire in a 0.020-inch modified ribbon-arch slot, showed that stainless steel wire of reduced diameter could provide some of the biomechanical resilience many orthodontists had been sorely missing. The mood was now right for a downsizing of edgewise slot dimensions from 0.022×0.028 inch to 0.018×0.022 inch to allow lighter forces with stainless steel wire, the only arch wire material in use at the time. Orthodontists were informed that the stiffness of a 0.018×0.025-inch steel wire was the same as a 0.021×0.025-inch gold wire. Some edgewise folks switched, others did not. Indeed, the slot-size dichotomy persists today: 0.018 and 0.022 inch!

Now, however, we have a new and improved landscape of orthodontic wire metallurgy, as Robert Rubin has mentioned. ''Miracle'' wires are available, including nickel-ti-

TABLE 1. Excerpted Table of the ''American Standard'' Showing Dimensions Customarily Associated with Present-day Orthodontic Appliances[a]

American Standard Wire Gauge Numbers	Diameter of the Wire in Inches (to 3 decimal places)
16	0.051
17	0.045
18	0.040
19	0.036
20	0.032
21	0.028
22	0.025
23	0.022
24	0.020
25	0.018
26	0.016

[a] In all integer wire-gauge systems, the higher the guage number, the smaller the wire diameter.

tanium alloys, titanium-molybdenum alloys, and multistranded wires. All are highly resilient, even in dimensions exceeding 0.022 × 0.028 inch. In effect, the primary rationale of the 0.018-inch orthodontic slot width has been technologically outmoded by the past 20 years of wire evolution and revolution. Tradition dies hard. Nonetheless, in our fresh new century, we should try to consolidate the 0.022- and 0.018-inch groups into a new slot size standard somewhere between the two standards and with *metric* dimensions, the undisputed language of science. For example, 0.022 inches = 0.559 mm and 0.018 inches = 0.457 mm. Why not settle on a single global metric standard slot size of 0.55 mm (0.02165 inches) or 0.50 mm (0.01969 inches)? We are overdue for metrification of our biomaterials, and now may be the right time to proceed.

Clinicians often think of their technique as religion; they are loath to impose systematic changes on something that is already so finely tuned and workable. Resistance to change may never abate, but we have to start somewhere, sometime. Personally, I like the idea of a 0.55- × 0.70-mm edgewise slot (0.02165- × 0.02756-inch slot). Most practitioners would be able to use up their old wire inventories in these new slots—this makes the switch rather painless financially. The orthodontic hardware manufacturers would be prudent to orchestrate collectively a slow, global phase-in for the new standard to minimize changeover problems. If the manufacturers do not cooperate in fostering this change, they risk a bruising competition later. Experience with earlier manufacturing advances in other fields shows that the company first to offer a progressive new standard becomes ''king of the road,'' miles ahead of the latecomers trying to jump on the bandwagon.

From feedback I have received abroad, I feel the non-US orthodontic community will be 100% behind efforts to restandardize and metricate brackets and wires. Over a century ago, the United States led an orthodontic revolution, introducing standardized fixed appliances. It is time for yet another orthodontic revolution, to simplify and retool our basic hardware—the wires and brackets. There could not be a better place to start than here in the country of origin.

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REFERENCE

1. Rubin RM. A plea for agreement. *Angle Orthod.* 2001;71:156.