

# RIGHT WIRE IN ORTHODONTICS: A REVIEW

## ABSTRACT

Quality of orthodontic wire such as stiffness, hardness, resiliency, elasticity and working range are important determinants of the effectiveness of tooth movement. Commonly used types of orthodontic arch wire: 1) stainless steel(ss) wire, 2) conventional nickel- titanium (NiTi) alloy wire, 3) improved super elastic NiTi- alloy wire( also called low hysteresis(LH)wire), and titanium molybdenum alloy(TMA) wire.

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## KEYWORDS

Stiffness. Resiliency. Proportional limit. Modulus of elasticity.  
Working range.

## INTRODUCTION

Orthodontist should recognise the paramount importance of wire in the orthodontic treatment; brackets don't move teeth, bands don't move teeth wires do. Orthodontist need diverse selection of wire types, sizes, and arch forms. Since each patient is different and each doctor's technique and bracket system are different, no single arch form can satisfy everyone. Usually Bonwill Hawley form and the Brader form are used.<sup>1</sup>

## MATERIAL AND METHODS

Over the last few years, introduction of new orthodontic wires has provided the profession with a much greater selection of wire properties. Accompanying this vastly increased selection has been a like increase in the amount of confusion in choosing optimum wires. Wire selection is an extremely complex subject transcending all aspects of orthodontics including biology of tooth movement, stress magnitude, mechanotherapy and individual treatment philosophies, physics, physical properties and individual patient response.<sup>2</sup> There are three factors that determine a wire's stiffness and working range (elastic properties); the span, the cross sectional area, and the material composition of the wire. Arch wire selection may be based upon varying one or more of these factors.<sup>3</sup>

Until a few years ago, the traditional method of varying wire stiffness and range was

by changing the size of the wire (cross sectional area) and/the length or span of the wire (i.e., loops).<sup>4</sup> Modern metallurgical technology has now given us a third option of varying the material composition. This has greatly increased treatment options.

As more wire is added between two points (i.e., brackets), the resulting force given the same deflection, is reduced. The effect on force is a cubic relationship whereby doubling the length decreases the force by  $1/8^{\text{th}}$ . In the same manner decreasing the length by one-half will result in 8 times the force.<sup>5</sup>

While the effect of doubling the length decreases the force, it provides twice the amount of deflection or working range. In practice the appliance of choice (inter bracket width) somewhat establishes a limiting role over the length variable unless loops are bent into archwire segments.<sup>6</sup>

When the diameter of the wire is reduced in size, the forces are reduced by the  $4^{\text{th}}$  power of the difference in size (round wires) and to the third power for rectangular wires. Thus a reduction in diameter from .018 to .016 round wire (an 11% size reduction) will reduce the resultant stiffness approximately 40%.

Most wire diameter decisions are made on the assumption that the smaller diameter wires provide a much greater elastic deflection. Although this is true it might be clinically insignificant as maximum elastic

deflection varies inversely with the first power of the diameter. A reduction in diameter from 018 to .016 wire provides only a 15% increase in the amount of elastic deflection.<sup>7</sup>

The load deflection rate (stiffness) with this elastic property, reducing the diameter provides only minimal incremental elastic deflection while significantly altering the load deflection rates.<sup>8</sup> In addition smaller diameter wires are more susceptible to the forces of occlusion and the probability of arch wire distortions and or breakage within the mouth.

The utilization of length and cross section, alone provides a variety of load deflection rates given the use of only one material like stainless steel. However the incorporation of the third variable, material, has vastly increased the potential load deflection rates that can be utilized by the orthodontist in the selection criteria.<sup>9</sup>

Available load deflection choices continue to expand with new materials and an understanding of the relationships between the three influencing variables.<sup>10</sup> The ultimate goal of course would be the optimization of effective tooth movement between patient recalls providing maximum patient comfort with minimal treatment side effects.<sup>11</sup>

There is no easy way to recommend an ideal arch wire sequence without a clear understanding of all the variables.<sup>12</sup> Yet one thing is clear, with a good understanding of the relationships of the arch wires to the appliance

along with the good understanding of the working ranges and material values of the available wires, you will be able to choose the right wire for any phase of treatment.<sup>13</sup>

## DISCUSSION

Given the recent proliferation of wire alloy choices and sizes, the diverse treatment philosophies, and the empirical nature of orthodontics, it is most difficult to select the optimum wire for a particular situation. The following wire selection criteria are a few generalised that should help in narrowing the field.<sup>14</sup>

How much control is required? Is it an important treatment consideration to fill the arch wire slot, at this point in treatment, to gain or maintain torque control? A decision on control can limit wire selection to round or rectangular wires and to a narrow range of sizes.

What are the load / deflection requirements? Do the prevailing conditions call for a wire with high deflection or one which resists deformation? A decision on the load or deflection rate requirement can then further narrow the wide choices.<sup>15</sup>

Elastic or plastic wire working range? Do you wish to place a bend(s) in the wire? If the decision is to make a bend in the wire or to place loops, etc, you will automatically limit the wire choices to those wires which exhibit a good plastic range (i.e., stainless steel or TMA).

Wire cost vs value? If the three previous decisions have indicated the possible wire choice that include one of the most expensive alloys, will that wire return a value commensurate with its cost? <sup>16</sup> Some additional questions must then be posed: will the wire remain in place long enough to bring about the desired change? Is the desired correction localized or to be accomplished for several teeth, or will adding wire length with an adjustment loop in a stainless steel wire accomplish the same result as with a more expensive alloy with a high deflection? <sup>17</sup> What are the potential undesirable side effects from the wire selected and are these side effects controllable?

### CONCLUSION

Arch wires are designed and manufactured to deliver the best possible orthodontic performance in every treatment but providing the orthodontist with exactly the right combination of size, strength, elasticity, workability and other qualities necessary to move teeth effectively and minimize discomfort to the patient.<sup>18</sup>

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