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Nitinol in dentistry

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Abstract: An alloy of nickel and titanium In recent years, endodontic instruments have been made using nitinol. A lower modulus of elasticity and better strength are found in nitinol alloys when compared to stainless steel alloys. Because of their extremely elastic nature, Nitinol wires regain their original shape after deformation upon unloading. These qualities are interesting to endodontists because they make it possible to build root canal tools that take advantage of these advantageous traits to give them an advantage while creating curved canals. In order to fully understand the special qualities of nitinol alloys utilized in dentistry, this review attempts to give an overview of them.

Keywords: nitinol; nickel; titanium; dentistry.

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The nickel-titanium alloys that are utilized in dentistry have a temperature transition range and are composed of 55% nickel and 45% titanium. To reduce the temperature transition range, cobalt is used. The martinitic NiTi phase has a monoclinic, triclinic, or hexagonal structure, while the austenitic NiTi phase has a body-centered cubic structure. Furthermore, as the transformation progresses, a third form known as the R phase (rhombohedral) emerges as an intermediary phase. Changes in composition result in modifications to the mechanical characteristics and start and completion temperatures of martensitic and austenitic materials. As a result, several Ni-Ti alloy variants have been created for use in dentistry (1). The mechanical characteristics of an orthodontic nickel titanium alloy are contrasted with those of a beta-titanium alloy and stainless steel. The biggest spring back, or maximal elastic deflection, is found in nickel titanium alloys, which is significant when substantial deflections are required, like in cases with misaligned teeth. Between the three alloys used to make orthodontic wires, nickel-titanium has the lowest spring rate and the highest resilience. Clinically, a greater working range and lower, more constant stresses can be applied with activations due to the low elastic modulus and strong resilience (2). Shape memory effect may be seen in NiTi wire constructed of martensitic alloy that changes to an austenitic structure at body temperature (37 °C). Shape memory wires are often utilized in orthodontics because they have a better springback than superelastic wires (1). Conversely, endodontic instrument alloys have an austenite-finish temperature of roughly 25 oC (16), because only wires with austenitic finish temperatures lower than 37 oC show superelasticity. Super-elastic files are advantageous because they preserve the canal's shape closely without posing a risk of file breakage (3). The equipment induces a transition from austenite to martensite within the canal. Keep in mind that martensite has a modulus of 50 GPa and Ni-Ti austenite has a modulus of 120 GPa. Springback without permanent deformation and a return to the austenitic phase happen when the tension lowers. Ni-Ti's exceptional elasticity allows for 8% strain deformations in endodontic files while still allowing for full recovery. When compared to stainless steel instruments, this value is less than 1%. Furthermore, Ni-Ti alloys are better at creating curved root canals than stainless steel because they have lower moduli of elasticity (3). Still, forming the nitinol wire is not without its challenges. The orthodontic nickel wire is better suited for use with pre-torqued, pre-angulated brackets since it requires certain bending techniques and cannot be twisted over a sharp edge or into a complete loop. Additionally, wires must be linked mechanically because the alloy cannot be soldered or welded. (16) Unlike stainless steel endodontic instruments, which require a special apparatus to twist the starting wire, nickel-titanium endodontic instruments must be made by machining the starting wire (3). Nickel-titanium alloy finds numerous uses in the biomedical field, including endovascular stents, distraction osteogenesis appliances, and devices for mending fractured bones (4).

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