



## Recycling of Nickel Titanium Alloy Wires in Orthodontics

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Nickel titanium gained substantial popularity because of their desirable properties. Relative high cost has prompted clinicians to recycle these alloy wires. It was seen that 52% of the orthodontists using these wires recycled them. Recycling involved repeated exposure of the wire to mechanical stresses, oral environment sterilization and the combined effect of the above exposures could subject the wire to corrosion and cold working. According to Waters et al., Nitinol was susceptible to corrosion when subjected to either oral fluids or chloride solutions. Clinard et al. (1981) have reported that nickel titanium wires are as resistant to corrosion as stainless steel wires even though it showed tendency of pitting. This effect does not appear to be deleterious to mechanical properties of the wires or significantly affect the progress of orthodontic treatment. Edic et al (1981) Suggested that these wires are corrosion resistant and no evidence of pitting was usually seen [1].

Schwaniger et al. [2] (1982) in their study suggested that sporadic failure of nitinol orthodontic wire is due to the presence of surface defect generated during manufacturing and not to the effect of corrosion. The flexural properties were evaluated for both control and corroded samples of nitinol wire and were found to be not statistically different from the corroded samples immersed in a 1% NaCl solution at 37°C. Nicholson (1984) in his study suggested that reusing nitinol wire may face a decrease from the expected mechanical properties of the wire i.e. decrease in elasticity and increased susceptibility to permanent deformation. Andresen et al. [3] (1985) studies the physical properties of the thermodynamic nitinol alloy and found that the stiffness, flexural yield strength and permanent deformation were directly related to the increase in temperature between 75°F and

100°F. As the stiffness of this wire increases, yield point decreases.

Harris et al. [4] (1988) suggested that significant change in specific mechanical properties were observed in .016 inch nitinol wire which was unilateral in a simulated oral environment (37°C) for at least 1 month and upto 4 months when compared to dry, unstained samples. Significant decrease in tensile strength, modulus of elasticity and 0.2% yield strength were noted. Buckthal et al. (1988) studied that the effect of disinfectants likes 2% glutaraldehyde, chlorine dioxide and iodophoresis in mechanical properties and surfaces topography of nitinol and titinol wire. No detrimental changes were detected in the mechanical properties on surface topography of either of these wires. Miura et al. [5] (1988) studied the effect of direct elastic heat treatment method on the mechanical properties of Japanese NiTi and found that the excellent springback properties of the wire were not diminished.

Mayhew and Kusy [6] (1988) conducted a study on the effect of sterilization on the mechanical properties and surface topography of nickel titanium arch wire and no significant change were observed. Nitinol was stronger than titanol. Three heat treatment methods i.e. dry heat, formaldehyde, alcohol vapors and steam autoclave were used to determine the effect of sterilization on the mechanical properties and the surface topography of nitinol and titanol arch wire. Kapila et al. [7] (1991) in their study on the effect of clinical recycling on mechanical properties of nickel titanium alloys were observed that recycling produced a significant change in both the loading and unloading characteristics of NiTi wires, and only the loading forces associated with nitinol

wires. Scanning electron microscopic graphs demonstrated pitting on both nitinol and NiTi wires.

Smith et al. (1992) conducted a study on the effect of clinical use and various sterilization and disinfection protocols on three types of nickel titanium and one type of beta titanium and stainless arch wires. The sterilization / disinfectant procedures including disinfectants alone or with steam autoclave, dry heat or cold solution were used. No significant differences were found between new and used wires. Kapila et al. [8] (1992) noted significant changes in the load deflection characteristics of nickel titanium alloy wires after clinical recycling and dry heat sterilization. Dry heat sterilization as well as clinical recycling produced significant changes in the loading and unloading which was seen to increase significantly for both the types of wire after clinical recycling. Clinical recycling was seen to reduce the pseudoplasticity of NiTi wire and increase the stiffness of both NiTi and nitinol wire. Stagers in his study used three methods of sterilization, autoclaving, dry heat ethylene oxide, to determine the effect of sterilization on tensile strength of nickel titanium wires.

The sterilization procedures significantly produced increase in tensile strength of sentalloy wires although the mean strength after 5 sterilization cycles and after one cycle were not significantly different. In a study conducted by Huerter and Nikolai where .018 nitinol wire was exposed oral environment for 12 weeks and sterilized by ethylene oxide and tested, although change in mechanical properties had occurred these wires, according to them could be recycled [9].

And researchers like James E. Buthal and Robert P. Kusy support the use of these cold disinfectant procedures as part of infection control process if clinicians elect to reuse these wires. The results of investigation done by Smith and Fraunhafer they concluded that although these wires were subjected to various malocclusions, clinical handling techniques, lengths of time in the mouth and different sterilization protocols. Yet there was no overall clinically significant differences in the new and the used wires which agrees to the work by Huerter and Nikolai and these results suggested that nickel-titanium arch wire can be recycled at least once.

Although investigations done by different researchers agree to the fact that there is change in the mechanical

properties of recycled wires and unused wire small differences were seen and the clinical importance was negligible because of the small size of difference to cause any clinical concern [10].

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