Comparative Study of The Shaping Ability And Cleaning Efficiency of Three Rotary Ni-Ti Instruments
(In vitro study)

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By

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Dedication

To my loving father, mother and lovely helpful brother who always had confidence in me and gave unconditional support and love.

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Introduction

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Chemo-mechanical preparation of the root canal includes both mechanical instrumentation and anti-microbial irrigation and is principally directed toward the elimination of micro-organisms from the root canal system. This is followed by placement of root canal filling and canal restoration in order to seal potential avenues of entry of micro-organisms into the root canal and to entomb any remaining micro-organisms to prevent their proliferation.

Recently there have been significant technological advantages to facilitate root canal cleaning and shaping. New instruments have been developed employing super elastic alloys and novel engineering philosophies and there has been a notable departure from the ISO standard 2% taper (0.02mm/mm) instruments.

From a biological perspective, the goals of chemo-mechanical preparation are to eliminate micro-organisms from root canal system, to remove pulp tissue that may support microbial growth and to avoid forcing debris beyond the apical foramen, while the technical goals of canal preparation are directed toward shaping the canal so as to achieve the biological objectives and to facilitate placement of high quality root filling. Canal shaping should be performed with respect to the unique anatomy of each root and fulfilling the mechanical objectives for optimal instrumentation where: *the canal should* be *continuously tapering funnel from the access cavity to the apical foramen, root canal preparation maintaining the path of the original canal, the apical foramen remaining in its original position, the apical opening kept as small as practical*.

Historically, a variety of different techniques have been developed for preparation of canal using ISO 0.02 tapered **st**ainless **st**eel (St.St.) hand files, but canal systems vary through multiple geometric planes and curve significantly more than the roots therefore, the step-back technique when employed in curved canals, often results in iatrogenic damage to the natural shape of the canal due to the inherent inflexibility of all -but the smallest- St.St files resulting in uneven force distribution in certain contact areas and tendency to straighten inside the canal adopting complications as ledges, perforations or excessive thinning of the canal wall transportation or zipping . In an effort to reduce the incidence of iatrogenic defects, step-down techniques were developed.

For about two decades, the introduction of Ni-Ti alloy has permitted the manufacture of extremely flexible instruments which are capable of preparing curved canals with less straightening compared with St.St instruments.

Errors observed with the traditional stainless steel files are now markedly reduced. At the beginning nickel titanium files were used as hand instruments but their cutting efficiency was low, this led the manufacturers to use them as rotary instruments with controlled torque and reduced speed to improve its cutting efficiency. Manufacturers continue to introduce Ni-Ti systems into the market with new designs, tapers, and surface treatment claiming more efficiency, increased safety and ease of use.

So designing a study to compare the shaping ability and cleaning efficacy of newly introduced rotary Ni-Ti system with two commercially used systems may be beneficial.

Review of Literature

Review of literature

About Ni-Ti alloy:-

This alloy was introduced to the world in **1960** by **Buehler** [29]**,** a metallurgist who was investigating non-magnetic, salt resisting and water proof alloy for the spaceships program, he named it Nitinol: an acronym for its components; **Ni**ckel **Ti**tanium **N**aval **O**rdinance **L**aboratories. By continuing his research, he found its unique properties of shape memory and super-elasticity by special heat treatment. Super-elastic behavior means that on unloading they return to their original shape before deformation as defined by **Lee *et al.* (1988)** [89] **and Serene *et al.* (1995)** [142].

Nickel Titanium alloy at high temperature is referred to as austenite phase while at low temperature it is referred to as martensite phase. Transformation from austenitic to martensitic phase can also occur as a result of stress, as occurs during root canal preparation (stress-induced martensitc transformation). Plastic deformation that occurred in the alloy within or below 125^{o}C -known as transformation temperature range- is recoverable within certain limits. This has been termed by **Buehler and Wang in 1968** as *"mechanical memory"* [30].

In 1978 Andreasen and Morrow [8] compared the Ni-Ti alloy to st.st and found that it has greater strength and lower modulus of elasticity. The corrosion behavior of Nitinol orthodontic wires was compared with St.St by **Sarkar *et al.* (1979)** [124]. Scanning electron microscopy (SEM) revealed that Nitinol alloy was the only specimen to exhibit a pitting type corrosion attack. **Edie and Andreasen (1980)** [39] examined nitinol wires under SEM as received from manufacturer and following one month to one year use in the mouth and found no corrosion of the Nitinol wires with maintenance of a smooth, undulating surface.

To assess corrosion potential, **Edie *et al.* (1981)** [40] compared Nitinol wire with St.St wire in clinical use for periods ranging from 1-8 months, obvious pits occurred on electrolyticaly corroded Nitinol wires, with loosely bound corrosion products; however after clinical use, no differences in surface characteristics were obvious when comparing pre and post-operative SEM photographs. There were no significant differences between the surface oxygen content of Nitinol compared to St.St which would suggest that there were no differences in the clinical performance of the two wires, in terms of corrosion.

In **1988 Mayhew and Kusy** [95] examined the effects of dry heat, formaldehyde-alcohol vapor and steam autoclave sterilization on the mechanical properties and surface topography of two different nickel-titanium arch wires. No detrimental effects were noted and the arch wires maintained their elastic properties, which led the authors to conclude that stabilized martensitic alloys as Nitinol could be heat sterilized without deformation.

Walia *et al*. in 1989 [173] found that by cooling the Ni-Ti alloy through a critical transformation temperature range (TTR), the alloy shows dramatic change in its modulus of elasticity (stiffness), yield strength and electric resistivity as a result of changes in electron bonding and also there is a change in crystal structure and this is known as martensitic transformation. The phenomenon causes a change in the physical properties of the alloy and gives rise to the shape memory and super-elastic characteristics. In **1995**, **Serene *et al.*** [142] tried to heat the alloy above 125^{o}C (reverse transformation temperature range) and found that this may remove any deformation within the Ni-Ti instruments.

Load-deflection characteristics of Ni-Ti wires after clinical recycling and dry heat sterilization were examined by **Kapila *et al.* (1992)** [75], it was observed that recycling these wires after sterilization causes significant changes to loading and unloading forces with reduction in super-elasticity of Ni-Ti wires and increase in