SHAPING ABILITY OF THREE DIFFERENT NICKEL-TITANIUM ROTARY INSTRUMENTS (IN VITRO STUDY)

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By

YASER OSAMA ALGOHARY
B.D.S Faculty of Dentistry, Ain Shams University
(2012)

Faculty of Dentistry
Ain Shams University
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Supervisors

Dr. ABEER ABDELHAKIM EL GENDY

Professor of Endodontics
Faculty of Dentistry
Ain Shams University

And

Dr. MOHAMED MOKHTAR NAGY

Associate Professor of Endodontics
Faculty of Dentistry
Ain Shams University

بسم الله الرحمن الرحيم

(رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحاً تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ)

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Yaser Algohary

Dedication

I would like to dedicate this work to my parents for their support.

List of content

List of Figure

List of Table

List of abbreviation

NiTi	Nickel-titanium
NOL	Naval Ordnance Laboratory
Af	austenite finish temperature
R-phase	Rhombohedra microstructure-phase
CM	controlled memory
wt	weight
TiO	Titanium oxide
GT	Great Taper
TF	Twisted file
PP	Pathfile-ProTaper
μCT	Microscopic computerized tomographic
CBCT	Cone beam computed tomography
Mb	Mesio-buccal
ML	Mesio-lingual
WL	Working lenght
PG	ProGlider
PTN	ProTaper Next
WO	Wave one
PT	ProTaper
RS	Revo-S

OS	One shape
MS	Mani silk
PTG	Protaper gold
UnO	UnicOne
HR	Hero 642
CEJ	cementoenamel junction
HF	Hyflex CM
IR	iRaCe
Rcp	Reciproc
TFA	TF Adaptive
SS	stainless steel
SMI	structure model index
SAF	Self-Adjusting File
mA	Milli ampere
3D	3 dimension
EDTA	Ethylenediaminetetraacetic acid

Introduction

Root canal shaping is a crucial procedure in endodontic treatment that influences the subsequent steps of root canal disinfection and obturation. The principles of root canal shaping are to form a continuously tapering funnel from the coronal access cavity to the root apex, preserving the original canal shape, and sustaining the integrity and location of the apical canal anatomy. However, procedural errors during instrumentation such as ledging, zipping, perforations, root canal transportation, and instrument separation can happen, especially when preparing curved canals. .

Preparation can be achieved by using stainless steel files or rotary Nickel-titanium (NiTi) instrumentation, the super elasticity of NiTi alloy provides enhanced flexibility and facilitates the NiTi rotary instruments to efficiently follow the original path of the root canal. Accordingly, NiTi rotary instruments have become an imperative adjunct for root canal shaping.

In recent years, there have been considerable improvements in of the design, the method of manufacture and the metallurgy of NiTi rotary instruments to improve their clinical performance.

Revo-s introduced in 2008 a sequence of 3 instruments of continuous rotation with asymmetrical cross-section that facilitates penetration by a “snake-like” movement. Debris elimination improved by the upward removal of the generated dentine debris. **One shape** endodontic file has been introduced in 2012, it is a single file shaping system of continuous rotation with asymmetrical cross-section. **Mani silk file** introduced in 2015, It’s a heat treated file and has a tear drop cross sectional design that move in continuous rotation rotary files system, which may be reciprocated.

Studying the shaping ability of these different rotary NiTi instruments (Revo-S, One shape and Mani Silk file) seems to be of great interest

REVIEW OF LITERATURE

I. Development of Rotary Nickel titanium (NiTi) instruments:

Over the years, NiTi alloys have become indispensable materials in endodontic treatment. This alloy had displayed an array of interesting properties, such as shape memory, superelasticity and cyclic fatigue resistance arise from reversible crystallographic changes. Before the advent of NiTi instruments, Gates Glidden drills and stainless-steel hand files were used to shape canals. While predictable results were possible using these instruments, iatrogenic risk (including canal transportation and block age, lengthy treatment, hand fatigue and complex treatment were frequent challenges.

In the 1960s, Buehler and wang [1] developed Nitinol wire while working at the Naval Ordnance Laboratory in White Oak, Maryland. The name Nitinol was derived from nickel, titanium, and the three letter acronym for the Naval Ordnance Laboratory (NOL). It is more commonly referred to as nickel titanium, or NiTi.

In 1988, Walia *et al.* [2] milled Nitinol orthodontic wires as prototype endodontic files and compared their bending and torsional properties to stainless steel files. They found that the nickel titanium files were two to three times more flexible in bending and torsion, and more resistant to torsional failure. canal preparation was shown to cause less transportation and more centered preparations compared to stainless steel files [3,4].

Nickel titanium alloys which are used to manufacture endodontic instruments are generally equiatomic mixtures of nickel (56% by weight) and titanium (44% by weight) [5,6]. NiTi can undergo solid phase transformations between three different crystalline structures: austenite (referred to as the parent phase), martensite, and R-phase. The changes between phases is classified as a diffusionless transformation, where atoms move in small coordinated ways to change the crystalline structure of the metal.[7]

The austenite phase is a stable cubic crystalline structure which is considered the parent phase of the alloy because it can be recovered once the alloy is heated above a certain temperature[6]. The temperature at which transformation from martensite to austenite (or the reverse) is complete is called the finish temperature. The ability of the metal to return to a parent phase once above the transition finish temperature is termed shape memory, one of the distinguishing features of NiTi [8].

Another important property of NiTi is its superelasticity and is a result of stress induced transformation from the austenite to martensite phase. Deformation of up to 8% strain (vs. 1% in stainless steel) can occur as a result of this phase change without plastic, or permanent, deformation [5,6,8].

Brantley *et al.* [9] found that in studying instruments made from superelastic NiTi, the austenite finish temperature (Af) was 25◦C which indicated that the files would be completely austenite at room temperature. An x-ray diffraction method employed by Kuhn *et al.*[10] also showed that files made with superelastic NiTi were composed of solely austenite at room temperature.

The martensitic phase consists of a closely packed hexagonal lattice [6], which allows for the large recoverable strain without permanent deformation. Application of force results in the twinned martensite formation of the crystal structure to a de-