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# The principles of techniques for cleaning root canals: Review

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**Abstract**---Chemomechanical root canal preparation involves both mechanical instrumentation and antibacterial irrigation, and is aimed primarily at removing microorganisms from the root canal system. For this essential step of root canal therapy, a number of devices and procedures have been developed and described. Nickel-titanium (NiTi) rotary devices have been a standard in clinical endodontics since their debut in 1988 because of their excellent ability to form root canals with possibly fewer procedural problems. Basic metallurgy of the alloy, including fracture processes and their relevance to canal anatomy, is required for safe clinical use of NiTi devices. This study examines the biological principles of root canal preparation, with a focus on the proper use of contemporary rotary NiTi instrumentation techniques and systems. The role and properties of contemporary root canal irrigants is also discussed.

**Keywords**---nickel-titanium alloy, root canal instrumentation, rotary preparation, irrigation, endodontics.

**Introduction**

The prevention or cure of apical periodontitis is a primary goal of endodontic therapy<sup>1</sup>. The major cause of apical periodontitis is bacterial infection of the root canal<sup>2,3</sup>. Bacteria infiltrate and populate the whole root canal system in teeth

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with apical periodontitis, and therapy focuses on removing microorganisms from the root canal system and preventing re-infection<sup>3</sup>. The essential stage in canal disinfection is chemomechanical preparation of the root canal using a mix of mechanical equipment and antibacterial irrigation. Following that, a root canal filling and coronal restoration are placed to seal any possible pathways for microorganisms to enter the root canal<sup>4</sup>

## **Principles of Chemomechanical Preparation**

### **Biological Purpose**

The goal of chemomechanical preparation, from a biological standpoint, is to remove pulp tissue and bacteria from the root canal system while also preventing debris from being pushed into the apical foramen and causing inflammation<sup>4</sup>. One of the most significant aspects in reducing the quantity of germs in infected root canals is the use of mechanical devices. After instrumentation with stainless steel files and irrigation with physiological saline. The decrease of germs following 0.04 taper instrumentation on NiTi rotary instrumentation with stainless steel K-file and step back method was reported by Dalton et al the administration of a dressing material/root canal medicament in the root canal has been shown to remove any residual germs<sup>5</sup>

### **Mechanical Objective**

Root canal preparation, according to Schilder, must be done properly in relation to the varied anatomy of the root canal and the technique of root canal filling. The following are some mechanical goals for good instrumentation<sup>5,6</sup>. The anatomical form of the root canal must be preserved during root canal preparation. The root canal modifications take on an hourglass form, and they may result in insufficient cleaning as well as additional issues such ledging, root perforation, or excessive root canal wall cutting<sup>2</sup>The anatomical location of the apical foramen must be maintained. The apical foramen can be damaged during mechanical root canal preparation, resulting in a distinctive elliptical form known as foraminal rip, zip, or tear<sup>7</sup>.

### **Manual Instrumentation Techniques**

Using ISO specified 0.02 tapered stainless-steel hand files, a range of various procedures for canal preparation have been established in the past suggested a step-back approach that comprised first preparing the apical portion of the root canal, then coronal flaring to enable obturation<sup>8</sup>. Step-down procedures were created to limit the frequency of iatrogenic abnormalities by starting with bigger instruments at the canal opening and working down the root canal with increasingly smaller files<sup>9,10</sup>

### **Rotary Niti Instrumentation**

Since the introduction of the NiTi rotary instrument in 1988, there has been a shift away from manual rotational preparation and toward mechanization<sup>11</sup>. According to recent study, this new technique is gaining enough

traction to become the favoured way (See Figure 1). 1st Figure At ISO or standard taper, the diameter of a 2 percent taper instrument rose by 0.02 mm for every mm in length from D1 to D16. For every millimetre of taper on the instrument, the optimal diameter improved by 0.06 mm (6 percent taper). The best diameter on the instrument taper increased by 0.06 mm (6% taper) for every mm of lengths D1 to D16.<sup>12,13</sup>

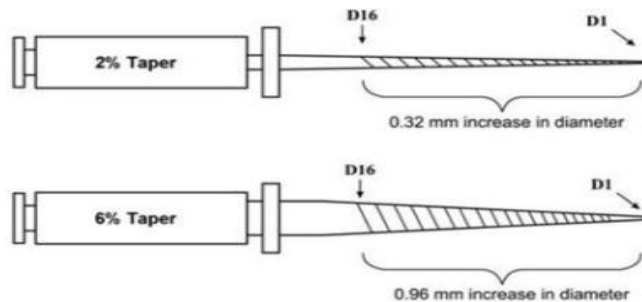
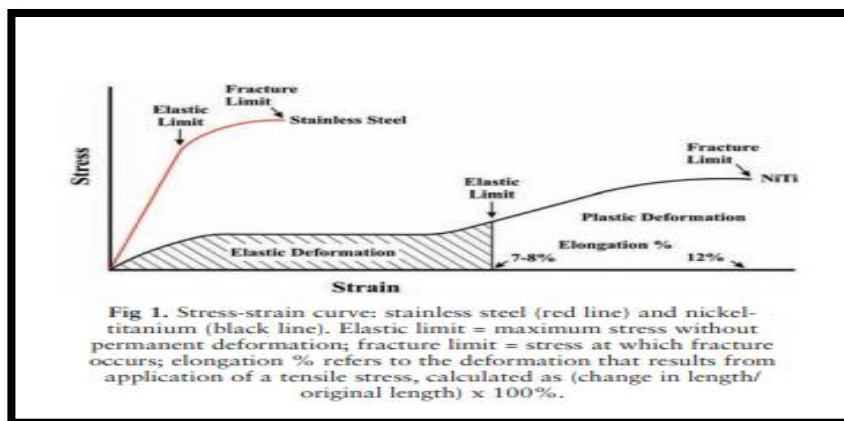


Figure 1. The diameter of a 2% taper instrument increased by 0.02 mm at every mm in length from D1 to D16 at ISO or standard taper. The best diameter on the instrument taper increased by 0.06 mm (6% taper) for every mm of lengths D1 to D16.<sup>14</sup>

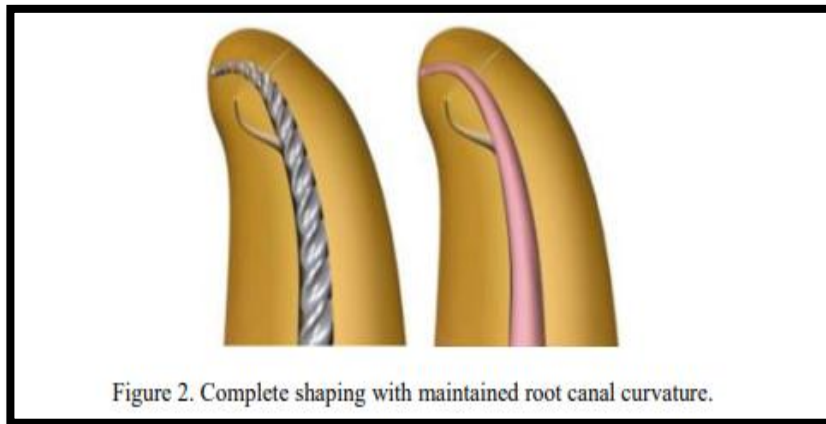
### Metallurgy of Niti Alloys

Nitinol is a nickel-titanium alloy that is used to make endodontic tools. It is made up of roughly 56 percent nickel and 44 percent titanium<sup>12</sup> NiTi instruments' superelasticity is due to a stress-induced phase shift in the material's crystalline structure. NiTi's superelasticity allows it to fully recover deformations of up to 8% strain, compared to less than 1% for alloys like stainless steel (Fig 1)<sup>14</sup>



### Ability for Root Canal Shaping

Because of its capacity to produce root canals with fewer procedural difficulties, the NiTi rotary file has become popular in the clinical endodontics sector<sup>12,15</sup>



### **Cleaning Ability**

Endodontic tools have been studied for their capacity to remove debris from root canals, which is normally analysed using light- or scanning electron microscopy discovered that employing rotational NiTi instruments to instrument bigger file sizes resulted in much cleaner canals in the apical 3mm than manual instrumentation.<sup>14</sup>

### **Working Duration**

Some studies have found that working time is reduced when rotary NiTi is used instead of manual instrumentation, while others have found no difference.<sup>16</sup>

### **Instrument Fracture**

All endodontic devices have the potential to cause root canal fractures if used incorrectly. While the prevailing consensus among dentists is that NiTi rotary devices cause more fractures than stainless steel hand files<sup>17,18</sup>. When the tip or section of an instrument gets trapped into the root canal during the rotational procedure, torsion fractures develop. Torsional fractures are more prone to develop with lower file sizes when the instrument is subjected to extreme apical force. Metal fatigue causes flexural fractures when files are used on curved root canals. It is advised that instruments be destroyed after use to minimize flexural fractures<sup>19,20</sup>.

### **Root Canal Irrigants**

Antimicrobial irrigating solutions must always be used in conjunction with root canal instrumentation. Despite technological advances in the ability to shape root canals, at least 35% of root canal surfaces remain uninstrumented and due to the anatomic complexity of the pulp space, cleaning of the canal in terms of soft tissue removal and bacterial elimination relies heavily on the adjunctive action of chemically active irrigating solutions. Irrigation is also used to lubricate tools and eliminate the smear layer that accumulates on instrumented dentine surfaces<sup>21</sup>. Root canal irrigants should ideally have a broad antimicrobial spectrum with

robust action against endodontic pathogen biofilms, dissolve pulp tissue remains, prevent or dissolve the formation of a smear layer during instrumentation, and have low caustic or allergic potential<sup>22,23</sup>. Because of its high antibacterial and proteolytic action, sodium hypochlorite (NaOCl) is the most appropriate irrigation material for use in any instruments. 25 percent, is commonly used for root canal irrigation. Tissue toxicity and caustic potential rise in tandem with bactericidal activity and tissue dissolving capability as NaOCl concentrations rise. However, when 5 percent NaOCl was utilised during instrumentation instead of 0.5 percent, the decrease of germs in the root canal did not rise considerably, according to various studies.

### **Ethylenediamene Tetraacetic Acid (EDTA) Solution**

EDTA (17%) is a chelating chemical that removes calcium ions from dentine's inorganic component, demineralizing it. To eliminate the smear layer formed by root canal instrumentation, EDTA irrigation has been recommended. EDTA irrigation alone is unable to dissolve the smear layer entirely, leaving the organic component remaining.<sup>24</sup> Smear layer removal is most successful when a mixture of EDTA and NaOCl is used. After the canals have been shaped, they can be extensively washed with EDTA to dissolve the smear layer. This should be followed by a final rinse with NaOCl to aid in the removal of debris<sup>25</sup>.

### **Ultrasonic Use to Enhance the Cleaning of Root Canal System**

The use of ultrasonic-activated tools can help clean the root canal system by agitating the irrigation fluid. Acoustic cavitation and streaming are two processes that can cause air bubbles to grow and burst in liquids<sup>26</sup>.

### **Alternative Concepts in the Cleaning of Root Canals**

The difficulty of reliably sterilising an infected root canal system using currently known treatment procedures has sparked research into innovative approaches aimed at completely eradicating intracanal microbes. In photo activated disinfection (PAD), a photosensitizer-containing solution is injected into the root canal and binds to bacteria's cell walls<sup>27</sup>

### **Conclusion**

Root canal therapy, from a biological standpoint, is aimed at removing microorganisms from the root canal system and preventing reinfection. Chemomechanical root canal preparation, which includes both mechanical instrumentation and antibacterial irrigation, is the single most essential stage in pulp space disinfection. The use of rotational NiTi devices has resulted in remarkable increases in the ability to shape root canals with perhaps fewer procedural difficulties. While interventions like greater apical expansion or a more efficient antimicrobial irrigation routine may help reduce microbial load, predicted elimination of germs from the root canal is still a long way off. More clinical research is needed to achieve full root canal disinfection.

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