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Clinical Review

Smart Advancement Technique (SAT): A Clinical Approach for Management of Severely Curved Root Canals

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Abstract

Aim: The aim of this scientific work is to explain the shaping of root canal system efficiently and economically using the SAT.

Objectives: The SAT is a flexible technique designed to shape all the root canals, where it reduces the risk of instruments fracture, allows a smooth transition between instruments, decreases ledges or transportation formation and minimizing the iatrogenic mishaps.

Introduction: Last years, many different instrumentation techniques have been proposed starting from "Step-back" technique to the "Crown-down" technique to the "Single-length" technique. Moreover, Morphological variations of root canal system became so popular, and no single rotary system can do all the endodontic cases specially the severely curved root canals, where hybridization of rotary systems becomes a must.

Technique: The Smart Advancement Technique includes five sequential steps for shaping of the root canals. It simplifies the hybridization concept where there is a mix between different NiTi rotary systems and the usage of manual stainless steel instruments is involved. This technique mainly depends on rotary files from which we get benefit from either their heat treatment technology or cross section modifications.

Conclusion: The SAT depends on using a simplified, reproducible and clinical approach, where it can be applied for all root canal cases, helping to reduce the risk of instruments fracture and decreasing the formation of ledges or transportation where the economic part is taken into consideration.

Keywords: *Clinical Approach; Hybridization; Root Canal Shaping; Rotary Systems; Endodontic Instruments*

Introduction

The root canal treatment steps include mechanical preparation and obturation.

Since morphological variations of the root canal anatomy becomes more evident nowadays due to the great technology in magnification or x-ray imaging devices.

With these variations, advances in root canal materials, instruments, devices and techniques were a must to cope with these anomalies, aiming to provide an efficient, quick, economic and decent root canal treatment. Endodontic instruments undergone continuous innovation since the introduction of nickel titanium alloy in the mid-90s, although the mechanical and biological objectives stated by Schilder[1] are still the same for about 40 years. Since then, numerous types and various modifications have been proposed in the endodontic instrumentation field.

Technique

After many years of clinical experience and doing many root canal treatment cases using different rotary systems, reaching a standardized clinical approach for management of severely curved canals was achieved, leading to safe, efficient root canal preparation. This technique depends mainly on hybridization between different rotary systems by different companies. This technique can be used in severely curved root canals, long roots and very narrow canals.

It comes in a five sequential steps using endodontic instruments made of stainless steel and nickel titanium, where manual and rotary types are incorporated together. The five sequential shaping steps must be done in exact order for maximum efficiency and predictability (Table 1).

Scouting	Coronal Flaring	Glide Path	Shaping	Recapitulation
Manual	Rotary	Rotary	Rotary	Manual
Stainless steel	NiTi	NiTi	NiTi	Stainless steel
W.L	Coronal Third	W.L	W.L	W.L
	Single file	Single file	Multiple Files	

Table 1: *Steps for the SAT.*
NiTi: Nickel Titanium

The first step is scouting and ensuring patency, that is done with an International Organization for Standardization (ISO) manual stainless steel instruments of small tip diameters (0.10, and 0.15) with a standard taper (0.02). These instruments are used in a watch winding motion till reaching the estimated working length and sometimes file precurving is mandatory to this step.

Then, the 0.10/0.02 file is used to determine the working length using electronic apex locator or radiographic method and will be used as a patency file in all the other steps of the technique. The patency step is mandatory before proceeding with any other step during the root canal treatment. Sometimes working length determination is postponed to be done after the second step.

The second step involves the coronal third flaring of the root canal, using nickel titanium rotary instruments which are specific for this purpose (in continuous rotation), which must have some specific features as large resistant tip diameter either 0.25 or 0.30, large taper from 0.08 to 0.12 with shorter instrument length and working part. These instruments are used only in the first coronal 3 to 5 mm of the root canal.

The objective of this step is to remove the dentin triangle at the orifice and canal interferences which allows a straight line access. Coronal flaring instruments should be used in a brushing motion on the outer canal walls specially in molars to avoid strip perforations at the dangerous zone (inner walls). For this step, using One Flare file (Micro-Mega, France) would be very beneficial due to its average size of its non-cutting tip 0.25 and moderate taper 0.09. This file is made of T-wire technology where the file undergone a special thermal treatment for more flexibility so that it can adapt to the coronal third curvatures if present. Also, One Flare has a modified triple helix cross with variable helix angle helping for more upward debris removal.

The third step is creating a smooth glide path, using nickel titanium rotary instruments which are exclusively used for that purpose (in clockwise continuous rotation), Glide path files must have the following characteristics; a small tip size ranging from 0.10 to 0.20 and moderate taper from 0.03 to 0.05. These tools must reach the working length either in one or two waves.

They can be either a multiple files system of two or three instruments, or a single file system. Glide path is the creation of a smooth radicular tunnel extending from the apical foramen to the orifice. These instruments are the first rotary files to reach the working length helping to ensure that slight resistance will be applied on the shaping files in the next step.

This step can be done easily using One G file (Micro-Mega, France), as this file have some features serving to reach the working length safely even in severely curved root canals. The combination of small non-cutting tip of size 0.14 with a 0.03 taper along the file length, combined with the asymmetrical cross section of this instrument, serves to provide more flexibility and less incidence of ledges creation with more removal of debris coronally.

These three steps of the technique are the safe key for the next step where they ensure that the shaping files will be less prone to fracture incidence or forming ledges or transportations within the root canal.

The fourth step in this technique is the shaping step of the root canal, using either rotary or reciprocating instruments. Many files with different characteristics are present in the market depending on different manufacturers. Files used can be either a Single file system or Multiple files system. The instruments of this step must reach the premeasured working length.

The goal of this step is to shape the canal on the working length with a file of 0.25 tip diameter and a taper of 0.06. This size helps in achieving a proper disinfection of the root canal system using most of the irrigation devices. Moreover, it enables filling of the root canal with thermo-plasticized gutta-percha effectively. But, in cases of severely curved root canals, achieving 0.06 diameter is very difficult so 0.04 taper with tip size of 0.25 is suggested to be the final shaping file.

This step involves three files that will be used in sequential order where gradual increase in tip size and taper will be done to avoid any iatrogenic mishaps.

The first file is N2 file of Smarttrack X3 Rotary system (Nikinc Dental, Netherlands), which is 0.17 tip size and 0.04 taper. This file is of modified triple helix cross section and undergone annealed heat treatment enabling it to be highly flexible file with controlled memory feature and with moderate cutting efficiency. Followed by Hyflex CM file (Coltene, Switzerland) of tip size 0.20 and taper 0.04 with controlled memory and more resistant to cyclic fatigue, so less incidence of file separation. This file shows extreme flexibility so it has the ability to follow the canal anatomy and decreases the risk of ledging, transportation or perforation, but decreased cutting efficiency. The third file for shaping is TS1 of 2Shape Rotary system (Micro-Mega, France) which is 0.25 tip size (Non-cutting) and 0.04 taper. In this point exactly, the canal is already prepared to 0.20/0.04 so a file with good cutting efficiency and flexibility is needed to give the final size of the shaping step. The 2Shape rotary system is thermally treated and made of T-wire technology providing good flexibility while maintain the NiTi resiliency. The cross section of this file is asymmetrical cross section with two cutting edges and 1 offset cutting edge, helping for good cutting efficiency and less resistance on the file respectively. Moreover, this design helps for more upward debris removal so less apical extrusion of debris and hence, less post-operative pain. After using this file, the shaping procedure has ended and proper disinfection should be carried out followed by the obturation phase.

The fifth step in SAT, is the recapitulation step which is the insertion of a small diameter file to the working length to ensure the patency and total canal debridement. This step must be done in between each rotary file used in the second, third and fourth steps of the proposed technique to maintain the apical portion free of debris and avoid packing of dentin in this critical area. A file of size 0.10 or 0.15 of ISO taper 0.02 can be used throughout the whole technique, while a file of size 0.25 of ISO 0.02 can be used after finishing the preparation.

This shaping technique is hence called Smart Advancement Technique where there is advancement inside the canal either in tip size or diameter but in a smart way allowing a smooth transition between all the rotary files used.

This helps in achieving more safety while using the rotary instruments and at the same time providing adequate shaping for the root canal.

The dilemma of shaping severely curved root canals is now solved where shaping of the canals could be done efficiently using these files where maximum benefit is gained from each file according to its characteristics.

It is not always advised to do the mechanical preparation step with single file although it can be done, but in severely curved root canals, single file technique can be used for some steps but not for the whole mechanical preparation method. Sometimes the size 10 K file can't reach the end of the root in the patency step where working length by X-ray can be taken and more information about the case

can be obtained (Figure 1). After coronal flaring with One Flare, all interferences in the coronal third of the root canal are eliminated so that the size 10 K file can reach the radiographic apex ensuring patency of the canal (Figure 2). Then a glide path step now can be applied and ensuring that further instruments in the shaping step can be used safely. After the end of mechanical preparation, a master cone X-ray is mandatory to ensure that shaping principles are applied for the obturation phase (Figure 3). Two postoperative X-rays in different directions are a must to confirm the obturation step (Figure 4-6).

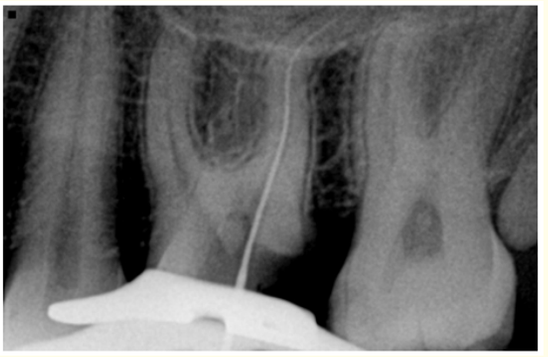

Figure 1: *Working length X-ray: Initial scouting to the DB root of Maxillary Left First Molar with size 10 K file.*

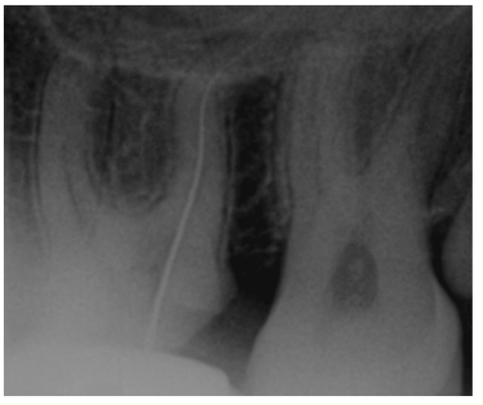

Figure 2: *Trying to ensure patency to the DB root with size 10 K file.*

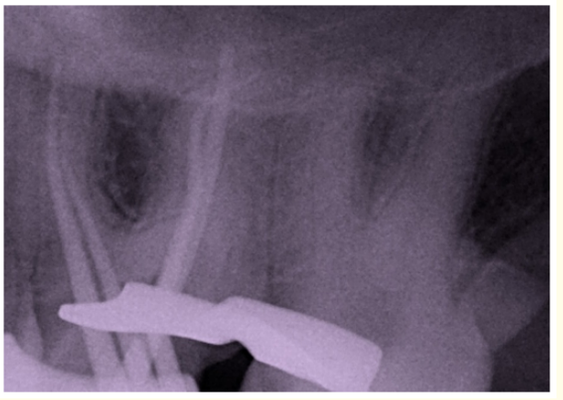

Figure 3: *Master Cone X-ray, showing the abrupt severe curvature of the DB root.*

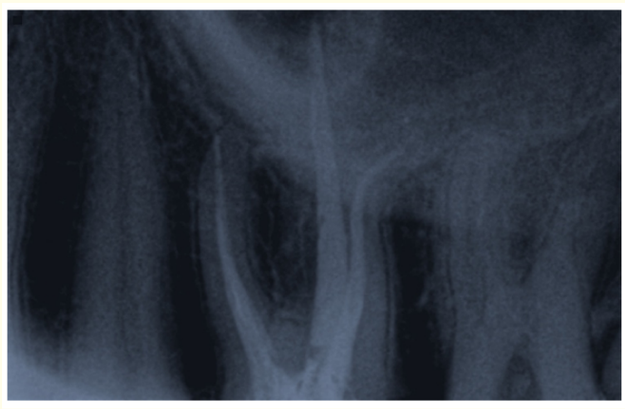

Figure 4: *Postoperative X-ray.*

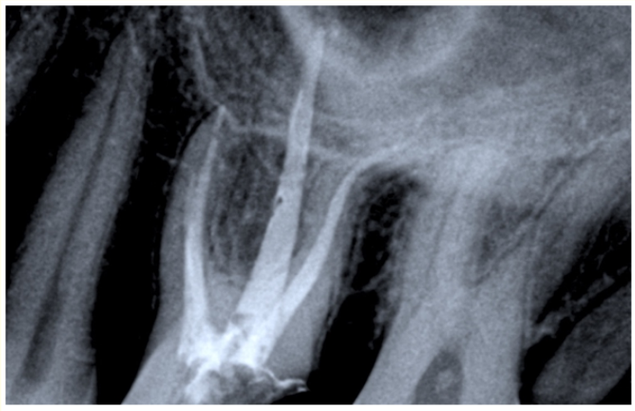

Figure 5: *Postoperative X-ray showing the degree of curvature of the DB root.*

Figure 6: *Highlighting the DB root only with different angulation, working length was 26.5 mm.*

Discussion

Having many techniques for root canal shaping such as "step-back" technique [1] which was first introduced by Schilder using manual stainless steel files in apical coronal manner starting by the smallest diameter to the largest ones followed by obturation [2]. The other techniques such as "step-down" or "crown-down" [3,4] were further introduced. In the "crown-down" technique, the mechanical preparation is done in a coronal-apical direction starting by the largest instruments followed by smaller ones till the actual working length. After that, a hybrid approach was proposed where a mix between the two mentioned techniques was encoded [5].

Also, there were many different concepts and techniques for root canal shaping suggested by many authors as Riitano [6-11] who explained all techniques in relation to root canal morphology or Ruddle [12-15], who also assured the importance of endodontic access cavity as initial step before the root canal preparation. The "simultaneous" technique was later introduced by Malagnino., *et al* [16-18]. In this technique, a crown down approach is applied where all the rotary files are used to the full working length (Single length technique).

Gallottini [19-21] assured the necessity for mixing shaping techniques and rotary nickel titanium instruments in case of curved canals and complex cases. Mounce [23] stated the importance of manual scouting with stainless steel hand instruments before the mechanical preparation by rotary files.

Ruddle and Machtou [24-26] showed the different options for doing the glide-path step, where they emphasized the importance of new geometries of the mechanical nickel titanium instruments. Ruddle [12-15] also proposed different concepts and strategies for root canal shaping. Riitano., *et al.* [27] and Ruddle [28] showed the importance of apical third preparation and finishing step.

Conclusion

Lately, there has been a great advancement in the field of endodontics [29] with huge continuous technological development in all tools used in this field.

These changed the approaches for successful root canal treatment but still the axioms of endodontic shaping and teeth morphology are the same [30], although development in diagnostic tools such as Cone Beam CT and microscopes made the anatomy of the teeth clearer and evident [31]. The technology helped a lot to increase the efficacy and efficiency of endodontic treatment by reducing treatment time, decreasing operational errors, increasing rate of success and improving the predictability of the cases done even by general practitioners.

Provided that the objectives of endodontic shaping procedure remain constant and are being followed till the day, it is a necessity to reach to a standardized, well defined and sequential clinical approach through which shaping step can be done easily even in cases of severely cured root canals which are considered one of the most challenging cases. This approach will provide the desired outcome of endodontic success whatever the skills, knowledge or experience of the operator.

The use of this technique will incorporate the use of endodontic instruments from different manufacturers, creating a hybridization technique that aims to improve the endodontic treatment regardless of manufacturers' recommendations. Knowing that no single rotary system can perform all the endodontic cases and that no dental company produced a system which can be useful in all cases, the necessity to integrate different rotary files from different systems for better results became a must and that may provide more guaranteed and better results.

Our Technique shows five steps only and 5 rotary files too, but depending on the severity of the case where number of files may decrease but the steps are quite the same. This flexibility will allow more reduction in the operating time and more patient comfort eventually.

This technique offers a simplified clinical approach for management of root canal cases according to their complexity. The use of this technique make the root canal shaping step easier even for non-experts.

For these reasons, Smart Advancement Technique (SAT) is recommended.

Clinical Significance

The smart advancement technique is a root canal preparation technique, which is based on a simple, standardized and flexible clinical approach, which is found to be safe, easy, effective, economic and predictable.

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