ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4

Journal of Coastal Life Medicine

Comparative Evaluation of Effectiveness of Startx and Endo Success for Instrument Retrieval Under Dental Operating Microscope - An In - Vitro Study

Received: 20 October 2022, **Revised:** 16 November 2022, **Accepted:** 14 December 2022

Dr. Vishwesh Prashant Joshi,
P.G. Student, Department of Conservative Dentistry and Endodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Dr. Kailash Attur,
H.O.D. and Professor, Department of Conservative Dentistry and Endodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Dr. Nikunj A. Patel,
Reader, Department of Conservative Dentistry and Endodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Dr. Shylaja Attur,
H.O.D. and Professor, Department of Oral & Maxillofacial Pathology and Oral Microbiology, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Dr. Prateek Pachore,
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Dr. Sidharth Menon,
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Corresponding Author: Dr. Vishwesh Prashant Joshi,
vpjoshi.fds@spu.ac.in

Keyword:
Instrument separation, Ultrasonic instrumentation, StartX system, Endo Success system

Abstract:
Introduction: A curved, tortuous canal comes with a challenge of avoiding instrument fracture. Considering the mild diameter of the instrument tip which is expected to cut a substance as hard as dentine. It is remarkable that few instruments are broken. This study was undertaken to evaluate the efficacy of two ultrasonic system Endo Success and StartX in retrieval of fractured instrument from root canals.

Material and Methods: 40 extracted permanent Mandibular First molar which was randomly assigned as 2 groups corresponding to the StartX and Endo Success which was used during the treatment to evaluate their efficacy in removing separated instrument.

Results: Mean time required for removing file fragments was more in StartX system (51.25 ±

7.85 minutes) than Endo Success system (33.80 ± 5.80 minutes). Statistically, significant difference was present in time mandatory for removing file fragments between StartX system and Endo Success system. Most probably result in higher success rate and at the same time minimalize the quantity of dentin forfeited in Endo Success system.

Conclusion: Better visualization combined with a conservative approach selectively removing tooth structure. Tough situations in which exact tip design of Endo Success system permits access to limited work areas offer chances that are not possible with StartX system.

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

1. Introduction:

"The dentist who has not fractured the tip of a reamer, file or broach has not treated many root canals." A curved, tortuous canal comes with a trial of instrument fracture. As the slight diameter of the instrument tip which is expected to cut a substance as hard as dentine. It is notable that very few instruments are broken.

Endodontics, come with a variety of procedural complexities that could be encountered at any stage of treatment, one of which being intra-radicular instrument separation. The separation of an instrument in Endodontics can alter the case, from simple case to hard case. Instrument separation in endodontics is tough and its incidence ranges from 4% to 10% for the cases treated.[1]

Ultra-sonic tips are designed specially which improve safety and success of removal procedure. In this technique, a staging platform is prepared by dry ultrasonic instrumentation about the fragment which is followed by ultrasonic vibrations in the presence of irrigating solution. This whole procedure is achieved under the direct visualization and illumination of an operating microscope.

With the advantage of an operating microscope in the field of dentistry all procedures can be performed with more accuracy and precision. Magnification and illumination from a microscope enhance vision and allows clinicians to perceive the most coronal aspects of broken instruments and to eliminate them without any perforation. Dental microscopes are accommodating for the removal of fractured instruments. These advantages can be associated with any technique for retrieval of fractured instrument.[2]

Fractures of Ni-Ti rotary instruments are imminent despite their favorable qualities and increased use. The success rate of methods that can be used in the removal of separated instruments from different levels in curved and straight canals.

Hence the study was undertaken to evaluate the efficacy of two ultrasonic system Endo Success and StartX in recovery of fractured instrument from root canals.

2. Materials and Method:

In-vitro study was carried out in the Department of Conservative dentistry and Endodontics at Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, after taking ethical approval from the Institutional Ethical Committee with the registration number of a research proposal as NPDCH/IEC/2021/13.

40 extracted Permanent Mandibular First Molars were randomly assigned to 2 groups corresponding to the instrument retrieval systems to evaluate for their efficacy in removing separated instrument.

Permanent Mandibular First Molar with mature root apex and root curvature not more than 30^0 with long axis was included in the study. Teeth with fractured root, calcified canals, root resorption, developmental anomalies, open apex, decayed teeth, and previous root canal treatment were excluded.

With the use of computers, two reference lines were generated on a digital radiograph (Dimaxis version 4.1.6; Planmeca, Plandent, Finland). The angle of the root canal curvature was generated by two lines. For the investigation, teeth with root curvatures of 200 to 300 were chosen (Figure 1). Deroofing was done after opening the access cavity with an endo access bur and an Airoter. Following the determination of the canal working length, biomechanical preparation using rotary endodontic files with a 06% taper and an ISO size of 25 was carried out. Saline solution was used to irrigate the canal during the biomechanical preparation. Neo-endo Profile rotary Ni-Ti files with an engine were chosen. Orifice shaper #2 and 06% taper rotary endodontic instrument, ISO size 15 (Neo-endo), was used to extend the orifice openings and canals before inserting file. Instruments were notched to a depth of half the instrument thickness with a high-speed diamond disc at a 5-mm distance to enable their fracture in the curvature of the canal. Samples were randomly divided into 2 groups Endo Success system and StartX system. Each group had 20 samples. To recover the visibility to the fractured instrument, the canal was forcefully flushed from time to time with normal saline before opening ultrasonic procedures. All ultrasonic work below the orifice was accomplished continuously irrigating

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

with normal saline. A low- power setting was used to stop the fracture of ultrasonic tips as suggested by the manufacturer. These tips were used in a counter-clockwise direction to achieve dry ultrasonic troughing about the coronal part of an instrument to expose it. During the ultrasonic action the fractured instrument started to loosen, unwind and spin. An energized tip was gently wedged between the fractured instrument and the canal wall. Vibrations brought the fragment out of the canal.

Time duration taken for retrieval of instrument by each system and weight of tooth at instrument separation and after instrument separation was recorded and data was sent forstatistical analysis. RVG was taken pre-operatively after breaking the instrument in the canal and postoperatively to confirm instrument retrieval (Figure 2 and Figure 3).

Data was analyzed using SPSS version 20.0. Following statistical tests were done. Unpaired T test, paired T test for categorical variables was used. $P < 0.05$ measured statistical significance.

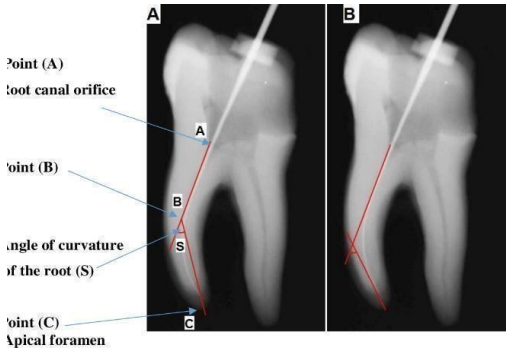


Figure 1: Shidler's angle measurement technique

Figure 2 Pre-Operative Radiograph

Figure 3 Post-operative Radiograph

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

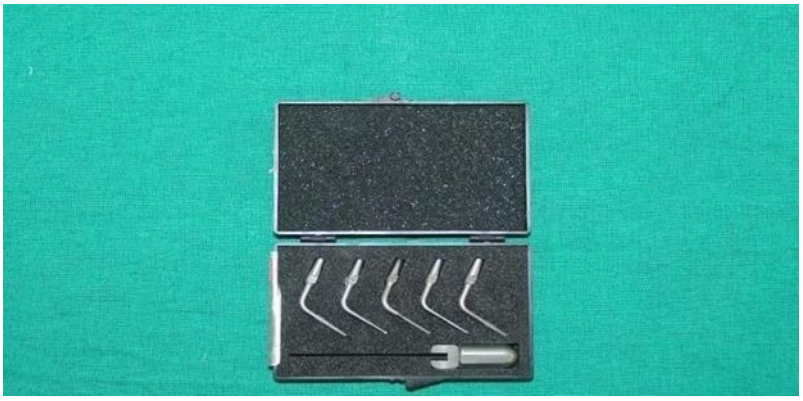


Figure 4 StartX ultrasonic system

3. Results:

Mean time required for removing file fragments was more in StartX system (51.25 ± 7.85 minutes) than Endo Success system (33.80 ± 5.80 minutes). Endo Success system took less time for instrument retrieval than the StartX system and the duration was statistically significant with p≤ 0.05 (Table 1).

The present study showed that no significant difference was present in teeth weight between StartX system and Endo Success system before and after removal of file fragment (Graph 1, Table 2) which suggests that both the system effectively retrieved the instrument fragment without compromising much of the dentin wall.

Table 1- Time required for removing file fragments between StartX system and Endo Success system

Groups	Number	Time required for removing file fragments (Min.)		P value
		Mean	SD	
StartX	20	51.25	7.85	≤ 0.05*
Endo Success	20	33.80	5.80	

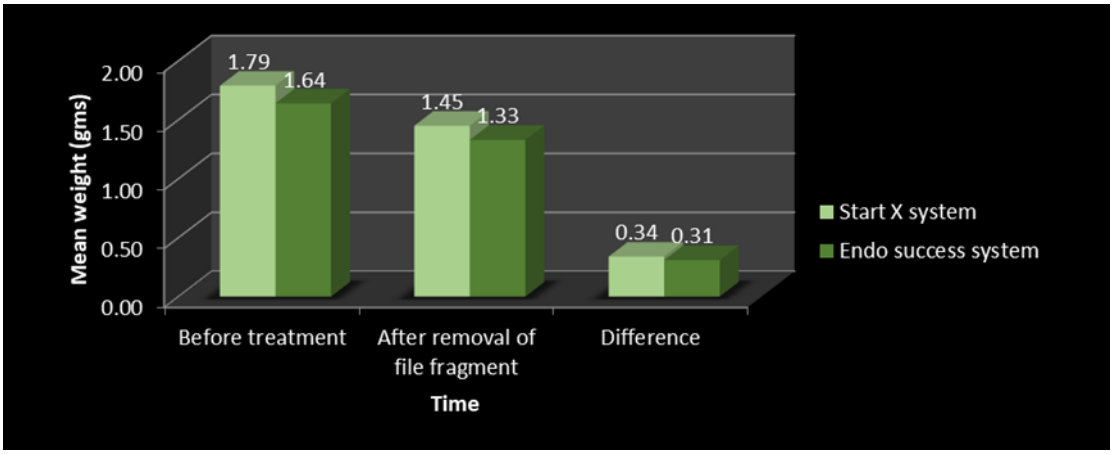
Table 2- Teeth weight between Start X system and Endo success system

Time	Groups	Number	Teeth weight (gms)		P value
			Mean	SD	
Before treatment	Start X system	20	1.79	0.29	> 0.05**
	Endo success system	20	1.64	0.38	

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

After removal of file fragment	Start X system	20	1.45	0.34	> 0.05**
	Endo success system	20	1.33	0.41	
Difference	Start X system	20	0.34	0.22	> 0.05**
	Endo success system	20	0.31	0.21	

Graph 1 Teeth weight between StartX system and Endo Success system



4. Discussion:

The root canal system needs to be cleaned for endodontic treatment to be successful. Intracanal file separation is nevertheless a troublesome occurrence that can take place even in the absence of obvious evidence of irreversible distortion.

Several metallurgical modifications have been done to improve the fracture resistance of the alloys during intracanal use. Ni-Ti files have been described to be 4 times stronger, more flexible and have larger resistance to torsional fracture compared to stainless steel files.[3]

Rotary Ni-Ti endodontic instruments have been indicated chiefly in the preparation of curved root canals. The largest concern with Ni-Ti endodontic files has been their fracture which occursbecause of torsional fatigue or cyclic fatigue. Torsional fracture happens if the tip of the endodontic instrument remains immobilized and torque greater than the fracture strength limit ofthe instrument is applied.

The rotational force to the right permits "flow limit" of the Ni-Ti alloy causing plastic deformation located in the helical shaft of the instrument. Deformation surges mechanical hardening of the material. The continuous increase in torque can cross the limit of fracture resistance of the instrument producing it to break into two parts close to the immobilization point. Torsional fracture to occur during the clinical use is necessary for the tip of the instrument to be immobilized inside the root canal while the torque of the hand piece connected to an electric motor is applied at the other extremity.

The cycle repetitions of these stresses endorse cumulative micro-structural changes that induce nucleation of cracks that increase and spread until the fatigue fracture of die endodontic instrument. Fracture occurs when the instrument is rotated in a curved canal which could occur due to anatomical diversity of the root canals which make it incredible to safely control the number of cycles and the intensity of stresses in the cyclic fatigue region.[4]

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

The preoperative state of the periapical tissues has a major impact on the prognosis of cases with detached instruments. The canal can be properly cleaned and filled once an instrument is removed or bypassed. Endodontic treatment without surgery is more preferable and cautious. Usually, the damaged tool makes it impossible to reach the root apex. This may affect the technician's capacity to adequately clean, disinfect, and obturate the entire root canal system.[5]

Before attempting to remove broken instruments, a number of variables must be taken into account. It is important to weigh the likelihood of success against any potential difficulties. The prognosis is affected by the location of the shattered instrument. When a large tool breaks during the latter stages of cleaning and shaping in the coronal portion of the canal, prediction is most accurate. The prognosis is worse for canals that haven't been cleansed at all and when a little instrument has been used to split the tissue close to the apex.[6]

Since the heat produced by the ultrasonic instruments could melt the resin blocks and decrease the cutting efficiency of the ultrasonic tips, removed teeth were preferred in the current study over resin blocks. Teeth extractions enable more accurate evaluation of ultrasonic removal techniques in medical settings.

Mesio-buccal canals of permanent mandibular first molar teeth were selected because they are frequently involved in instrument fracture. ISO size 25 and 06 rotary instruments were preferred as fractured instrument at a length of 5.0 mm. It is the most common master apical file size and fractured instrument length. Neo-endo rotary instruments were selected for retrievalas the literature reports sparse studies with this system.

Several techniques can be used depending upon the difficulty level and individual situations like Specialized forceps, Ultrasonic removal, H-files, Braiding technique, Microtube removal methods. Instrument removal kits like Masserann Kit, Endo Extractor, Instrument Removal System, the Extractor system, and the Mounce Extractor can be used.

Ultrasonics in endodontics was first introduced by Richman in 1958. Ultrasound is sound energy with frequency above the range of human hearing which is 25 kHz. There are two methods of producing ultrasound which are magneto strictive and piezoelectric. Piezoelectric technology has more advantages compared to the former as it produces more cycles and works in a linear, back and forth motion. This applies for troughing for hidden canals or when removing posts and separated instruments. The technique applies use of piezoelectric ultrasonic technology along with the use of specific ultrasonic instruments. An ultrasonic generator delivers a broad range of power.

Ultrasonic instrument should be of contra-angled design to provide access to all regions of the mouth, should have parallel sided walls to create a line of sight between the instrument and the tapered canal and should have non aggressive costings such as zirconium nitride to precisely remove dentin.

Suitable length of the instrument should be chosen that it contacts the fragment easily. Deeper the fragment, longer and thinner should be the instrument.[7]

All ultrasonic instrumentation below the orifice is conducted with compressed air stream visualization if the energized tip against the broken instrument is likely. The ultrasonic tip and both the dentin and broken instrument generate heat that can be transmitted to the external root surface and then to the periodontium. They can potentially produce enough heat to raise the temperature of the external root surface by 15° C or more.[8]

Temperature raises of the periodontal ligament in excess of 20°C can cause damage to the attachment apparatus. To overcome this disadvantage thinner and smaller diameter ultra-sonic tips at lower power setting along with irrigating regimen minimize the risk of high temperature during activity. The ultrasound device does not have tips with water ports. There should be an assistant to use a continuous coolant air/water spray during usage. Frequent breaks should be taken to let the tooth cool down and high-power settings should be evaded.

Richman unveiled the StartX kit in 1957. For endodontic application, StartX ultrasonic tips offer significant benefits for cleaning access cavities and removing broken tools. The best results are obtained when using ultrasonic tips under the control of the dentist operatingmicroscope with a light brush

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

contact and low power. The cutting surface of StartX tips is madeup of longitudinal rounded micro-blades that are separable by grooves. The grooves between the blades aid in cooling and dirt removal while increasing efficiency and precision. StartX tips after being applied to extracted teeth to create a 1.7 mm-deep cavity. Compared to tips with diamond coating, it tends to collect a lot less trash. The StartX tips have water port that allow an actual cooling of the dentin during their use.[9]

The StartX tips are robust; under long-term, continuous clinical usage, they show no tendency to break or deform. StartX tips are functional for cutting dentin. When the tips are utilised with water, the cutting efficiency appears to be compressed. To cool the dentin and get rid of dentinal dust, the water ports can be intermittently activated. Compared to diamond tip preparations, which are noticeably more uneven and rougher, StartX was able to create cavities that were symmetrical and smooth. The operating microscope or the human eye can see more clearly when using StartX tips since they are made with a 110° angle between the shaft and the cutting surface.Overall, StartX has 5 tips (Figure4).

Another ultrasonic technique used in this study is Endo Success. Endo Success has total 5 tips. The CAP1 tip has a non-active end to prevent the risk of perforating the pulp chamber floor. Themicro-blades are not as much as aggressive than diamond and their coating makes these tips verydurable. Due to its very sharp point the CAP3 tip must be handled with care.

Introduction of operating microscope in endodontics, has been a significant addition to the profession's armamentarium. The increased magnification and illumination have better thetreatment possibilities in retreatment procedures.

Treatment modalities that were not possible in the past have become reliable and expectable. The operating microscope has enabled the clinician to work in a more comfortable ergonomic position. Enhanced visibility has enhanced the performance of various endodontic procedures.[10]

Vertical root fracture is commonly seen in instrument retrieval cases caused by using any of the ultrasonic techniques; it can be reduced by attributing the preparation of staging platform under dental operating microscope. When utilised correctly and cooled with water and air during the removal of broken instruments, microsonic procedures do not produce enough heat to endanger the attachment apparatus.

Endo Success system has a non-active, diamond-coated steel and rounded end of the tip that appearances smooth with concentrated cutting ability, most probably result in higher success rate. StartX tips can be used in a variety of situations, allowing the dentist to choose the best one for the job. StartX tips may vibrate in the air without breaking since they are comprised of stainless steel that has been hard-tempered for increased resilience to wear and strain.[11]

Our research shows that the Endo Success method has a greater success rate while also sacrificing less dentin than expected.

5. Conclusion:

It makes sense that removing fragmented shards from canals presents a problem for Dental practitioner. Location of the fragment and the anatomy of the root canal, affect the success of fractured instrument management. The present study showed that Endo Success system took lesser time for instrument retrieval than the StartX system and both the system could retrieve the instrument fragment without compromising much of the dentin.

In order to remove broken pieces, ultrasound is used in conjunction with a dental operating microscope. A collection of novel approaches and tools should constantly be used in the procedure to remove separated instruments. Consequently, the Endo Success technology has a better success rate while minimising the amount of dentin sacrificed.

Acknowledgement: We are thankful to Dr. Rahul Patel of Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India for his cooperation in this study.

Financial support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interests.

References

[1] El-Kishawi M, Khalaf K. An Update on

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

root canal preparation techniques and how toavoid procedural errors in endodontics. Open Dent. J. 2021 Aug 24;15(1).

[2] Tomer AK, Guin A, Sabharwal G, Saini N. Dental operating microscope in endodontics:enlarged vision & success. Int. J. Clin. Dent. 2022 Aug 17;3(2):29-39.

[3] Zanza A, D'Angelo M, Reda R, Gambarini G, Testarelli L, Di Nardo D. An update on nickel- Titanium rotary instruments in endodontics: mechanical characteristics, testing and future perspective—an overview. Bioeng. 2021 Dec16;8(12):218.

[4] Silva, Emmanuel JNL, et al. "NiTi Rotary Systems: From Revolution to the "More of the Same" Phenomenon." Shaping for Cleaning the Root Canals. Springer Sci. Rev, 2022. 127-157.

[5] Van der Vyver PJ, Vorster M, Jonker CH. Modern considerations when approaching fractured endodontic instruments-Part 2: A review of the literature and clinical techniques. S. Afr. Dent. J. 2020 Nov;75(10):564-574.

[6] Pillay M, Vorster M, Van der Vyver PJ. Fracture of endodontic instruments-Part 1: Literature review on factors that influence instrument breakage. S. Afr. Dent. J. 2020 Nov;75(10):553- 563.

[7] Terauchi Y, Ali WT, Abielhassan MM. Present status and future directions: Removal of fractured instruments. Int. Endod. J. 2022 Apr 4.

[8] Park E. Ultrasonics in endodontics. Endod Topics. 2013 Sep;29(1):125-159.

[9] Patel B. Endodontic Armamentarium. Endodontic Diagnosis, Pathology, and TreatmentPlanning: Mastering Clinical Practice. 2015:117-140.

[10] Aqrabawi J, Al-Hadidi A, Zaghlan RA. The Use of Magnification, Loops, and Light Source in Daily Endodontic Practice. J Int Dent Medical Res. 2021 Jan 1;14(1):350-359.

[11] Salim S, Feroze Raheem D, Kumar GA, Ch T, Mustafa M, Vajpayee A. Ultrasonic inEndodontics Saudi J Dent Res 2019 jan 21;15(2).