ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 4, Issue – 4, July - 2021, Page No. : 236 - 240

Buckling Resistance of Pathfinders for negotiation of root canals

[1]Ram Arun Bhojane, Post graduate student, Dept of Conservative Dentistry & Endodontics, ACPM Dental College, Dhule, Maharashtra, India.

[2]Kavita Rudagi, Professor, Dept of Conservative Dentistry and Endodontics, ACPM Dental college, Dhule, Maharashtra, India

[3]Zinnie Nanda, Professor and Head of the department, Conservative dentistry and Endodontics, ACPM Dental college, Dhule, Maharashtra, India

[4]Sayali H Khandale, Post graduate student, Dept of Conservative Dentistry & Endodontics, ACPM Dental College, Dhule, Maharashtra, India.

[5]Jasmeet Kaur, Post graduate student, ACPM Dental College, Dhule, Maharashtra, India.

[6]Prasad Rane, Reader, Dept of Conservative Dentistry & Endodontics, ACPM Dental College, Dhule, India

Corresponding Author: Ram Arun Bhojane, Post graduate student, Dept of Conservative Dentistry & Endodontics, ACPM Dental College, Dhule, Maharashtra, India.

Citation of this Article: Ram Arun Bhojane, Kavitarani Rudagi, Zinnie Nanda, Sayali H Khandale, Jasmeet Kaur, Prasad Rane, “Buckling Resistance of Pathfinders for negotiation of root canals”, IJDSIR- July - 2021, Vol. – 4, Issue - 4, P. No. 236 – 240.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Endodontic hand instruments which are used for the negotiation of constricted root canals must exhibit small dimensions and possess mechanical strength to resist torsion and buckling so as to bear the loads on them during apical canal negotiation. This study compared and evaluated the buckling resistance of the following endodontic pathfinders: Canal probe (THOMAS, France), C+ file (Maillefer/Dentsply, Ballaigues, Switzerland), Pathfinder TM file (Sybron endo, Mexico) and size 10 k-file (Mani, Vietnam).

Objective: To compare and evaluate the buckling resistance of three endodontic pathfinders on application of axial apical pressure.

Methods: The test instruments were subjected to a devised buckling resistance test, which consisted of the application of an increasing load in the axial direction of the instrument by using a universal testing machine.

Keywords: Buckling resistance, Path finding files, Calcified canals.

Introduction

Negotiation of the calcified root canal is an important treatment step as we explore the anatomic apex of the tooth which is supposed to be the origin of the pathology.

On early exploration, the clinician must confirm the number of canals located, establish an unrestricted access to the most apical part of the canal, and gauge the diameter of the anatomic apex (1, 2).

Endodontic instruments of smaller size and taper display a greater resistance to mechanical torsion and buckling, and are hence recommended for negotiating calcified canals, as they are better able to sustain the loads imposed on them during apical progression.(3)

For the exploration of fine tortuous root canals, the instrument is first directed apically until it reaches a binding point along the canal wall. Then a watch-winding (left and right rotating motion along an arc) or a quarter-turn/pull movement is applied while keeping the file engaged with a light inward pressure until it approaches the apex. (4)

Repetition of this motion, gently directs the instrument further ahead within a narrow calcified canal. (4)

Buckling is the phenomena in which an endodontic instrument is subjected to elastic lateral deformation under a compressive load directed along its axis. (5).

Instruments with a low buckling resistance develop elastic or plastic deformation that deters their progression into the apical portion of the canal. (6)

In recent years, several hand operated and engine driven instruments have been introduced for path finding purposes. (7)

These pathfinding instruments display adequate buckling resistance and simplify both the location of orifices as well as provide an unimpeded access to the apical portion of the canal. (7)

There are only few studies comparing their mechanical properties.

Numerous factors influence the performance of pathfinding instruments (7), however buckling resistance is one such significant property that has not been investigated thoroughly.

This study evaluated the buckling resistance of endodontic pathfinder instruments and compared the maximum load required to bring about buckling of four different groups of pathfinder instruments.

Materials and Methods

The following instruments as pathfinders were evaluated in this study:

- **Canal probe (THOMAS, France):** Stainless steel instruments with a nominal diameter in D0 of 0.10 mm and a length of 25 mm; the instrument taper is 0.01mm/mm from the tip to the rest of the shaft with ISO size of 12.
- **C+ file (Maillefer/Dentsply, Ballaigues, Switzerland):** Stainless steel instruments with a nominal diameter in D0 of 0.1 mm and a length of 25 mm; the instrument taper is 0.04 mm/mm in the first 4 mm from the tip and 0.02 mm/mm along the rest of the shaft of instrument.

Pathfinder ™ file (Sybron endo, Mexico): Stainless steel instruments with a nominal diameter in D0 of 0.20 mm and a length of 25 mm; the instrument taper is 0.02 mm/mm from the tip to the rest of the shaft with the ISO size 7.

Size 10 k-file (Mani,Vietnam): Stainless steel instruments with a nominal diameter in D0 of 0.10 mm and a length of 25 mm; the instrument taper is 0.02 mm/mm along the entire shaft.

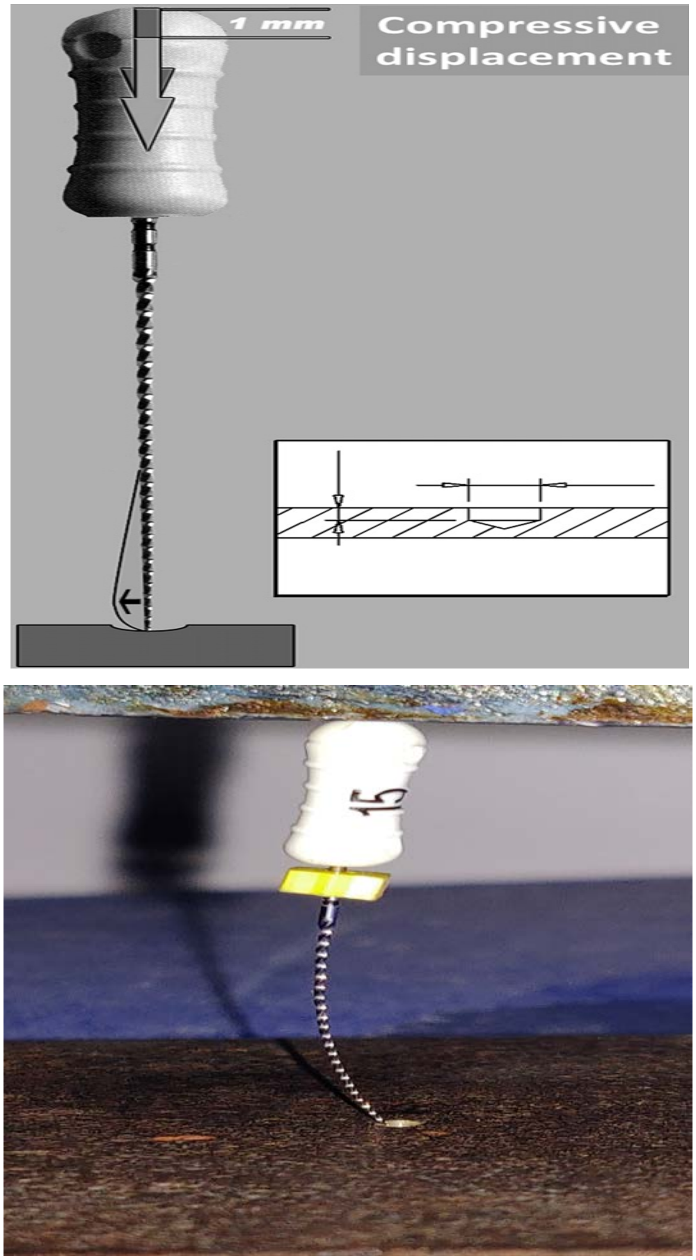

Fig (1) & (2)

Six specimens of each instrument were used in the test. For the buckling test, an increasing load was applied in the axial direction of each instrument by using a universal testing machine (DL 10.000; Emic, S~ao Jos_e dos Pinhais, PR, Brazil). A load cell of 20 N was used and the maximum load for elastic lateral deformation i.e (buckling) was recorded.

The handle of the instrument was fixed to the universal testing machine. Instrument tip was positioned in contact with the bottom of a small cavity prepared onto the aluminium plate (Fig. 1). The cavity was prepared with a 0.5-mm round bur.

The load was applied in the axial direction from the handle to the tip, with a speed of 1 mm/min until a lateral elastic (compressive) displacement of 1 mm is recorded. During the buckling test, it was possible to obtain for each instrument a diagram of load (N) _deformation (mm). The maximum load which was needed to induce the elastic displacement of the instrument up to 1 mm was considered as the buckling resistance of the instrument.

Data were statistically evaluated by the analysis of variance test and the Student-Newman- Keuls test for multiple comparisons, with a significance level established at 5% ($P < .05$).

Results

The results for the buckling test are shown in Table 1. Statistical analysis showed a significant difference in the maximum load necessary to buckle the 4 instruments tested ($P < .05$). The highest values were recorded for C+ files and the lowest values for PathFile instruments.

Table 1 : Results of buckling test

Values	N	Std. Deviation	Std. Error	Minimum	Maximum	Mean
1	6	0.08262	0.03373	1.05	1.27	1.17
2	6	0.01633	0.00667	0.33	0.37	0.35
3	6	0.01472	0.00601	0.24	0.27	0.25
4	6	0.04665	0.01905	0.46	0.57	0.52

Table 2: ISO sizes. Taper and Mean load values until instrument deformation.

Instruments	Size	Taper(mm/mm)	Mean Load(N)
C+ files	15	0.04 (first 4 mm from the tip)	1.17
10-k files	10	0.02	0.35
Pathfinder file	7	0.02	0.25
Canal probe	12	0.01	0.52

Table 3: Intergroup comparison values.

Student-Newman-Keuls

Groups	N	Subset for alpha = 0.05			
		1	2	3	4
3	6	.2583			
2	6		.3533		
4	6			.5217	
1	6				1.1767
Sig.		1.000	1.000	1.000	1.000

Discussion

In geriatric patients, negotiation of the calcified canals is a stressful and challenging task for an endodontist and it may lead to the instrument separation (8). Chances of ledges and the perforations can occur during the exploration of narrow curved canals which may affect the prognosis (9). Most of the small conventional k-type instruments when rotated on its axis in root canal for several 360 degree twist, shows deformation, so range of materials specifically advocated for negotiating the canals as pathfinders have been introduced. (10)

Instruments evaluated in the present study, differed in terms of taper, sizes, and alloy manufacturing process. However, according to the manufacturer's instructions these instruments are indicated for negotiation of calcified canals. Therefore these instrument groups were included in the present study.

Various methods are employed to check the performance of these files. Allen et al performed a study on path finding instruments and emphasized on the importance of path finding instruments to resist buckling. (7)

The method used in this study for the buckling resistance analysis applied an axial load to the instrument with the help of the universal testing machine. This was simple to perform and could be reproducible. The results obtained for the test instruments can be explained by the different tapers and sizes.

In this study, the C+ files has shown the maximum buckling resistance followed by canal probe, 10k-file and Pathfinder file respectively. C+ file have shown the better results because of the difference in the taper sizes (4% from D_o-D_4 ; 2% from D_5-D_{16}) and number of the flutes as compared to the other files used in this study. Owing to its greater taper design, the C+ file is more rigid, and may perhaps bind earlier in a fine restricted canal. But, the C+ file resists deformation due to their quadrangular cross section design.

Lopes et al, conducted a similar study in 2012, and concluded that stainless steel instruments such as C and C Pilot were more resistant to buckling than Nickel titanium and Carbon steel instruments; the results of which are coherent with the current study. In the study they found that the C plus files have shown the better results in negotiation of the curved canals.

Canal probe and 10k file have shown less resistance to buckling than C+ file which is supposed to be attributed to the smaller instrument taper (1% & 2% respectively) and ISO sizes (12 &10).

The Pathfinder file is manufactured from a non-heat tempered alloy with a comparatively reduced file size (ISO size-7). Therefore it shows expectedly a greater degree of the flexure that is the lesser buckling resistance.

However, more clinical and mechanical tests to evaluate the other factors influencing the buckling resistance of the endodontic instruments should be performed

Conclusion

Within the limitations of this study, the buckling resistance of C+ file is highest followed by canal probe, 10k-file,Pathfinder file respectively.

References

1. Peters OA, Peters CI. Cleaning and shaping of the root canal system. In: Hargreaves KM, Cohen S, eds. Cohen's Pathways of the Pulp, 10th ed. St. Louis, MO: Mosby/Elsevier; 2010:283–348.

2. Siqueira JF Jr, Lopes HP. Chemomechanical preparation. In: Siqueira JF Jr, ed. Treatment of Endodontic Infections. London: Quintessence Publishing; 2011:236–84.
3. Machado R, Silva EJ, Vansan LP. Constricted Canals: A New Strategy to Overcome This Challenge. Case reports in dentistry. 2014 May 11;2014.
4. Jafarzadeh H, Abbott PV. Ledge formation: review of a great challenge in endodontics. Journal of endodontics. 2007 Oct 1;33(10):1155-62.
5. Beer F, Johnston E, DeWolf J. Mechanics of materials, 5th SI Edition. Stress. 1999;1(10):1-2
6. Serene TP, Adams JD, Saxena A. Nickel-titanium Instruments Applications in Endodontics. St. Louis, MO: Ishiyaku Euroamerica Inc; 1995.
7. Allen MJ, Glickman GN, Griggs JA. Comparative analysis of endodontic pathfinders. Journal of endodontics. 2007 Jun 1;33(6):723-6.
8. Ibarrola JL, Knowles KI, Ludlow MO, McKinley IB Jr. Factors affecting the negotiability of second mesiobuccal canals in maxillary molars. J Endod 1997;23: 236–8.
9. Kobayashi C. Penetration of constricted canals with modified K files. J Endod 1997; 23:391 3
10. Gutmann JL, Lovdahl PE. Problem Solving in Endodontics. Prevention, Identification, and Management, 5th ed. Maryland Heights, MO: Elsevier/Mosby; 2011.
11. Lopes HP, Elias CN, Siqueira JF Jr, et al. Mechanical behavior of pathfinding endodontic instruments. J Endod 2012;38:1417–21.
12. Elias CN, Lopes HP. Materiais Dent_arios—Ensaios Mec^anicos. S~ao Paulo: Livraria Santos Editora; 2007.
13. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. J Endod 1988;14:346–51.
14. Brau-Aguade E, Canalda-Sahli C, Berastegui-Jimeno E. Cutting efficiency of K-files manufactured with different metallic alloys. Endod Dent Traumatol 1996;12: 286–8.
15. Ajuz NC, Armada L, Gonc¸alves LS, et al. Glide path preparation in S-shaped canals with rotary pathfinding nickel-titanium instruments. J Endod 2013;39:534–7.
16. Alves Vde O, Bueno CE, Cunha RS, et al. Comparison among manual instruments and PathFile and Mtwo rotary instruments to create a glide path in the root canal preparation of curved canals. J Endod 2012;38:117–20.
17. Elnaghy AM, Elsaka SE. Evaluation of root canal transportation, centering ratio, and remaining dentin thickness associated with ProTaper Next instruments with and without glide path. J Endod 2014;40:2053–6.
18. Arias A, Singh R, Peters OA. Differences in torsional performance of single- and multiple-instrument rotary systems for glide path preparation. Odontology 2016; 104:192–8.
19. C¸ apar ID, Kaval ME, Ertas H, Sen BH. Comparison of the cyclic fatigue resistance of 5 different rotary pathfinding instruments made of conventional nickel-titanium wire M-wire, and controlled memory wire. J Endod 2015;41:535–8.
20. Allen MJ, Glickman GN, Griggs JA. Comparative analysis of endodontic pathfinders. J Endod 2007;33:723–6.
21. Hashem AA, Ghoneim AG, Lutfy RA, et al. Geometric analysis of root canals prepared by four rotary NiTi shaping systems. J Endod 2012;38:996–1000.