

Comparison of Variability in Diameter and Taper of Gutta- Percha Cones of Different Brands using Stereomicroscopy and Digital Micrometer

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Abstract

Background: During Obturation, the variations present at the tip of the gutta-percha (GP) cone often causes premature binding, extrusion, poor adaptability to canal walls, microleakage leading to endodontic failure. The purpose of this investigation was to measure the variability from the listed cone tip diameter and taper of size #25, 0.06 taper GP cones from three different brands with the help of stereomicroscope and digital micrometer. **Materials and Methods:** Forty-five GP points ($n = 45$) of size #25 with an 0.06 taper from three different brands were divided into Group A – Diadent, Group B – K3, and Group C – ProTaper Next. Each group has 15 GP ($n = 15$). The diameters and tapers were measured at D0 and D3 according to the American National Standard Institute/American Dental Association Specification No. 78 using stereomicroscope and digital micrometer. Kruskal–Wallis test and Mann–Whitney U-test were to detect any significant differences between two or more groups and pairwise comparison, respectively. $P < 0.05$ was considered as statistically significant. **Results:** The standard values for D0 diameter which was 0.25 ± 0.23 , ProTaper Next GP cones were the similar to the standardized values compared to Diadent and K3 GP cones which were significantly different from the standard values. On comparing diameter variation at D3, ProTaper Next, 0.043 ± 0.018 was once again similar to its manufacturer standard values of 0.43 ± 0.022 . **Conclusion:** High variability exists between the different brands of GP, the clinician should anticipate the discrepancy and must depend on the manufacturer's reported specification of GP cones to be as accurate as possible.

Keywords: Obturation, Diameter variation, Endodontics, Gutta-percha, Taper.

INTRODUCTION

The rationale behind the endodontic treatment is to extirpate the pulpal tissue, disinfecting, cleaning, and shaping the root canal system (RCS) followed by obturation. The obturation entirely fills and seals the disinfected RCS with gutta-percha (GP) to prevent bacterial microleakage from the oral environment, apical, and periradicular tissues.^[1] Fluid infiltration from the periradicular tissues seeps into the RCS through apical foramen and/or lateral canals providing nutrition to remaining bacteria and enables their proliferation.^[2] An apical seal prevents the entry of tissue fluid into the canal, also preventing the exit of bacteria from the canal to the periradicular tissues.^[3,4]

GP has been used in dentistry for over 150 years and was introduced by Hill in 1847 which was then called as “Hills Stopping.”^[5] This close adaptation of the GP to the prepared RCS paves way for a minimal amount of sealer and an efficient way to achieve a “snug” fit of the master cone before complete

obturation. Despite its popularity as a root canal filling material, it lacks universal manufacturing standardization. The concept of standardizing instruments and dental obturating cones was first recommended by Ingle in 1955.^[6,7] The two current standards for dental GP obturating cones are the American National Standard Institute/American Dental Association (ANSI/ADA) Specification No. 78 published in 2000 and ISO 6877, published in 1995.

Although a perfect match between instrumented canal and GP cone is impossible, if the size and taper of the master

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cone differ significantly from the prepared area by the master file, insufficient obturation may result.^[8] Variations in cone tip diameter can lead to premature binding, extrusion, or poor adaptability of GP to the canal walls and microleakage, thus ultimately affecting the outcome of the treatment.^[9] The purpose of this short study was to measure the variability from the listed cone tip diameter and taper of size #25, 0.06 taper GP cones from three different brands with the help of stereomicroscope.

MATERIALS AND METHODS

The Institutional Ethical Committee approval was obtained for the study (Ref/PCDS/ACAD/9/2015/24). The total sample size was 45 GP points ($n = 45$) of size #25 with a 0.06 taper from three different brands: Diadent (Diadent Group International Inc., Vancouver, BC, Canada); K3 (SybronEndo, Orange, CA), and ProTaper Next (Dentsply/Maillefer). They were further divided into three groups. Each group has 15 GP points:

Group A ($n = 15$) had 15 GP points from Diadent while Group B had 15 GP points ($n = 15$) from K3 and Group C with 15 GP points ($n = 15$) from ProTaper Next.

The diameters and tapers were measured according to the protocol given by ANSI/ADA Specification No. 78 using a stereomicroscope (Leica MZ75, Wetzlar, Germany) (Figure 1) with an accuracy of 0.001 mm. The cone diameter was measured at the projected tip diameter D0 and D3 (Figures 1 and 2) and digital micrometer (M and W precision tool model No. IP65 set with 0.001 mm accuracy). The measurement was done by two blinded observers and the mean value was taken. The results were tabulated, presented as mean (range). Kruskal–Wallis test was to detect any significant differences between two or more groups and Mann–Whitney U-test for pairwise comparison. Statistical analysis was performed with the Statistical Package for the Social Services (SPSS) software version 23 (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY: IBM Corp. Released 2015). $P < 0.05$ was considered as statistically significant.

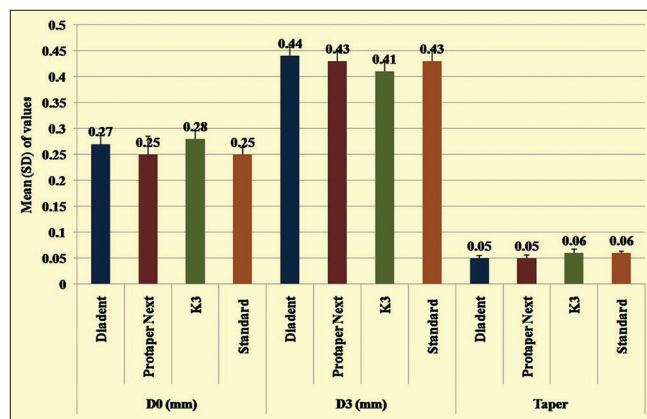


Figure 1: Comparison of Diadent, Protaper Next and K3 D0, D3 and Taper values with standard values examined under Stereomicroscope

RESULTS

In our study, we analyzed the diameter and taper variations at D0 and D3 using stereomicroscopy and digital micrometer. Table 1 shows the comparison between the three brands with stereomicroscopy, the standard values for D0 diameter which was 0.25 ± 0.23 , ProTaper Next GP cones were the similar to the standardized values compared to Diadent and K3 GP cones and were significantly different from the standard values ($P < 0.05$). Protaper Next cones had a similar values 0.043 ± 0.018 closest to the manufacturer standard values of 0.43 ± 0.022 on observing the D3 variation. For Taper, Significantly lower values of Diadent and Protaper Next from standard values were observed. For Taper, K3 values, 0.06 ± 0.007 was similar to standard value 0.06 ± 0.003 with no significant difference [Figure 1].

The values observed with digital micrometer are given in table 2, Diameter variation at D0 was significantly different for ProtaperNext and K3. Diadent had a diameter variation of 0.025 ± 0.016 was similar to standard value 0.25 ± 0.013 . There was significant difference between the groups for Percentage deviation of D3 from standard values ($p < 0.001$). When compared pairwise, there was no significant difference between Diadent and ProtaperNext for Percentage deviation of D3 from standard values. But K3 showed significant Percentage deviation of D3 from standard values was significantly different from Diadent and Protaper Next [Figure 2]. For Taper, K3, Diadent and Protaper values are similar to standard values. Stereomicroscope was accurate in determining the diameter and taper variation compared to the digital micrometer.

There was a significant difference between the groups for percentage deviation of D3 from standard values ($P < 0.001$). When compared pairwise, there was no significant difference between Diadent and ProTaper Next for percentage deviation of D3 from standard values. However, K3 showed that significant percentage deviation of D3 from standard values was significantly different from Diadent and ProTaper Next [Figure 2].

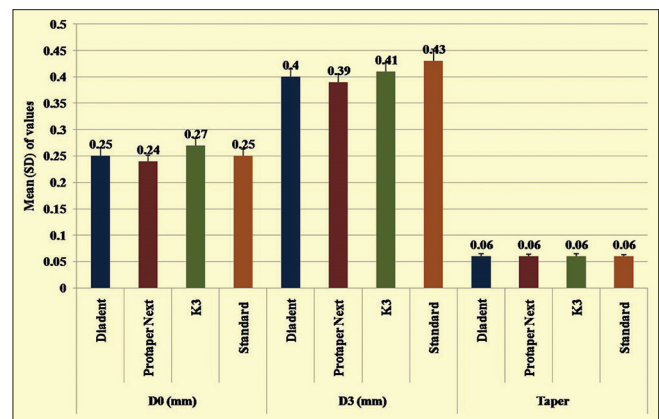


Figure 2: Comparison of Diadent, Protaper Next and K3 D0, D3 and Taper values with standard values examined under Digital micrometer.

For taper, K3, Diadent, and ProTaper values are similar to standard values. Stereomicroscope was accurate in determining the diameter and taper variation compared to the digital micrometer [Table 2].

DISCUSSION

Clinically, while selecting GP cones for obturation, unexpected variations in cone tip diameter lead to incomplete obturation, lack of tridimensional seal, and subsequently endodontic failure. This study was the first of its kind to observe and compare the diameter variability and taper dimension of GP cones from three different brands using stereomicroscopy and digital micrometer. We also compared which of the novel devices, that is, stereomicroscope and digital micrometer was accurate in determining the taper and diameter variation of GP cones from the standard values.

According to the current standards, the accepted diameter of GP cone may vary from 0.005 mm to 0.007 mm, as followed by most of reputed companies. Such variation means that cone of one stated size can be one size above and/or below, for example, ISO # 25 cone can have ISO # 30 or ISO # 20. About 60% of root canal failures occur due to incomplete obturations. This requires that GP cones used for obturation be standardized and also closely match with the working length of the last instrument.

In 2006, Cunningham *et al.* evaluated size 30/0.04 GP points of five different commercial brands: Diadent®, Lexicon®, Maillefer®, K3®, and Maxima®. Since the ANSI/ADA Specification no. 78 established a variation of ± 0.07 mm for D0 in size #30 points, the acceptable pattern for the points measured at D0 would be of 0.23–0.37 mm. The taper of the points was determined from D3 and D16 diameter. The authors observed a significant variability of the diameter and taper for GP points observed; but, all results were within the limit accepted by the ANSI/ ADA Specification no. 78, because they did not surpass ± 0.07 mm.^[3] In our study, we observed that the diameter variability at D0, ProtaperNext GP points were closer to the standard values. However, K3 and Diadent were within standard limits. Kunert *et al.* analyzed through two gauge rulers of different brands, the adaptation at D0 of sizes F1, F2, and F3 GP points of ProTaper® system in relation to the Ni–Ti instruments of the same system. The authors found that none of the measuring rulers used exhibited ideal conditions for the assessment of the adaptation of the GP points and rotary instruments of the ProTaper® system. In addition, it was also seen that the diameter variation of GP points at D0 varied.^[10]

The diameter between D0 and D3, the zone responsible for the apical seal showed variation between the two brands but was within the range of standard values, ProTaper Next GP

Table 1: Comparison of Diadent, Protaper Next and K3 D0, D3 and Taper values with standard values examined under Stereomicroscope.

Groups		Mean $\pm$ SD		Unpaired t-test	P value
		Experimental Group value	Standard value		
D0 (mm)	Diadent	0.27 $\pm$ 0.021	0.25 $\pm$ 0.013	3.136	0.004 (<0.01), Sig. Diff
	Protaper Next	0.25 $\pm$ 0.035	0.25 $\pm$ 0.013	0.000	1.000 (>0.05) Not Sig.
	K3	0.28 $\pm$ 0.017	0.25 $\pm$ 0.013	5.429	0.000 (<0.001), Sig. Diff
D3 (mm)	Diadent	0.44 $\pm$ 0.017	0.43 $\pm$ 0.022	1.393	0.175 (>0.05) Not Sig.
	Protaper Next	0.43 $\pm$ 0.018	0.43 $\pm$ 0.022	0.000	1.000 (>0.05) Not Sig.
	K3	0.41 $\pm$ 0.018	0.43 $\pm$ 0.022	2.725	0.01 (<0.05), Sig. Diff
Taper	Diadent	0.05 $\pm$ 0.005	0.06 $\pm$ 0.003	6.642	0.000 (<0.001), Sig. Diff
	Protaper Next	0.05 $\pm$ 0.006	0.06 $\pm$ 0.003	5.774	0.000 (<0.001), Sig. Diff
	K3	0.06 $\pm$ 0.007	0.06 $\pm$ 0.003	0.000	1.000 (>0.05) Not Sig.

Table 2: Comparison of Diadent, Protaper Next and K3 D0, D3 and Taper values with standard values examined under Digital micrometer.

Groups		Mean $\pm$ SD		Unpaired t-test	P value
		Experimental Group value	Standard value		
D0 (mm)	Diadent	0.25 $\pm$ 0.016	0.25 $\pm$ 0.013	0.000	1.000 (>0.05) Not Sig.
	Protaper Next	0.24 $\pm$ 0.011	0.25 $\pm$ 0.013	2.274	0.031 (<0.05), Sig. Diff
	K3	0.27 $\pm$ 0.013	0.25 $\pm$ 0.013	4.213	0.000 (<0.001) Sig. Diff.
D3 (mm)	Diadent	0.40 $\pm$ 0.015	0.43 $\pm$ 0.022	4.364	0.000 (<0.001) Sig. Diff.
	Protaper Next	0.39 $\pm$ 0.015	0.43 $\pm$ 0.022	5.818	0.000 (<0.001) Sig. Diff.
	K3	0.41 $\pm$ 0.016	0.43 $\pm$ 0.022	2.848	0.008 (<0.01) Sig. Diff.
Taper	Diadent	0.06 $\pm$ 0.005	0.06 $\pm$ 0.003	0.000	1.000 (>0.05) Not Sig.
	Protaper Next	0.06 $\pm$ 0.004	0.06 $\pm$ 0.003	0.000	1.000 (>0.05) Not Sig.
	K3	0.06 $\pm$ 0.005	0.06 $\pm$ 0.003	0.000	1.000 (>0.05) Not Sig.

points were similar to the standard values on observation through stereomicroscope. K3 and Diadent were not exactly similar to the standard values but they were within the permissible range. It is necessary that the GP point used as master cone has D0 diameter as closer as possible to the position corresponding to the instrument used to construction the apical stop.^[11] This correspondence between the diameter of the GP points and the instruments will promote a proper locking of the master cone at D0 and D3, because it is at this diameter that the apical stop is constructed. From our findings, there was no significant difference between the three brands on assessing the D0 diameter variability between the three brands.

Despite carefully following the standard manufacturing procedures and packing, mechanical deformation can also occur. This variability of GP cones such as shrinkage and expansion might be caused due to the high plasticity during transportation, storage but to there seems to be a lack of information regarding the influence of environmental changes on the GP cones.^[12,13] There are also concerns about fit of GP along the entire length of root canal from apical to coronal third as any discrepancy can lead to leakage. This can result in either over or under obturations and endodontic treatment failure. In these situations, clinician resorts to cut the tip of GP cones using GP gauge or uses a smaller size GP cones arbitrarily. Due to flexible nature of GP cones and chances of dimensional change with change in temperature, there might be variation in diameter measurement.^[14] Further, measuring diameter of these types of materials with metal digital caliper is extremely difficult as slight change in pressure can alter the size, which could explain why measurements made by digital micrometer in our study did not yield accurate values.

The results of our study indicate a significant variability between GP cone brands for both diameter and taper. The actual diameter values across brands varied from 0.2495 mm to 0.251 mm, while the taper measurements across brands ranged from 0.0595 to 0.0605 mm. These results substantiate the clinical observation that there is great GP cone variability between and within GP brands for both diameter and taper.

In this study, the brand that presented the best result was ProTaper Next. Comparing stereomicroscopy and digital micrometer, the former proved to be accurate in its measurement of the GP points. This could be attributed to the standardized procedures in examining the GP point compared to digital micrometer where it is handheld perpendicularly and measured thereby subjecting to manual errors. It should be expected that there will be variability within and between different manufacturers. The clinician should keep in mind the variability, and in certain situation, it is best to use a smaller size tip diameter.

CONCLUSION

To be efficient and productive, the clinician must depend on the manufacturer's reported diameter and taper of GP cones to be as accurate as possible. The clinician should anticipate variability from the manufacturer's stated GP cone diameter and taper. Further research needs to be conducted in this area. On comparing between the three groups, the periapical diameter of ProTaper Next was similar to the manufacturing standard values without any major deviation compared to the other brands while K3 brand of GP cone showed a taper variability similar to that of the standard value.

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REFERENCES

- Godiny M, Hatam R, Khavid A, Khanlari S. Apical microleakage in root canals containing broken rotary instruments. *Iran Endod J* 2017;12:360-5.
- Narayanan LL, Vaishnavi C. Endodontic microbiology. *J Conserv Dent* 2010;13:233-9.
- Carvalho E, Junior JA, Malvar MF, Albergaria S. Avaliação do selamento apical em dentes obturados pela técnica da condensação lateral híbrida, de Tagger e Thermafil. *Rev Ciên Méd Biol Salv* 2006;5:239-44.
- Mozayeni MA, Dianat O, Tahvildari S, Mozayani M, Paymanpour P. Subcutaneous reaction of rat tissues to nanosilver coated gutta-percha. *Iran Endod J* 2017;12:157-61.
- Taft J. A Practical Treatise on Operative Dentistry. Philadelphia, PA: Lindsay and Blakiston; 1859. p. 75-93.
- Ingle J. The need for endodontic instrument standardization. *Oral Surg Oral Med Oral Pathol* 1955;8:1211-3.
- Ingle J, LeVine M. The need for uniformity of endodontic instruments, equipment and filling materials. In: Grossman L, editors. *Transactions of the Second International Conference on Endodontics*. Vol. 234. Philadelphia, PA: University of Pennsylvania Press; 1958. p. 123-42.
- Schulte A, Pieper K, Charalabidou O, Stoll R, Stachniss V. Prevalence and quality of root canal fillings in a German adult population. A survey of orthopantomograms taken in 1983 and 1992. *Clin Oral Investig* 1998;2:67-72.
- Cunningham KP, Walker MP, Kulild JC, Lask JT. Variability of the diameter and taper of size #30, 0.04 gutta-percha cones. *J Endod* 2006;32:1081-4.
- Kunert GK, Melo TA, Oliveira EP, Barletta FB. Accuracy of the tip diameter on gutta-percha cones of different tapers. *Rev Assoc Cir Dent* 2008;62:309-13.
- Waechter F, Antunes RO, Irala LE, Limongi O. Avaliação comparativa entre o diâmetro de cones estandarizados e cones secundários B8 calibrados por régua calibradora, distando 1 mm das suas pontas (D1). *RSBO* 2009;6:34-43.
- Wei YJ, Silikas N, Zhang ZT, Watts DC. Hygroscopic dimensional changes of self-adhering and new resin-matrix composites during water sorption/desorption cycles. *Dent Mater* 2011;27:259-66.
- Zaslansky P, Fratzl P, Rack A, Wu MK, Wesselink PR, Shemesh H. Identification of root filling interfaces by microscopy and Tomography methods. *Int Endod J* 2011;44:395-401.
- Moon HJ, Lee JH, Ahn JH, Song HJ, Park YJ. Temperature-dependent rheological property changes of thermoplastic gutta percha root filling materials. *Int Endod J* 2015;48:556-63.