

Physical Properties of Seven Different Brands of Standardized Endodontic Paper Cones

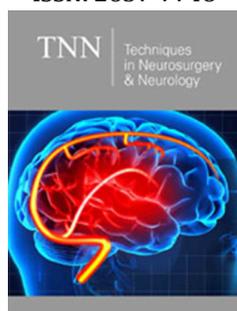
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Abstract

Aim: To evaluate the physical properties of 7 brands of standardized endodontic paper cones.

Methodology: Standardized endodontic absorbent paper points, size 30, from 7 different brands of 7 manufacturers were used for this study. Forty absorbent paper cones from each brand were selected at random from packages with assorted cones. A total of 280 cones were tested, all tests were conducted at a temperature of 23 °C.

Results: Three brands of standardized endodontic paper points (Diadent, Kerr, and Pearson) showed significantly higher absorbencies than the remaining 7 brands tested ($p < 0.05$).

Conclusión: Absorbent paper points, even inside packs sterilized by the manufacturer, may be contaminated. The most reliable method to maintain the aseptic chain during endodontic treatment is the sterilization of paper points before their use, regardless of the commercial type.

Keywords: Paper cones; Paper points; Pain; Apical healing

Introduction

Endodontic treatment attempts to remove bacteria from the root canal system to stimulate periapical healing. For that purpose, clinicians must consider elements as preoperative diagnosis, the ability to obtain infection control, root canal anatomy, procedural complications, and factors like patients' signs and symptoms [1]. All the involved processes are aimed at creating and maintaining aseptic conditions and then obturation of the clean root canal system [2]. The presence of bacteria is totally linked to situations of failure in endodontic treatment, and many times this is due to failure in manage of root canals, as well as microbial permeation through saliva or the use of contaminated instruments and/or materials [3]. Infection persisting in the root canal and/or peri-apex is considered to be the most significant factor that affects the outcome of endodontic treatment.

Absorbent paper cones are used extensively in endodontics for several purposes, in endodontic treatment, the absorbent property, tapered and standardized size have been developed to aid in the cleansing and drying of the canal and to carry antiseptic or disinfecting coverings [4]. Paper points or paper cones were introduced for canal drying and applying intracanal medicaments [5]. Initially manufactured from bibulous paper, they exhibited low tensile strength and tended to disintegrate within the canal. They are now manufactured from long-fibre papers such as cotton, mitsumata or silk by rolling a triangular blank with longitudinally oriented fibres thus optimizing tensile strength and wicking properties [6]. Paper points consist of plant cellulose, an unbranched polymer of b-D-glucose. Darvell pointed that the abundant hydroxyl groups of cellulose form hydrogen bonds between polymer chains and render the polymer hydrophilic, allowing significant absorption of water within its structure and adsorption onto its surface [7]. The addition of organic resin binders improves the point's integrity and stiffness, albeit at the expense of absorbency [7]. As manufacturers use different papers and binders, absorbency and integrity vary significantly between brands of paper point [8].

There is a risk of cellulose fibres being deposited periapically when inserting a point beyond the apical foramen (direct shedding) [9]. Paper points may also shed fibres within the canal that may subsequently be pushed through the apical foramen by another paper point, gutta-percha point or endodontic instrument (indirect shedding) [10,11].

As the paper cones are the last material inserted into the prepared canal before root filling, they play an important role and must be considered important to the outcome therapy. Desirable properties and characteristics of the absorbent paper cones:

- A. Paper cones should have the property to absorb water, blood, and some other fluid like serous fluid,
- B. Paper cones should have sufficient wet strength when it has been saturated with fluids and rigidity to be inserted and withdrawn from a root canal without collapsing under their own weight,
- C. When dry, absorbent paper cones should be straight and have a uniform length, taper and size,
- D. According with ISO draft specifications paper cones should have sufficient integrity [12] and
- E. Absorbent paper cones should be clean and capable to be disinfected.

The aim of this study was to evaluate physical properties of 7 brands of standardized endodontic paper cones.

Materials and Methods

Standardized endodontic absorbent paper points, size 30, from 7 different brands of 7 manufacturers were used for this study (Table 1). Forty absorbent paper cones from each brand were selected at random from packages with assorted cones. A total of 280 cones were tested, all tests were conducted at a temperature of 23 °C.

Table 1: Brands and manufacturers of standardized absorbent paper points used in the study.

Name	Manufacturer	Country
Diadent	Diadent Int Group	Chongiu City Korea
Maillefer	Maillefer	Ballaigues, Switzerland
Premier	S.P.A.	Montechia, Italia
Spectrapoint	The Hygenic Corporation	Akron, OH, USA
Kerr	Sybron Kerr	Romulus, MI, USA
Hygenic	Dental Produkte	Munich, Alemania
Meta	Meta Dent Co LTD	USA

Each dry absorbent paper cone was weighted using an electronic laboratory balance (Sartorius, model 1712 MP8: Göttingen, Germany). Physical properties of paper cones include: dimension, length, taper, absorbency, fiber shedding and stiffness. The dimensions of each paper cone were measured by using a Mitutoyo Projection microscope at 20X magnification. The length

was measured as the distance between the two ends of the paper cone (head and point).

Taper were measured at distances of 3mm and 16mm from the tip or narrow end using a digital caliper (Figure 1). The difference of these two diameters divided by 13mm gave the value of taper of each paper cone. $Taper = \frac{D_1 - D_2}{13}$, where D_1 is the diameter at the 16mm from tip, and D_2 is the diameter at 3mm from the tip.

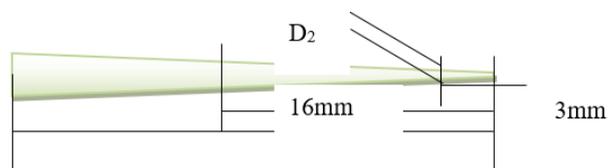


Figure 1: Determination of Taper.

For absorbency test, every paper cone was gripped in a pin vise, which was suspended vertically from a hanger with the tip pointing downwards. A length of 5mm from the tip was lowered into a 2% aqueous solution of mercurochrome. The rise in height of solution, by capillary action in 60 seconds were recorded.

For the fiber shedding test, 7 cones were placed in a particle free sterile test crystal cylinder containing 10ml of distilled water. The crystal cylinder and its content were gently agitated for 60 seconds, and then filtered through a 1µm gridded particle monitor filter paper (Millipore AABG 047). The filter paper allowed to dry and was then examined under 50X magnification for the number of fibers or particles having a dimension exceeding 200 -250µm.

All procedures were carried out in a similar condition of laminar flow cabinet conforming to AS 1386-1976 [15] as a controlled environment to prevent airborne particulate contamination of the particle monitor and the paper cones under examination. A length of 16mm from the tip was then lowered in distilled water for 5 seconds, paper cone was weighted again, and the difference between both measurements was taken as the value of the fluid absorbed (Figure 1).

For the Stiffness test, the paper cones were immersed in water at 40 °C for 20 minutes, the lifted out horizontally by their ends. All paper cones were inspected visually without magnification to note any indication of unrolling, disintegration or sagging after 30 seconds. To determine which brand presented the highest absorbency, a statistical analysis of the results obtained was conducted using the Kruskal-Wallis test and the Mann-Whitney U test. Dissimilarities in relation to the standard deviation were assessed by means of the F test (Fisher-Snedecor). The relationship between the variables dry weight and fluid absorbed was analyzed with the Pearson's product-moment correlation coefficient (r).

Results

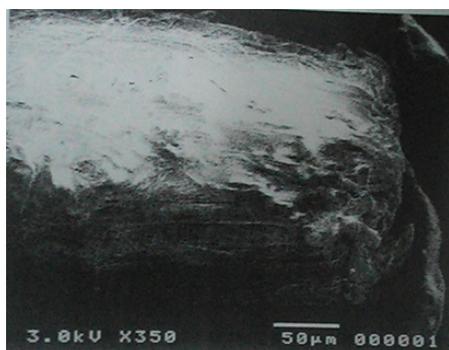
Three brands of standardized endodontic paper points (Diadent, Kerr, and Pearson) showed significantly higher absorbencies than the remaining 7 brands tasted ($p < 0.05$) (Table 2 & 3). Figures 2 and 3 show some irregularities under SEM in cross section and longitudinal view.

Table 2: Range of length of paper points.

	Manufacturer
Diadent	27.4mm-28.1mm
Maillefer	24.8mm-26.5mm
Premier	24.7mm-28.2mm
Spectrapoint	23.4mm-25.7mm
Kerr	22.9mm-24mm
Hygienic	23mm-26.8mm
Meta	23mm-26.7mm

Table 3: Mean value, standard deviation (SD), and coefficient of variation (CV) of dry and post immersion standardized endodontic paper points and for fluid absorbed

Brand	Dry Weight		Post Immersion weight		Fluid Absorbed	
	Mean±SD (in g)	CV (%)	Mean±SD (in g)	CV (%)	Mean±SD (in g)	CV (%)
Diadent	0.0057±0.00024	4.31	0.0148±0.0006	4.85	0.0009±0.0005	6.20
Maillefer	0.0032±0.0001	4.02	0.0082±0.0003	4.83	0.0050±0.0003	6.75
Premier	0.0042±0.0001	2.62	0.0062±0.0003	6.73	0.0030±0.0004	17.65
Spectra points	0.0024±0.0001	2.53	0.0067±0.0004	6.76	0.0025±0.0004	18.24
Kerr	0.0051±0.00030	6.01	0.0135±0.0010	7.42	0.0084±0.0007	8.92
Hygienic	0.0042±0.0001	3.58	0.0129±0.0006	5.04	0.0129±0.0006	5.04
Meta	0.0129±0.0006	5.04	0.0007±0.0005	7.36	0.003±0.0005	18.01

**Figure 2:** Irregularities of a paper cone, longitudinal view (SEM 350X).**Figure 3:** SEM view of cross section of a Size 30 paper cone.

Discussion

In each of the properties measured, the study demonstrated wide variations. Tip diameters of products marked with standardized size designation did not correspond to the tip size defined by ISO size designation [13-15]. No correlation was observed between size and absorbency in any product range. The results suggest that better quality control is needed during the manufacture of this product [16]. A better paper cone will have adequate and closely controlled dimensions, good absorbency, no one brand can fulfill all these requirements completely. Paper cones with the highest absorbing capacity (Diadent, Kerr, and Hygienic) showed high SD values.

Conclusion

Absorbent paper points, even inside packs sterilized by the manufacturer, may be contaminated. All brands of endodontic have a variation in the number of fibers and it can be shed directly when inserted through the apical foramen. The most reliable method to maintain the aseptic chain during endodontic treatment is the sterilization of paper points before their use, regardless of the commercial type.

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