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An evaluation of D, E and F-speed intraoral radiographic film for endodontic working length determination

ABSTRACT

Objective: to test three types of intraoral radiographic films: D, E and F-speed (Agfa M2 Comfort, E-Speed and Insight) and their influence on the file visualization when determining the working length.
Study design: access cavities and insertion of different caliber files simulating endodontic treatment were carried out on two human inferior molars. Radiographic references were standardized using a device that allowed similar set of instructions and radiographic film exposure and developing. Ten examiners measured radiographic length of the files inside the root canals. The data were examined using Fisher's Exact test to determine the influence of the reading of the film on the working length.
Results: E-Speed film produced a higher percentage of correct measurements even though there were no statistically significant differences between the three types of film.
Conclusion: E-Speed films, which give good visualization with minimal exposure, should be the film of choice in practical clinical dentistry.

Key words:
Endodontics, dentistry, radiology, working length, radiographic films.

INTRODUCTION

Good quality periapical radiography is indispensable at all stages of endodontic treatment in order to achieve reliable results. Fast films are more sensitive and are capable of producing good images with less radiation.
Intra-oral radiographic films classified according to their sensitivity as type E reduce exposure to x-rays by up to 50% compared with those of type D. Type F films reduce such exposure by 20% in relation to type E and by 60 % in relation to type D, without any loss of image contrast or quality (1).
As the processing affects both the detail and definition of the radiographic image, it needs to be carried out with care, since any failure during the processing could result in a mistaken interpretation of the radiograph (2). It is of critical importance that the processing solutions are in perfect condition, as these are as sensitive as the radiographic films themselves (3).
One of the most crucial factors during endodontic treatment is the estimate of the working length; for this purpose good contrast radiographs must be provided. The present study was carried out in order to compare the accuracy of periapical radiographic type E films (E-speed from Kodak Co. and Agfa M2 Comfort from Heraeus Kulzer GmbH & Co.) and type F films (Insight from Kodak Co.) in the visualization of the endodontic files for determining working lengths.

MATERIALS AND METHODS

After obtaining approval from the Ethics in Research Committee of the Federal University of Pernambuco (Protocol # 115/2005-CEP/CCS), a dried mandible, obtained from The Department of Human Anatomy, Centre of Health Sciences, Federal University of Pernambuco, was covered in the molar region with 2 layers of wax. One layer was 6-mm thick utility wax and the other layer was 2-mm thick wax #7 simulating the cheek and gums in order to closely resemble *in vivo* conditions (4).
An acrylic resin mount was constructed to secure the mandible while allowing 2 radiographic films to be positioned and removed as required.
A portable darkroom was tested for leakage of light and found to offer optimum conditions for the processing of radiographic films.
Next, a pilot study on periapical radiographs was carried out to obtain a standard exposure time for all the types of films, which was found to be 0.2 seconds.
Radiographs of the specimens were taken to decide on the opening of the crown and to locate the root canals.
In the first molar endodontic files of the

same length were inserted into the respective root canals as follows: in the mesiobuccal (MV) root canal up to 1 mm short of the radiographic vertex and in the mesiolingual (ML) and distal (D) canals up to the limit of the radiographic apex. In the second molar the files of the MV canal were inserted up to the limit of the radiographic apex, and in the ML and D canals up to 2 mm and 1 mm, respectively, short of the radiographic apex. The first files to be inserted into all the canals were the K-File #06 ones up to the predetermined length. After that, the radiographs were taken with an X-Ray XRM 70/10 unit (produced in Brazil).

The processing method used was time/temperature, followed by the standard 5 min for developing, 30 seconds in an intermediate bath, 2.5 min for fixing and then washing in running water for 5 min. The Eastman Kodak Co. developing and fixing solutions were used, ready for use in manual processing. The intermediate bath water was changed for each new processing. After each group of three films had been processed, the solutions were renewed. The radiographs were hung out to dry in a dust-free film drying cabinet at room temperature.

The radiographic films were divided into groups according to the type of film tested:

Group A - Agfa Dentus M2 Comfort (Heraeus Kulzer GmbH & Co. – KG – Germany) (Fig. 1)

Group B - E-speed (Eastman Kodak Co. – New York – USA) (Fig. 2).

Group C - Insight (Eastman Kodak Co. – New York - USA) (Fig. 3).

All the films tested had the same lot number according to the markings of the supplier and all were within their respective validity dates.

A total of 15 radiographs were taken and processed, all with the same standard exposure and processing time.

Ten specialists in endodontics, using a predetermined standard system, individually examined the radiographs. There was a minimum interval of 15 minutes between samples so as not to influence the findings and without any previous knowledge of either the type of files or the type of film being used. The radiographs, mounted on black cardboard trays so as to eliminate light dissemination and avoid any interference with the details of the image, were examined with a x10 magnification lens under uniform lighting conditions in an endodontic x-ray viewing cabinet. All measurements were taken using a standard millimeter ruler. The data collected

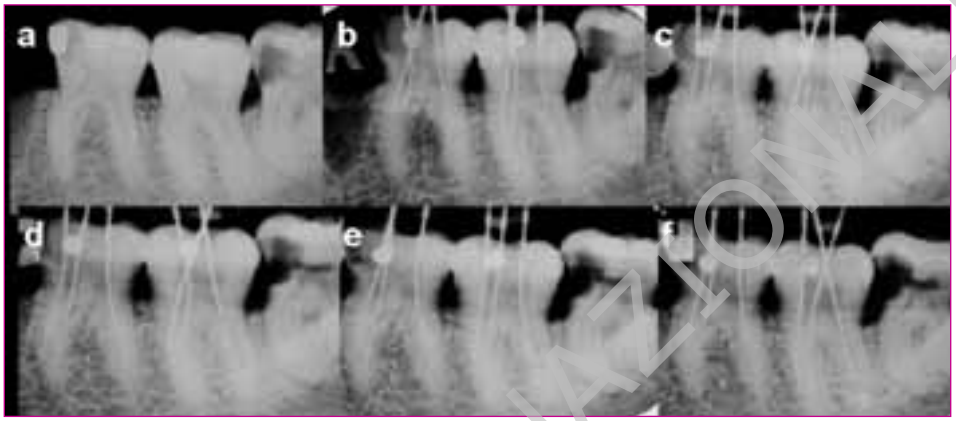

Fig. 1 - *Sequence of periapical radiographs taken with Agfa Dentus M2 Comfort films.*
Sequenza di radiografie periapicali scattate con pellicole Agfa Dentus M2 Comfort.

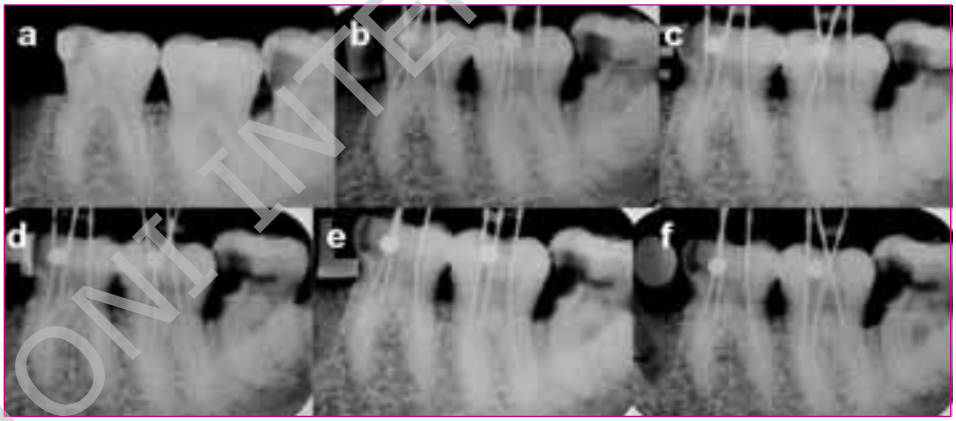

Fig. 2 - *Sequence of periapical radiographs taken with E-speed films.*
Sequenza di radiografie periapicali scattate con pellicole E-speed.

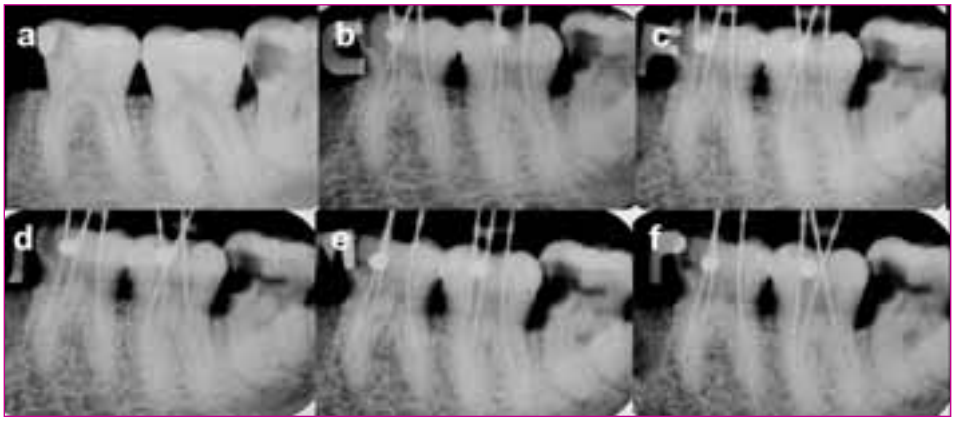

Fig. 3 - *Sequence of periapical radiographs taken with Insight films.*
Sequenza di radiografie periapicali scattate con pellicole Insight.

were statistically analyzed using Fisher's Exact test with a 0.05% level of significance.

RESULTS

Table 1 shows that, in the first inferior molar, the lower the caliber of the file inserted into the root canal to determine the working length, the greater the possibility of error, since the caliber #06 and #08 files showed significant statistical differences in relation to the files studied. The #10 and #15 caliber files did not show any significant differences between them, nor did the caliber #20 file. Although there were no significant differences between film types the E-Speed was seen to be better than Insight, which was better than Agfa when the absolute values for the measurement of the files themselves were compared.
There were no significant differences between the results for the first (Table 1) and second (Table 2) molars.

File	Film	Reading of working length of file: Less than actual working length n	Less than actual working length %	Same as actual working length n	Same as actual working length %	Greater than actual working length n	Greater than actual working length %	Total n	Total %	Value of *p*
06 #	Agfa	28	93.3	1	3.3	1	3.3	30	100	0.779
	E-sp	25	83.3	3	10.0	2	6.7	30	100	
	Insg	27	90.0	2	6.7	1	3.3	30	100	
	Total	80	88.9	6	6.7	4	4.4	90	100	
08 #	Agfa	22	73.3	8	26.7	0	0.0	30	100	0.236
	E-sp	23	76.7	7	23.3	0	0.0	30	100	
	Insg	18	60.0	9	30.0	3	10.0	30	100	
	Total	63	70.0	24	26.7	3	3.3	90	100	
10 #	Agfa	19	63.3	10	33.3	1	3.3	30	100	0.099
	E-sp	9	30.0	17	56.7	4	13.3	30	100	
	Insg	12	40.0	14	46.7	4	13.3	30	100	
	Total	40	44.4	41	45.6	9	10.0	90	100	
15 #	Agfa	11	36.7	15	50,0	4	13.3	30	100	0.977
	E-sp	9	30.0	16	53,3	5	16.7	30	100	
	Insg	9	30.0	16	53,3	5	16.7	30	100	
	Total	29	32.2	47	52,2	14	15.6	90	100	
20 #	Agfa	8	26.7	18	60.0	4	13.3	30	100	0.714
	E-sp	4	13.3	22	73.3	4	13.3	30	100	
	Insg	5	16.7	22	73.3	3	10.0	30	100	
	Total	17	18.9	62	68.9	11	12.2	90	100	

Table 1 - *Distribution of absolute and relative frequencies of the reading of the working length of the files inserted into the root canals of the first molar according to the type of film used.*

Distribuzione delle frequenze assolute e relative della lettura della lunghezza di lavoro dei file inseriti all'interno dei canali radicolari del primo molare divisi in base al tipo di pellicola impiegata.

DISCUSSION

The evaluation of the increase in size of the silver bromide grains (5), using the quality of the radiographic images as a reference, revealed that the arrangement of the grains did not influence the determination of the elements evaluated. In the present study, even though there were no significant statistical differences, there were a greater number of correct measurements with the E-Speed film, which consists of intermediate grains. This is in agreement with other studies (5, 6), which concluded that type E films had a size of silver grains which made it ideally sensitive. It was also noted that Kodak E-Speed film had a projected velocity and contrast levels to reduce the exposure time for the patients during intra-oral radiography. Other studies have shown that the caliber #10, #15 and #25 files were clearly visible in 82% of the root canals examined using D-Speed film (7). This was contrary to the findings in the present study, which used Agfa M2Comfort and did not obtain a better result than with other films.
Even though there were no significant differences between the films in this study, the best result was achieved with the E-Speed film, which is in agreement with other studies (8). This justifies the use of film type E due to its lower degree of exposure to radiation and consistently good quality of the images.
In determining the length of human teeth using K-File #15 and film types D and E, it was found that the latter was able to produce good quality radiographic images and required only half the exposure time compared with type D. This is in agreement with other authors (1, 6).
The results presented in this study are in agreement with other studies (9) that recommended the use of E-Speed film in endodontics, since the #6 and #15 files had no effect on the measurement of the root canal.
In a study evaluating the conventional radiographic and digitalized images for the visualization of the lowest size files, low values were obtained for the size #6 files (10). This is in agreement with the results of the present study, in which the correct values for size #6 file were also low.
Both the digitalized and conventional images produced good results during the different stages of endodontic treatment (11). The present study, using low size number files, showed that Ektaspeed film produced sharp radiographic im-

rea	Film	Reading of working length of file: Less than the actual working length n	%	Same the actual working length n	%	Greater than the actual working length n	%	Total n	%	Value of *p*
06 #	Agfa	29	96.7	1	3.3	0	0.0	30	100	0.435
	E-sp	26	86.7	2	6.7	2	6.7	30	100	
	Insg	27	90.0	3	10.0	0	0.0	30	100	
	Total	82	91.1	6	6.7	2	2.2	90	100	
08 #	Agfa	23	76.7	3	10.0	4	13.3	30	100	0.735
	E-sp	20	66.7	7	23.3	3	10.0	30	100	
	Insg	21	70.0	6	20.0	3	10.0	30	100	
	Total	64	71.1	16	17.8	10	11.1	90	100	
10 #	Agfa	14	46.7	10	33.3	6	20.0	30	100	0.768
	E-sp	11	36.7	15	50.0	4	13.3	30	100	
	Insg	14	46.7	11	36.7	5	16.7	30	100	
	Total	39	43.3	36	40.0	15	16.7	90	100	
15 #	Agfa	8	26.7	15	50.0	7	23.3	30	100	0.992
	E-sp	9	30.0	16	53.3	5	16.7	30	100	
	Insg	9	30.0	15	50.0	6	20.0	30	100	
	Total	26	28.9	46	51.1	18	20.0	90	100	
20 #	Agfa	5	16.7	17	56.7	8	26.7	30	100	0.803
	E-sp	5	16.7	19	63.3	6	20.0	30	100	
	Insg	6	20.0	20	66.7	4	13.3	30	100	
	Total	16	17.8	56	62.2	18	20.0	90	100	

Table 2 - *Distribution of absolute and relative frequencies of the working length of the reading of the working length of the files inserted into the root canals of the second molar according to the type of film used.*

Distribuzione delle frequenze assolute e relative della lettura della lunghezza di lavoro dei file inseriti all'interno dei canali radicolari del secondo molare divisi in base al tipo di pellicola impiegata.

ages. The same was noted when other authors used endodontic type K files with sizes ranging from 15 and 35 to evaluate the distances between the foramen of the root canals and the radiographic apex using conventional radiographic images (12). This was observed with periapical Ektaspeed Plus film, but with the Schick CDR digital system there were no statistical significant differences.

In this study the Insight film produced less exact results than the Ektaspeed film, but again there were no statistically significant differences. A study comparing the images obtained with the Kodak RVG 6000 and Schick CDR digital systems and conventional radiographs with Insight film to determine the working length of the root canals using small size type K files, found no statistically significant differences were observed. However, the Kodak digital system produced sharper images than the Schick CDR and conventional radiography. Conventional radiography produced less exact values than the other groups (13). Again, statistical findings sometimes do not pinpoint nuances of differences that may have clinical relevance. In a science which minor details can make a difference, obtaining the sharpest possible image with minimal exposure should be the gold standard of current endodontic treatment.

CONCLUSION

Even though there were no significant statistical differences between the films, the Kodak E-Speed showed a higher percentage of correct measurements of the files within the root canals than the Agfa Dentus M2 Comfort and the Kodak Insight.

E-Speed film, which gives a good visualization of the structures involved, should be the film of choice in practical clinical endodontics. This is followed by the Insight film, as type D films need longer exposure times in order to obtain satisfactory images, thereby exposing the patient to excessive radiation.

Size #6 and #8 files should not be used for root length determination as these have a greater margin of error, regardless of the type of film used.

REFERENCES

1. Thunthy KH, Weinbergh R. Sensitometric comparison of Kodak Ektaspped Plus, Ektaspeed, and Ultra-speed dental films. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995a;79:114-16.*

2. Moore WS. Successful intraoral radiography. San Antonio: *The Academy of Dental Therapeutics and Stomatology*; 2004.

3. Thunthy KH, Weinbergh R. Effects of developer exhaustion Ektaspeed Plus, Ektaspeed, and Ultra-speed dental films. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995b ;79:117-21.*

4. Moule AJ, Wong A, Monsour PA, Basford KEA. A comparison of Kodak Ultraspeed and Ektaspeed Plus dental X-ray films for use in endodontics. *Aust Dent J 2001;46:95-9.*

5. Girsch WJ, Matteson SR, McKee NM. An Evaluation of Kodak Ektaspeed periapical film for use in endodontics. *J Endod 1983;9:282-88.*

6. Brown R, Hadley JN, Chambers DW. An evaluation of Ektaspeed Plus film versus Ultraspeed film for endodontic working length determination. *J Endod 1998;24:54-6*.
7. Olson AK, Goerig AC, Cavataio RE, Luciano J. The ability of the radiograph to determine the location of the apical foramen. *Int Endod J 1991;24:28-35*.
8. Ludlow JB, Platin E. Densitometric comparisons of Ultra-speed, Ektaspeed, and Ektaspeed Plus intraoral films for two processing conditions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79:105-13*.
9. Powell-Cullingford AW, Pitt Ford TR. The use of E-speed film for root canal length determination, *Int Endod J 1997;26:268-72*.
10. Pace SRB, Habitante SM. Comparative Analysis of the Visualization of Small Files Using Digital and Conventional Radiography. *J Appl Oral Sci 2005;13:20-3*.
11. Kawauchi N, Bullen IRFR, Chinellato LEM. Evaluation of the liner measurements by conventional radiographs and indirect digital imagens in the endodontic treatment. *J Appl Oral Sci 2004;12:303-36*.
12. Melius B, Jiang J, Zhu Q. Measurement of the distance between the minor foramen and the anatomic apex by digital and conventional radiography. *J Endod 2002;28: 125-26*.
13. Radel RT, Goodell GG, McClanaban SB, Coben ME. In Vitro radiographic determination of distances from working length files to root ends comparing Kodak RVG 6000, Schick CDR, and Kodak Insight Film. *J Endod 2006;32:566-68*.