SEM Analysis of Smear Layer Removal after Manual and Automated Handpiece Root Canal Preparation

Gilson Blitzkow SYDNEY[1,2]
Antonio BATISTA[1]
Carlos ESTRELA[3]
Hildeberto Francisco PESCE[4,5]
Luciano Loureiro de MELO[1,2]

[1]Departamento de Endodontia, Faculdade de Odontologia, Universidade Federal do Paraná, Curitiba, PA, Brasil [2]Departamento de Endodontia, Curso de Odontologia, Tuiutí, Curitiba, PA, Brasil
[3]Departamento de Endodontia, Faculdade de Odontologia, Universidade Federal de Goiás, Goiânia, GO, Brasil
[4]Departamento de Endodontia, Faculdade de Odontologia, Universidade de São Paulo, São Paulo, SP, Brasil
[5]Departamento de Endodontia, Faculadade de Odontologia, Universidade São Francisco, São Paulo, SP, Brasil

Braz Dent J (1996) 7(1): 19-26 ISSN 0103-6440

Scanning electron microscopy was used to analyze the smear layer removal after root canal preparation by a manual technique and by an automated handpiece, the Canal Finder System (CFS). When 1% sodium hypochlorite was used as the irrigating solution, both manual and CFS techniques showed root canal walls with a dense smear layer obscuring the dentinal tubules entrance plus a large amount of debris. Root canal walls of the group of teeth treated with a chelating agent (EDTA) for 5 min and a final flush, after the preparation, with 1% sodium hypochlorite as an irrigating solution showed the cervical, middle and apical thirds extremely smooth and clear.

Key Words: automated handpiece, smear layer, root canal preparation.

Introduction

Root canal preparation has clear and well-defined goals: to eliminate all pulp tissue, necrotic debris or microoganisms and to smooth, shape and enlarge the canal space to conveniently accept a three-dimensional filling (Schilder, 1974; Paiva and Antoniazzi, 1991). Since smear layer was recognized some years ago, endodontists have been trying to understand the relationship between the presence of this layer and the success of root canal treatment. McComb and Smith (1975), Baker et al. (1975), Mizrachi et al. (1975) and Moodnick et al. (1976) concluded that the presence of a smear layer was related to the effectiveness of the endodontic instruments on the canal walls, the amount of dentinal chips, necrotic tissue and debris. These authors and others (Goldman et al., 1981; Baumgartner et al., 1984; Aun, 1990; Gavini, 1992) stated that the ability to remove debris depends on the solution volume rather than the solution type and that different instruments produce similar values of cleanliness. Goldman et al. (1981) showed that the smear layer could be removed by a combination of irrigants (REDTA + sodium hypochlorite in a final flush) according to its nature (either organic or inorganic components). Czonstkowski et al. (1990) suggested that the amount of smear layer produced by an automated handpiece preparation is greater in volume than that produced by manual instrumentation. Mandel et al. (1990), evaluating the cleansing efficiency of three root canal preparation techniques, manual, ultrasonic and the Canal Finder System using 2.5% sodium hypochlorite as irrigant, concluded that there was no difference between these techniques. The aim of this study was to

evaluate the presence of the smear layer after manual root canal preparation and by the use of an automated handpiece, the Canal Finder System, using 1% sodium hypochlorite and EDTA.

Material and Methods

Thirty-five extracted human upper lateral incisors with one canal and a moderate curvature were selected for this study. Prior to access cavity preparation all teeth were immersed for at least 72 h in saline. After access preparatioin, a size 10 K-file (Maillefer) was used to remove all canal contents, and to determine the working length, estabilished 1-mm short of the apex. The apexes were covered with nail polish (Risqué, Niasi) and each root previously covered with vaseline was included in a resin block. The teeth were then removed from the resin blocks and grooved on the buccal and lingual surfaces by means of a diamond disk, without penetration into the root canals. They were then split bucco-lingually using a wire cutter and reinserted into its original block. The teeth were then ramdomly divided into seven groups according to root canal preparation technique and irrigating solution. Root canal surfaces in group 1 were treated with a chelating agent (EDTA) for five min without instrumentation. Root canals of the teeth in groups 2, 4 and 6 were instrumented by a manual technique using the following irrigating solutions: saline (group 2), 1% sodium hypochlorite (group 4) and 1% sodium hypochlorite plus EDTA for five min with a final flush of sodium hypochlorite (group 6). The remaining three groups (3, 5 and 7) were prepared using an automated handpiece, the Canal Finder System (CFS), subjected to the same irrigating solutions. In the CFS technique, proposed by Sydney and Melo (1996), root canal preparation starts and ends manually and the automated handpiece is used as an auxilliary aid. The root hemi-sections were then left 24 h in a drying chamber with silica gel and finally mounted on aluminum studs, coated with palladium gold and analyzed in a scanning electron microscope. Photomicrographs were obtained from the cervical, middle and apical thirds of each hemi-section of each root canal. Representative areas were photographed and blindly evaluated by five investigators regarding the presence of smear layer, debris and patency of dentinal tubules.

Results

Group 1. Non-instrumented teeth.

Figure 1 shows the appearance of the canal wall treated with a chelating agent (EDTA) for 5 min without root canal preparation. Dentinal tubules are clearly seen with oval or circular openings and intracanal dentin.

Figure 1 - Canal wall of a tooth treated with a chelating agent (EDTA) for five min without root canal preparation (Group 1). 1000X.

Groups 2 and 3. Instrumented teeth; irrigating solution, saline solution.

Figure 2 shows the typical appearance of the specimens of both groups. A continuous smear layer completely obscures the dentinal tubules and a large amount of debris is present.

Figure 2 - Groups 2 and 3. Instrumented teeth irrigated with saline. A, Manual technique. B, CFS. c: cervical third; m: middle third; a: apical third. 1000X.

Groups 4 and 5. Instrumented teeth; irrigating solution, 1% sodium hypochlorite.

Cervical, middle and apical thirds of the specimens in both groups (manual and CFS technique) show the same characteristics. Dentinal tubules are not visible and the smear layer is present in all lengths. The continuous smear layer seems to be more dense in group 5 where the automated handpiece was used (Figure 3).

Figure 3 - Groups 4 and 5. Instrumented teeth irrigated with 1% sodium hypochlorite. A, Manual technique. B, CFS. c: cervical third; m: middle third; a: apical third. 1000X.

Groups 6 and 7. Instrumented teeth; irrigating solution, 1% sodium hypochlorite and EDTA (5 min).

Figure 4 represents the specimens treated by manual (A) and CFS technique (B). All the thirds are extremely smooth and clean. The smear layer is noticeably absent. Little superficial debris is seen in the manual preparation group. In the CFS technique (group 7) the grooves produced by the use of the Set-files are free of smear layer and debris. It is important to notice that smear layer is not present in the dentinal tubules, common when the manual technique is used.

Figure 4 - Groups 6 and 7. Instrumented teeth irrigated with 1% sodium hypochlorite and EDTA for 5 min. A, Manual technique. B, CFS. c: cervical third; m: middle third; a: apical third. 1000X.

Discussion

Root canal preparation should remove all tissue, necrotic debris, infected predentin and dentin and finally shape the canal to receive a three-dimensional root filling (Schilder, 1974; Paiva and Antonizzi, 1991). When dentin is cut by hand or by an automated handpiece the mineralized matrix is destroyed, providing considerable debris. This results in a smear layer composed of both organic and inorganic components (McComb and Smith, 1975; Mizrachi et al., 1975; Moodnik et al., 1976; Goldman et al., 1981). Our study demonstrated that both manual and CFS techniques did not influence the results regardless of the irrigating solution used. These findings are in agreement with other authors (Goldberg and Spielberg, 1982; Goldberg et al., 1984; Baumgartner and Mader, 1987; Mandel et al., 1990; Batista et al., 1996). The advantages of using the CFS are linked to the similarity of the movements provided by this handpiece as compared to the manual technique added to the high flexibility and cutting efficiency of the Set-file. However, endodontists should understand that the CFS does not substitute hand instruments. It must be used as an auxilliary aid in root canal preparation (Sydney and Melo, 1996). Our results indicated that, using hand or automated handpiece instrumentation, the presence of a smear layer is almost the same. The continuous smear layer seemed to be more dense in Group 5 where root canal preparation was performed with the CFS than in Group 4 (manual technique), but not significantly. This was a common observation to all investigators, probably because of the appearance of two or more different layers superimposed, defined by Prati et al. (1994) as a tree-bark configuration. The use of EDTA associated with 1% sodium hypochlorite resulted in cleaner canals, with complete removal of smear layer. This fact is probaly due to the demineralization action of EDTA on the inorganic components of this layer (Goldman et al., 1981; Goldberg and Spielberg, 1982; Goldberg et al., 1984; Baumgartner and Mader, 1987). It is important to note the findings in group 7 (CFS, 1% sodium hypochlorite and EDTA for 5 min) where the grooves produced by the Set-files were free of smear layer and debris, including the dentinal tubules entrance.

Conclusions

1. Smear layer is present when root canal preparation is performed by manual and by an automated handpiece (CFS).
2. The continuous smear layer seems to be more dense in the group where root canal preparation was performed by the automated handpiece (CFS).
3. The use of EDTA for 5 min after complete root canal preparation and a final flush of 1% sodium hypochlorite showed the absence of the smear layer in all groups.

References

Aun CE: Análise ïn vitro through da microscopia eletrônica de varredura, da quantidade de canalículos dentinários livres da camada residual de magma no terço apical do canal radicular após preparo químico

mecânico, variando-se o instrumento e seu número de uso. Livre Docência thesis, Universidade de São Paulo, 1990

Baker NA, Eleazer PD, Auerbach RE: Scanning electron microscopic study of the efficacy of various irrigating solutions. J Endodont 4: 127-135, 1975

Batista A, Pesce HF, Bombana AC, Sydney GB: Análise com auxílio da microscopia eletrônica de varredura da limpeza das paredes do canal radicular (terço apical), frente a algumas soluções irrigadoras. Rev Bras Odontol 1996 (in press)

Baumgartner JC, Brown CM, Mader CL, Peters DD, Schulman JD: A scanning electron microscope evaluation of root canal debridment using saline, sodium hypochlorite and citric acid. J Endodont 11: 525-531, 1984

Baumgartner JC, Mader CL: A scanning electron microscopic evaluation of four root canal irrigation regimens. J Endodont, 4: 147-157, 1987

Czonstkowski M, Wilson EG, Holstein FA: The smear layer in endodontics. Dent Clin N Amer 34: 13-25, 1990

Gavini G: Avaliação "in vitro" da limpeza da parede do canal radicular (terço apical), após o preparo químico-mecânico, valendo-se da microscopia eletrônica de varredura, tendo como fonte de variação a solução irrigadora e seu volume. Master's theses, Universidade de São Paulo, Brasil, 1992

Goldberg F, Spielberg C: The effect of EDTAC and variation of its working time with scanning electron microscope. Oral Surg 53: 74-77, 1982

Goldberg F, Massone EJ, Spielberg GC: Estudio comparativo de la acción del EDTAC y el salvizol sobre la parede del conducto radicular instrumentado: análisis com microscopia eletrônica de barrido. Rev Esp Endodoncia 1: 17-20, 1984

Goldman M, Goldman L, Kronman J, Lin PS: The efficacy of several irrigating solutions for endodontics: a scanning electron microscopic study. Oral Surg 2: 197-204, 1981

McComb D, Smith DC: A preliminary S.E.M. study of root canals after endodontic procedures. J Endodont 1: 238-242, 1975

Mandel E, Machtou P, Friedman S: Scanning electron microscope observation of cleanliness. J Endodont 6: 279-283, 1990

Mizrachi SJ, Tucker JW, Seltzer SA: Scanning electron microscopic study of the efficacy of various endodontic instruments. J Endodont 10: 324-333, 1975

Moodnik RM, Dorn SO, Feldman MJ, Levey M, Borden BG: Efficacy of biomechanical instrumentation: a scanning electron microscopic study. J Endodont 9: 261-266, 1976

Paiva JG, Antoniazzi JH: Endodontia: Bases para a prática clínica. 2nd. ed., Artes Médicas, São Paulo, 1991

Prati C, Seliguini M, Ferrieri P, Mongiorgi R: Scanning electron microscopic evaluation of different endodontic procedures on dentin morphology of human teeth. J Endodont 4: 174-179, 1994

Schilder H: Cleaning and shaping the root canal. Dent Clin N Amer 18: 269-296, 1974

Sydney GB, Melo LL: O emprego do Canal Finder System no preparo do canal radicular. Rev Bras Odontol 1996 (in press)

Correspondence: Gilson B. Sydney, Departamento de Endodontia, Faculdade de Odontologia, Universidade Federal do Paraná, 80060-020 Curitiba, PA, Brasil.

Accepted March 4, 1996
Electronic publication: September, 1996

BACK TO CONTENTS