Treatment decisions for deep carious lesions in the Public Health Service in Southern Brazil

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Abstract

Objectives: The aim of the present study was to assess Public Health Service clinicians' treatment decisions about deep carious lesions in the city of Porto Alegre, Brazil.
Methods: Treatment decisions were assessed with a structured questionnaire (open/discursive and containing information about gender, university and year of college graduation, and college major) and three simulated clinical cases composed of teeth with primary deep carious lesion. All professionals working for the Public Health Service in the city were addressed.
Results: Out of 122 professionals, 54 participated in the study (response rate of 44 percent). There was no difference between respondents and non-respondents regarding gender, year of college graduation, or college major. The most commonly indicated procedure was direct complete excavation (71.1 percent), followed by stepwise excavation (17.6 percent), partial caries removal (8.8 percent), and pulp therapies (direct pulp capping, partial or complete pulpotomy, and endodontics) (2.5 percent). Year of college graduation was the only variable influencing treatment decision. Logistic regression analysis showed that professionals who had graduated after the year 2000 were significantly more likely to indicate a conservative treatment than were dentists who graduated through 1979 (odds ratio = 5.5).
Conclusions: The most commonly proposed treatment is the one with the highest risk of pulp exposure, and consequently the poorest prognosis. Younger dentists tended to indicate more conservative approaches, compared with those indicated by older dentists.

Introduction

Dental caries is a dynamic process that takes place in dental biofilm as a result of a disturbance in the equilibrium between tooth substance and microbial deposit. The control of dental biofilm is essential to preventing the onset and development of carious lesions. However, at an advanced stage, the cavity resulting from carious lesions usually impairs biofilm control, and restorative treatment is required (1-3). The traditional restorative approach recommends removal of all soft carious dentin prior to restoration to prevent further cariogenic activity and to provide a well-mineralized dentin base for restoration. When the lesion floor is near the pulp, caries excavation represents a risk of pulp exposure, and the maintenance of tooth vitality becomes of particular importance (2,3).

In this context, to preclude or at least minimize the potential complications of complete excavation, some alternative approaches for the treatment of deep carious lesions have been proposed such as stepwise excavation (4), indirect pulp capping (5), and partial caries removal (2).

The stepwise excavation technique involves the staged removal of decayed tissue and has been widely used in permanent dentition. In this treatment, only part of the soft dentin is removed during the first session, while the patient is in the acute phase of caries progression (4). The cavity is sealed with a temporary filling and reopened after a period of time. In the second session, all or most of the remaining decayed tissue is removed. The purpose of this approach is to arrest lesion progression before the final excavation, thus making pulp exposure less likely. Studies assessing the risk of pulp exposure in deep lesions in deciduous and permanent teeth have reported

that stepwise excavation is safer than direct complete excavation because it promotes fewer pulp exposures (4,6,7). However, this technique has disadvantages associated with cavity reopening such as the risk of pulp exposure during the removal of temporary filling or final excavation, additional discomfort to the patient, and increased cost. Moreover, the possibility that patients will not return to the Health Service to conclude a multiple-appointment treatment can lead to treatment failure.

Based on several studies reporting the halting of the carious process by sealing the carious tissue (8-16), the necessity of reentering the cavity to remove the remaining decayed dentin has been discussed (17,18). Indirect pulp capping is a technique in which the decayed tissue is removed as much as possible, and a thin layer of carious dentin is left over the pulp (5). This approach does not require cavity reopening and is usually indicated for primary dentition. Recently, another conservative approach, referred to as partial caries removal, has been suggested (2). In this method, only the necrotic disorganized dentin is excavated, and the cavity is filled with a long-lasting material during a single session. Partial caries removal differs from the indirect pulp capping because a thicker layer of carious dentin is left in the bottom of the cavity. This technique has been successfully used in permanent dentition (11,13,14,16).

Many treatment concepts have been proposed to solve the deep carious lesion dilemma. It is very important to analyze the wide range of treatment decisions made by clinicians, to maintain the quality of care (19). There are marked differences in how dentistry is practiced among regions of a country and among professionals in the same area (20). There is a lack of studies evaluating the differences between professionals' proposals for the treatment of deep carious lesions in permanent dentition.

The aim of the present study was to assess Public Health Service clinicians' treatment decisions about deep carious lesions in the city of Porto Alegre, Brazil.

Methods

This study was approved by the Research Ethics Committee of the Municipal Health Department of Porto Alegre city (process nº001.003512.09.6/register nº334), and all participants signed a free, informed consent.

The overall population of dentists linked to the Public Health Service of Porto Alegre, Brazil was addressed. Out of 139 professionals, 13 were excluded because they were no longer practicing clinical activities, and 4 were excluded because they were recently involved in clinical training with the main researcher. Therefore, 122 dentists were included in the study.

Professionals were reached by phone at the Health Unit for which they currently work and were invited to participate. A structured questionnaire was sent by post mail or personally delivery for each professional. The research documentation was to be returned by post mail, and if there was no answer, the Health Units were visited.

The open/discursive questionnaire asked for the following information: dentist identification, gender, university and year of college graduation, college major, three simulated clinical cases, treatment indication and justification. The simulated clinical cases were composed of young patients (ages 25, 11, and 14 for cases A, B, and C, respectively) with no medical history of allergies or use of medications, reporting the occurrence of pain provoked by chewing or by cold in posterior teeth as their main complaint. Descriptions of the physical examination and pictures and periapical radiographs were also provided (Figure 1). The teeth were permanent molars with the following descriptions: primary deep carious lesion (lesion depth > $^1/_2$ of dentinal thickness, radiographically assessed); presence of soft, wet and yellowish or brownish dentin indicating lesion activity; positive pulp sensitivity tested by cold stimulation; no sensitivity to percussion; no history of spontaneous pulpal pain; and absence of apical pathosis observed through radiographic examination. The answers were classified by one investigator (CMW) and checked by the senior researcher (MM).

Pilot study

Prior to the application of the questionnaire, a pilot study was performed with 15 dentists to test its suitability. After evaluating the professional's responses, the questionnaire was considered appropriate to be used in this survey and was not modified.

Statistical methods

A Chi-square test was used to analyze the differences between respondents and non-respondents as well as to compare the proposed treatments for each clinical case (direct complete excavation versus conservative approaches, i.e., stepwise excavation and partial caries removal). Logistic regression was used to assess the association between independent variables and treatment indications.

The level of significance was 5 percent. Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) software (IBM, Somers, New York, USA).

Results

A total of 54 dentists took part in the study, representing a response rate of 44 percent. There was no difference between respondents and non-respondents regarding gender (male or female, $P = 0.87$), year of college graduation (through 1979, 1980-89 or after 1990, $P = 0.38$), and college major (with or

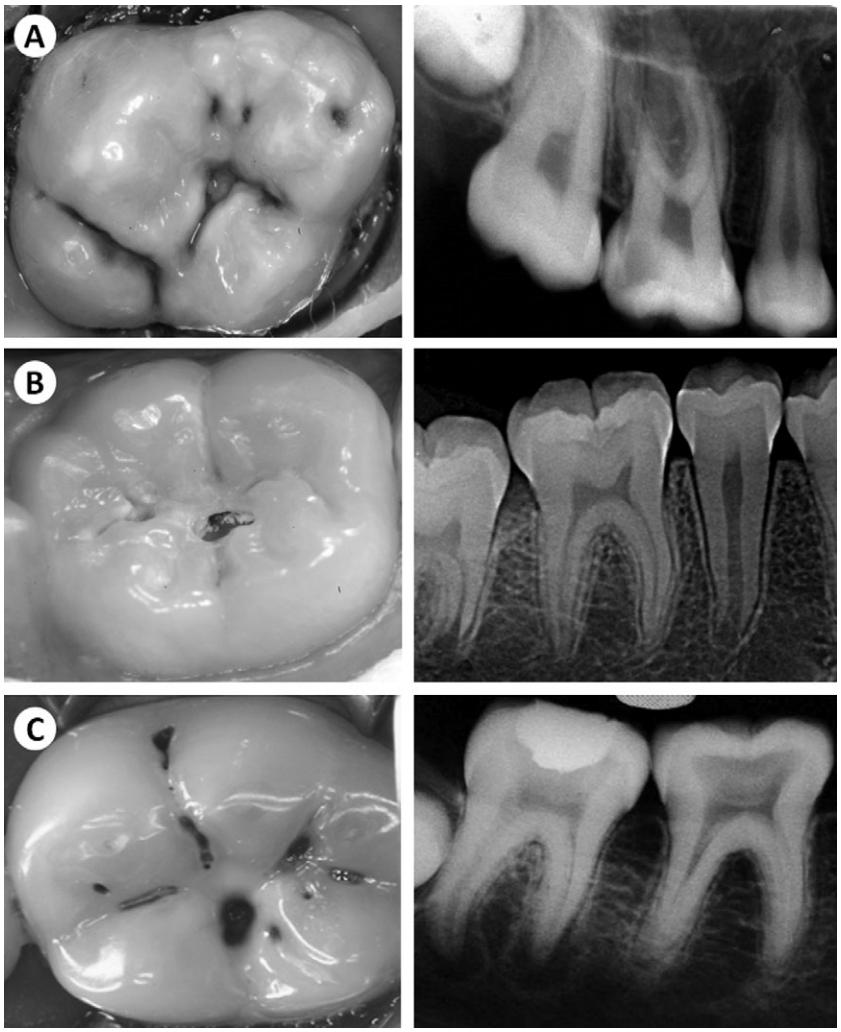

Figure 1 Clinical aspect and periapical radiograph of clinical cases A, B, and C.

without, P = 0.83). It was possible to contact 34.3 percent of the non-respondents. Lack of time to answer the questionnaire was the reason claimed by 74 percent of non-participants.

Table 1 shows the proposed treatments for each clinical case. Overall, the most commonly indicated procedure was direct complete excavation (71.1 percent), followed by stepwise excavation (17.6 percent), partial caries removal (8.8 percent), and pulp therapies (direct pulp capping, partial or complete pulpotomy, endodontics) (2.5 percent). Three professionals indicated noninvasive procedures for case B and were excluded from the analyses. Case C was significantly more likely to receive indication of a conservative approach (stepwise excavation or partial caries removal) than the other cases (Chi-square test, $P < 0.05$), although the majority of professionals still indicated direct complete excavation for this case.

Table 1 Proposed Treatments for Each Clinical Case

	Pulp therapy*	Direct complete excavation	Stepwise excavation	Partial caries removal	Total
Case A	0	43 (79.6%)	8 (14.8%)	3 (5.6%)	54
Case B	0	41 (80.4%)	5 (9.8%)	5 (9.8%)	51
Case C	4 (7.4%)	29 (53.7%)	15 (27.8%)	6 (11.1%)	54
	4 (2.5%)	113 (71.1%)	28 (17.6%)	14 (8.8%)	159

* Direct pulp capping, partial or complete pulpotomy, endodontics.

Table 2 Association between Independent Variables and Treatment Indications (Logistic Regression Analysis)

	Direct complete excavation	Conservative treatments*	OR (95% CI)	*P*
Gender				
Male	31 (66%)	16 (34%)	1.0	
Female	82 (76%)	26 (24%)	0.6 (0.2-1.2)	0.20
University				
UFRGS	91 (75%)	31 (25%)	1.0	
Others	22 (67%)	11 (33%)	1.4 (0.6-3.3)	0.36
Year of graduation				
Through 1979	27 (80%)	7 (20%)	1.0	
1980-1989	51 (76%)	16 (24%)	1.2 (0.4-3.3)	0.70
1990-1999	28 (76%)	9 (24%)	1.2 (0.4-3.8)	0.70
After 2000	7 (41%)	10 (59%)	5.5 (1.5-19.7)	0.01
College major				
No	59 (74%)	21 (26%)	1.0	
Yes	54 (72%)	21 (28%)	1.1 (0.5-2.1)	0.80

* Stepwise excavation or partial caries removal.

OR, odds ratio; CI, confidential interval; UFRGS, Federal University of Rio Grande do Sul.

As shown in Table 2, the year of college graduation was the only variable influencing treatment decision. Logistic regression analysis showed that professionals who had graduated after the year 2000 were significantly more likely to indicate a conservative treatment than were dentists who graduated through 1979 [odds ratio (OR) = 5.5].

Discussion

Forty-four percent of the targeted professionals participated in the survey. Although it is difficult to establish whether the non-participants represented different opinions from those who participated, the comparison between respondents and non-respondents showed that both groups were similar with regards to gender, year of college graduation, and major college. Therefore, the response rate does not seem to compromise the present findings.

The treatment of deep carious lesions approaching the pulp tissue represents a particular challenge to the clinician because there is a high risk of accidental pulp exposure in this kind of lesion (4,6,7,18). Nevertheless, direct complete excavation was the most indicated procedure in the present study, being indicated for about 80% of cases A and B, and 53% of case C. The fact that cases A and B have received indication for direct complete excavation significantly more often than case C allows us to infer that professionals underestimated the lesion depth presented in the first two cases. Clearly, the carious lesion presented in case C is deeper than those in cases A and B; however, all of them reach 75 percent of dentinal thickness, and the risk of pulp exposure is a reality for all three cases. Studies have shown that direct complete excavation of deep carious lesions (similar to the ones presented in this paper) results in a rate of pulp exposure between 28.9 percent and 53 percent (4,6,7). When pulp exposure occurs, direct pulp capping and pulpotomy are the available options at the primary care level. A retrospective study assessing the success rate of direct pulp capping showed that only 13% of capped teeth had pulp sensitivity after 10 years (21). A recent multicenter clinical trial comparing direct pulp capping with partial pulpotomy in caries-exposed pulps of permanent teeth found low success rates after 1 year of monitoring in both groups (31.8 percent and 34.5 percent, respectively) (7). Another alternative for treating an exposed pulp is endodontic treatment, which requires referring the patient to a secondary care level. Endodontic treatment, besides being a more biologically invasive and radical therapy, is a complex, costly, and protracted procedure that demands the use of more advanced technology and specialized training. Statistics from the Brazilian Ministry of Health show that the specialized dental services in 2004 corresponded to no more than 3.5 percent of all dental procedures. This limited access to secondary care in the Public Health Service could be one of the reasons for the high prevalence of tooth loss observed in Brazilian youth (22,23). Despite the low success rates of therapies such as direct pulp capping and pulpotomy, and the restricted access to endodontics, four professionals indicated these treatments for case C – a vital tooth, with no symptoms or signs of irreversible pulpal inflammation. Adopting a conservative approach in the treatment of deep carious could allow treatment to be given at the primary care level – which is more accessible to the patient – and reduce the demand for secondary care. Nevertheless, the present study showed that most clinicians continue to follow the principles of traditional operative dentistry by removing all softened dentin before restoration. Similar results were observed in a recent study evaluating the North American dentist population. In this survey, the majority of respondents (62 percent) would remove all caries, even if the procedure presented a risk of

pulp exposure, whereas 18 percent would partially remove caries (24). Although direct complete excavation appears to be a single appointment intervention, which therefore makes it the choice procedure of government and public health professionals, this treatment usually promotes pulp exposures (4,6,7). The poor prognosis and the consequent need for endodontic treatment (which is more costly and requires multiple appointments and availability of secondary care) should be matters taken into account by professionals.

Stepwise excavation represents an alternative to avoid pulp exposure and its consequences (4,6). Although this technique has been described and investigated scientifically for over 30 years, it has barely been implemented in clinical practice (24). A low proportion of professionals indicated stepwise excavation in the present study. Several observational studies of dental practice environments have demonstrated the benefits of treating deep carious lesions with this less invasive procedure (4,6-10). However, clinical experience in Brazil reveals that the necessity of a second appointment is a disadvantage to this procedure. Many patients do not return to the Health Service to receive the definitive restoration (25), which leads to the deterioration of the temporary filling and consequent caries progression. Considering the likelihood that the patient will not return for multiple appointments and its cost to the Public Health Service, the need of cavity reopening for additional excavation should be questioned. A recent systematic review comparing complete with minimal caries removal reported that "whilst there is insufficient evidence to know whether it is necessary to re-enter and excavate further in the stepwise excavation technique, the studies that did not re-enter reported no adverse consequences" (18). A critical review analyzing 10 studies reported that there is substantial evidence that removing all infected dentin from lesions approaching the pulp is not necessary for successful caries treatment (17). Although current evidence supports the implementation of partial caries removal (11,13,14,16,18), it was the least indicated treatment in the present study. Apart from the biological advantages of this therapy related to the maintenance of tooth vitality (less risk of pulp exposure at the second session), the possibility of concluding the treatment in a single session reduces its cost, an important factor to be considered during the decision-making process.

It was observed that dentists who had graduated after the year 2000 were 5.5 times more likely to indicate a conservative treatment than dentists who graduated through 1979. The trend of younger professionals adopting more conservative approaches was also observed in other studies, which found that younger dentists were less likely to initiate treatment for occlusal (26) and approximal carious lesions (27,28) than older professionals.

The clinical decision-making process has three phases: diagnosis, decision about intervention, and selection of the treatment (20). It is well known that not all dentists will make the same decisions when faced with the same clinical situation (19). These differences among professionals are commonly accepted as reflections of the "art of dentistry" and are described as natural variations in dentists' clinical judgments. Although it has long been acknowledged and not generally regarded as a problem or a potential problem, variability in clinical judgments can compromise the effectiveness of care. This variability identifies those aspects of dentistry where there is uncertainty or disagreement concerning the most effective approaches for treatment (20). Variations in dentists' clinical decisions and their consequences have encouraged the development of guidelines that aim to reduce variation and assure the quality of care to any patient.

There are recent and continuous changes in knowledge of the caries disease process, which is transformed every day by new scientific evidence, changing how dentists make decisions about its diagnosis and management. A study concerning evidence-based dentistry in clinical practice discussed the application of systematic review findings to everyday clinical practice (29). Authors emphasized that dental professionals must evolve by evaluating the best evidence currently available and by identifying the newest information to help them provide the best care for patients. In the present study, the year of college graduation influenced treatment decisions. Younger dentists indicated treatments based on the latest scientific evidence regarding caries excavation. This finding demonstrates the difficulty of transferring knowledge derived from evidence-based dentistry to clinical practice, especially among older professionals.

In conclusion, the majority of professionals indicated the direct complete excavation for the treatment of deep carious lesions. The indication of direct complete excavation in 71.1 percent of the cases is a call for reflection considering the strong evidence that: (a) complete caries removal of decayed tissue in deep lesions increases the risk of pulp exposure (4,6); (b) there is a poor prognosis in cases involving pulp exposure (7,21); and (c) caries progression halts after sealing decayed dentin (8-16). It also shows that, despite the large availability of scientific knowledge for dental practitioners, the translation of that knowledge into clinical practice appears to be slow.

References

1. Fejerskov O. Concepts of dental caries and their consequences for understanding the disease. *Community Dent Oral Epidemiol.* 1997;**25**(1):5-12.
2. Kidd EA. How "clean" must a cavity be before restoration? *Caries Res.* 2004;**38**(3):305-13.
3. Kidd E, Bjørndal L, Beighton D, Fejerskov O. Caries removal and the pulp-dentinal complex. In: Fejerkov O, Kidd E, editors. *Dental caries: the disease and its clinical management*. 2nd ed. Oxford: Blackwell Munksgaard; 2008. p. 367-83.

4. Magnusson BO, Sundell SO. Stepwise excavation of deep carious lesions in primary molars. *J Int Assoc Dent Child.* 1977;**8**(2):36-40.
5. King JB, Jr, Crawford JJ, Lindahl RL. Indirect pulp capping: a bacteriologic study of deep carious dentine in human teeth. *Oral Surg Oral Med Oral Pathol.* 1965;**20**(5):663-9.
6. Leksell E, Ridell K, Cvek M, Mejare I. Pulp exposure after stepwise versus direct complete excavation of deep carious lesions in young posterior permanent teeth. *Endod Dent Traumatol.* 1996;**12**(4):192-6.
7. Bjørndal L, Reit C, Bruun G, Markvart M, Kjældgaard M, Näsman P, Thordrup M, Dige I, Nyvad B, Fransson H, Lager A, Ericson D, Petersson K, Olsson J, Santimano EM, Wennstrom A, Winkel P, Gluud C. Treatment of deep caries lesions in adults: randomized clinical trials comparing stepwise vs. direct complete excavation, and direct pulp capping vs. partial pulpotomy. *Eur J Oral Sci.* 2010;**118**(3): 290-7.
8. Bjørndal L, Larsen T, Thylstrup A. A clinical and microbiological study of deep carious lesions during stepwise excavation using long treatment intervals. *Caries Res.* 1997;**31**(6):411-7.
9. Bjørndal L, Thylstrup A. A practice-based study on stepwise excavation of deep carious lesions in permanent teeth: a 1-year follow-up study. *Community Dent Oral Epidemiol.* 1998;**26**(2):122-8.
10. Bjørndal L. A long-term follow-up study on stepwise excavation of deep carious lesions in permanent teeth. *Caries Res.* 1999;**33**:314.
11. Maltz M, de Oliveira EF, Fontanella V, Bianchi R. A clinical, microbiologic, and radiographic study of deep caries lesions after incomplete caries removal. *Quintessence Int.* 2002;**33**(2): 151-9.
12. Massara ML, Alves JB, Brandao PR. Atraumatic restorative treatment: clinical, ultrastructural and chemical analysis. *Caries Res.* 2002;**36**(6):430-6.
13. Oliveira EF, Carminatti G, Fontanella V, Maltz M. The monitoring of deep caries lesions after incomplete dentine caries removal: results after 14-18 months. *Clin Oral Investig.* 2006;**10**(2):134-9.
14. Maltz M, Oliveira EF, Fontanella V, Carminatti G. Deep caries lesions after incomplete dentine caries removal: 40-month follow-up study. *Caries Res.* 2007;**41**(6):493-6.
15. Orhan A, Oz F, Ozcelik B, Orhan K. A clinical and microbiological comparative study of deep carious lesion treatment in deciduous and young permanent molars. *Clin Oral Investig.* 2008;**12**(4):369-78.
16. Alves LS, Fontanella V, Damo AC, Oliveira EF, Maltz M. Qualitative and quantitative radiographic assessment of sealed carious dentin: a 10-year prospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2010;**109**:135-41.
17. Thompson V, Craig RG, Curro FA, Green WS, Ship JA. Treatment of deep carious lesions by complete excavation or partial removal: a critical review. *J Am Dent Assoc.* 2008;**139**(6):705-12.
18. Ricketts DN, Kidd EA, Innes N, Clarkson J. Complete or ultraconservative removal of decayed tissue in unfilled teeth. *Cochrane Database Syst Rev.* 2009;**3**:CD003808.
19. Bader J, Shugars D. Understanding dentists' restorative treatment decisions. *J Public Health Dent.* 1992;**52**(2):102-10.
20. Bader J, Shugars D. Variation, treatment outcomes, and practice guidelines in dental practice. *J Dent Educ.* 1995;**59**(1):61-95.
21. Barthel CR, Rosenkranz B, Leuenberg A, Roulet JF. Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. *J Endod.* 2000;**26**(9):525-8.
22. Leal R, Tomita N. Dental care and universalization: perceptions of public health services managers. *Ciência & Saúde Coletiva.* 2005;**11**:155-60.
23. Narvai PC, Frazao P, Roncalli AG, Antunes JL. Dental caries in Brazil: decline, polarization, inequality and social exclusion. *Rev Panam Salud Publica.* 2006;**19**(6):385-93.
24. Oen KT, Thompson VP, Vena D, Caufield PW, Curro F, Dasanayake A, Ship JA, Lindblad A. Attitudes and expectations of treating deep caries: a PEARL Network survey. *Gen Dent.* 2007;**55**(3):197-203.
25. Parolo CCF, Heller D, Bitello LF, Podestá K, Souza DCC, Hashizume LN, Maltz M. Effectiveness of the stepwise excavation treatment performed by dental students in Porto Alegre, Brazil. *Caries Res.* 2007;**41**:269. Abstr. 5.
26. Espelid I, Tveit A, Mejàre I, Sundberg H, Hallonsten A. Restorative treatment decisions on occlusal caries in Scandinavia. *Acta Odontol Scand.* 2001;**59**(1):21-7.
27. el-Mowafy O, Lewis D. Restorative decision making by Ontario dentists. *J Can Dent Assoc.* 1994;**60**(4):305-10.
28. Mejàre I, Sundberg H, Espelid I, Tveit B. Caries assessment and restorative treatment thresholds reported by Swedish dentists. *Acta Odontol Scand.* 1999;**57**(3):149-54.
29. Ismail A, Bader J, Science ACoSAaDo, Association JotAD. Evidence-based dentistry in clinical practice. *J Am Dent Assoc.* 2004;**135**(1):78-83.