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Treatment preferences of deep carious lesions in mature teeth: Questionnaire study among dentists in Northern Norway

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Abstract

Objective. To investigate preferred treatment methods of deep carious lesions in mature permanent teeth among dentists in Northern Norway. ***Materials and methods.*** The survey included all 437 general dental practitioners in Northern Norway working in the private or the public dental health service. The participants received an invitation with a radiograph and a clinical picture of a deep carious lesion in a mature permanent tooth and a questionnaire asking about demographic characteristics and their preferred treatment methods related to different clinical deep caries diagnoses. ***Results.*** The response rate was 56%. There was an over-representation of publicly employed dentists among the respondents; otherwise no systematic bias related to non-responders was detected. In the absence of carious exposure and no symptoms, total caries excavation was the preferred treatment method (49%) followed by stepwise excavation (45%). In cases of deep caries and no exposure with symptoms, the preferences were equally distributed between root canal treatment (39%) and stepwise excavation (38%). In the presence of carious exposure but no symptoms, the preferred treatment method was direct pulp capping (51%) and in carious exposure with symptoms root canal treatment was the preferred treatment method (91%). ***Conclusions.*** There is no uniform treatment method of deep carious lesions among dentists in Northern Norway.

Key Words: *deep caries, dental caries, dental pulp exposure, reversible pulpitis*

Introduction

The discussion of treatment of deep caries can be traced back to 1746 with Fauchard and continuing with Tomes in the 19th century (cited in [1]). Both of them recommended partial caries excavation in order to avoid pulpal exposure, leaving just 'discolored dentine' at the pulpal wall. It has been concluded in a Cochrane review article that partial caries excavation reduces the risk of pulpal exposures [2]. In deciduous teeth a partial caries excavation procedure has been shown to alter the microflora and the consistency of the remaining dentine [3]. Later partial caries excavation has been identified as two alternative techniques used for treating adults. These are stepwise excavation with re-entry including final total carious dentine removal [4] and indirect pulp capping without re-entry, leaving carious dentine under the permanent restoration [5]. The need of re-entry has recently been challenged [6,7].

In contrast to partial caries excavation, Black wrote in the early 20th century '. . .it is better to expose the pulp of a tooth than to leave it covered only with softened and infected dentine' (cited in [1], p. 337). Total caries excavation assumes soft and demineralized dentine removal to provide a well-mineralized dentine base for restoration and preventing further cariogenic activity by removing bacteria. However, it has been shown that remaining dentine was more infected after total caries excavation compared with partial caries excavation covered with calcium hydroxide based material and sealed for 6–7 months [8]. Moreover, total caries excavation has demonstrated a high risk of pulpal exposure and lower success rate than stepwise excavation [9]. Bjørndal et al. [9] have shown that the success rate for teeth without carious exposures is higher (62–74%) than for teeth with carious exposures (32–34.5%).

If a deep carious lesion results in carious exposure, the challenge is whether to perform pulpectomy, followed by root canal treatment (RCT) or to preserve tooth vitality. Vital pulp therapies including direct pulp capping and partial pulpotomy are well-documented

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treatment methods for young permanent (open apex) teeth with carious exposures [10–12]. However, for mature permanent teeth direct pulp capping is still a controversial treatment method with reported success rates varying between 13–82% [13–15], while RCT is evaluated as the most predictable with reported success rates between 86–93% [16].

Deep carious lesions represent a challenge for dentists, as a survey in the US could not identify a commonly agreed, uniform treatment preference for deep caries in mature permanent teeth [17]. A Cochrane review dealing with pulp management of caries in adults was inconclusive regarding the most effective treatment method [18]. Furthermore, dentists' preferences for treatment of deep carious lesions might be influenced by a variety of premises, such as regional traditions, clinical experience and educational background [19].

The aim of the present study was to investigate, in Northern Norway, the preference of treatment method of deep carious lesions in mature permanent teeth. Specifically, the influence of symptoms and/or carious exposure on the decision was emphasized.

Materials and methods

The present study was carried out in Northern Norway (Nordland, Troms and Finnmark counties) during autumn 2011. The survey included all dentists working in the area, both private and in the public dental health service. The dentists' names and addresses were retrieved through registrations by the chief dental officers or local dental associations. A total of 437 dentists were contacted by mail. The invitation explained the purpose of the investigation and indicated confidential and anonymous processing of the data. A questionnaire with 20 multiple-choice questions related to treatment modalities of deep caries was enclosed with a pre-paid coded return envelope. A bitewing radiograph and a photograph of a primary deep carious lesion in a mature permanent tooth (Figure 1) were presented.

The questions included demographic characteristics of the participants and dentists' preferred treatment method of deep carious lesions in mature permanent teeth in four different scenarios: absence or presence of symptoms and carious exposure. The tooth was considered non-symptomatic when there were neither subjective complaints nor a history of pain or symptomatic when subjective symptoms of sharp transient pain to cold or hot liquids and/or air were present. Different treatment options and their definitions were given as follows: (i) total caries excavation: removal of all carious dentine, partial caries excavation referring to two techniques; (ii) with re-entry for final carious dentine excavation (stepwise excavation); (iii) without re-entry when carious dentine is left under the permanent restoration (called indirect pulp capping in this study); (iv) direct pulp capping: an exposed pulp is covered with capping material; (v) partial pulpotomy: part of the coronal pulp adjacent to an exposure is removed and the rest is covered with a capping material; and (vi) pulpectomy: total removal of vital pulp tissue and root canal filling. The dentists were also asked to indicate three reasons and three factors out of a list of options of why they preferred their chosen treatment method. After 8 weeks non-respondents received a second identical letter as a reminder. Collected data were coded, entered and analyzed by the statistical program packages IBM SPSS Statistics 19.0 (IBM, Somers, New York, NY). Chi-square statistics in 2×2 contingency tables were used to study the association between the absence/presence of carious exposure and symptoms and RCT compared to any other treatment preference. Due to incomplete answers the n varied from 212–219 depending on the scenario. Binary logistic regression analysis was used to investigate characteristics of the participants (independent variables) related to preference of treatment method. The level of significance at $p = 0.05$ and 95% CI were set throughout the study.

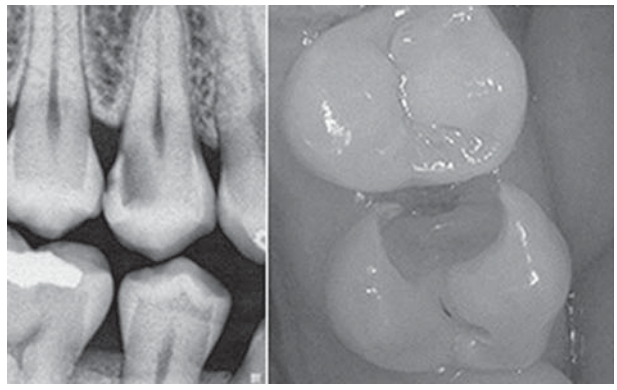

Figure 1. One bitewing radiograph and one clinical picture of the same primary deep carious lesion case in a mature permanent upper right first premolar used to explain the case for participants related to questionnaire. Photos reprinted with permission of Dentaltown.com.

As no patient information was included, ethical approval was considered unnecessary by the Regional Ethical Committee of Northern Norway.

Results

From 437 envelopes sent on the first mailing round, 21 questionnaires were returned because of changed address and 16 returned due to other reasons (retirement, other fields of interest), leaving a final sample of 400. The total number of returned and completed questionnaires was 222, giving a final response rate of 56%. No systematic differences between respondents and non-respondents were detected in gender and location of practice, but an over-representation of publicly employed dentists was registered (Table I).

Table I. Background characteristics of participants.

	Non-respondents				Respondents							
	Practice (n = 178)		Location (n = 178)		Practice (n = 222)		Location (n = 220)		Graduation (n = 222)		Years in practice (n = 222)	
Gender	Public	Private	Urban	Rural	Public	Private	Urban	Rural	In Norway	Outside Norway	≤5	>5
Female	39	49	64	24	77	25	60	42	70	32	37	65
Male	30	60	61	29	53	67	82	36	90	30	19	101
Total	69	109	125	53	130	92	142	78	160	62	56	166

Statistical analysis with Chi-square test: respondents/non-respondents vs male/female, NS; respondents/non-respondents vs urban/rural, NS; respondents/non-respondents vs public/private; $p < 0.001$.

The preferred treatment options for non-exposed pulps without symptoms were equally distributed between total caries excavation (49%) and stepwise excavation (45%). In the presence of symptoms an equal distribution for RCT (39%) and stepwise excavation (38%) was detected (Table II).

In the scenario of carious exposure without symptoms, more than half of the respondents preferred vital pulp therapy, while in the case of symptoms, 91% preferred RCT. Symptoms and carious exposure were found to have a statistically significant impact on preference of RCT (Table II, $p < 0.001$).

Binary logistic regression analysis showed in the absence of pulpal exposure and absence of symptoms, urban location of practice resulted in a statistically significant higher odds ratio (OR) for total caries excavation (2.2) (vs partial excavation, OR = 1) and, in the absence of pulpal exposure but with symptoms, RCT (2.2) (vs any attempt to preserve the tooth vital, OR = 1), respectively ($p < 0.05$) (Table III). Graduation in Norway favored a preference for partial caries excavation in the scenario where both exposure and symptoms were absent ($p < 0.05$). In the presence of carious exposure and symptoms, 5 years or more in practice and graduation in Norway were statistically significantly related to preference of performing root canal treatment ($p < 0.05$) (Table III).

When asked for reasons of why the dentists preferred their chosen method, 'Good results' and 'Easy procedure' were the most frequent answers, chosen by 85% and 45% of the respondents, respectively. The remaining five options listed in the questionnaire (biological basis for the treatment, recommendations by colleagues, recommended in textbooks, continuous education courses and contemporary scientific publications) were selected by less than 34% of the respondents.

Among patient-related factors guiding the selection of preferred treatment method, two factors, 'Final restoration' and 'Patient's oral health', were chosen by 58% and 52% of the respondents, respectively. The dentists indicated the same two factors irrespective of their treatment preference, apart from 'Patient's age', which was selected as the second most important factor among those who favored direct pulp capping and partial pulpotomy. The remaining options listed in the questionnaire (patient's attitude, patient's general health, treatment duration and type of tooth) were given as patient-related factors by less than a half of all respondent.

Discussion

In order to increase the response rate in the present survey, the questionnaire was kept short, comprising

Table II. Distribution (%) of the preferred treatment options in four deep caries scenarios based on the absence/presence of carious exposure and symptoms.

	Exposure								
	Absence					Presence			
Symptoms	Indirect pulp capping	Stepwise excavation	Total caries excavation	RCT[a]	n	RCT	Direct pulp capping	Partial pulpotomy	n
Absence	13 (6%)	95 (45%)	104 (49%)	0 (0%)	212	92 (42%)	111 (51%)	15 (7%)	218
Presence	9 (4%)	82 (38%)	41 (19%)	86 (39%)	218	200 (91%)	6 (3%)	13 (6%)	219

Statistical analysis with Chi-square test: In the absence of symptoms: presence/absence of exposure vs RCT/Other[b], $p < 0.001$; In the presence of symptoms: presence/absence of exposure vs RCT/Other, $p < 0.001$; In the absence of exposure: presence/absence of symptoms vs RCT/Other, $p < 0.001$; In the presence of exposure: presence/absence of symptoms vs RCT/Other, $p < 0.001$.

[a]Pulpectomy followed by root canal treatment.

[b]Other treatment method than pulpectomy.

Table III. Binary logistic regression analysis of the associations with participants' background characteristics on preferred treatment method.

	Preferred treatment method/*scenario*		
Independent variable	Total excavation (vs Partial[a]) *No exposure No symptoms* (n = 212) OR (95% CI), p	RCT[b] (vs vital[c]) *No exposure Symptoms* (n = 218) OR (95% CI), p	RCT (vs vital) *Exposure Symptoms* (n = 219) OR (95% CI), p
Male gender (vs female)	1.5 (0.8–2.8), NS	0.8 (0.5–1.6), NS	0.7 (0.2–2.0), NS
Graduation in Norway (vs outside Norway)	0.5 (0.2–0.9), 0.03*	1.2 (0.6–2.3), NS	3.1 (1.1–8.9), 0.04*
Public practice (vs private)	0.6 (0.3–1.3), NS	0.7 (0.4–1.4), NS	1.3 (0.4–4.2), NS
≥5 years in practice (vs <5 years)	1.3 (0.7–2.6), NS	0.95 (0.5–1.9), NS	3.1 (1.1–8.9), 0.03*
Urban location of practice (vs rural)	2.2 (1.2–4.1), 0.01*	2.2 (1.2–4.1), 0.02*	1.2 (0.4–3.3), NS

[a]Stepwise excavation or indirect pulp capping.
[b]Pulpectomy followed by root canal treatment.
[c]Any attempt to preserve tooth vital.
*$p < 0.05$.

20 questions only. Moreover, a second mail with an identical copy of the questionnaire and personalized introduction letter was sent to non-respondents [20]. An over-representation of publicly employed dentists was detected. Both groups were, however, similar regarding gender and location of clinics. This selection bias may, therefore, have little impact on the results. Information from non-respondents regarding university of graduation and years of practice was not obtainable due to confidentiality. However, there were 178 early-respondents after the first mailing round (response rate 44.5%) and 44 late-respondents after the second mailing round. Both early- and late-respondents were similar comparing their background characteristics and their treatment method preferences ($p > 0.05$). Thus, we can assume that respondents and non-respondents might be similar.

With these limitations, it is reasonable to assume that the present sample, with a response rate of 56%, is sufficient for making conclusions about treatment preferences of deep caries among dentists in Northern Norway [21].

Since the 1980s there has been a constant lack of dentists for the public dental health services and a high turnover among dentists in Northern Norway has been registered. In the 1990s the problem was partially solved by recruiting dentists from other countries. This may result in additional variation in treatment preferences for deep carious lesions in mature permanent teeth and emphasize the importance of the present survey.

In the present study, total caries excavation (49%) and stepwise excavation (45%) were almost equally preferred treatment methods for a deep, but symptomless carious lesion without pulpal exposure (Table II). This result is in contrast to a study from the US where total caries excavation was preferred by more than two-thirds of the dentists if no pulpal exposure was anticipated [17]. Even if pulpal exposure was anticipated, total caries excavation was still preferred by 62% of the American respondents, while one fifth of the respondents only preferred partial caries excavation. In addition, none of the respondents in the present study preferred RCT, while one fifth of the American dentists favored it, even in the absence of both symptoms and an (anticipated) exposure.

In the present study, almost half of the participants chose stepwise excavation in the absence of exposure and symptoms. These dentists, thus, demonstrated confidence in a biologically-based treatment concept, which has been shown to favor partial caries removal in the Cochrane review [2]. Stepwise excavation is also recommended in guidelines from Scandinavia [22]. Moreover, the success rate for stepwise excavation was reported to be 74%, compared with 65% for total caries excavation [9].

Indirect pulp capping was preferred by only 6% of the respondents. This low percentage is in line with Scandinavian guidelines, where this method is not recommended due to lack of scientific support [22].

In the absence of exposure but presence of symptoms, only one fifth of the respondents preferred total caries excavation (Table II). This is in contrast to a study from Southern Brazil, where total caries excavation was preferred by 80% of publicly employed dentists. Moreover, preferences of stepwise excavation and RCT were much higher in the present study, 38% and 39%, compared with the Brazilian study, 15% and 0%, respectively [23].

In our study the symptoms were intentionally described as indicating reversible pulpitis at the most [24]. Nevertheless, symptoms heavily influenced treatment preferences for unexposed pulps, as more than one third of the respondents preferred root canal treatment (Table II). This is in contrast to guidelines in relevant literature, indicating that an inflamed pulp has the potential to heal and teeth should preferably be restored vitally [9,25]. However,

the presence of symptoms might indicate a more severe pulpal inflammation, even if pain is an uncertain diagnostic criterion [26]. This might be the reason why more than one third of the participants were reluctant to choose the vital treatment modality in the presence of symptoms.

The high prevalence of direct pulp capping (51%) in the presence of carious exposure but no symptoms was in accordance with the study from the US, where this treatment was preferred by 73% of the respondents if exposure occurs when removing all caries [17].

The limitation of the present study was that exact age of the patient was not indicated, although it was clear that the study dealt with mature (closed apex) teeth. Nevertheless, age of the patient was chosen as one of the most important patient-related factors for vital pulp therapy of carious exposures. This is in line with studies showing that the success rate of vital pulp therapy was related to patient's age, with a better prognosis in young patients [9,14]. However, in contrast, Hørsted et al. [13] have shown excellent results also in elderly patients, although the success rate in the oldest group was significantly lower than in the youngest group.

The main reasons of why participants preferred vital pulp therapy of carious exposures in mature permanent teeth were subjective, i.e. 'Good results' and 'Easy procedure' In fact, the reason 'Good results' is not in line with contemporary literature. The low success rate for direct pulp capping and partial pulpotomy ranging from 13–34% and decreasing with longer follow-up period have been reported [9,15]. On the other hand, to our knowledge there are three studies showing high success rates of direct pulp capping in permanent mature teeth with exposures [13,14,27]. Unfortunately, all these studies have limitations. The study by Hørsted et al. [13] was retrospective, where only 80 teeth had carious exposure, the remaining 352 being accidental exposures and 78 with unknown origin of exposure. Stratification was not sufficient to reveal the success rate for carious exposures in mature teeth. Cases with pain where excluded, which could explain the better success. In the two other studies, cases with symptoms were included, although the study by Matsuo et al. [14] did not clearly define pain status as an inclusion criterion. The latter study was not randomized and comprised a limited number of patients who were followed up for a short period only. Bogen et al. [27] included 53 teeth with a diagnosis of no more severe than reversible pulpitis, comprising a mixture of mature and immature teeth in their prospective, but not randomized study. However, there were three patients aged 15–16 years with three permanent mature first molars and 14 patients aged 17 years or more with 14 permanent mature first and second molars, from which all teeth survived 1 or more years after direct pulp capping with mineral trioxide aggregate (MTA). However, despite this promising new report with MTA, direct pulp capping and partial pulpotomy are controversial treatment methods in mature permanent teeth with a carious exposure and are not recommended in Scandinavia [22]. Nevertheless, only 42% of the participants preferred RCT in the absence of symptoms, which is in line with the American study where the majority of the dentists also selected methods aiming to maintain tooth vitality [17].

In the present study, more than 90% of the participants preferred RCT in teeth with carious exposures and symptoms. This is in accordance with the literature and Scandinavian recommendations [22,28].

More than 5 years in practice and graduation from Norway were significant characteristics related to preference to perform RCT in the presence of carious exposure and symptoms (Table III). The more experienced dentists and those who graduated from Norway seemed to prefer this well-established, evidence-based treatment method for carious exposure.

In conclusion, in none of the scenarios was a unanimously agreed treatment method disclosed. RCT was frequently chosen in scenarios where the literature suggests preserving tooth vitality and vital methods were chosen where RCT is the prevailing method of choice. This controversy might be partly because of the lack of evidence of the best treatment method. More clinical trials are needed in this field to solve the problem.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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