

Caries assessment and restorative treatment thresholds reported by Swedish dentists

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The aim was to study any variability in approximal and occlusal caries diagnoses and restorative treatment decisions among Swedish dentists. The material consisted of a pre-coded questionnaire sent to a random sample of 923 dentists with 4 items concerning approximal and occlusal caries diagnosis and restorative treatment decisions. Responses were received from 651 (70.5%) dentists. In an adolescent with low caries activity and good oral hygiene, more than 90% of the dentists stated that they would not automatically restore a primary approximal caries lesion if its radiographic appearance did not show obvious progression in the outer 1/3 to 1/2 of the dentin. Moreover, 67% of the dentists would only consider immediate restorative treatment of an occlusal surface if obvious cavitation and/or radiographic signs of dentin caries could be observed. When diagnosing questionable occlusal caries, the dentists largely relied on the radiographic appearance. Concerning both approximal and occlusal caries, the threshold for restorative treatment differed between the metropolitan regions in Sweden, and younger more often than older dentists would postpone restorative treatment of approximal caries until the lesion had reached a relatively advanced stage of progression. The responses also showed that dentists in private practice would restore approximal caries at an earlier stage of progression than the dentists in the Public Dental Health Service.

□ *Approximal caries; occlusal caries; questionnaire*

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In Sweden, as in many other industrialized countries, the prevalence and incidence of caries in children and young adults have decreased markedly (1–3). A low rate of progression of approximal caries has also been reported (4–6). Accordingly, treatment philosophies have shifted towards a more conservative approach implying remineralization rather than restorative treatment strategies (7–10). However, a wide disparity of diagnoses and treatment plans has been observed (11, 12). In Norway, for instance, around 18% of dentists stated that an approximal lesion confined to the enamel would require a restoration, while another 62% stated that only lesions which had reached the outer third of the dentin would require such treatment (16). A similar variation might be expected among Swedish dentists.

In 1988 the Swedish National Board of Health and Welfare (13) presented diagnostic guidelines which stated that, in general, approximal enamel lesions should be given non-operative treatment and monitored rather than being restored. Little is known, however, about the dentists' own opinions and philosophies on these matters.

The use of restorative materials has also changed considerably in Sweden, not least after a political proposal to ban amalgam for environmental reasons. Alternative materials are therefore being used to a growing extent (14). In view of this, it was considered of interest to obtain information about preferences with respect to restorative materials for primary carious lesions at different stages of progression and on different surfaces.

The aim of this study was accordingly to investigate any

variability in caries diagnoses and restorative treatment strategies among Swedish dentists and to assess the choice of restorative dental material for different caries diagnoses and different surfaces. The diagnostic criteria and their relation to the need for restorative treatment of primary approximal and occlusal caries are assessed in this paper. The choice of preparation technique and restorative material is reported in another paper.

Material and methods

A pre-coded questionnaire was sent to a random sample of 923 dentists in October 1996. The sample was drawn from the Swedish National Board of Health and Welfare's register of authorized dentists. Dentists aged 65 years or more were omitted. The questionnaire was anonymous and reminders were not sent.

Responses were received from 651 (70.5%) dentists. Of

Table 1. Distribution of dentists, by age

Age group (years)	No.	%
27–34	49	8.4
35–44	197	33.7
45–54	198	33.8
55–64	141	24.1
Total	585*	100

* Of the 590 responders, 5 did not state their age.

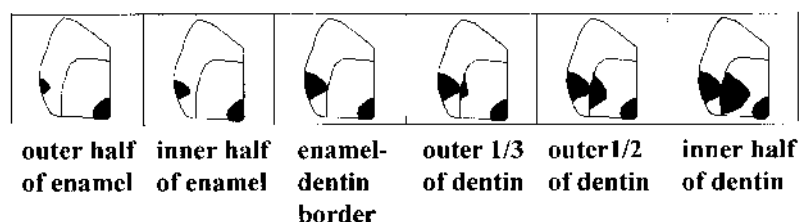


Fig. 1. Radiographic scores of approximal surfaces—related to item 1.

these, 61 had ceased to practice and were therefore excluded from the analysis. Of the remaining 590 responses, 52% were employed by the Public Dental Health Service, 42% were private practitioners and 6% were not practicing at the time of the study. The distribution by age is presented in Table 1. The same questionnaire had been sent to a sample of dentists in Norway in 1995 (15, 16).

To assess the stage of lesion progress at which restorative treatment was considered appropriate, different stages of approximal and occlusal caries were illustrated (Figs 1, 2). To evaluate how the clinical and radiographic appearances influenced the diagnosis of occlusal caries, questionable appearances of 2 occlusal caries lesions were combined with their radiographic appearance (Figs 3, 4). The examples referred to a 20-year-old patient with low caries activity and good oral hygiene. The following questions were asked:

Item 1. The figure (Fig. 1) illustrates different radiographic stages of approximal caries progression. Which lesion(s) do you think requires immediate restorative treatment? That is, the lesion(s) for which you would not postpone restorative treatment under any circumstances even if the patient has low caries activity and good oral hygiene.

Item 2. The figure (Fig. 2) illustrates different clinical appearances of occlusal caries. Which lesion(s) do you think requires immediate restorative (operative) treatment? That is, the lesion(s) for which you would not postpone restorative treatment under any circumstances even if the patient has low caries activity and good oral hygiene.

The following descriptions were added beneath the grades:

Grade 1. Caries characterized by white/brownish discoloration in the enamel, no cavitation. No radiographic signs of caries.

Grade 2. Minor loss of tooth substance with a break in the enamel surface or discolored surface or discolored fissures with grey/opaque enamel and/or caries confined to the enamel. No radiographic signs of caries.

Grade 3. Moderate loss of tooth substance and/or caries in the outer 1/3 of the dentin according to the radiograph.

Grade 4. Considerable loss of tooth substance and/or caries in the middle 1/3 of the dentin according to the radiograph.

Grade 5. Considerable loss of tooth substance and/or

caries in the inner 1/3 of the dentin according to the radiograph.

Item 3. Caries diagnosis. Do you think that from its clinical and radiographic appearance tooth A (Fig. 3) has occlusal dentin caries?

Item 4. Caries diagnosis. Do you think that from its clinical and radiographic appearance tooth B (Fig. 4) has occlusal dentin caries?

Statistics

The chi-square test, Spearman's correlation, and regression analysis (ANOVA) were used to test differences between proportions and correlations between variables. When the cell counts were <5, Fisher's exact test was used. The level of significance was set at 5%. The data were processed in SPSS (Statistical Package for Social Sciences), Windows version 7.5.

Results

Criteria for restorative treatment of approximal caries (Fig. 1, Table 2)

Of the 575 responders to this item, 42% would immediately restore an approximal lesion that was observed in the outer 1/3 of the dentin, 52% would not automatically restore until the lesion had reached 1/2 of the thickness of the dentin, whereas lesions confined to the enamel would be restored by 1% of the dentists. Of the remaining, 4% would be restored at the enamel-dentin border and 1% when the lesion had reached 2/3 of the thickness of the dentin.

There was a general tendency that younger more often than older dentists would postpone operative treatment of approximal caries until the lesion had reached a more advanced stage (ANOVA, $P < 0.005$). Using >50 years of age as the cut-off point, this could be demonstrated with the chi-square test.

The distribution by geographical regions is given in Table 2. While there was no statistically significant difference between the southern, middle, and northern parts of Sweden, a difference was observed between the three metropolitan regions. Thus, dentists in the Malmö

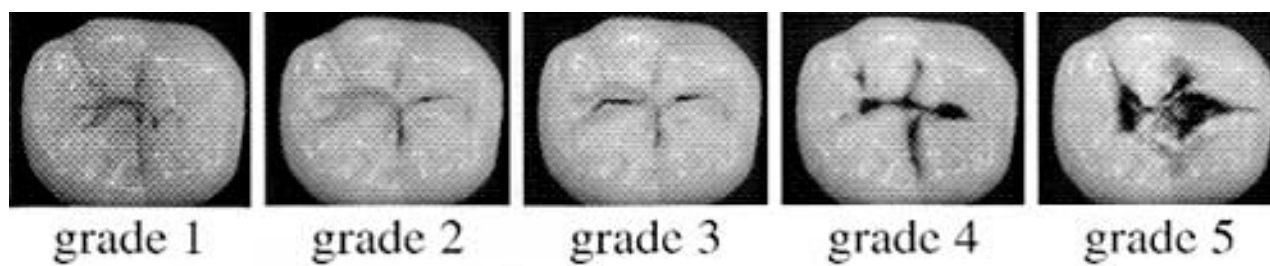


Fig. 2. Clinical appearances of occlusal caries—related to item 2. A detailed description of the different grades is given under Material and methods.

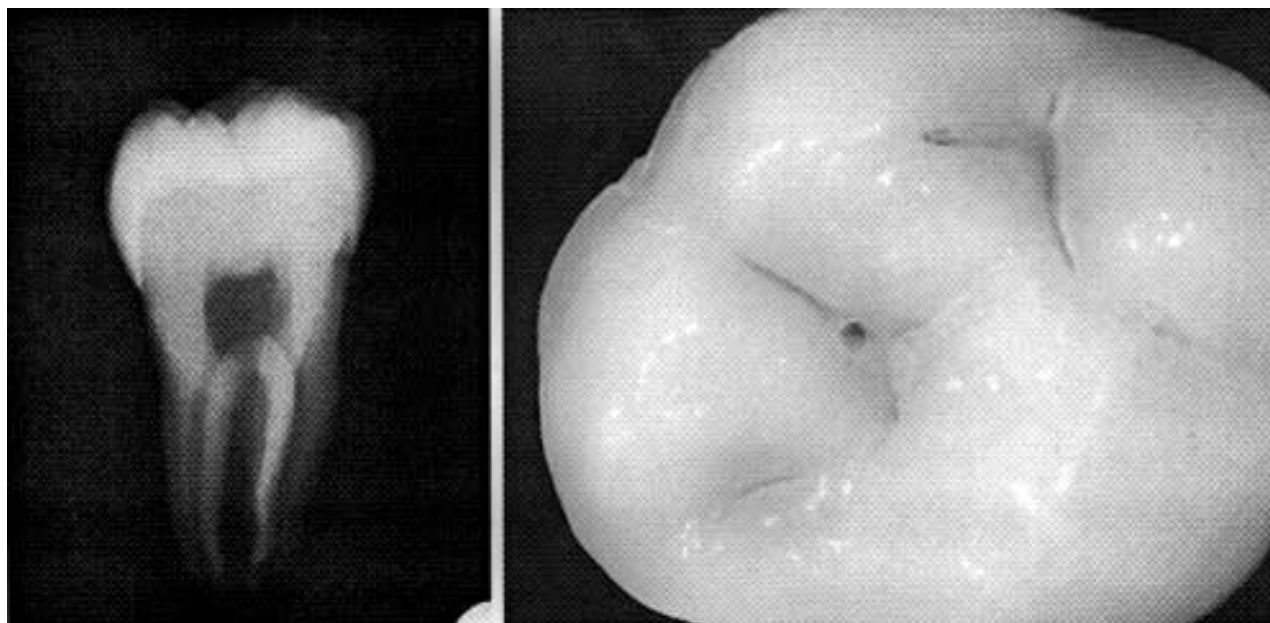


Fig. 3. Tooth A—related to item 3. Clinical photograph showing a minor occlusal cavity combined with a small radiolucency in the dentin.

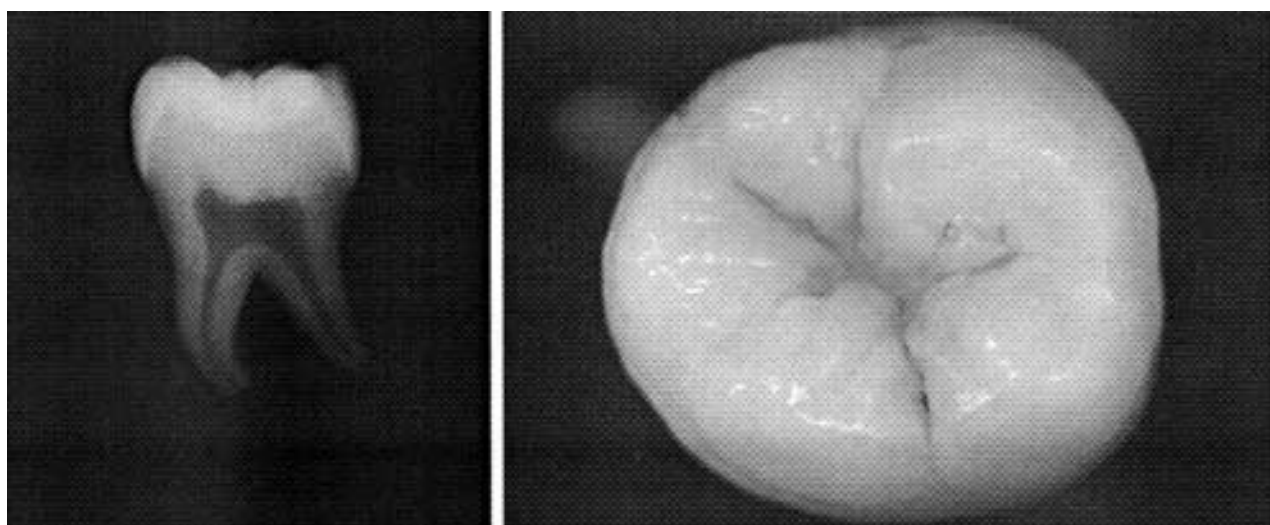


Fig. 4. Tooth B—related to item 4. Clinical photograph showing deep fissures but no obvious cavitation combined with no obvious radiolucency in the dentin.

Table 2. Percentage distribution of answers regarding criteria for restorative treatment of approximal caries (according to Fig. 1) related to regions in Sweden

Regions	Radiographic scores according to Fig. 1						Total (n)
	1/2 of enamel	2/3 of enamel	ed-border	1/3 of dentin	1/2 of dentin	2/3 of dentin	
South/middle/north of Sweden							
South	0.7	1.4	4.9	45.5	46.9	0.7	143
Middle	0	0.9	4.2	38.0	55.1	1.8	332
North	0	0	2.6	51.3	44.9	1.3	78
Total (all regions)	0.2	0.9	4.2	41.8	51.5	1.4	553*
Metropolitan regions							
Stockholm County	0	1.5	5.3	31.1	59.1	3.0	132
Göteborg and Bohus County	0	0	4.8	40.3	53.2	1.6	62
Malmö and Malmöhus County	1.7	1.7	5.2	60.3	29.3	1.7	58
Total (all metropolitan regions)	0.4	1.2	5.2	40.1	50.8	2.4	252

* Of the 590 responders, 37 did not give their locality of practice.

and Malmöhus County region gave an earlier stage for restoration of an approximal lesion than dentists from the other 2 metropolitan regions. The difference was statistically significant ($P = 0.015$). Dentists in private practice indicated an earlier stage than dentists in the Public Dental Health Service ($P < 0.001$), (Table 3).

Criteria for restorative treatment of occlusal caries (Fig. 2)

Of the 572 responders to this item, 67% considered that grade 3 surfaces needed immediate restorative treatment, 26.7% selected grade 4, and 5.9% grade 2 (Table 4). There was no variation in this respect between different parts of Sweden, but a difference was again found between the metropolitan regions (Table 4). Thus, dentists in the Malmö and Malmöhus County region would perform restorative treatment at an earlier stage than dentists in the other 2 regions ($P = 0.002$). No differences were observed in relation to the age of the dentists or between those working in the Public Dental Health Service and those in private practice.

Caries diagnosis of questionable occlusal caries (Figs 3, 4)

The results relating to Teeth A and B are given in Table 6. No differences were found for any of the variables studied. A statistically significant correlation was found

between the answers to item 1 and item 2, that is, when to restore an approximal lesion and when to restore an occlusal lesion. Those who would restore an approximal lesion "late" were those more likely to restore an occlusal carious lesion "late" as well ($r = 0.339$; $P < 0.01$).

Discussion

Considering that no reminder was sent, the number of drop-outs must be regarded as acceptable. The initial sample was handled in such a way that the drop-outs could not be identified for analysis. However, a comparison between the register of authorized dentists and those who answered the questionnaire showed no difference in the distribution by age. It is therefore not likely that any age-related bias from the drop-outs influenced the results.

The proportions of responding dentists in the Public Dental Health Service and in private practice were also practically the same as the national proportion between the 2 groups (according to statistics from the National Board of Health and Welfare). It is impossible to say whether the non-respondents represented different opinions from those responding. Although there are no obvious reasons for assuming that the results were biased

Table 3. Percentage distribution of answers regarding criteria for restorative treatment of approximal caries (according to Fig. 1) related to dentists in private practice or in the Public Dental Health Service

Type of practice	Radiographic scores according to Fig. 1						Total (n)
	1/2 of enamel	2/3 of enamel	ed-border	1/3 of dentin	1/2 of dentin	2/3 of dentin	
Private	0.4	2.0	8.2	45.1	43.4	0.8	244
Public	0	0.3	1.0	36.5	60.2	2.0	299
Other*	0	0	9.4	53.1	37.5	0	32
Total	0.2	2.0	4.5	41.0	51.8	1.4	575**

* Not practicing the dental profession at the time of the study.

** Of the 590 responders, 15 did not give their type of practice.

Table 4. Percentage distribution of answers regarding criteria for immediate restorative treatment of occlusal surfaces according to Fig. 2 related to the metropolitan regions

Metropolitan regions	Grade 2	Grade 3	Grade 4	Grade 5	Total (n)
Stockholm County	3.0	62.1	33.3	1.5	132
Göteborg and Bohus County	6.5	71.0	22.6	0	62
Malmö and Malmöhus County	15.8	73.7	10.5	0	57
Total (all metropolitan regions)	6.8	66.9	25.5	0.8	251
Total (all regions)	5.9	67.0	26.7	0.3	572*

* Of the 590 responders, 18 did not answer this item.

because of this, some caution when interpreting the results may, however, be appropriate.

The differences between the metropolitan regions as regards the criteria for restorative treatment of both approximal and occlusal caries must remain a matter of speculation. One factor could be the influence of philosophies of those who give postgraduate courses in each region. Another could be influence of undergraduate education programmes.

The private dental practitioners gave an earlier stage for the restoration of approximal lesions than the dentists in the Public Dental Health Service. In Sweden, the two categories largely work with different clienteles: private practitioners mainly with adults, while dentists in the Public Dental Health Service are also responsible for the dental health of children and teenagers. Thus, their reference base differed; the private practitioners mainly have experience of adults, while the Public Dental Health dentists may have mostly considered children and teenagers, whose dental health implies mainly unrestored teeth. Bader and Shugars (17) suggest that treatment decisions are influenced by practice-related characteristics. Consequently, a dentist who mostly encounters unrestored teeth might be more reluctant to restore than one who observes more restored teeth in his daily practice.

According to the 1988 guidelines issued by the Swedish National Board of Health and Welfare concerning criteria for restorative treatment of approximal caries (13), a lesion that shows obvious progression in the dentin, should, in general, be restored. To judge from the present results, it seems that these guidelines are no longer followed by a considerable number of Swedish dentists. Furthermore, Swedish dentists stated that they would restore at a more advanced stage of lesion progress compared to dentists in Norway (15, 16).

The optimal stage for restoration is debatable. Con-

cerning approximal caries, for a relatively long time progression through the enamel has been considered to be a slow process (4). There is little information, however, about progression in the dentin. The present results suggest that the dentists observed and judged from their own experience and many considered that progression in the dentin might also be reasonably slow. This perception has been supported recently by the finding that 50% of lesions which had only just penetrated the enamel-dentin border still did not show any radiographically visible progression in the dentin after 3 years (6).

A small occlusal restoration is not nearly as demanding or as hazardous for the tooth as an approximal restoration. It is therefore surprising that although the example concerned a 20-year-old patient, as many as 27% of the dentists stated they would consider postponing restorative treatment of occlusal caries until grade 4, corresponding to "considerable loss of tooth substance and/or caries in the middle 1/3 of the dentin according to the radiograph" (Fig. 2, Table 4).

The difficulties in diagnosing occlusal caries have been discussed in a number of studies (18–21). The present results clearly indicate that, for the diagnosis of questionable occlusal surfaces, the dentists relied to a large extent on the radiographic appearance. Thus, Tooth A and Tooth B were judged differently, although their clinical appearances were similar. A majority of the dentists judged Tooth A as having dentin caries, as against only 9% in the case of Tooth B, most probably due to the differences in the radiographic appearance of the teeth (Table 6). This seems logical. It has been shown that the combination of radiographic appearance and visual inspection gives the best accuracy in the diagnosis of occlusal caries (22). This also emphasizes the importance of including the occlusal surfaces when examining bitewing radiographs and of having radiographs of good quality.

Table 5. Percentage distribution of criteria for restorative treatment of approximal caries according to Fig. 1 in relation to 2 age groups of dentists

Age, (years)	Radiographic scores						Total (n)
	1/2 of enamel	2/3 of enamel	ed-border	1/3 of dentin	1/2 of dentin	2/3 of dentin	
23–50	0	0.8	2.4	39.4	56.1	1.3	371
>50	0.5	1.4	8.5	43.4	44.8	1.4	212
Total	0.2	1.0	4.6	40.8	52.0	1.4	583*

* Of the 590 responders, 7 did not answer this item.

Table 6. Percentage distribution of the diagnostic assessments of Tooth A and Tooth B (related to items 3 and 4)

Occlusal surface	Diagnostic assessment			Total
	Dentin caries	No dentin caries	Uncertain	
Tooth A	82.4	6.3	11.3	100
Tooth B	9.4	65.2	25.3	100

The responses to the questionnaire do not necessarily always correspond to what the dentists would do in practice and an essential question concerns the extent to which the answers of the questionnaire reflected the decision-making of the responders. To get these answers, it would be necessary to analyse representative patient files. At the time of this study, such an approach was not practicable, however. Furthermore, the drawings for the radiographic scoring of approximal caries may have induced some bias. Thus, it has been shown that restorative thresholds reported by dentists may correlate poorly with treatment decisions based on radiographic examination (23). However, treatment philosophies have changed in recent decades in the other Scandinavian countries (8–10) and there seems to be no logical reason why this should not have occurred in Sweden, too. As the examples in the present questionnaire referred to a 20-year-old patient, the results may be applicable only to treatment philosophies for adolescents.

In conclusion, in an adolescent with low caries activity and good oral hygiene, 90% of Swedish dentists reported that they would not automatically restore a primary approximal caries lesion until it showed obvious progression in the outer 1/3 to 1/2 of the dentin. Moreover, 67% of the dentists would not consider immediate restorative treatment of an occlusal surface unless obvious cavitation and/or radiographic signs of dentin caries could be observed. When diagnosing questionable occlusal caries, the dentists relied to a large extent on the lesion's radiographic appearance.

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