EVALUATION OF TWO DIFFERENT INDICES USING PHOTOGRAPHIC METHOD OF ASSESSMENT OF ENAMEL DEFECTS (OPACITIES)

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ABSTRACT

Objective: *The aim of the study was to evaluate the use of two different indices (Thylstrup and Fejerskov index and modified Developmental Defects of Enamel index) devised for measurement of enamel opacities (defects) using photographic method of assessment.*

Material and Methods: *Using the indices, the scoring for enamel defects (on upper central incisor teeth) was made from a sample of 1000 colour photographs (slides). These photographs were of incisor teeth of 10-year-old children living in an area with water fluoride levels below 0.45 parts per million. The slides were viewed using Kodak Carousel S-A 2000 Projector.*

Results: *Results relate to photographs of 987 children, including a total of 1957 teeth. Enamel defects that fulfilled criteria described by Thylstrup and Fejerskov as characteristic of "fluorosis" were recorded in 181(18.3%) children and 358(18.3%) upper central incisor teeth. In majority of the cases, the score was of mild fluorosis. On modified Developmental Defects of Enamel (DDE) index, 652(66.0%) children and 1086(55.5%) teeth (upper central incisors) were scored as having enamel defects. Diffuse defects were the most common.*

Conclusion: *It is concluded that both the Thylstrup and Fejerskov index and the modified Developmental Defects of Enamel (DDE) index can be used with reasonable reproducibility to measure enamel defects. However, if diffuse defects recorded on the modified DDE index were taken to be a result of fluoride intake, then fluorosis may be over-estimated in relation to fluorosis as recognized by Thylstrup and Fejerskov.*

Key words: *Enamel defects, Photographic assessment, Thylstrup and Fejerskov Index, Modified DDE Index, Fluorosis.*

INTRODUCTION

An enamel opacity (defect) can be defined as a qualitative defect in enamel and as a visible abnormality in the translucency of enamel.[1] Qualitative defects in enamel imply a disturbance in enamel matrix formation and/or in its mineralization or maturation during amelogenesis.

It is widely accepted that enamel defects may arise from a large variety of causes.[2-4] More than 100 causes of enamel defects have been described. These may be broadly divided into localized and generalized. Generalized causes include predominantly environmental and genetic. Ingestion of inappropriate levels of fluoride during the developmental period of the teeth represents one environmental cause of enamel defects. This type of opacity (defect) has been extensively investigated, and has been described in relation to excessive ingestion of fluoride in water, food and drinks, fluoride supplements and fluoride toothpaste.[5-15] Some authors suggest that opacities related to excessive fluoride ingestion (fluorosis) can be differentiated on the basis of clinical appearance alone.[16,17] However, differential diagnosis of enamel defects has proved difficult even when comprehensive medical and dental histories are available. This is particularly true in the case of mild enamel defects in low fluoride areas or of defects arising from more than a single cause.[1,18-22] One reason for the difficulty in determining aetiology has been the lack of a well-defined and universally acceptable index of measurement.

A wide range of indices has been used in the past. These can be divided into specific fluorosis indices and descriptive indices.[23] Fluorosis indices are designed to measure only those defects which are thought to arise from

excessive fluoride ingestion and include Dean's index, Moller's index, Thylstrup and Fejerskov index and Tooth Surface Index of Fluorosis.[5,16,24,25] Descriptive indices are based simply upon the clinical appearance of the defects without any reference to aetiology. These indices include those by Losee., Young., Al Alousi., Jackson., Suckling., Murray and Shaw., FDI (Federation Dentaire Internationale)., Smith and the modified Developmental Defects of Enamel (DDE) index.[1,19,26-32] The choice of index is critical to any study of enamel defects and it is one of the many factors that influence the findings of a study.[33,34] Factors which influence the choice of an index include the aims of the study, the practicality of use, the comparability of the results of the study to those of other investigations, validity and reproducibility.

The aim of the present study was to evaluate the use of two different indices devised for measurement of enamel opacities (defects) using photographic method of assessment.

MATERIAL AND METHODS

The present study was carried out using two different indices for scoring colour photographs (slides) of the upper incisor teeth of 10-year-old children. These children were residing in Norwich (England) where fluoride levels in the drinking water supplies are below 0.45 ppm. Two-thirds of the sample of children had taken part in a clinical trial of low fluoride toothpaste and one-third represented a random sample of children attending the same schools but who had not done so. Photographs of the upper incisor teeth were taken in schools blind by one operator. Children were seated in a standard folding chair to which an adjustable headrest had been fitted. Incisors were dried with a guaze square before photograph. The photographic set up used was made up of an Olympus 101 Camera with an Elicar 90mm Macro Lens and a T10 ring flash. The flash was powered by a T power control unit. Films were Kodachrome Professional PKM 135-36. Processing was carried out by Kodak.

The indices used to score photographs were Thylstrup and Fejerskov index (a specific fluorosis index) and modified DDE index (a descriptive index). The criteria and scores used for the indices are shown in Table-1 and 2. The examiner scoring the photographs was trained and calibrated against an epidemiologist with

THYLSTRUP AND FEJERSKOV INDEX

SCORE	Clinical Appearance
0	Normal translucency of enamel remains after prolonged air-drying.
1	Narrow white lines located, corresponding to the perikymata.
2	Smooth surfaces More pronounced lines of opacity which follow the perikymata. Occasional confluence of adjacent lines. Occlusal surfaces Scattered areas of opacity <2mm in diameter and pronounced opacity of cuspal ridges.
3	Smooth surfaces Merging and irregular cloudy areas of opacity. Accentuated drawing of perikymata often visible between opacities. Occlusal surfaces Confluent areas of marked opacity. Worn areas appear almost normal but usually circumscribed by a rim of opaque enamel.
4	Smooth surfaces The entire surface exhibit marked opacity or appears chalky white. Parts of surface exposed to attrition appear less affected. Occlusal surfaces Entire surface exhibits marked opacity. Attrition is often pronounced shortly after eruption.
5	Smooth and occlusal surfaces Entire surface displays marked opacity with focal loss of outermost enamel (pits) <2mm in diameter.
6	Smooth surfaces Pits are regularly arranged in horizontal bands <2mm in vertical extension. Occlusal surfaces Confluent areas <3mm in diameter exhibit loss of enamel. Marked attrition.
7	Smooth surfaces Loss of outermost enamel in irregular areas involving <1/2 of entire surface.
8	Occlusal surfaces Changes in the morphology caused by merging pits and marked attrition. Smooth and occlusal surfaces Loss of outermost enamel involving >1/2 of surface.
9	Smooth and occlusal surfaces Loss of main part of enamel with change in anatomic appearance of surface. Cervical rim of almost unaffected enamel is often noted

Table 1

MODIFIED DDE INDEX

Code	Defect
Code 0	Normal
Code 1	Demarcated opacity - white/cream
Code 2	Demarcated opacity - yellow/brown
Code 3	Diffuse opacities - lines
Code 4	Diffuse opacities - patchy
Code 5	Diffuse opacities - confluent
Code 6	Diffuse opacities - confluent + staining + enamel loss
Code 7	Hypoplasia - pits
Code 8	Hypoplasia - missing enamel
Code 9	Any other defects
Combinations: K	 Demarcated + diffuse
L	Demarcated + hypoplasia
M	Diffuse + hypoplasia
N	All three defects
Extent of defect: Code 0	 Normal
Code 1	<1/3
Code 2	At least 1/3, <2/3
Code 3	At least 2/3

Table 2

experience of using both the indices. Kappa statistics for inter and intra-examiner reproducibility was 0.54 and 0.82 respectively for Thylstrup and Fejerskov index. For modified DDE index, the equivalent values were 0.70 and 0.75.

Following training and calibration in use of the indices, a series of 1000 colour slides were viewed and scored by the examiner separately for each index. The Projector (Kodak Carousel S-A 2000) was set at a standard distance of screen to front of lens of 2.51 meters (giving a width of projected image of 0.83 meters), with operator seated at 2.41 meters from the screen. Scoring was confined to the upper permanent central incisor teeth. Primary, unerupted and traumatized teeth (where more than one-third of the tooth was lost) were not scored. Single defects smaller than 1mm in diameter were excluded. If doubt existed as to whether a defect was present or not, the tooth was scored as normal. Scores were recorded on the data collection sheets. The findings for each index were demonstrated through tables.

RESULTS

The investigation relates to the examination and scoring of colour photographs (slides) of 1000 children, using two different indices. The photographs of 13 children were excluded from the study for various reasons. Similarly in the case of further 17 children one or other incisor tooth was not scored. Results therefore relate to photographs of 987 children, including a total of 1957 teeth. Results are presented in terms of number of children and teeth

NUMBER OF CHILDREN SCORED AS HAVING FLUOROSIS OF THEIR UPPER CENTRAL INCISORS USING THYLSTRUP AND FEJERSKOV INDEX

Score	0	1	2	3	4	5	Total
Number of Children	806 (81.7%)	143 (14.5%)	13 (1.3%)	19 (1.9%)	4 (0.4%)	2 (0.2%)	987
		181 (18.3%)					

Table 3

affected using each index. For clarity, results of scoring using the modified DDE index are summarized in broad categories of normal, demarcated defects diffuse defects, hypo plastic defects and combination of defects. Numbers of children and teeth having a score of 9 on the modified DDE index (any other defect) were very small and were included in the "hypoplastic defects" category in each case. The results of the study are given in tables (3-5).

FINDINGS FOR EACH INDEX

Thylstrup & Fejerskov Index:

A total of 181(18.3%) of the 987 children had defects that fulfilled criteria described by Thylstrup and Fejerskov as characteristic of "fluorosis". The remaining 806 (81.7%) children either had no defects of their central incisors or defects that were not covered by the criteria. In all cases, defects affected both central incisors (in four cases where fluorosis apparently affected only one tooth, the second was excluded as being either traumatized or unerupted). The number of children and the number of teeth with fluorosis against each score of Thylstrup and Fejerskov index are shown in Table-3 and Table-5 respectively. It is apparent from the table that the mildest score was much the most common. No scores of 6 or more were made from the sample of photographs.

Modified DDE Index:

Using the modified Developmental Defects of Enamel (DDE) index, defects were recorded on the upper central incisors of 652(66.0%) out of 987 children. The number of children with defects on one incisor or both incisors are shown in Table-4. Diffuse defects alone affected the largest number of children. The data given in the table also show that while demarcated defects occurred more frequently on one incisor (in 79 of the 106 children), diffuse defects were found more often on both central incisors of children (304 of the 428 had both teeth affected). The number of teeth assigned to each type of score is shown in Table- 5.

RELATIONSHIP BETWEEN SCORINGS USING THYLSTRUP AND FEJERSKOV INDEX AND MODIFIED DDE INDEX

Children:

Using photographs, fewer children were recorded as having fluorosis (181 of the 987, i.e. 18.3%) on Thylstrup and Fejerskov index as compared to 652/987 (66.0%) children scored as having enamel defects with the modified DDE index (the difference was statistically significant [chi-square P<0.001] with a 95% confidence interval of 43%-52%). Defects were always symmetrical in the case of Thylstrup and Fejerskov index as compared to 434/652 (66.6% of children having enamel defects on both incisors) using the modified DDE index.

Teeth:

Fewer teeth were scored as having a defect (fluorosis) on the Thylstrup and Fejerskov index (358/1957, i.e. 18.3%) as compared to modified DDE index where 1086/1957(55.5%) teeth were scored as having a defect of some description. The difference in percentages affected was highly significant with a 95% confidence interval of 34%-40% about the observed difference of 37%.

Table-5 shows that almost all (167 0f the 169) demarcated opacities and 507 of the 808 diffuse opacities scored on modified DDE index

CHILDREN WITH DEFECTS ON ONE OR BOTH UPPER CENTRAL INCISORS - USING MODIFIED DDE INDEX

	Number of children with defects on one or both incisors		
Scores	**Defects only on one incisor**	**Defects on both incisors**	**Total**
Demarcated defects (score 1 and 2)	79	27	106 (10.7%)
Diffuse defects (scores 3-6)	124	304	428 (43.4%)
Hypoplastic defects (scores 7-9)	-	-	-
Combination of defects on a single tooth (scores K-N)	15	17	32 (3.2%)
Children with different scores excluding score "0"	-	86	86 (8.7%)
TOTAL	218 (22.0%)	434 (44.0%)	652 (66.0%)

Table 4

were recorded as normal (no fluorosis) on Thylstrup and Fejerskov index. Teeth fulfilling criteria for the score of 1 or higher on Thylstrup and Fejerskov index were most often also scored as having diffuse defects on modified DDE index; 301 of the 358 teeth scored as 1 or higher using the Thylstrup and Fejerskov index were recorded as having a diffuse opacity on the modified DDE index. A further 32 teeth had a combination of defects recorded on the modified DDE index, 2 were scored as having demarcated defects and 2 as having hypoplastic defects. The remaining 21 teeth scored as having fluorosis were scored as normal by the modified DDE index.

DISCUSSION

Diagnosis of enamel defects including fluorosis has always been regarded as difficult.[1,22] There is particular controversy as to whether use of a specific fluorosis index or a descriptive index is more appropriate when recording enamel defects. In the present study Thylstrup and Fejerskov index (specific fluorosis index) and modified DDE index (descriptive index) were compared and evaluated for their use. However no attempt was made to attribute any aetiology to any particular type of defect.

Thylstrup and Fejerskov index revealed mouth and tooth prevalence of fluorosis in the study sample to be 18.3%. In most of the cases, it was of mild degree. Direct comparison with other investigations is difficult, as no other photographic study has been carried out using Thylstrup and Fejerskov index. However, the results of many clinical studies using Thylstrup and Fejerskov index in low-fluoride areas are in agreement with the present study. As in the present study, fluorosis was of mild degree in most of the cases. Differences between studies may reflect geographic variation but may also be partly a consequence of examiner variation in an index, which is based on an assumed aetiology. In all fluorosis indices, examiners must judge which defects are and are not fluorosis before applying a score. Fluorosis as a defect seems likely to be symmetrical since it arises from systemic effects. Regarding the finding of symmetrical distribution of fluorosis, this study supports the views of Moller (1965), Thylstrup and Fejerskov (1978), Larsen et al. (1985;1986) and Manji et al. (1986b).[5,16,35-37]

On modified DDE index 66.0% of children and 55.5% of teeth were found to have enamel defects. Diffuse opacities were recorded more frequently both in this study and that of Levine, Beal and Fleming (1989) who used Jackson-Al. Alousi index while Dooland and Wylie (1989), who used DDE index in a non-fluoridated area of Australia, reported a higher prevalence of demarcated opacities as compared to diffuse opacities.[34,38]

Comparing findings using the two indices, two major points emerged. First, only a proportion of teeth with diffuse defects recorded on modified DDE index (37%) were scored as having fluorosis on Thylstrup and Fejerskov index; secondly, 84% of teeth scored as having fluorosis on Thylstrup and Fejerskov index were scored as having diffuse defects on modified DDE index. These findings indicate that whilst most of the teeth recorded as having fluorosis on Thylstrup and Fejerskov index are included in the diffuse defects category of

NUMBER OF CHILDREN SCORED AS HAVING FLUOROSIS OF THEIR UPPER CENTRAL INCISORS USING THYLSTRUP AND FEJERSKOV INDEX

	Modified DDE Index						
	Score	Normal (0)	Demarcated defects (1&2)	Demarcated defects (1&2)	Hypoplastic defects (7-9)	Combinations of defect (K-N)	Total
Thylstrup & Fejerskov Index	0	850	167	167	3	72	1599 (81.7%)
	1	20	2	2	1	21	282 (14.4%)
	2	-	-	-	-	3	26 (1.3%)
	3	-	-	-	-	6	38 (1.9%)
	4&5	1	-	-	1	2	12 (0.6%)
	Total	871 (44.5%)	169 (8.6%)	169 (8.6%)	5 (0.3%)	104 (5.3%)	1957

Table 5

modified DDE index, if the teeth with diffuse defects on the modified DDE index are considered as having fluorosis (as some authors suggest), it will highly over-estimate fluorosis as defined by Thylstrup and Fejerskov.

It may be thought that the additional diffuse defects recorded using the modified DDE index are those arising from other causes. However, this hypothesis still rests on the basic assumption of aetiology underlying fluorosis indices. Whilst the Thylstrup and Fejerskov index records particular types of diffuse defects, the contention that in the milder forms as well as the severe grades these are exclusively a consequence of fluoride may be more open to doubt. Manji et al. (1986), for example, using a similar fluorosis index, have reported an apparent fluorosis associated with residence at high altitude but not with known fluoride exposure.[39]

Whatever its aetiology, in the majority of the cases (79%), the teeth scored as having fluorosis were given the score of 1 on Thylstrup and Fejerskov index. This gives two indications first, that “fluorosis” recorded in the study area is mostly of a minor degree and second, that the higher sensitivity of Thylstrup and Fejerskov's index relates to score 1 and it is this score of the index where there is risk of over- or under-estimating fluorosis. This concurs with the findings of Granath, et. al (1985).[40]

It may be concluded that both the modified DDE index and the Thylstrup and Fejerskov index can be used with reasonable reproducibility to measure enamel defects. Results using both types of index have varied widely and those in the current study concur with findings of some other authors. This is especially true of findings using the Thylstrup and Fejerskov index. Results may suggest that the modified DDE index may be thought likely to over-estimate prevalence of defects occurring as a result of excessive fluoride intake (if diffuse defects are taken as being particularly a consequence of fluoride ingestion). However, it is not known which index most truthfully indicates differing levels of fluoride intake.

CONCLUSION

Comparing results of using the two indices, it was found that 37% of teeth recorded as having diffuse defects on the modified DDE index were also scored as having fluorosis on the Thylstrup and Fejerskov index. Ninety four percent of teeth scored as having fluorosis on Thylstrup and Fejerskov index were included as showing enamel defects on the modified DDE index.

If diffuse defects recorded on the modified DDE index were taken to be a result of fluoride intake, then fluorosis may be over-estimated in relation to fluorosis as recognized by Thylstrup and Fejerskov. The index described by Thylstrup and Fejerskov defines particular types of diffuse defects, not separately distinguished by the modified DDE index. It is not known whether the milder forms of defect included in the index and recorded in this sample are uniquely a consequence of fluoride intake. It is these cases, which made up the greatest proportion of teeth scored by this system.

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