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RESEARCH ARTICLE

INDICES FOR MEASURING DENTAL FLUOROSIS: A REVIEW

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ABSTRACT

Dental fluorosis, a specific disturbance in tooth formation and an esthetic condition, is defined as a chronic fluoride -induced condition in which enamel development is disrupted and the enamel is hypomineralised. Different indices have been introduced to assess the prevalence of dental fluorosis and there by the harm caused by it. These indices has been used to carry out analytical studies examining risk factors for fluorosis, the dental risks and benefits associated with fluoridation, the effects of adjustments in water fluoride levels on fluorosis and age at which individuals are at risk. These indices also helped to carry out the investigation of risk factors for dental fluorosis, risks and benefits of fluoridation and other fluoride exposures, the affect of dental fluorosis severity on caries susceptibility, and trends in fluorosis.

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INTRODUCTION

Dental fluorosis, a specific disturbance in tooth formation and an esthetic condition, is defined as a chronic fluoride -induced condition in which enamel development is disrupted and the enamel is hypomineralised.[1] It occur due to disturbance in the tooth formation caused by the excessive ingestion of fluoride during the formative period of the dentition.[2] It has been established that the hypo mineralized alterations of fluorotic enamel are not due to general effects of fluoride on the calcium metabolism, or due to the poisoning effects that depress the fluoride metabolism, but are primarily due to in-situ effects of the fluoride in the local environment (tooth bud). The fluoresced enamel retains a relatively high proportion of immature matrix proteins (high proline contents).[3,4] An incomplete removal of amelogenin proteins under influence of fluoride during tooth development leads to fluorosis.[5]

In the presence of elevated levels of fluoride ions in the forming of enamel, a significant amount of hydroxyapatite is converted to fluoroapatite. The reaction releases hydroxyl group, which could limit the pH drop, accompanied by rapid crystal growth.[6,7] This change in pH could cause amelogenins to aggregate and prevents the diffusion of the protein out of the maturing enamel. Developmental enamel defect was described in the United States initially by Frederick McKay which later called "Colorado Brown Stain". This defect was later identified as "mottled enamel" or more specifically, chronic endemic enamel fluorosis. Later, on considering the preventive benefits achieved by fluoride and risks of dental fluorosis, the limits of optimal fluoridation were set between 0.7 and 1.2 ppm fluoride in drinking. [8]

Indices used to diagnose dental fluorosis

Quantification of the dental fluorosis is an essential step in epidemiological studies and in dental public health and is considered as a main tool to find out the incidence, prevalence and severity of the dental fluorosis. It is required for knowing the fluorosis status or health status of the individual or in relation to other population group, thus it gives the relative status of the population. It is necessary to measure dental fluorosis for surveillance purposes, research purposes and for treatment decisions. An index for measuring any condition should be sensitive, easy to understand and reliable. In the 20th century, the various indices used for measurement of dental fluorosis are;

1.Dean's Index- 1934
2.Community Fluorosis Index-1946
3.Thylstrup-Fejerskov Index-1978
4.Tooth surface Index of Fluorosis -1984
5.Fluorosis Risk Index-1990

Dean's Index [9]

Dean provided a standard classification system for clinical conditions as described by McKay on 2000 subjects in

Diagnostic criteria and weighting system for Dean's Index

Classification And weight	Original criteria (Dean, 1934)	Modified criteria (Dean, 1942)
Normal 0	The enamel presents the usual translucent semi-vitriformtype of structure. The surface is smooth and glossy and usually of a pale creamy white color.	The enamel presents the usual translucent semi-vitriform type of structure. The surface is smooth, glossy and usually of a pale creamy white color.
Questionable 0.5	Slight aberrations in the translucency of normal enamel, ranging from a few white flecks to occasional white spots, 1 to 2 mm in diameter	The enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification is utilized in those instances where a definite diagnosis of the mildest form of fluorosis is not warranted and a classification of "normal" not justified.
Very Mild 1.0	Small, opaque, paper-white areas are scattered irregularly or streaked over the tooth surface. It is principally observed on the labial and buccal surfaces, and involves less than 25% of the tooth surfaces of the particular teeth affected. Small pitted white areas are frequently found on the summits of the cusps. No brown stain is present in the mottled enamel of this classification.	Small, opaque, paper-white areas scattered irregularly over the tooth but not involving as much as approximately 25% of the tooth surface. Frequently included in this classification are teeth showing no more than about 1-2 mm of white opacity at the tips of the summits of the cusps of the bicuspids or second molars.
Mild 2.0	The white, opaque areas on the surfaces of the teeth involve at least half of the tooth surface. The surfaces of molars, bicuspids, and cuspids subject to attrition show thin white layers worn off and the bluish shades of underlying normal enamel. Faint brown stains are sometimes apparent, generally on the upper incisors.	The white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the tooth.
Moderate 3.0	No change is observed in the form of the tooth, but generally all of the tooth surfaces are involved. Surfaces subject to attrition are definitely marked. Minute pitting is often present, generally on the labial and buccal surfaces. Brown stain is frequently a disfiguring complication. It must be remembered that the incidence of brown stain varies greatly indifferent endemic areas, and many cases of white opaque mottled enamel, without brown stain, are classified as "moderate" and listed in this category.	All enamel surfaces of the teeth are affected, and surfaces subject to attrition show marked wear. Brown stain is frequently a disfiguring feature.
Moderately Severe	Macroscopically, a greater depth of enamel appears to be involved. A smoky white appearance is often noted. Pitting is more frequent and generally observed on all the tooth surfaces. Brown stain, if present, is generally deeper in hue and involves more of the affected tooth surfaces.	
Severe 4.0	The hypoplasia is so marked that the form of the teeth is at times affected, the condition often being manifest in older children as a mild pathologic incisal occlusal abrasion. The pits are deeper and often confluent. Stains are widespread and range from a chocolate brown to almost black in some cases	It Includes teeth formerly classified as "moderately severe" and "severe". All enamel surfaces are affected, and hypoplasia is so marked that the general form of the tooth maybe affected. The major diagnostic sign of this classification is the discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded like appearance.

endemic areas of six states in USA. It was first described in 1934 and was later modified in 1942. The index was developed to gain an understanding of the relationship between fluoride concentrations in drinking waters and mottled enamel. It emphasizes the aesthetic aspect of dental fluorosis. It became the most universally acceptable classification system for dental fluorosis found on two or more teeth. If two teeth are not equally affected, the less affected will be scored.

Shortcoming of Dean's Index

- Single score is given to a tooth rather than, a separate score to each tooth surface. Hence differences in the severity of fluorosis in different tooth surfaces cannot be ascertained.
- Questionable diagnostic category (score 0.5) in Dean's Index is difficult to define and interpret precisely.
- The distinctions between some of the diagnostic categories in Dean's system are unclear, imprecise or lack sensitivity.

Community fluorosis index[9]

Trendly H Dean in 1946 devised a method of calculating the prevalence and severity of fluorosis in a group or community which he termed as 'Community fluorosis Index' (CFI).

This gave an indication of the public health significance of the fluorosis

$$CFI = \frac{n \times w}{N}$$

Where n= number of individual in each category
w= the weightning for each category
N= total population

Public health significance of CFI index

Range of Scores for Community Fluorosis Index	Public Health Significance
0.0 - 0.4	Negative
0.4 - 0.6	Border line
0.6 - 1.0	Slight
1.0 - 2.0	Medium
2.0 - 3.0	Marked
3.0 - 4.0	Very marked

Thylstrup and Fejerskov Index (TFI)[10]

The Thylstrup and Fejerskov developed an index in order to refine, modify and extend the original concepts established by Dean. The primary aim was to develop a more sensitive classification system for recording enamel changes associated, with increasing level of fluoride in water. The basis of TFI is the classification scale, closely to the histological changes that occur and fluoride content found in the enamel. A 10-point ordinal scale is used to classify enamel changes associated with increasing fluoride exposure. As originally proposed, facial and occlusal surfaces were scored with different criteria. From 1988, onwards the scoring of facial surface was recommended for TFI.

Diagnostic criteria of TFI Index

Score	Score original criteria (Thylstrup and Fejerskov, 1978)	Modified criteria (Fejerskov *et* al. 1988)
0	Normal translucency of enamel remains after Prolonged air-drying.	The normal translucency of the glossy, creamy-white enamel remains after wiping and drying of the surface.
1	Narrow white lines located corresponding to the perikymata.	Thin white opaque lines are seen running across the tooth surface. The lines correspond to the position of the perikymata. In some cases, a slight "Snowcapping" of cusps/incisal edges may also be seen.
2	Smooth surfaces More pronounced lines of opacity which follow the perikymata. Occasionally confluence of adjacent lines. Occlusal surfaces Scattered areas of opacity < 2 mm in diameter and pronounced opacity of cuspal ridges.	The opaque white lines are more pronounced and frequently merge to form small cloudy areas scattered over the whole surface. "Snowcapping" of incisal edges and cusp tips is common.
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	Merging of the white lines occurs, and Cloudy areas of opacity occur spread over many parts of the surface. In between the cloudy areas, white lines can also be seen
4	Smooth surfaces The entire surface exhibits marked opacity or appears chalky white. Parts of surface exposed to attrition appear less affected. Occlusal s urfaces Entire surface exhibits marked opacity. Attrition is often pronounced shortly after eruption.	The entire surface exhibits a marked opacity or appears chalky white. Parts of the surface exposed to attrition or wear may appear to be less affected.
5	Smooth and occlusal surfaces Entire surface displays marked opacity with focal loss of outermost enamel (pits) < 2 mm in diameter	The entire surface is opaque, and there are round pits (focal loss of the outermost enamel) that are less than 2 mm in diameter.
6	Smooth surfaces Pits are regularly arranged in horizontal bands < 2 mm in vertical extension. Occlusal surfaces Confluent areas < 3 mm in diameter exhibit loss of enamel. Marked attrition	The small pits may frequently be seen merging in the opaque enamel to form bands that are less than 2 mm in vertical height. In this class are also included surfaces where the cuspal rim of facial enamel has been chipped off, and the vertical dimension of the resulting damage is less than 2 mm
7	Smooth surfaces Loss of outermost enamel in irregular areas involving < 1/2 of entire surface. Occlusal surfaces Changes in the morphology caused by merging pits and marked attrition.	There is a loss of the outermost enamel in irregular areas, and less than half the surface is so involved. The remaining intact enamel is opaque.
8	Smooth and occlusal surfaces: Loss of outermost enamel involving >1/2 of surface.	The loss of the outermost enamel involves more than half the enamel. The remaining intact enamel is opaque.
9	Smooth and occlusal surfaces Loss of main part of enamel with change in anatomical appearance of surface.Cervical rim of almost unaffected enamel is often noted.	The loss of the major part of the outer enamel results in a change of the anatomical shape of the surface/tooth. A cervical rim of opaque enamel is often noted.

Critics of TFI

The TFI seems more appropriate than Dean's Index for use in clinical trials or analytical epidemiologic studies, primarily because teeth are dried and fluorosis can be identified in its milder forms. This feature of the TFI is a particular advantage when potential fluoride effects are small, or when the exposure may be wide spread.[11]

On comparing the Dean and TF indexes, latter was more detailed and sensitive, because it was based on biological aspects.[12]

Tooth surface index of fluorosis (TSIF)[13]

This was proposed by Horowitz et al (1984)[13] in an attempt to reduce some of the shortcomings of Dean‘s index. It allows for separate assessment of cosmetic fluorosis i.e fluorosis discoloration, staining or pitting on surfaces visible to others. According to the authors, a separate score is given to each unrestored tooth surface. Two scores are assigned to anterior teeth (from the labial and lingual aspects) and three to the posterior teeth (from the buccal, lingual and occlusal aspects). The TSIF permits a distinction between pitting and more advanced pitting and between staining alone and staining in conjunction with pitting. It was developed and used by researchers in the National Institute of Dental Research in USA. More sensitive than Dean‘s Index for mildest forms of fluorosis. The tooth surface index of fluorosis has identified seven types.

Diagnostic criteria of TSIF

Score	Criteria
0	Enamel shows no evidence of fluorosis.
1	Enamel shows definite evidence of fluorosis, namely, areas with parchment-white color that total less than one-third of the visible enamel surface. This category includes fluorosis confined only to incisal edges of anterior teeth and cusp tips of posterior teeth ("snow capping").
2	Parchment-white fluorosis totals at least one third of the visible surface, but less than two thirds.
3	Parchment-white Fluorosis totals at least two thirds of the visible surface.
4	Enamel shows staining in conjunction with any of the preceding levels of fluorosis. Staining is defined as an area of definite discoloration that may range from light to very dark brown.
5	Discrete pitting of the enamel exists, unaccompanied by evidence of staining of intact enamel. A pit is defined as a definite physical defect in the enamel surface with a rough floor that is surrounded by a wall of intact enamel. The pitted area is usually stained or differs in color from the surrounding enamel.
6	Both discrete pitting and staining of the intact enamel exit.
7	Confluent pitting of the enamel surface exists. Large areas of enamel may be missing, and the anatomy of the tooth may be altered. Dark-brown stain is usually present.

Critics of TSIF

Examiner reliability may be of more concern than with Dean's Index or the modified TFI because of the larger number of assessments to be made. Lingual surfaces are more difficult to visualize than buccal surfaces, which also adds to the concern about examiner reliability.

Fluorosis Risk Index[14]

This was proposed by Pendrys 1990 [14] and can been used in Analytical Epidemiological studies. It was designed to permit a more accurate identification of risk factors of enamel fluorosis and developed to allow for the identification of the time during tooth maturation at which exposure was most likely to have been experienced. This index divides the enamel surfaces of teeth in the secondary dentition into 2 groups of surface zones:

i.) Classification 1-Enamel surface zones that begin formation during the first year of life
ii.) Classification 11--- Enamel surface zones that begin formation between the third to sixth year of life

Criteria for scoring fluorosis

Negative finding

Score = 0 A surface zone will receive a score of O when there is absolutely no indication of fluorosis being present. There must be a complete absence of any white spots or striations, and tooth surface coloration must appear normal.

Questionable finding

Score = 1 Any Surface zone that is questionable as to whether there is fluorosis present (i.e., white spots, striations, or fluorotic defects cover 50 percent or less of the surface zone) should be scored as 1.

Score = 7 Any surface zone that has an opacity that appears to be non-fluoride opacity is scored as 7

Positive findings

Score = 2 A smooth surface zone will be diagnosed as being positive for enamel Fluorosis if greater than 50 percent of the zone displays, parchment while striations typical of enamel fluorosis. Incisal edges and occlusal tablets will be scored as positive for enamel fluorosis if greater than 50 percent of that surface is marked by the Snow capping typical of enamel Fluorosis.

Score = 3 A surface zone will be diagnosed as positive for severe fluorosis if greater than 50 percent of the zone displays pitting, staining, and deformity, indicative of several Fluorosis.

Surface zone excluded

Score = 9 A surface zone is categorized as excluded (i.e. not adequately visible for a diagnosis to be made) when any of the following conditions exist;

Incomplete eruption

Rule 1: If a tooth is in proximal contact but the occlusal surface is not parallel with existing occlusion, the occlusal two thirds of the tooth is scored, but the Cervical one third is recorded as excluded

Rule 2: If a tooth is erupted, but not yet in contact, the Incisal/occlusal edge is scored, but all other surfaces are recorded as excluded.

Orthodontic appliances and bands

Rule 1: If there is an orthodontic band present on a tooth only the occlusal table or Incisal edge should be scored

Rule 2: If greater than 50 % of the surface zone are banded, the subject should be excluded from the examination.

Surface crowned or restored

Rule: Surface zones that are replaced by either a crown or restoration covering greater than 50% of the surface zone should be recorded as excluded.

Gross plaque and debris

Rule: Any subjects with gross deposits of plaque or debris on greater than 50% of the surface zones should be excluded from examination.

Critics of Fluorosis risk index

The index is complex, both from a biological perspective and in its application. Acceptable levels of examiner reliability may be difficult to establish due to this complexity.

CONCLUSION

Dental fluorosis used to be regarded as the cosmetic problem initially, but it effect the social, emotional, psychological and quality of life of individuals. Thus there is need for the more valid and reliable instrument for measuring the dental fluorosis.

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