Histological changes in tooth enamel, dentin and cementum of patients with sickle cell anemia.

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Abstract
The present study aimed at obtaining histological evidence of changes in tooth enamel, dentin and cementum in patients with sickle cell anemia. A total of 27 patients were included, age ranging from 6 years – 14 years, clinically diagnosed with sickle cell anemia. A comparative control group was considered which included 10 disease free individuals. Exfoliated teeth of the subjects and controls were obtained and ground sections of the same were prepared. The histological appearance of all samples from those diagnosed with sickle cell anemia showed significant changes in tooth enamel, dentin and cementum when compared with healthy controls.

Key words: Enamel; Dentin; Hemoglobinopathies; Sickle cell.

Introduction
Hemoglobinopathies occur widely across the world and an increased numbers of affected births and high rates of mortality and morbidity are still observed in the majority of affected countries of the developing world (1). In India, frequency in terms of carrier rate is 0-44% and an estimated 5 million carriers are living with the gene. The native tribes of Central India i.e. Kunbi and Teli inhabiting around Nagpur, Madhya Pradesh and extending to Orissa are affected more frequently (2).
Sickle cell anemia was first described by Herrick in 1910 (3). Linus Pauling in 1949 discovered that sickle hemoglobin α2β2s has an abnormal electrophoretic mobility and is a molecular disease (3). The pathogenesis of sickle cell disease is based in the fact that single base substitution occur in the gene encoding the human β-globin subunit, with the resulting replacement of β6 glutamic acid by valine. This leads to devastating clinical manifestation. The polymerization of HbS is the primary event in molecular pathology of sickle cell disease resulting in distortion of shape of RBCs (i.e. sickle shaped, holy leaf or crescent shaped). These rigid cells are responsible for the occlusive phenomenon. Due to this occlusive phenomenon, almost every organ of the human system is involved (i.e. hand-foot syndrome, splenomegaly and liver) (4-6). Though there are many studies which documents changes in different parts of the body, very few studies have been observed with changes in dental hard tissue. This study is an attempt to assess the histological changes in tooth structure in patients with sickle cell anemia.

**Material and methods**

A total of 27 patients (22 males and 5 females) were included in the study with age ranging from 6 years to 14 years, diagnosed with homozygous sickle cell disease (Hb-SS) from the Department of Pediatrics, Acharaya Vinobha Bhave Rural Hospital. In addition, a control group of 10 subjects with normal hemoglobin was recruited who were matched for age and sex. The specimens used in this study were retained tooth of the sickle patient. The patients were provided with a vial each and were asked to collect the tooth, when they exfoliated (over a period of one year). Seven and ten exfoliated teeth specimens were obtained from the sickle cell anemia patients and control subjects respectively. Ground sections of all the specimens were prepared which was done by cutting the tooth specimen longitudinally into two halves and grinding them to 1mm thickness on a lathe machine and then lapping the section on an Arkansas stone. Then the prepared sections were mounted on the slide with distyrene plasticizer and xylene (DPX). The prepared ground section was visualized under light microscope to assess the histological changes.

**Results**

On observation of histological appearance of all the teeth obtained from patients with sickle cell anemia, significant changes in the microscopic structure of the teeth were observed. The following changes were observed in enamel, dentin and cementum:

- Decrease in number of dentinal tubules. (Figure 1)
- Decrease and irregular dead tract formation. (Figure 2)
- Decrease in thickness of the secondary tubules. (Figure 3)
- Increase in enamel lamellae.
- Presence of gnarled enamel not below the cusp but more towards the DEJ.
- Hypercementosis.

**Figure 1:** Decreased number of dentinal tubules

Number of dentinal tubules was calculated for all the samples and control group as well. Five high fields for each slide were observed and number of dentinal tubules for each was calculated under 40X. Then for each slide average number of dentinal tubules was calculated.
Changes in teeth associated with sickle cell anemia

We observed that per high field on an average of 84 dentinal tubules were seen as compared to normal which was found to be 120. Hypercementosis showed diffuse arrangement without any specific location where as in control group it was more seen in apical area. In healthy teeth, gnarled enamel was present below the cusp or incisal area but in the anemic subjects it was randomly found. The formation and mineralization of enamel and dentin appeared to be affected by sickle cell anemia.

Discussion

Deoxygenation of Hb-S containing RBCs results in aggregation of abnormal Hemoglobin chain into long chain. This irreversible process distorts the RBCs into rigid sickle shape and pointed. They become longer, up to four times the diameter of the original RBCs. This change occurs when oxygen tension is low. These sickle shaped cells leads to obstruction of microcirculation or vaso-occlusion, ischemia, infarction and superimposed infection. Due to chronic anemia marrow hyperplasia, reversion of yellow marrow to red marrow and occasionally extra medullary hematopoiesis is also seen (7, 8). Ischemia and infarction may have long term effect on the growth of bone; similarly it may have effect on development of tooth.

The sickle cell anemia patient has frequent disturbances of the mineralization of the skeleton, affecting vertebrae, skull, mandible and maxilla (9). These changes results when the abnormal erythrocytes that are produced act as foreign bodies and are destroyed prematurely by reticulo-endothelial system causing anemia. The bone marrow, in its attempt to overcome the anemia increases production of red cells, become hyperplastic and cause expansion of the marrow cavities. This compensatory expansion progresses at the expense of bone and produces secondary changes in the skeletal system. Since the mandible and maxilla play a role in hematopoiesis. The changes in dental tissue are also part of the same process (10). We found changes in enamel and dentin structure in patients with sickle cell anemia in conjunction with study done by Soni. He described mineralization disturbances in enamel, dentin and cementum of heterozygous and homozygous states of disease in year 1966. His study through microradiography suggested hypomineralization of dentin, hypercementosis, calcified areas in pulp (11). We found similar changes in our study which was done by Cox et al., in year 1984 reported changes in dentin and pulp. The changes seen in their study are formation of interglobular dentin chiefly in crown and near DEJ, abnormal deposition of secondary dentin, linear calcification in pulp (10). The inadequate
Changes in teeth associated with sickle cell anemia

Sample size is one of the major limitations of the present study and thus future studies on a larger sample are recommended. We hypothesize that changes in dental tissue are also due to more production of uncalcified matrix at the expense of calcified matrix. The formation of dentin and enamel is not homogenous and in rhythmic manner as is seen in normally developing tooth. Thereby enamel and dentin shows poor structural integrity, as the rate of blood supply to the developing tooth is slow due to microcirculation obstruction.

References
2. Bankar MP, Kate SL, Mokashi GD, Phadke MA. Distribution of sickle cell hemoglobin among different tribal group in Maharashtra. Ind J hematol. 1984;2:224.