

## Study Protocol

### **Effect of radiotherapy on microhardness and surface morphology of pretreated primary teeth with silver diamine fluoride: An in vitro study**

#### **Abstract:**

**Background:** Radiation therapy has proven to be an effective modality in treating children suffering from cancer. High prevalence of dental caries is seen in children undergoing radiation therapy. This is primarily due to the direct effects of these harmful radiation on the enamel and not as a consequence to the reduced salivary flow. Mechanical properties of the enamel have been seen to be affected by radiation according to various studies conducted.

**Objectives:** The objective of this study is to evaluate whether radiotherapy causes changes in the microhardness and surface morphology of enamel in primary teeth pretreated with silver diamine fluoride.

**Methodology:** 22 primary teeth samples will be divided into two groups, 11 samples each-study group which will be pretreated with silver diamine fluoride (SDF) and control group. Both groups will be subjected to radiotherapy of 10 Gy radiation for a duration of 6 days. The samples will be tested for Vickers microhardness test and SEM analysis for surface morphological changes post radiotherapy. Statistical analysis will be done using “chi square test, paired and unpaired student t -test”. Surface microhardness and morphological changes of the study and control group compared.

**Expected Results:** It is expected that SDF application will be effective modality in prevention of caries due to frequent radiation exposure in children suffering from cancer and undergoing radiotherapy.

**Conclusion:** The study will conclude that SDF will cause a reduction in the microhardness of the surface and lesser morphological changes in the enamel of the primary teeth post radiation therapy in children suffering from cancer.

**Keywords:** Radiotherapy, Silver Diamine Fluoride, Primary teeth.

#### **INTRODUCTION:**

Cancer is one of the deadliest diseases known to mankind resulting in around 4 lakh children being diagnosed each year, of which a large number around the globe do not have proper access to health care. <sup>1</sup>

Radiation therapy has been used extensively in the field of medicine, for the treatment of various kinds of cancers but its margin of safety is still low. Underdosage of radiation may result in missing parts of the tumor. While, increased radiation dose may result in intolerable complications. Both leading to massive treatment failures.

Head and neck region undergoing radiation therapy has various adverse effects on the oral cavity like changes in the saliva production which leads to xerostomia, radiation caries and also changes in the oral flora these effects are even more profound in children who are not able to maintain good oral hygiene. <sup>2</sup>

In addition, as seen in various literature review articles, the increased amount of caries incidence observed in patients undergoing radiation therapy especially children are primarily due to the direct effects of these harmful radiation on the enamel and not as a consequence to the reduced salivary flow. The main content of the tooth structure that is the organic and inorganic content is affected during radiation therapy. Various studies have proved that there is destruction of the prismatic structure of enamel, decrease in mechanical properties such as tensile strength, wear resistance, and acid attack resistance all these changes have been seen in the permanent teeth of patients who have undergone radiation therapy. However, destruction of the collagen fibrils is also seen, which results in decrease in the hardness of dentin, tensile strength, and stability of the DEJ. Primary teeth when compared to permanent teeth have thinner and higher density of rods, large number of microporosities, exposed rods in some areas, and a lot of carbonate addition. All these factors make primary teeth more susceptible to radiation caries and more extensive carious lesions.<sup>2,3,4</sup>

The use and applications of different concentrations of silver diamine fluoride (SDF) can stop and obstruct the progression of carious process. Various studies have shown that SDF has a positive antibacterial effect on Streptococcus mutans and lactobacilli which proves its anticariogenic properties. DNA replication is impaired and cell wall damage occurs when Silver nitrate (AgNO<sub>3</sub>) nanoparticles pierce the bacterial cell wall. Not only with the presence of bacteria but also bacteria-free conditions, it has been seen that it prevented further demineralization of the already very carious lesion.<sup>5,6</sup>

### **RATIONALE:**

Children having cancer and undergoing radiation therapy have compromised oral health. Such children have to undergo a series of invasive treatment approaches for the management of caries which are not readily acceptable by them. Evaluating the effect of radiotherapy on the enamel of primary teeth treated with SDF and if it is effective in prevention of development of caries.

### **AIM:**

To evaluate the effect of radiotherapy on microhardness and surface morphology of pretreated primary teeth with silver diamine fluoride.

### **OBJECTIVES:**

- To evaluate the microhardness of pretreated enamel of primary teeth with SDF before and after radiotherapy.
- To evaluate the microhardness of the enamel of normal primary teeth before and after radiotherapy.
- To compare the microhardness of the pretreated enamel of primary teeth with SDF and normal primary teeth after radiotherapy.
- To evaluate and compare the surface morphology of pretreated enamel of primary teeth with SDF and normal primary teeth after radiotherapy.

## **MATERIALS AND METHODS**

### **MATERIALS:**

- Mouth mirror
- Straight probe
- Kidney tray
- Gloves
- Mouth mask
- Head cap
- Disposable cups
- Primary teeth slabs (3x3x2 mm)
- Kids E SDF (Silver diamine fluoride)

## **METHOD:**

### **“Study Design”**

This in vitro study will be conducted in the “Department of Pediatric and Preventive Dentistry, Sharad Pawar Dental College, Sawangi, Wardha”.

**Inclusion criteria:** Anterior or posterior caries free primary teeth.

**Exclusion criteria:** (1) Carious teeth.

(2) Primary teeth with any developmental defect.

(3) Primary teeth with any cracks

**Sample size:** 11 samples will be taken in each group.

### **Sample Preparation**

The selected teeth will be sectioned into crown and root, with the help of cutting machine which has a double-sided diamond disc. The buccal and lingual surfaces of the crown would be separated, the final specimens will have dimensions of  $3 \times 3 \times 2$  mm. Specimen will then be grinded and polished. Sandpaper grains of 600 and 1,200 will be used for polishing the enamel. The specimens will be numbered.

Specimens will be divided into two groups:

1. Study group: Deciduous teeth pretreated with SDF.  
N=11
2. Control group: Normal deciduous teeth.  
N=11

### **Sample size justification:**

Sample size formula for difference between two means

$$n = \frac{(z\alpha + z\beta)^2 \left[ \delta_1^2 + \frac{\delta_2^2}{k} \right]}{\Delta^2}$$

Were,

Z $\alpha$  is the level of significance at 5% level of significance i.e 95% confidence interval =1.96

$Z\beta$  is the power of test=80%=0.84

$\delta_1$ =SD of control group=53.48

$\delta_2$ =SD of 20 Gy group=26.31

$\Delta$ =204.19-152.34=51.84

$$n = \frac{(1.96+0.84)^2[(53.48)^2+(26.31)^2/1]}{(51.84)^2}$$

=10.35

=11 samples in each group

### **SDF application before radiation**

SDF will be applied on the specimens of the study group as per the manufacturer's instructions.

### **Enamel Irradiation**

Specimens of both the study and control group will be subjected to 10Gy radiation per day for 6 days. Children suffering from head and neck cancers are given a radiation therapy of 45-60 Gy radiation over a stipulated time, so this protocol has been replicated. The specimens will be kept in individual wells immersed in artificial saliva of pH7.0 containing 0.9 mM PO<sub>4</sub>, 1.5 mM Ca & "150 mM KCl incorporated into 20 mM Tris buffer". SDF will be reapplied on the samples of the study group after the 2<sup>nd</sup> and 5<sup>th</sup> cycle of radiation.

### **Enamel Microhardness Analysis**

For evaluation of microhardness after irradiation, three indentations will be created on the central areas of the enamel specimens, using a Vickers microhardness tester. The average will be calculated of all the three indentations for each specimen of the study, and the final median microhardness's of enamel will be calculated and expressed as the Vickers hardness number.

### **SEM Analysis**

Two specimens each of the study and control group will be kept in silica for at least 48 h for dehydration while double-sided carbon tapes will be used to fix the stubs. Then, scanning electron microscope will be used for examination of the specimen. Standardized images will be acquired of the enamel surfaces.

### **STATISTICAL ANALYSIS:**

"Chi square test" and "paired and unpaired student t -test" will be used for statistical analysis.

### **HYPOTHESIS:**

It is expected that SDF application will be effective modality in prevention of caries due to frequent radiation exposure in children suffering from cancer and undergoing radiotherapy.

### **REVIEW OF LITERATURE:**

Lenita Marangoni-lopes et al (2019)<sup>2</sup> in their study evaluated the "microhardness, mineral content, organic composition and morphological changes" in the primary teeth after radiotherapy. Thirty prepared samples of deciduous teeth were exposed to radiotherapy. At

different amounts of radiation, the samples had to undergo various tests for evaluation. They were immersed in artificial saliva so its pH was determined along with the calcium and phosphate concentrations of the solution. The outcomes suggested that the microhardness of the study specimen reduced after 2nd dose of radiation which was 2,160 cGy. However, for dentin, the surface hardness reduced after the 1<sup>st</sup> dose of radiation. The mineral and organic content of enamel reduced after 3rd dose of radiation. For dentin, they noticed and could see a rising increase in the amount of “phosphate v2, amide, and hydrocarbon content” after 1st and 2nd and a reduction after 3<sup>rd</sup> dose of radiation. Results showed enamel cracks and destruction of peritubular dentin. The study inferred there was an all over decrease in “surface hardness, altered mineral and organic composition, and changes in the morphology are seen on the primary teeth after radiation therapy”.

**C.J. Soares et al (2011)**<sup>7</sup> evaluated the therapeutic outcome of using mouthwash in preventing radiation therapy damage to the “ultimate tensile strength (UTS)” of the hard tissue of the teeth. 120 teeth were separated into 2 groups. The first group was exposed to “60 Gy” of radiation in daily additions of “2 Gy” and the second group was not exposed to any radiation. Further categorized into “2 mouthwash protocols used 3 times per day”: First, CHX of 0.12% second, sodium fluoride of 0.05% and third was control group (n =10). Microtensile testing was performed on the samples. The UTS was significantly reduced after radiation therapy. SEM analysis detected structural alterations. It was concluded that mouthwash with 0.12% CHX partly helped in preventing harm to the “mechanical properties” of the tooth subjected to radiation.

Franzel et. al. reported on Effect of tumor therapeutic irradiation on the mechanical properties of teeth **tissue**<sup>8</sup>.

**Sura A. Abdil-Nafaa et al (2020)**<sup>9</sup> compared and evaluated the result of “fluoride varnish application and SDF application” on the “surface microhardness” of deciduous teeth. 150 deciduous anterior teeth were selected in the study population. Three groups were made of: Fluoride varnish, SDF and the control group of 50 samples then underwent PH cycling. Vickers tester machine was used to measure the microhardness once before and after the PH cycle. Results presented with a reduction in surface microhardness in all samples because of demineralization, but the minimum decrease in surface microhardness was seen with SDF group followed by varnish group. SDF showed better results with preserving the surface hardness of the enamel of the tooth structure.

Few of the studies on primary teeth were reported by Singh et. al.<sup>10</sup>, Teni et. al.<sup>11</sup>, Khubchandani et. al.<sup>12</sup>, Rathi et. al.<sup>13</sup> and Baliga S.<sup>14</sup>. Studies by Prabhakar A.<sup>15</sup> and Madan K.<sup>16</sup> were reviewed.

### **LIMITATIONS:**

In radiation therapy, the salivary glands are dysfunctional which leads to decrease in the salivary flow which was not taken into consideration in this study.

### **IMPLICATION:**

Children suffering from cancer undergo frequent radiotherapy and this radiation exposure to the enamel makes it more prone to radiation caries. The present study will suggest pre-treatment of the primary teeth with SDF for prevention from the harmful effects of radiation.

SDF application may prove as an effective and affordable prevention measure in children who are frequently undergoing radiation therapy for cancer.

## **REFERENCES:**

1. WHO: Global initiative for childhood cancer.
2. Marangoni-Lopes L, Rovai-Pavan G, Steiner-Oliveira C, Nobre-dos-Santos M. Radiotherapy reduces microhardness and mineral and organic composition, and changes the morphology of primary teeth: An in vitro study. *Caries research*. 2019;53(3):296-304.
3. De Sá Ferreira EM, Soares LE, Antunes HS, Uemura ST, da Silva Barbosa P, Salmon HA Jr, et al. Effect of therapeutic doses of radiotherapy on the organic and inorganic contents of the deciduous enamel: an in vitro study. *Clin Oral Investig*. 2016 Nov;20(8):1953–61.
4. De Siqueira Mellara T, Palma-Dibb RG, de Oliveira HM, Garcia Paula-Silva FW, Nelson-Filho P, da Silva RA, da Silva LA, de Queiroz AM. The effect of radiation therapy on the mechanical and morphological properties of the enamel and dentin of deciduous teeth - an in vitro study. *Radiat Oncol*. 2014;22:09-30.
5. Mohammadi N, Far MH. Effect of fluoridated varnish and silver diamine fluoride on enamel demineralization resistance in primary dentition. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. 2018 Jul 1;36(3):257.
6. Lee YE, Baek HJ, Choi YH, Jeong SH, Park YD, Song KB. Comparison of remineralization effect of three topical fluoride regimens on enamel initial carious lesions. *J Dent*. 2010 Feb;38(2):166-71.
7. Soares CJ, Neiva NA, Soares PB, Dechichi P, Novais VR, Naves LZ, Marques MR. Effects of chlorhexidine and fluoride on irradiated enamel and dentin. *Journal of dental research*. 2011 May;90(5):659-64.
8. Fränzel W, Gerlach R, Hein HJ, Schaller HG. Effect of tumor therapeutic irradiation on the mechanical properties of teeth tissue. *Zeitschrift für Medizinische Physik*. 2006 Jan 1;16(2):148-54.
9. Sura A, Abdil-Nafaa, Aisha A. Qasim: The Effect of Silver Diamine Fluoride and Fluoride Varnish on Microhardness of Primary Teeth Enamel (An In Vitro Study) *Al – Rafidain Dent J Vol. 20, No2, 2020*.
10. Singh, P.K. “Perioperative Radiation Exposure in a Pregnant Woman.” *Iranian Journal of Radiation Research* 8, no. 4 (2011): 253–55.
11. Teni, T. R., S. Mallick, V. Palve, S. Pawar, R. Patil, and J. P. Agarwal. “Mcl-1 Expression Is Associated with Pathogenesis and Radiotherapy Treatment Response in Chewing Tobacco-Associated Oral Carcinomas.” *ORAL ONCOLOGY*, July 2009, 70.
12. Khubchandani, M., M. Baliga, S. Rawlani, S. Rawlani, K. Khubchandani, and N. Thosar. “Comparative Evaluation of Different Obturation Techniques in Primary Molars: An in Vivo Study.” *European Journal of General Dentistry* 6, no. 1 (2017): 42–47. <https://doi.org/10.4103/2278-9626.198611>.
13. Rathi, N., R. Baid, S. Baliga, and N. Thosar. “Comparative Evaluation of Nano-Hydroxyapatite Preparation and Calcium Sucrose Phosphate on Microhardness of Deciduous Teeth after Iron Drop Exposure - An in-Vitro Study.” *Journal of Clinical and Experimental Dentistry* 9, no. 4 (2017): e579–83. <https://doi.org/10.4317/jced.53677>.
14. Baliga, S. “Emerging Trends in Pediatric Dentistry.” *Journal of Indian Society of Pedodontics and Preventive Dentistry* 36, no. 2 (2018): 107. <https://doi.org/10.4103/JISPPD.JISPPD.17118>.
15. Prabhakar, A. R., T. Mahantesh, and Vipin Ahuja. “Comparison of Retention and Demineralization Inhibition Potential of Adhesive Banding Cements in Primary

Teeth.” JOURNAL OF DENTISTRY FOR CHILDREN 77, no. 2 (August 2010): 66–71.

16. Madan, Kavita, Sudhindra Baliga, Pranjali Deulkar, Nilima Thosar, Nilesh Rathi, Meghana Deshpande, and Sphurti Bane. “A Comparative Evaluation between Propolis and Mineral Trioxide Aggregate as Pulpotomy Medicaments in Primary Molars.” JOURNAL OF EVOLUTION OF MEDICAL AND DENTAL SCIENCES-JEMDS 9, no. 15 (April 13, 2020): 1256–60. <https://doi.org/10.14260/jemds/2020/273>.

UNDER PEER REVIEW