REVIEW

ON THE QUI VIVE - GENOTOXIC AND CYTOTOXIC CHANGES FOLLOWING THE CONVENTIONAL DENTAL RADIOGRAPH

[1] Sudhaa Mani M, [2] Yasmeen Ahamed S, [3] Ambiga.P, [4]Sivaraman G,[5]Gokulapriya S, [6] Balan N

[1] Professor,Department of Oral Medicine and Radiology,Vivekanandha Dental College for Women
[2]Reader,[3,4]Senior Lecturer
[5] 2nd Year MDS Postgraduate Student
[6] Head of Department Department of Oral Medicine and Radiology, Vivekanandha Dental College for Women

ABSTRACT

Of the past decades, X-rays have been used widely for diagnosis in dentistry.However, it is well known that ionizing radiation causes damage to DNA by DNA–protein crosslinks and induces cellular death. Therefore, outlining the cytogenetic effects induced by X-ray is necessary to identify the degree of cancer risk and minimize potential risk to patients and clinician. To date, a variety of assays have been proposed in cytogenetic biomonitoring studies, including those that assess metaphase chromosomal aberrations, sister chromatid exchanges assay. Cytogenetic biomonitoring studies focusing on oral mucosa cells of individuals exposed to dental X-ray were reviewed in this article. This review will contribute to a better understanding that X-ray-induced effects upon the cellular system in individuals continually exposed to dental diagnostic radiation and ensures the fact that dental radiograph should be prescribed only when deemed indispensable.

Keywords: Dental X-ray; DNA damage, cytogenetic biomonitoring

INTRODUCTION:

The term “Qui vive” is derived from the French sentinel guarding their castle which actually senses “a careful vigilance / high degree of alertness”. X – Rays are the potent mutagenic agent capable of inducing mutation and chromosomal aberrations.

Radiation is indispensible in modern dentistry. The short term effect of X-rays on continuously proliferating tisssues (Bone marrow, Oral mucous membranes) which were irradiated with the moderate dose may lead to increased apoptosis. Genotoxicity refers to a factor or a substance that causes chromosomal or DNA damage thereby causing mutations or cancer.

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Address for correspondence:

Dr. Sudhaa Mani M, MDS, Professor
Department of Oral Medicine and Radiology, Vivekanandha Dental College for Women, Tiruchengode, Tamilnadu, India,637205

Cytotoxicity refers to the property of being able to cause damage to the cells (pyknosis,karyorrhexis, karyolysis).[1]

Although dental diagnostic radiograph uses less than 5RAD of radiation exposure, it is necessary to monitor the patient after the radiation exposure to rule out the safety limits of radiation.[2] By assessing the genotoxic and cytotoxic changes following the conventional dental radiation helps us to reinforce the importance of evaluating the side effects of radiation.[3] Thereby contribute to the "Micronucleus Data Base" which will improve our understanding and practice methodology in children as well as Adults. Hence the micronuclei formation and cytotoxic effects were consider as a sensitive biomarker for assessing the cytogenetic damage due to the radiation.[4]

EFFECTS OF RADIATION ON GENETIC MATERIALS:

The irradiated tissue depending upon the frequency of exposure shows any of the following changes which includes the simple disruption of hydrogen bonds between the strands, cross linking of the DNA strands, defect in DNA repair, chromatid aberration and chromosomal aberration.

The potential risk of induction of fatal cancer from the dental radiography -3 in 1,000,000.The risk is same as that of smoking 1.4 cigarettes per day, radiation acts as initiator & promoter of carcinogenesis.[1] Repeated use of cytotoxic factors will cause the chronic cell damage, degenerative changes, finally leading to appropriate field of neoplasia.[1]The frequency of micronucleus occurrence will indicate DNA/chromosomal damage.[5]

FACTORS INFLUENCING EFFECT OF RADIATION EXPOSURE:

The factors that consider to influence the effect of radiation exposure include dose, dose rate, frequency, age, inter-individual variation causing chromosomal aberrations, susceptibility of individuals, type of cells irradiated, type & number of nucleic acid broken, the ability of cell to repair the damage and finally the virus alterations in the immune system.[6]

Various technique of bio-monitoring of cytogenetic changes involves the Metaphase chromosomal aberrations, Sister chromatid Exchanges, Host cell reactivation, Humanperipheral lymphocytes. Being simple and non-invasive way, the buccal epithelial cells pave the way to monitor the cytogenetic changes [7]

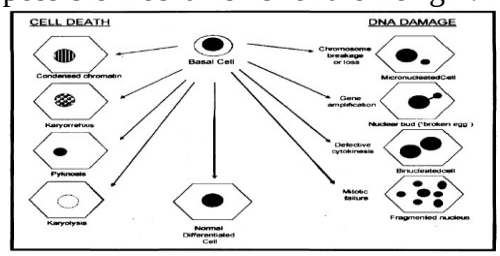
Buccal epithelial cells:

Buccal epithelial cells have the characteristic high turn overrate and being non keratinized, it accurately reflects the cytogenetic changes and genomic instabilities following radiation exposure.

Smear collection and staining:

Exfoliated cells were collected once after the mouth is rinsed with water, those cells were obtained by scraping the right /left buccal mucosa with cytobrush or moist wooden spatula. Cells were transferred to tube containing saline solution, centrifuged (800) rpm for 5 minutes, fixed in methanol/acetic acid and dropped onto pre cleaned slides.

Later the air- dried slices were stained using the papanicolaou stain, Other stains employed were wright giemsa stain, feulgen /fast green method, modified feulgen stain. [8] In 2008,Holland et al.,[3] Buccal MN assay cytome model representing the Schematic diagram of different types of buccal cells and the possible mechanisms for their origin.



Micronucleus arise from acentric fragments or from the whole chromosomes which are not included into the main nuclei of daughter cells.[Figure.1] The formation of micronuclei can be induced either by clastogens (substances that cause chromosome breakage) or by aneugens (agents that affect the spindle apparatus)

Criteria for identification of Micronucleus given by Tolbert et al.,[9]

The rounded smooth perimeter, suggestive of a membrane. Less than a third the diameter of the associated nucleus, but large enough to discern shape and color.Staining intensity similar to that of nucleus.Texture similar to that of the nucleus.Same focal plane as nucleus. a. Pyknosis refers to nuclear shrinkage/DNA Condenses into Shrunken basophilic mass.[2] [Figure.2] b. Karyolysis is nuclear fading/ Chromatin Dissolution due to the action of DNAases and RNAases.[2] [Figure.3] c.Karyorrhexis means nuclear fragmentation i.e.,rupture of Pyknotic nuclear membrane followed by nuclear fragmentation. [Figure.4]

DISCUSSION:

Various studies about the frequency of micronucleus and cytotoxicity changes were discussed.In 2003, Cerqueria et al detect the genetic damage in the exfoliated cells from the oral mucosa who were exposed to panoramic dental radiography and stated about the cytotoxic effect with increased frequency of apoptosis /necrosis. [10] Angelieria et al [5] (2006) Riberiro et al [11] (2007) done a study in patients exposed to dental panoramic radiography to determine the DNA damage and cellular death in Oral mucosal cells and concluded that, it may not induce the genotoxicity but apparent cytotoxicity was well documented.

Similarly Papova et al, Micronuclei test in buccal epithelial cells from the patients subjected to panoramic radiography with no significant increase in the frequency of the micronuclei.[12]Anuradha et al in 2012 noted the biomonitoring of genotoxic and cytotoxic effects of gingival epithelial cells with significant induction in cytotoxicity. [6] Similarly Roza Haghgoo observed the cytogenetic changes following the lateral cephalometry and panoramic radiograph and thereby concluded that absorbed dose of x-ray cannot make a significant genotoxic changes.[13]

Manjushri Waingade[8] 2011, Vidhya K B et al [7]2014, Mahima sandhu[14] 2014 evaluated the patients subjected to panoramic radiography following an analysis of micronuclei and noted a significant genotoxic changes after the exposure. In 2016 N Mohan et al noted the significant increase in the genotoxic effect following the periapical radiography as well as increased cytotoxic effect after the panoramic radiography.[16] Similarly Naveen preethi et al stated an increased frequency of micronuclei in children following the exposure to bitewing and digital panoramic radiography.[17] Sunitha kesidi et al in 2017 pointed out dental diagnostic full mouth radiograph can induce the cytotoxic effect and to some extent of genotoxic effect following the post exposure.[18]

Poonam agarwal et al in 2015 done a pediatric study on the patients exposed to panoramic radiography with a significant increase in the cytotoxicity. [15] Recently In 2018 Soha bhasha et al done a biomonitoring before and after CBCT and noticed a significant increased frequency of micronuclei following the post exposure radiation to CBCT.[19]

CONCLUSION:

X-ray exposure cannot be considered as a risk free procedure. The safe limits of radiation must be constantly monitored. It helps in Radiation hazards Management thereby "justifying and ensuring it protection of patient." Exposure must be limited whenever necessary following the ALARA principle

hence minimizing the chances of potential risks. So, hopefully further research will help us to scrutinize and elucidate the prospective management.

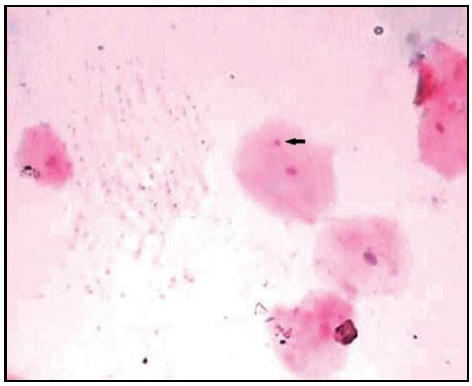


Figure 1: Photomicrograph showing micronuclei (Rapid Pap, ×400)

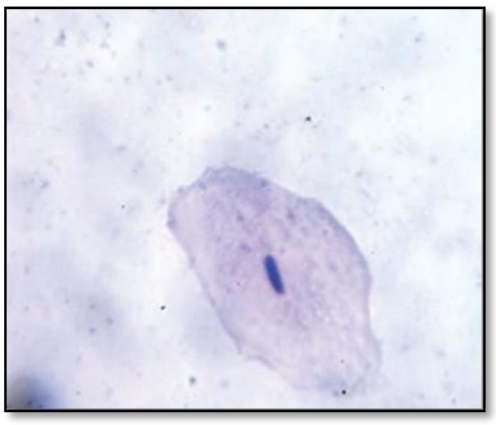


Figure 2: Photomicrograoh showing pyknosis (pap,X 40)

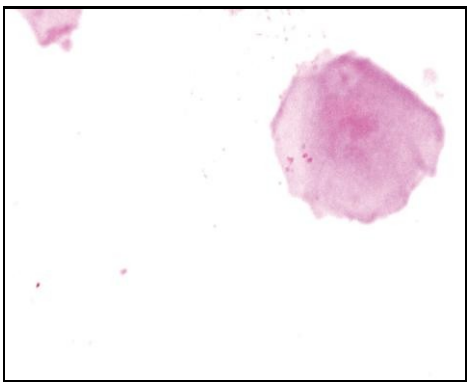


Figure 3: Photomicrograph showing karyolysis (Rapid Pap, ×400)

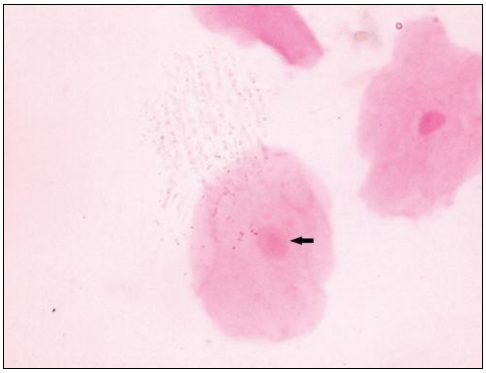


Figure 4: Photomicrograph showing karyorrhexis (Rapid Pap, ×400)

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