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Ultrasonographic Changes in Salivary Glands Following Radiotherapy

Dr Ritika Jindal

Post Graduate,
Department of Oral Medicine and Radiology,
Manipal College of Dental Sciences,
Mangalore.
Affiliated to Manipal University.

Dr Junaid Ahmed, MDS*(Corresponding Author)*

Professor and Head,
Department of Oral Medicine and Radiology,
Manipal College of Dental Sciences,
Mangalore. Affiliated to Manipal University
**junaid.ahmed@manipal.edu*

Dr Nandita Shenoy, MDS

Associate Professor,
Department of Oral Medicine and Radiology,
Manipal College of Dental Sciences,
Mangalore. Affiliated to Manipal University.
nandita.shenoy@manipal.edu

Dr Santosh Rai, MD

Associate Professor,
Department of Radiodiagnosis,
Kasturba Medical College, Mangalore.
Affiliated to Manipal University

Dr Ravikiran Ongole, MDS

Professor,
Department of Oral Medicine and Radiology,
Manipal College of Dental Sciences,
Mangalore. Affiliated to Manipal University.
oralcare@gmail.com

Dr Aditya Gupta

Post Graduate,
Department of Oral Medicine and Radiology,
Manipal College of Dental Sciences,
Mangalore.
Affiliated to Manipal University.

Abstract: *The oral cavity is irradiated during radiation therapy of radio - sensitive oral malignant tumors. Radiation therapy for malignant lesions of the oral cavity is usually indicated when the lesion is advanced or deeply invasive and cannot be approached surgically.*

The major salivary glands are at times unavoidably exposed to 20 to 30 Gy during radiotherapy for cancer in oral cavity or oropharynx. The parenchymal component of the salivary glands is radiosensitive. A marked and progressive loss of salivary secretion is usually seen in the first few weeks after initiation of radiotherapy.

Aim: Aim was to evaluate changes in parotid and submandibular salivary glands after radiotherapy for head and neck malignancies using ultrasonography

Methods: Ultrasonographic evaluation was performed extra orally for bilateral parotid and submandibular salivary glands before radiotherapy and after completion of radiotherapy.

Discussion: On ultrasonographic examination we observed decrease in size of salivary glands following radiotherapy. There was decrease in length, width and depth. This decrease in size of salivary glands can be related to chronic inflammation which sets in the glands after exposure to radiation and which leads to subsequent fibrous changes in glands.

1. INTRODUCTION

The oral cavity is irradiated during radiation therapy of radio - sensitive oral malignant tumors. Radiation therapy for malignant lesions of the oral cavity is usually indicated when the lesion is advanced or deeply invasive and cannot be approached surgically.

The major salivary glands are at times unavoidably exposed to 20 to 30 Gy during radiotherapy for cancer in oral cavity or oropharynx. The parenchymal component of the salivary glands is radiosensitive. A marked and progressive loss of salivary secretion is usually seen in the first few weeks after initiation of radiotherapy. The extent of reduced flow is dose dependent and reaches essentially zero at 60 Gy. Histologically an acute inflammatory response may occur soon after

initiation of therapy, particularly involving the serous acini. In the months after irradiation the inflammatory response becomes more chronic and the glands demonstrate progressive fibrosis, adiposis, loss of fine vasculature, and concomitant parenchymal degeneration. Oral dryness is the most common complication in patients who are receiving radiotherapy for their head and neck malignancies. Salivary flow reduces by 50-60% during first week of radiotherapy and reaches zero after 60 Gy of radiation[1].

Various imaging techniques, including CT scan, MRI and sonography can be used to evaluate all these changes occurring in salivary glands. Ultrasonography is a simple and safe technique for the evaluation of salivary gland changes caused by radiotherapy. It is a non invasive diagnostic tool commonly used for soft tissue imaging. It uses sound waves that acquire images in real time and without the use of ionizing radiations. The clinical application uses vibratory frequency in the range of 1 to 20 MHz^2.Color Doppler is a combination of sonography and Doppler system, it gives information about the vascularity of tissue.

2. MATERIALS AND METHODS

We planned our study with an aim to evaluate changes in parotid and submandibular salivary glands after radiotherapy for head and neck malignancies using ultrasonography.

After obtaining ethical committee approval from the institute, we recruited 20 patients of head and neck malignancy who were planned to receive radiotherapy as treatment. All aptients with known salivary gland disease or previous history of radiation received were excluded from the study. Radiotherapy was performed using standard procedure: 2Gy daily for 5 days / week and a total of 50-60 Gy using linear accelerator. All patients simultaneously received chemotherapy with cisplatin. Ultrasonographic evaluation was performed extraorallyfor bilateral parotid and submandibular salivary glands before radiotherapy and after completion of radiotherapy.

3. RESULTS

Out of the 20 patients recruited in our study 13were males and 7 were females. Mean age of our patients was 46.7yrs. Of all the patients of head and neck malignancy, 11 cases were of carcinoma oral cavity, 4 cases of carcinoma hypopharynx, 5 cases of carcinoma oropharynx.

All quantitative variables (dimension and blood flow) were assessed using Mann Whitney test. Qualitative variables (echogenicity and texture) using chi- square test. P value of <0.05 was considered significant.

We observed significant reduction in dimensions of both parotid and submandibular salivary glands in relation to length, width and depth of the glands. There was significant reduction in Peak systolic velocity (PSV) and End diastolic velocity (EDV) following radiotherapy in both the salivary glands. However, the change observed in resistive index (RI) was not statistically significant.

With respect to glandular texture we observed, on ultrasonography both the salivary glands had homogenous echotexture before radiotherapy which changed to heterogenousechotexture following radiotherapy. Inspite of decrease in PSV and EDV, In 35 out of salivary glands examined we found increase in resting salivary blood flow following radiotherapy.

Table1. *Changes in dimensions, Peak systolic velocity (PSV), End diastolic velocity (EDV), Resistive index (RI) following radiotherapy*

PARAMETERS	PAROTID PRE-RT	PAROTID POST –RT	SUBMANDIBULAR PRE- RT	SUBMANDIBULAR POST RT
Length (cm)	4.19	3.59	3.48	3.29
Width (cm)	1.94	1.64	1.47	1.23
Height (cm)	3.28	2.48	1.56	1.38
PSV (cm/sec)	13.47	11.8	11.86	10.80
EDV (cm/sec)	5.01	4.13	5.03	4.14
RI	0.58	0.58	0.58	0.57

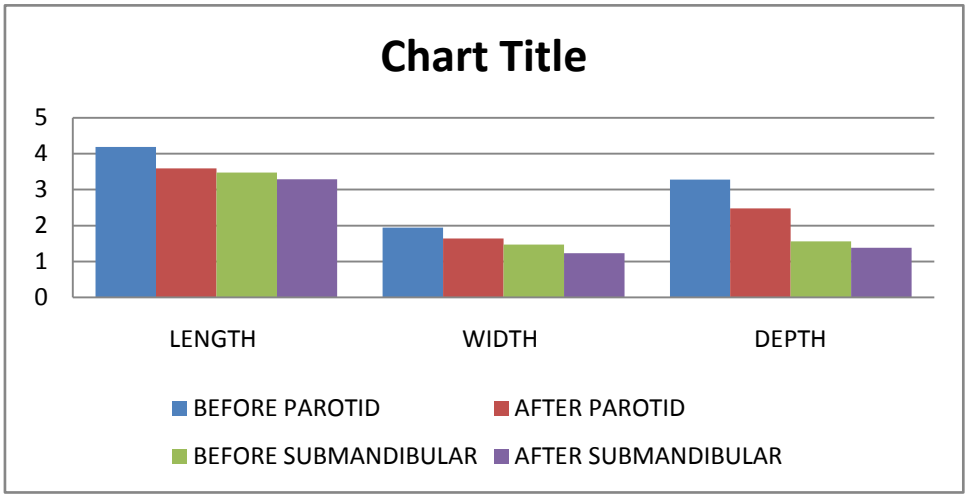

Figure1. *Changes in dimensions of parotid and submandibular salivary gland following radiotherapy*

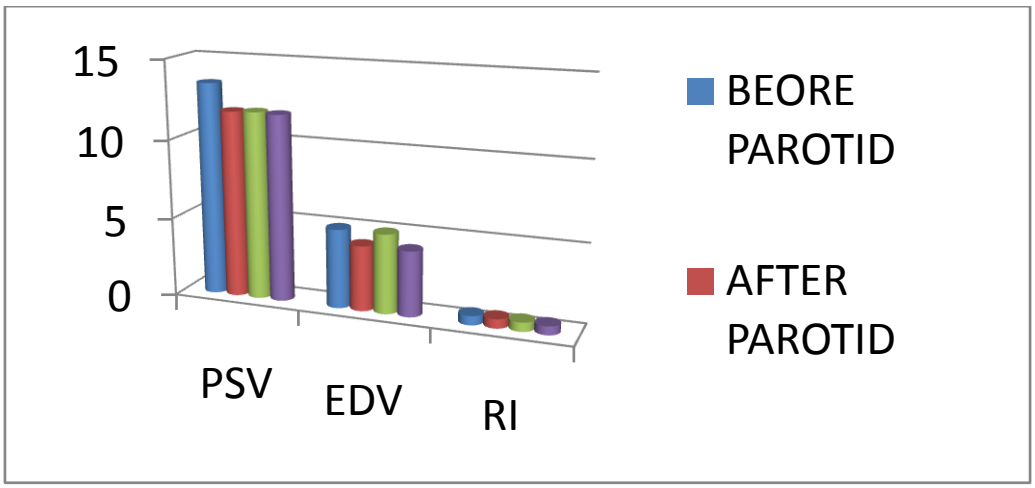

Figure2. *Changes in Blood flow in parotid and submandibular salivary glands following radiotherapy*

Qualitative Variables

PARAMETERS	BEFORE	AFTER
ECHO-TEXTURE	Homogenous	Heterogenous($p<0.01$)
ECHO-GENECITY	Hypoechoeic	Hypoechoeic
MARGINS	Regular	Regular
RESTING BLOOD FLOW	Adequate	Increased in 35 out of 80 salivary glands ($p<0.01$)

4. Discussion

We evaluated changes in 80 salivary glands including 40 parotid and 40 submandibular glands. In our study group maximum number of patients had carcinoma of oral cavity with male preponderance and mean age of presentation was 46.7yrs. All these findings may be correlated with increase incidence of oral cancer in males and to be common in elderly age group; however these incidental observations were not considered significant due to the chance of bias during patient selection.

Onultrasonographic examination we observed decrease in size of salivary glands following radiotherapy. There was decrease in length, width and depth. This decrease in size of salivary glands can be related to chronic inflammation which sets in the glands after exposure to radiation and which leads to subsequent fibrous changes in glands. This is similar to results of V W C Wu et al 2011 who performed ultrasonographic examination of parotid gland 8-11 years post radiotherapy and found significant decrease in volume of all patients after radiotherapy

On color Doppler we observed overall decrease in PSV, EDV and RI ; decrease in PSV was significant as compared to EDV and RI. The decrease in flow velocity can arise because of

destruction of glandular parenchyma secondary to radiation exposure there will be decrease resistance to blood flow initially but later because of both acinar, parenchymal destruction and endarteritis there will be decrease in blood flow in glandular tissue. We also observed, increase in blood flow in 35 out of 80 salivary glands which can be secondary to acute inflammatory response and decrease resistance to blood flow as observed as decrease in PSV, EDV.

We observed change in echotexture from homogenous to heterogenous, hypoechoic. This can be attributed to fibrous changes occurring in the gland following radiotherapy. Yang et al 2012, found gland echotexture became heterogenous following radiotherapy.

Our study results were similar to Imanimognaddam et al (2012)[1] who evaluated changes in parotid and submandibular glands 2 weeks and 6 weeks following radiotherapy and observed significant reduction in dimensions of glands. On ultrasound he found glandular texture became heterogenic, hypoechoeic and irregular following radiation exposure. S C H Cheng et al 2011[2], assessed post radiotherapy changes in parotid glands and observed a heterogeneous appearance of parotid gland post radiotherapy. This was in contrast to homogenous echotexture in normal parotid glands. The mean peak systolic velocity, resistive index and pulsatility index were decreased following radiotherapy

Thus Radiation induce changes in salivary glands. In our study we found both acute and chronic changes in our patients. As a result of acute inflammatory changes there was transient increase in blood flow. Subacute inflammatory changes lead to destruction of parenchymal and acinar tissue surrounding vessels resulted in decrease in resistance to blood flow and was noticed as decrease in RI, PSV, and EDV. Chronic inflammatory changes lead to fibrosis in the gland leading to decrease in size of gland[3,4].

So a mixed set of inflammatory changes sets up in salivary glands immediately following complete course of radiotherapy. Appropriate preventive measures should be taken as use of IMRT, conformational radiotherapy, radio protectors to limit the exposure of therapeutic radiation to target area thus preventing or limiting side effects occurring in salivary glands. Empirical treatment in the form of salivary substitutes, bicarbonate mouth rinses, sodium fluoride application can be given to patients undergoing radiotherapy to prevent the side effects secondary to xerostomia[5, 6]

5. CONCLUSION

On ultrasonography of salivary glands after radiotherapy, it has been observed that the gland echotexture becomes hypoechoeic and heterogenic in comparison to homogenous echotexture of normal salivary glands.

This study was designed to evaluate changes occurring in salivary glands following radiotherapy using ultrasound, a non ionizing imaging modality. The purpose of the study was to evaluate changes in echogenicity and vascularity of salivary glands post radiotherapy which will help us to minimize the morbidity in patients undergoing radiotherapy for head and neck malignancies.

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