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Pulmonary Functions deteriorate with increasing duration of exposure to ionizing radiations

Ionizing radiations affects pulmonary functions.

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Abstract

Background – Radiologic technologists are under the exposure of ionizing radiations for long duration of their occupational work life. Ionizing radiations have previously been found to damage the lung tissue and cause fibrosis.

Methods–Spirometry, a measure of pulmonary function tests was performed on radiologic technologists (n=23) and was compared with healthy subjects (n=23). To assess the effect of duration of radiation exposure over spirometry, correlation analysis along with linear regression was performed with their duration of exposure to ionizing radiations.

Results – There was a significantly lower FVC % of predicted (p = 0.04) and MVV% of predicted (p = 0.05) values among radiologic technologists as compared to healthy controls. Further with increasing duration of exposure to ionizing radiations, a significant negative correlation was observed for FVC % of predicted (p value = 0.004) FEV1 % of predicted (p value = 0.015) PEFR % of predicted (p value = 0.046) and MVV % of predicted (p value = 0.037).

Conclusion – Ionizing radiations affect the lungs of radiologic technologists and the restrictive type pattern was noted. In subjects with higher duration of radiation exposure the effect is more pronounced.

Key Words: Spirometry, Radiologic Technologists, Ionizing radiations, Pulmonary Function Tests, FEV1, FVC, PEFR, MVV.

Introduction -

Pulmonary function testing is useful for assessment of a variety of lung pathologies, and spirometry is the most commonly obtained component of it. Spirometry is useful in the evaluation of obstructive airway disorders along with with restrictive and mixed disorders[1].

Some of the primarily studied parameters to assess the different lung functions using spirometer are: Forced vital capacity (FVC), Forced Expiratory volume in first second (FEV1), Ratio of FEV1/FVC %, Peak Expiratory Flow Rate (PEFR) and Maximum Voluntary Ventilation (MVV).

Many studies have shown that pulmonary functions decline after radiotherapy in a dose-dependent manner[2–4]. Further, researches have proven that ionizing radiation damage lung parenchyma and lead to fibrotic changes in the lung tissue[5–7].

Radiologic technologists are considered to be exposed to ionizing radiations as a part of their occupation. Ionizing radiations has been shown to cause various health problems among radiologic technologists.[8–10]

Pulmonary function tests in radiologic technologists are however not studied well and moreover effects of duration of exposure to ionizing radiations over lung function tests have not been reported. Hence we designed a study to measure the pulmonary function tests of radiologic technologists using spirometry and to compare the same with age and sex matched healthy subjects. We also planned to assess the effect of duration of radiation exposure over spirometry measured lung functions.

Materials and Methods -

The study was conducted at Department of Physiology, G R Medical College & JA groups of Hospitals, Gwalior. 23 radiologic technologists with age between 30-60 years old who were occupationally exposed to long term low doses of ionizing radiation and having a history of at least 3 years exposure in radiology were recruited. The selected cases were compared with another group of 23 healthy participants from same institute, who were not exposed to radiations since 1 year as a control group.

The exposed group was matched with controls in age, sex and BMI. Cases included from different types of imaging modalities and equipment, including conventional and computed tomography (CT) and computed radiography. Cases worked in different shifts for 8 hours a day for six days per week.

Exclusion Criteria: Participants who had any history of smoking and any previous diseases such as respiratory illness, gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, and malignancy were excluded from the study to rule out the possible other etiology for neural affection. Also, participants with less than 3 years of exposure were excluded from the study.

All the cases and control subjects were initially demonstrated the ideal technique of performing spirometry. Followed by this best of three performed recordings was considered for analysis. All the measurements were done at same ambient room temperature to ensure BTPS correction using Spiro Excel computerized spirometer Machine, Medicaid Systems, Mohali, Punjab (India).

Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st Second (FEV1), FEV1/FVC %, Peak Expiratory Flow Rate (PEFR) and Maximum Voluntary Ventilation (MVV) were measured in all the cases and control subjects. Except FEV1/FVC % all the other measures of spirometry are invariably affected by gender and age of the subjects, hence percentage of predicted (% of

Predicted normal values for age and sex) values i.e. FVC % of predicted, FEV1% predicted, PEFR % of predicted and MVV % of predicted values were considered for analysis purpose.

Statistics - Data analysis was done using GraphPad Prism Version 5.01 software. Unpaired student t test, Pearson r correlation and regression analysis were performed. To assess the effect of duration of exposure to ionizing radiations Pearson r correlation and Linear regression analysis were performed.

Results –

Spirometry of 23 radiologic technologists (mean age 41.17 ± 9.59Yrs) and 23 age and sex matched healthy control subjects (mean age 42.26± 8.40Yrs) were compared.

Comparative analysis of general characteristics and spirometry parameters is shown in table no 1. There was no any significant difference in any of the spirometry parameters among radiologic technologists and healthy controls. However the parameters were on lower side in cases compared to controls.

Table No. 1

Parameter	**Radiologic Technologists n=23 (mean±SD)**	**Healthy Controls n=23 (mean±SD)**	**p-value**
Age in Yrs	41.17± 9.590	42.26± 8.400	0.91
Sex (M/F)	19/4	19/4	…….
BMI in Kg/m^2	25.57± 3.160	24.74±3.328	0.44
RBS	101.6±13.99	93.80± 22.58	0.12
Duration of exposure in Yrs	16.30± 11.48	……	……..
FVC % of predicted	74.26± 10.94	81.12± 11.49	0.04*
FEV1 % of predicted	78.78± 13.10	85.86± 13.46	0.08
FEV1/FVC %	88.65± 7.290	89.21± 8.358	0.81
PEFR % of predicted	79.91± 17.62	83.53± 20.55	0.53
MVV % predicted	63.70± 14.99	74.30± 19.88	0.05*

Table shows comparison of general characteristics and spirometric parameters of cases and control group subjects. Table shows significantly lower FVC in cases compared to control group subjects. Any of the other spirometry parameter was not significantly different between cases and control subjects.

Previous studies have proven that ionizing radiations lead to fibrotic changes in lung parenchyma. Further these changes are believed to progress with increasing duration of radiation exposure. To deduce this fact, a correlation analysis of all spirometry parameters with the duration of exposure to ionizing radiations was performed among radiologic technologists.(Figure 1).

We observed that there was a significant negative correlation of FVC % of predicted, FEV1 % of predicted, PEFR % of predicted and MVV % of predicted the spirometry parameters with duration of exposure to ionizing radiations and the results of same are shown in figure 1. FEV1/FVC % were however no correlated with the duration of exposure to ionizing radiations.

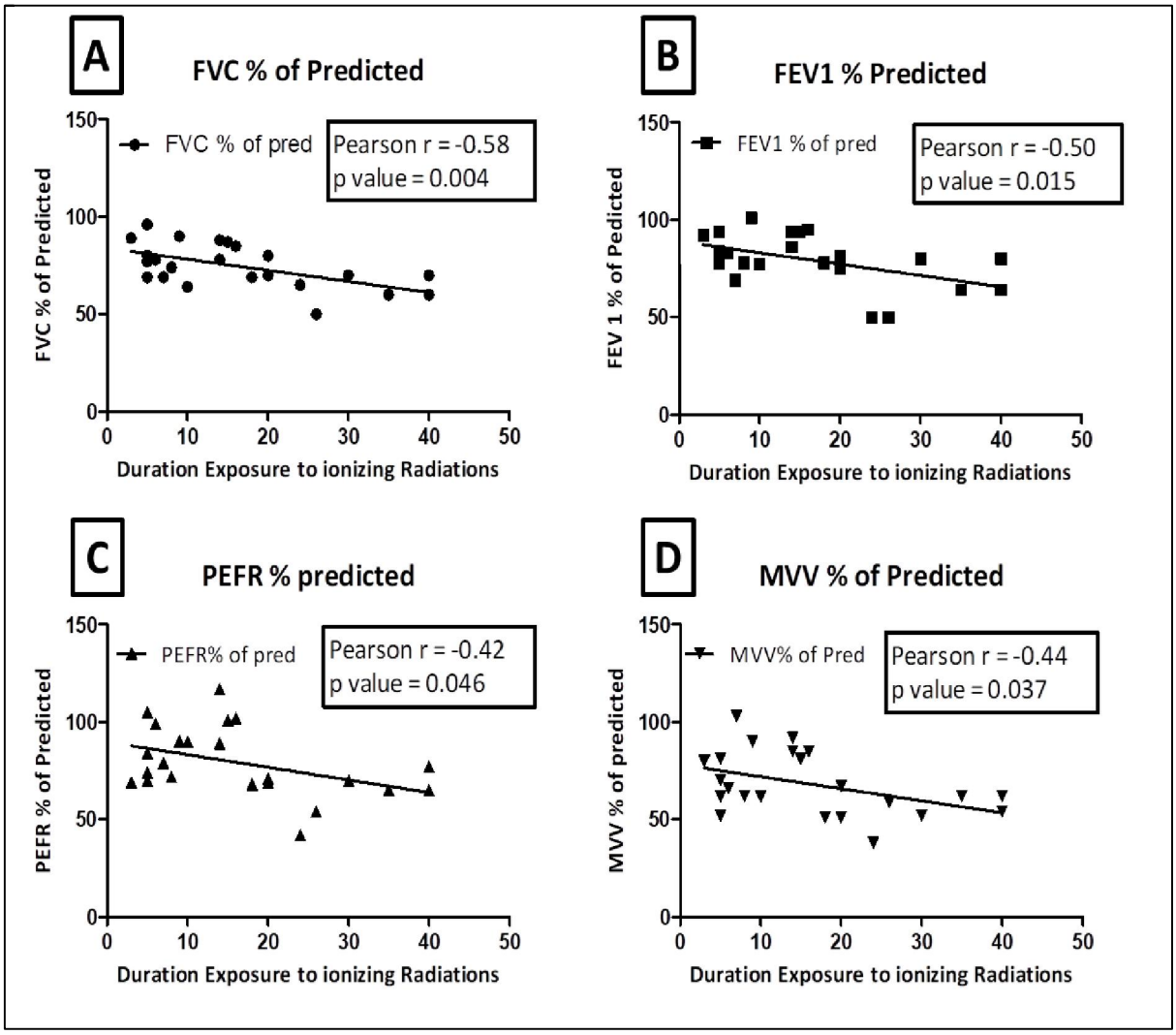

Figure-1. Figure shows Pearson r correlation of spirometryparameters with duration of exposure to ionizing radiations among Radiologic technologists. Spirometry parameters correlated are (A)FVC %of predicted (B) FEV1 % of predicted (C) PEFR % of predicted (D) MVV % of predicted. Figure shows that all the above parameters showed significant negative correlations.

Discussion –

Spirometry of 23 radiologic technologists was compared with age and sex matched 23 healthy controls at G R Medical College, Gwalior (M.P.).

FVC % predicted and MVV % predicted were significantly lower in radiologic technologists as compared to healthy control subjects. However there was no significant difference between FEV1 % predicted, FEV1/FVC Ratio and PEFR % predicted.

Lowered FVC with normal FEV1/FVC ratio is observed in restrictive pattern of lung disorders[11–13].This was one of its kind study where pulmonary function tests assessed in radiologic technologists depicted restrictive pattern. In previous studies either radiotherapy subjects were assessed for pulmonary functions or other illnesses were assessed in radiologic

technologists[2–5,8]. Although this restrictive pattern was not clinically evident in each of the case individually, overall analysis depicted restrictive pattern of lung pathology.

Although reduced MVV% is considered nonspecific[14], however in the present scenario of normal FEV1/FVC ratio it is not due to obstructive pathology. It may partly be due to restrictive reduction of lung volume and partly due to affection of musculoskeletal system as a result of radiation induced fibrosis.[15]

To assess the effect of duration of exposure to ionizing radiations a Pearson r correlation analysis was done with their duration of work in radiology unit. We observed a significant negative correlation between duration of exposure with FVC %of predicted, FEV1 % of predicted, PEFR % of predicted and MVV % of predicted (Figure 1). However there was no any correlation with FEV1/FVC %. This depicts that pulmonary functions deteriorate with increasing duration of exposure in a time dependent manner. It further supports the formerly derived conclusion that the deterioration of lung functions is of restrictive type. Reduction of PEFR % predicted values with increasing duration of exposure points to the associated presence of obstructive pattern in these patients. More detailed studies are recommended for this in future.

This study is limited by the fact that it does not included the radiologic imaging to confirm the actual changes in the lungs and also that diffusion lung capacities were not evaluated which could have given more insight into the radiation effects over lung tissue of radiologic technologists.

We conclude that ionizing radiations affect the lungs of radiologic technologists and the predominant pattern is of restrictive type. Further the effect is more pronounced in subjects with higher duration of radiation exposure.

Authors declare that there is no conflict of interest among the Authors.

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