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A Prospective Study of Auditory Alterations Following Radiotherapy in Patients with Head and Neck Malignancy

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Abstract

Introduction: *Head and neck cancers are most commonly of the squamous cell carcinoma type. In 2015, head and neck cancers globally affected more than 5.5 million people, and it has caused over 379,000 deaths. The head and neck malignancies constitute 5% of all the cancers worldwide. In India, the most common H and N cancers are those of oral cavity and pharynx.*

As both the ears and Eustachian tubes are included in the radiation field, in case of cancers of H and N, the otological complications are quite common following RT.

This study focuses on finding out the type of auditory alteration that occurs after radiotherapy so that the disease can be identified early and different methods of prevention and cure can be used promptly, thereby reducing the number of people suffering from unwanted post-RT auditory changes.

Materials & Methods: *Over a period of 1year 50 Patient who attended the OPD & indoor with Head and neck malignancy and were waiting to undergo Radiotherapy were included in this study and then subjected to ENT examination, Pure Tone Audiometry & Impedance Audiometry during RT, 1month after RT completion & 3months after RT completion. Patients with abnormal findings before Radiotherapy were excluded.*

Results and Analysis: *Out of 50 patients the study shows that 70-88% patients had no conductive hearing loss & 74-82% had no sensorineural hearing loss in PTA done during RT but 24-62% patients had >25 dB conductive hearing loss & 38-54% patients had >25dB sensorineural hearing loss in PTA done after completion of RT.*

Discussion: *Studies done so far show that as radiation field descends down from nasopharynx to Neck, the effect on otological structures decreases and auditory alterations occur soon after radiotherapy especially when subjected to doses greater than 60Gy.*

Conclusions: *Radiotherapy in Head & Neck cancer patients adversely affects the hearing apparatus causing varying degrees of conductive &/or sensorineural hearing loss with higher incidence of auditory alteration seen in cancers of regions higher up such as Nasopharynx due to its proximity to the Temporal bone which falls in the radiation field and also may be due to Eustachian tube blockage due to the disease process which is further aggravated due to RT.*

There is scope of future study on reducing radiation to adjacent sites with the help of newer methods such as Intensity modulated Radiotherapy/ Proton Radiotherapy, and comparing the auditory alterations in these patients with those receiving Conventional RT.

Introduction

Head and neck cancer is a group of cancers that starts in the mouth, nose, throat, larynx, sinuses, or salivary glands. Symptoms for head and neck cancer may include a lump or sore that does not heal, a sore throat that does not go away, trouble swallowing, or a change in the voice. There may also be unusual bleeding, facial swelling, or trouble breathing.

In 2015, head and neck cancers globally affected more than 5.5 million people (mouth 2.4 million, throat 1.7 million, and larynx 1.4 million),[3] and it has caused over 379,000 deaths (mouth 146,000, throat 127,400, larynx 105,900). Together, they are the seventh most frequent cancer and the ninth-most-frequent cause of death from cancer. In the United States, about 1% of people are affected at some point in their life, and males are affected twice as often as females. The usual age at diagnosis is between 55 and 65 years old. The average 5 year survival following diagnosis in the developed world is 42-64%.

The head and neck (H and N) malignancies constitute 5% of all the cancers worldwide. In India, the most common H and N cancers are those of oral cavity and pharynx.

Radiotherapy (RT) refers to the treatment of neoplastic diseases with ionizing radiation, here in addition to destructive effect on cancer cells, RT effects the normal tissues and passes through all the tissues of the body as well. The unwanted effects of RT on various tissues depend upon the structure involved, rapidity of treatment, total dose and type of radiation, age of the patient at treatment, length of survival after treatment and variations in the individual tolerance to the therapeutic modality. Most of the complications subside after cessation of RT but in some cases, the late sequelae of the radiation do occur as unavoidable and undesirable consequences of treatment. As both the ears and Eustachian tubes are included in the radiation field, in case of cancers of H and N, the otological complications are quite common following RT.

This study focuses on finding out the type of auditory alteration that occurs after radiotherapy so that the disease can be identified early and different methods of prevention and cure can be used promptly, thereby reducing the number of people suffering from unwanted post-RT auditory changes.

Materials & Methods

Over a period of 1year 50 Patient who attended the OPD & indoor with Head and neck malignancy and were waiting to undergo Radiotherapy were included in this study and then subjected to ENT examination, Pure Tone Audiometry & Impedance Audiometry during RT, 1month after RT completion & 3months after RT completion. Patients with abnormal findings before Radiotherapy were excluded. All the patients included in the study underwent radical RT and the radical doses given were between 60 to 70 Gy. The treatment was given on the Co-60 tele-therapy machine.

All the available results was documented, validated and was compared in terms of sensitivity, specificity, predictive values etc.

Results & Analysis

Table: Distribution of During RT PTA SNHL (Right Ear)

During RT PTA SNHL(R)	Frequency	Percent
0	41	82.0%
25	9	18.0%
Total	50	100.0%

41(82.0%) patients had no SNHL during RT (right ear) and 9(18.0%) patients had 25dB SNHL during RT (Right Ear).

Table: Distribution of During RT PTA SNHL (Left Ear)

During RT PTA SNHL(L)	Frequency	Percent
0	37	74.0%
25	13	26.0%
Total	50	100.0%

37(74.0%) patients had no SNHL during RT (Left ear) and 13(26.0%) patients had 25dB SNHL during RT (Left Ear)

Table: Distribution of During RT PTA CHL (Right Ear)

During RT PTA CHL(R)	Frequency	Percent
0	35	70.0%
25	8	16.0%
30	7	14.0%
Total	50	100.0%

35(70.0%) patients had no CHL (Right Ear), 8(16.0%) patients had 25dB CHL (Right Ear) and 7(14.0%) patients had 30dB CHL during RT (Right Ear).

Table: Distribution of During RT PTA CHL (Left Ear)

During RT PTA CHL(L)	Frequency	Percent
0	44	88.0%
25	2	4.0%
30	4	8.0%
Total	50	100.0%

44(88.0%) patients had no CHL (Left Ear), 2(4.0%) patients had 25dB CHL during RT (Left Ear) and 4(8.0%) patients had 30dB CHL during RT (Left Ear)

Table: Distribution of Post RT 1 month PTA SNHL (Right Ear)

Post RT 1 month PTA SNHL(R)	Frequency	Percent
0	23	46.0%
25	22	44.0%
30	1	2.0%
40	4	8.0%
Total	50	100.0%

23(46.0%) patients had no SNHL (Right Ear), 22(44.0%) patients had 25dB SNHL post RT 1 month (Right Ear), 1(2.0%) patients had 30dB SNHL post RT 1 month (Right Ear) and 4(8.0%) patients had 40dB SNHL post RT 1 month(Right Ear)

Table: Distribution of Post RT 1 month PTA SNHL (Left Ear)

Post RT 1 month PTA SNHL(L)	Frequency	Percent
0	31	62.0%
25	16	32.0%
30	1	2.0%
40	2	4.0%
Total	50	100.0%

31(62.0%) patients had no SNHL post RT 1month (Left Ear), 16(32.0%) patients had 25dB SNHL post RT 1 month (Left Ear), 1(2.0%) patients had 30dB SNHL post RT 1 month (Left Ear) and 2(4.0%) patients had 40dB SNHL post RT 1 month (Left Ear)

Table: Distribution of Post RT 1 month PTA CHL (Right Ear)

Post RT 1 month PTA CHL(R)	Frequency	Percent
0	19	38.0%
25	24	48.0%
30	1	2.0%
40	6	12.0%
Total	50	100.0%

19(38.0%) patients had no CHL post RT 1 month (Right Ear), 24(48.0%) patients had 25 dB CHL post RT 1 month (Right Ear), 1(2.0%) patients had 30dB CHL post RT 1 month (Right Ear) and 6(12.0%) patients had 40dB CHL post RT 1 month (Right Ear)

Table: Distribution of Post RT 1 month PTA CHL (Left Ear)

Post RT 1 month PTA CHL(L)	Frequency	Percent
0	38	76.0%
25	3	6.0%
30	8	16.0%
40	1	2.0%
Total	50	100.0%

38(76.0%) patients had no CHL post RT 1 month (Left Ear), 3(6.0%) patients had 25dB CHL post RT 1 month (Left Ear), 8(16.0%) patients had 30dB CHL post RT 1 month (Left Ear) and 1(2.0%) patients had 40dB CHL post RT 1 month (Left Ear)

Table: Distribution of Post RT 3 month PTA SNHL (Right Ear)

Post RT 3 month PTA SNHL(R)	Frequency	Percent
0	23	46.0%
25	14	28.0%
30	1	2.0%
35	8	16.0%
40	4	8.0%
Total	50	100.0%

23(46.0%) patients had no SNHL post RT 3 month (Right Ear), 14(28.0%) patients had 25dB SNHL post RT 3 month (Right Ear), 1(2.0%) patients had 30dB SNHL post RT 3 month (Right Ear), 8(16.0%) patients had 35dB SNHL post RT 3 month (Right Ear) and 4(16.0%) patients had 40dB SNHL post RT 3 month (Right Ear)

Table: Distribution of Post RT 3 month PTA SNHL (Left Ear)

Post RT 3 month PTA SNHL(L)	Frequency	Percent
0	26	52.0%
25	13	26.0%
30	3	6.0%
40	7	14.0%
50	1	2.0%
Total	50	100.0%

26(52.0%) patients had no SNHL post RT 3 month (Left Ear), 13(26.0%) patients had 25dB SNHL post RT 3 month (Left Ear), 3(6.0%) patients had 30dB SNHL post RT 3 month (Left Ear), 7(14.0%) patients had 35dB SNHL post RT 3 month (Left Ear) and 1(2.0%) patients had 40dB SNHL post RT 3 month (Left Ear)

Table: Distribution of Post RT 3 month PTA CHL (Right Ear)

Post RT 3 month PTA CHL(R)	Frequency	Percent
0	17	34.0%
15	3	6.0%
25	23	46.0%
30	1	2.0%
40	6	12.0%

Total	50	100.0%

17(34.0%) patients had no CHL post RT 3 month (Right Ear) , 3(6.0%) patients had 15dB CHL post RT 3 month (Right Ear), 23(46.0%) patients had 25dB CHL post RT 3 month (Right Ear) , 1(2.0%) patients had 30dB CHL post RT 3 month (Right Ear) and 6(12.0%) patients had 40dB CHL post RT 3 month (Right Ear)

Table: Distribution of Post RT 3 month PTA CHL (Left Ear)

Post RT 3 month PTA CHL(L)	Frequency	Percent
0	38	77.6%
25	1	2.0%
30	8	16.3%
40	2	4.1%

Total	49	100.0%

38(77.6%) patients had no CH post RT 3 month (Left Ear), 1(2.0%) patients had 25dB CHL post RT 3 month (Left Ear), 8(16.3%) patients had 30dB CHL post RT 3 month (Left Ear) , 2(4.1%) patients had 40dB CHL post RT 3 month (Left Ear)

Table: Distribution of During RT TYMP (Right Ear)

During RT TYMP(R)	Frequency	Percent
A	36	72.0%
Ad	5	10.0%
B	7	14.0%
C	2	4.0%
Total	50	100.0%

36(72.0%) patients had A during RT (Right Ear), 5(10.0%) patients had Ad during RT (Right Ear), 7(14.0%) patients had B during RT (Right Ear) and 2(4.0%) patients had C during RT (Right Ear)

Table: Distribution of During RT TYMP (Left Ear)

During RT TYMP(L)	Frequency	Percent
A	44	88.0%
Ad	1	2.0%
B	5	10.0%
Total	50	100.0%

44(88.0%) patients had A during RT (Left Ear), 1(2.0%) patients had Ad during RT (Left Ear) and 5(10.0%) patients had B during RT (Left Ear)

Table: Distribution of Post RT 1 month TYMP (R)

Post RT 1 month TYMP (R)	Frequency	Percent
A	13	26.0%
Ad	6	12.0%
B	26	52.0%
C	5	10.0%
Total	50	100.0%

13(26.0%) patients had A post RT 1 month (Right Ear) , 6(12.0%) patients had Ad post RT 1 month (Right Ear) , 26(52.0%) patients had B post RT 1 month (Right Ear) and 5(10.0%) patients had C post RT 1 month (Right Ear)

Table: Distribution of Post RT 1 month TYMP (Left Ear)

Post RT 1 month TYMP (L)	Frequency	Percent
A	33	66.0%
Ad	1	2.0%
B	8	16.0%
C	8	16.0%
Total	50	100.0%

33(66.0%) patients had A post RT 1 month (Left Ear), 1(2.0%) patients had Ad post RT 1 month (Left Ear), 8(16.0%) patients had B post RT 1 month (Left Ear) and 8(16.0%) patients had C post RT 1 month (Left Ear)

Table: Distribution of Post RT 3 month TYMP (Right Ear)

Post RT 3 month TYMP(R)	Frequency	Percent
A	16	32.0%
Ad	4	8.0%
B	13	26.0%
C	17	34.0%
Total	50	100.0%

16(32.0%) patients had A post RT 3 month (Right Ear), 4(8.0%) patients had Ad post RT 3 month (Right Ear), 13(26.0%) patients had B post RT 3 month (Right Ear) and 17(34.0%) patients had C post RT 3 month (Right Ear)

Table: Distribution of Post RT 3 month TYMP (Left Ear)

Post RT 3 month TYMP(L)	Frequency	Percent
A	34	68.0%
Ad	2	4.0%
B	6	12.0%
C	8	16.0%
Total	50	100.0%

34(68.0%) patients had A post RT 3 month (Left Ear), 2(4.0%) patients had Ad post RT 3 month (Left Ear), 6(12.0%) patients had B post RT 3 month (Left Ear) and 8(16.0%) patients had C post RT 3 month (Left Ear)

Discussion

This is a prospective study of 50 patients in which patients coming with Head & neck malignancies who were planned for RT (exclusively) were included in the study provided they did not have abnormal clinical findings in the external or middle ear and also did not have occupational exposure to hazardous loud sound.

Most patients with head neck malignancy in the this study had SCC.

64% patients presented in Stage 3 of the disease, 18% in Stage 2 & 18% in Stage 4 Cancer.

66% patients were in their 6th-7th decade of life. 78% of the patients were Male & 22% were female. All the patients belonged to Lower or Upper Lower Socio Economic Status.

Association of age, sex, socioeconomic status and stage of CA had no statistical significance.

Study shows that 70-88% patients had no conductive hearing loss & 74-82% had no sensorineural hearing loss in PTA done during RT but 24-62% patients had >25 dB conductive hearing loss & 38-54% patients had >25dB sensorineural hearing loss in PTA done after completion of RT.

Jain A et al[8] also concluded that >60Gy radiation dosage causes significant damage to both middle ear & inner ear leading to conductive & sensorineural hearing loss.

Dell'Aringa AH et al[9] reported bilateral hearing loss soon after radiotherapy.

In this study tympanometry and otoscopy majority of patients have been found to develop Otitis media with effusion with 'B' or 'C' curves in 28-60% patients, 'Ad' curve in 4-8% patients &>Grade 2 pars tensa/ pars flaccid retractions in 20-60% patients after completion of RT.

Malgonde MS et al[6] found that inspite of various strategies adopted to protect the sensitive structures during organ preservation strategies , radiation damage can occur from Pharyngotympanic tube to brain stem auditory pathway causing hearing loss with mixed hearing loss occurring due to damage to middle ear structures.

50% & 14% of the patients in this study had CA Larynx & Hypopharynx respectively, while higher up sites like CA Nasopharynx & Oropharynx were 12% & 24% respectively.

After completion of RT, Hypopharynx & Larynx being further lower down in the neck showed an incidence of >25dB sensorineural hearing loss in 58-72% & 20-68% patients respectively and >25dB conductive hearing loss in 14% & 13-60% patients, while CA Nasopharynx & Oropharynx being higher up in the neck closer to the auditory system showed an incidence of >25dB sensorineural hearing loss in 16-84% & 42-75% patients and >25dB conductive hearing loss in 100% & 19-67% patients.

We also found that 83% patients with Nasopharyngeal CA had 'C' curve in tympanometry which may be due to the disease process or Radiation induced inflammation/ changes leading to probable Eustachian tube blockage. This is further supported by the Otoscopic findings which shows that 83-100% of these patients had Grade 3/4 retraction of pars tensa/ flaccida of tympanic membrane.

Kaul A et al[10] found that the patients had hearing loss, tinnitus, ear fullness and serous otitis media. Hearing loss was mainly sensorineural and was mostly seen in carcinoma of the oral cavity, oropharynx, and nasopharynx. The patients with carcinoma of esophagus, thyroid, and occult primary did not show any significant change in hearing. As radiation field descends down from nasopharynx to esophagus, the effect on otological structures decreases.

Conclusion

Radiotherapy in Head & Neck cancer patients adversely affects the hearing apparatus causing varying degrees of conductive &/or sensorineural hearing loss with higher incidence of auditory alteration seen in cancers of regions higher up such as Nasopharynx due to its proximity to the Temporal bone which falls in the radiation field and also may be due to Eustachian tube blockage due to the disease process which is further aggravated due to RT.

There is scope of future study on reducing radiation to adjacent sites with the help of newer methods such as Intensity modulated Radiotherapy/ Proton Radiotherapy, and comparing the auditory alterations in these patients with those receiving Conventional RT.

Limitations

In spite of every sincere effort the study has few lacunae. The notable short comings of this study are:

1) The sample size was very small. Only 50 cases are not sufficient for this kind of study.
2) The study has been done in a single centre.
3) The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

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