Journal of Radiotherapy in Practice

Journal of Radiotherapy in Practice (2008)
7, 195–204

doi:10.1017/S1460396908006390

Original Article

Clinical evaluation of the effects of radiotherapy on oral mucosa and gingiva

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Abstract

Introduction: The use of radiotherapy, alone or in conjunction with surgical resection, is common in treating head and neck tumours. However, ionising radiation induces unavoidable changes in the surrounding normal tissues, causing severe complications. Therefore, we decided to study different effects of radiotherapy on gingiva and oral mucosa.

Methods and Materials: This prospective analytical study was performed on 30 patients with head and neck cancers referred to the radiotherapy department of Ghaem Hospital from March to October 2006. Data were collected by means of interviews, clinical examinations and patients' medical file investigation. The impact of different dosages of radiation on gingiva and oral mucosa was investigated. Data analysis was performed using general linear model (GLM), Cochran and multivariate analysis of variance (MANOVA) tests via SPSS V. 11.5 software.

Results: A direct relationship between increase in radiation dosage, irritation of oral mucosa, ulcer development and mucositis was observed. But there was no significant relationship between NUG (necrotising ulcerative gingivitis) and perlèche and radiation dosage. Periodontal index (PI), gingival index (GI) and papillary bleeding index (PBI) were increased, but due to limited time of study (6–7 weeks), no change in gingival recession was observed. Plaque index (PLI) decreased during treatment process because of oral hygiene instructions.

Conclusion: The oral and periodontal health status of head and neck cancer patients before and during radiotherapy has been described in this article. The authors believe that prevention or reduction of side-effects of radiation should be an integral part of treatment as they may have tremendous effect on the patient's quality of life. This study supports the need for dental assessment and treatment planning before radiation therapy.

Keywords

Radiotherapy; mucositis; cancer; oral health status; candidiasis.

INTRODUCTION

Cancers are now considered as the second common cause of death in developed countries.[1]

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Oral cancer accounts for 4% of all malignancies,[2] but is the sixth most common cancer in males and twelfth in females.[3] The use of radiotherapy, alone or in conjunction with surgical resection, is common in treating head and neck tumours. However, ionising radiation induces unavoidable changes in the surrounding normal tissues, causing compromises in function and host defenses, and severe complications.[4]

The parotid is the most radiosensitive of the salivary glands; if affected, widespread xerostomia will ensue. Xerostomia causes a decrease in the normal salivary mechanisms, buffering capacity of saliva and pH of oral fluids. As a result, oral bacterial population would shift to preponderance of cariogenic forms and candidiasis would ensue.[5]

Irradiation of teeth during their development severely retards their growth. If irradiation precedes calcification, it results in the destruction of tooth bud. Irradiation after calcification has begun may cause tooth malformation.[6]

High-dose radiation therapy results in hypovascularity of irradiated tissues with a reduction in wound healing capacity.[7,8] Radiation treatment induces an obliterative endarteritis that results in soft tissue ischaemia, fibrosis and bone hypovascularity.[5] The latter will ultimately result in osteoradionecrosis.[6,9]

As mentioned earlier, depending on the location of malignancy, inevitably, oral mucosa and jaws have to be included in the radiation treatment portals. As a result, changes induced by exposure to radiation occur in these tissues. The resulting oral sequelae may cause substantial problems during and after radiation therapy and are major factors in determining the patient's quality of life. The complications may also result in an increased burden of dental care in the long-term. Moreover, the precise incidence and prevalence of radiation-induced side-effects and sequelae are more difficult to obtain with rates ranging from 13 to 89%.[10,11]

The aim of this study was to focus on the side-effects of irradiation on oral mucosa and gingiva.

MATERIALS AND METHODS

This prospective, descriptive study was conducted on patients with head and neck cancers referred to the radiation oncology department of Ghaem hospital center, Mashhad, from March 2006 to October 2006. All patients had a biopsy-proven malignant neoplasm of the head region and were to be treated by external beam irradiation.

Study population

Thirty patients were selected for this prospective study. They were informed in detail about the objectives of this study and were asked to agree to participate in this study by signing an informed consent. In case of the illiterate patients, their companions were asked to sign the written consent form. The ethical committee of the Mashhad University of Medical Sciences, Mashhad, Iran, approved the study protocol, the patient information sheet and informed consent.

Dentate patients who received fields of irradiation that included portions of the dentition were included. Also, the patient had to be free of any systemic disease affecting the periodontal tissues at the time of study.

Before radiotherapy

To gather baseline information on the oral health status of patients at the moment of their first consultation, that is, before radiotherapy, the following data were collected by means of interviews and clinical examinations from all the patients: age, tumour site, tumour histology, oral hygiene and periodontal indices. The dental examination was conducted by one of the authors (K.S.). Periodontal sulcus depth measurements were completed on six surfaces of each tooth using a periodontal probe (PCP 12, Hu-Friedy, Chicago, IL, USA). Periodontal assessment included gingival recession measured from the cemento–enamel junction to the gingival margin, periodontal index (PI) (Russell, 1956) which evaluates periodontitis by means of measuring pocket depth (from the gingival margin to the depth of the pocket), gingival index (GI) (Löe and Silness, 1963) which indicates

https://doi.org/10.1017/S1460396908006390 Published online by Cambridge University Press

the inflammation of the gums (gingivitis), papillary bleeding index (PBI) (Saxer and Mühlemann, 1975) which is evaluated by the presence or absence of bleeding on probing and finally plaque index (PLI) (Silness and Löe, 1964) which is marked by these scores: 0, absence of plaque; 1, plaque discoloured by periodontal probe along the gingival margin; 2, visible plaque; 3, abundant plaque.

In our study, every kind of erythema in mucous was considered mucositis. However, it should be reminded that radiation-induced mucositis is formed in four phases:[12] (1) inflammatory or vascular phase, (2) epithelial phase, (3) ulcerative or bacteriologic phase, (4) healing phase. It is important to emphasise that the word 'mucositis' in this article refers to phase one of the mentioned phases.

Ten of the patients were evaluated for candidiasis before and 3 weeks after radiotherapy. Candidiasis was defined as the clinical presence of removable white oral plaques or white lesions associated with erythematous lesions. However, clinically, the signs may be confused with radiation mucositis or other sources of infection; so laboratory samples were acquired by sterile swab from the buccal mucosa of the patients and analysed.

All patients were instructed on dental cleaning and oral hygiene before radiation therapy. In addition, patients were instructed to rinse with a 0.2% chlorhexidine digluconate solution (Chlorhexidine SHD®, Shahrdarou, Tehran, Iran) twice a day, used concomitant with irradiation.

Teeth that were to be encompassed in the radiation field and were felt to be nonresorbable or had advanced periodontal involvement (probing depths >5 mm) and so could not be maintained were extracted 15 days before the initiation of radiotherapy. The extractions were performed as atraumatically (careful tissue handling) as possible and with primary closure.

Patient compliance with the recommended home care regimen including chlorhexidine use and plaque control was assessed through patient report and observation.

Radiation treatment characteristics

Radiotherapy was delivered through external beam irradiation with ^{60}Co unit (Theratron 780, Canada). The target volume for external therapy included both gross tumour as determined by clinical examinations, diagnostic imaging and subclinical extension of disease. Supine position was most frequently used to deliver radiation.

Patients were immobilised with head rest devices available in our radiation-oncology department. Target volume sizes were different according to the site of tumour and the treatment plan. An SSD (source-to-skin distance) of 80 cm was most frequently applied. With respect to tumour area different portal therapies were used: two lateral opposed photon fields (with equally weighted or unequally weighted beams), two portal angled wedge, and three-field radiation treatment with opposed lateral photon field most frequently applied.

For post-operative radiotherapy, patients received 180–200 cGy in ~30 fractions given in five fractions per week, over 6 weeks (range 5400–6000 cGy). For primary radiotherapy, a range of 6000–7000 cGy was given.

All the patients underwent oral examinations every 2 weeks on the second, fourth and sixth weeks with the mean interval of 2,000 cGy for each examination not to miss the effects of radiation.

Statistical analysis

For describing the data, distribution charts and tables, average and standard deviation parameters were used. Multivariate analysis of variance (MANOVA) was used for analysing quantitative variables and Cochran test for qualitative variables. For controlling the sex variable general linear model (GLM) was used. In all the stages of examination p value <0.05 was considered significant. All the statistical analysis was performed using SPSS V. 11.5 software.

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RESULTS

Thirty patients were monitored over a period of 8 months during radiation treatment. Clinical and demographical characteristics of the population are summarised in Table 1. The mean age of the patients was 45.17 ± 15.8 (range 14–80 years); 15 patients were male and 15 were female. Of the patients, 43.3% were illiterate, 34.4% had primary education and 23.3% of the cases had academic education.

Ninety percent of the patients received radiations for treatment of squamous cell carcinoma; 93.3% of the tumours were situated in oral cavity and the remaining tumour sites included larynx and oropharynx. Treatment plan of the patients comprised radiotherapy alone or surgery + radiotherapy.

Of the total population, 23.3% of the population had a history of smoking; one patient reported to have had a history of a systemic disease which could affect periodontal tissues. However, at the time of study, clinical and paraclinical studies showed that the patient was free of disease, so he matched the inclusion criteria.

Patients who had not taken part in all the examinations were excluded from the analysis.

Oral hygiene

In the first stage (before radiation treatment), 22 patients (73.3%) brushed and none of the patients used dental floss or rinses. In the second stage, 26 patients (86.7%) brushed, 4 patients (13.3%) flossed and one (3.3%) rinsed with chlorhexidine. In the third and fourth stages, brushing was the same as the second stage, but 10 patients (33.3%) flossed daily (Table 2). According to Table 2, there was a significant differences in brushing ($p = 0.001$) and using dental floss ($p = 0.002$) in different stages.

Clinical evaluation of oral mucosa

Table 3 summarises the most important changes in oral mucosa found in the study during radiotherapy. It is revealed that none of the patients experienced burning sensation or pain in the first stage. This experience mounted to 23.3%, 86.7% and 96.7% in a successive manner. Analysis of data using Cochran test shows a statistically significant alteration in this experience in different stages of examination ($p = 0.001$).

According to Table 3 there was a significant difference in number of patients having oral ulcers in various stages of examination (3.3% mounted to 90%, $p = 0.001$). Incidence of mucositis and candidiasis also showed a significant change in different stages (from 0 to 100% and 33.3%, respectively).

Table 1. Pateint and treatment characteristics

Variable	Category	Number (%)
Age (years)	Mean	45.17 ± 15.8
	Range	14–80
	10–35	1 (3.3)
	35–60	27 (90.0)
	60–85	2 (6.6)
Gender	Male	15 (50.0)
	Female	15 (50.0)
Tumour site	Oral cavity	28 (93.3)
	Other	2 (6.6)
Histology	Squamous cell carcinoma	27 (90.0)
	Adenoid cystic carcinoma	2 (6.6)
	Acinic cell adenocarcinoma	1 (3.3)
Radiation dose (cGy)	Surgery + radiotherapy	
	Mean	5,900
	Range	5,400–6,000
	Primary radiotherapy	
	Mean	6,400
	Range	6,000–7,000
Radiotherapy sessions	Mean	30
	Range	26–34
Education level	Academic education	7 (23.3)
	Primary education	10 (33.3)
	Illiterate	13 (43.3)

Table 2. Oral hygiene evaluation in different stages of examination

Stage of examination	Flossing percentage (number)	Brushing percentage (number)	Rinsing chlorhexidine
1	0	73.3	0
	0	−22	0
2	13.3	86.7	3.3
	−4	−26	−1
3	33.3	86.7	3.3
	−10	−26	−1
4	33.3	86.7	3.3
	−10	−26	−1
	$p = 0.002$	$p = 0.001$	$p = 0.36$

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Table 3. Status of oral mucosa in the population according to different stages of examination

Stage ofexamination	Pain		Oral ulcer		Mucositis		Candidiasis		NUG		Perleche	
	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
1	0	0	3.3	1	0	0	0	0	23.3	7	16.7	5
2	23.3	7	30	9	66.7	20	16.7	5	23.3	7	13.3	4
3	86.7	26	53.3	16	86.7	26	20	6	23.3	7	20	6
4	96.7	29	90	27	100	30	33.3	10	23.3	7	26.7	8
	p	*Q*	*p*	*Q*	*p*	*Q*	*p*	*Q*	*p*	*Q*	*p*	*Q*
Cochran test result	0.001	56.2	0.001	39.9	0.001	53.8	0.002	15	1	0	0.08	6.5

NUG, necrotising ulcerative gingivitis.

Table 4. Comparison of periodontal indices in different stages of examination

Stage of examination	GR		PBI		PLI		GI		PI	
1	0.29 ± 0.24*		0.81 ± 0.44		1.05 ± 0.37		0.97 ± 0.26		1.15 ± 0.83	
2	0.26 ± 0.30		0.86 ± 0.46		0.94 ± 0.29		0.97 ± 0.28		1.12 ± 0.79	
3	0.24 ± 0.30		0.83 ± 0.46		0.90 ± 0.41		1.01 ± 0.31		1.05 ± 0.71	
4	0.26 ± 0.30		0.87 ± 0.47		0.94 ± 0.39		1.03 ± 0.32		1.23 ± 0.73	
	p	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*
MANOVA* test result	0.41	0.95	0.001	8.7	0.01	3.7	0.24	1.4	0.001	15

*Multivariate analysis of variance.
GI, gingival index; GR, gingival recession; PBI, papillary bleeding index; PI, periodontal index; PLI, plaque index.

During this research, the incidence of NUG (necrotising ulcerative gingivitis) and perlèche (Angular Cheilitis) did not change significantly (Table 3).

Periodontal indices

According to Table 4, gingival recession and GI did not change significantly during radiation treatment; however, GI slightly increased.

There was a significant alteration in PBI (from 0.81 ± 0.44 to 0.87 ± 0.47), PLI (from 1.05 ± 0.37 to 0.94 ± 0.39) and PI (from 1.15 ± 0.83 to 1.23 ± 0.73).

Evaluation of periodontal indices according to sex

Table 5 indicates that there was no significant difference in any of the indices between the two sexes.

DISCUSSION

The age range of the patients evaluated in this study was 14–80 years. But as cited in Table 1, 90% of the patients were in the age range of 35–60 years with only three patients out of this range. A corresponding age range has been used in a similar study (14–87).[10] As cited in the Results section, 23.3% of the population had a history of smoking. However, these patients reported to have smoked only occasionally; therefore, according to Schwarz et al. and Tonetti et al.,[13,14] they were considered as non-smokers in the analysis.

The pre-radiotherapy consultation and dental clinical examinations show the patients' level of oral hygiene and dental awareness.[15] Jham et al. evaluated the oral health status of 207 head and neck cancer patients before and during radiotherapy and 109 patients after radiotherapy (they lost 98 patients). Most of the patients in their descriptive retrospective study were poorly educated low-income individuals, with minimal oral hygiene and level of dental awareness and a low compliance with the hygienic program.[10] In contrast, >70% of patients in our study reported to have brushed daily although 43% of patients in the study were illiterate. Oral

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Table 5. Comparison of periodontal indices in different stages according to sex

Stage of examination	Sex	GR		PBI		PLI		GI		PI	
1	Male	0.27 ± 0.32		0.80 ± 0.47		1.08 ± 0.26		0.92 ± 0.32		1.3 ± 1.01	
	Female	0.22 ± 0.28		0.83 ± 0.42		1.02 ± 0.47		0.90 ± 0.17		0.93 ± 0.54	
2	Male	0.22 ± 0.28		0.87 ± 0.48		1.01 ± 0.21		1.02 ± 0.33		1.28 ± 0.96	
	Female	0.30 ± 0.33		0.84 ± 0.44		0.89 ± 0.35		1.03 ± 0.21		0.97 ± 0.59	
3	Male	0.25 ± 0.32		0.79 ± 0.48		0.96 ± 0.40		0.92 ± 0.32		1.13 ± 0.80	
	Female	0.22 ± 0.30		0.88 ± 0.44		0.84 ± 0.43		1.11 ± 0.28		0.96 ± 0.61	
4	Male	0.30 ± 0.33		0.86 ± 0.53		0.98 ± 0.31		0.93 ± 0.34		1.39 ± 0.86	
	Female	0.22 ± 0.28		0.88 ± 0.44		0.91 ± 0.45		1.10 ± 0.29		1.09 ± 0.58	
		p	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*
GLM test result	According to stages	0.45	0.87	0.001	8.4	0.01	3.68	0.28	1.3	0.001	14.4
	According to sex	0.38	1.02	0.7	0.86	0.38	1.02	0.74	0.41	0.69	0.47

hygiene reinforcements in examination sessions showed to be effective as approximately >30% of the patients reported to have used dental floss for plaque control in the last examination session. This daily flossing rate was rather high among these patients as universal flossing rate is very low.[16,17] However, based on the population studied, there might be alterations in oral health status of cancer patients.[18,19]

Oral hygiene level of the samples remained high as Table 2 shows significant changes in both daily flossing and brushing. The significant reduction in PLI from 1.05 ± 0.37 to 0.94 ± 0.39 is consistent with these findings (Table 4). Encouragements and inspirations of the dental team played an important role in acquiring this result as these recommendations still are a part of most protocols aimed to reduce the oral sequelae of head and neck cancers. Plenty of evidence indicates that plaque control and oral hygiene should be maintained and reinforced during cancer treatment.[8,10,20,21]

Some antibacterial rinses have been used to assist in oral hygiene maintenance and to prevent or reduce radiation mucositis. The potential beneficial effects of aqueous chlorhexidine rinses to control chemotherapy-associated oral mucositis have been reported,[21] but it is said that chlorhexidine rinses are unable to control radiation mucositis.[22] Chlorhexidine was prescribed in this study, as it still has value in plaque control in oral cancer patients, but as the results show only one patient reported to have rinsed with chlorhexidine. The fact that patients undergoing radiotherapy are prescribed multiple drugs may have contributed to low compliance. Also, a diagnosis of cancer may have affected the patients' ability to assimilate the proposed treatment plan.[10] In a general view, however, the patients' compliance with the recommended treatment regimen was considered as fairly good.

With the initiation of radiotherapy, a variety of oral complications may arise. Radiation mucositis is considered to be an inevitable but transient side-effect of therapeutic head and neck cancer irradiation. Its occurrence and severity are strongly related to dose, fraction size, radiation portals, fractionation and type of ionising radiation.[23] It has been proposed that use of high-energy photon beam with linear accelerators, provides more homogenous dose distribution in and outside the target area compared with orthovoltage technique. This is due to the higher penetration of high-energy beams. Consequently, the number of hot spots in the normal tissue is reduced. This has resulted in some decrease in incidence and severity of mucositis. Furthermore, it has been claimed that new irradiation techniques such as hyperfractionation and accelerated treatment improve local control in head and neck cancers.[8] Despite all these advances, studies show that >80% of irradiated patients would eventually develop mucositis.[24] At the end of our study, all the

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patients developed mucositis. The technique and unit used in this study might have affected the result. However, caution should be taken when interpreting this finding as this was not the primary aim of this study. Moreover, other variables such as plaque control and oral hygiene status could have interfered.[8]

For relief of pain and discomfort due to mucositis, several anesthetics, analgesics and mucosal-coating agents have been recommended. However, it has been stressed that these agents exert no therapeutic effect and therefore their clinical value is questionable.[25,26] Prevention of mucositis is still limited to reduction of its severity by oral care programs,[8,27] a strategy followed in this study. Onset of mucositis, occurred at the end of the first week (with 66.7% of patients involved), the result is consistent with the published literature.[24] A quick look at Table 3 shows the cumulative effect of radiation dosage on the incidence of mucositis.

The acute form of oral candidiasis presents itself as erythema, but the diagnosis may be missed as this may be mistaken for radiation mucositis. For more accuracy, we analysed laboratory samples acquired from 10 of the patients; 33.3% of all patients had developed candidiasis at the final stage. Studies with their primary focus on the epidemiology of candidal infections in patients receiving radiation for head and neck cancers have produced similar results (17–29%).[28] Regarding the treatment, patients who developed infections that were not considered significantly severe were initially treated with only oral hygiene improvement, to avoid antifungal resistance. When medications deemed necessary, systemic ketoconazole (100 mg/day, 24 days) was prescribed.

NUG is a microbial disease of the gingiva in the context of an impaired host response. Characteristic lesions are punched-out, crater-like depressions at the crest of the interdental papillae, subsequently extending to the marginal gingiva and rarely to the attached gingiva and oral mucosa. In perlèche, candidiasis develops in the commissures of debilitated patients.[5] The incidence of NUG and perlèche did not change significantly in this study. This might mean that radiotherapy does not have a significant effect (at least in this extent of time and dosage) on these disorders. NUG and perlèche usually occur in a debilitating condition, so it may be deduced that the dosage administered in this study dose not have such a debilitating effect to induce NUG and perlèche.

As early as 1965, Silverman and Chierici stated that meticulous care must be taken in evaluating the periodontal status before, during, and after radiation treatment. Mechanical oral hygiene procedures must be used to remove the aetiological factors of inflammatory diseases of periodontium. Optimal oral and periodontal hygiene must be maintained indefinitely, due to the lowered biological potential for healing of the periodontium (alveolar bone, periodontal ligament, cementum) after radiotherapy.[8] Extraction of teeth or wounding during radiotherapy will create an extremely high risk for osteoradionecrosis and is strongly discouraged, because surgical wounding and radiation wounding result in an additive problem for the patient. Therefore, in our study, extractions and periodontal surgical procedures were performed before irradiation, whenever a minimum interval of 15 days could be respected before the initiation of radiotherapy. Researches show that this interval still poses a minor risk for the development of osteoradionecrosis. The risk was reduced to zero if there was $\geq$21-day interval between extraction and initiation of radiotherapy.[29] However, this ideal can rarely be achieved because the time between the diagnosis of the tumour and the start of the radiotherapy should be kept as short as possible if the highest probability of cure is to be attained.[7]

Because our study accessed the periodontal conditions of the patients during radiotherapy and the patients were not followed, our study failed to assess long-term side-effects of radiation on periodontium such as gingival recession, tooth mobility, loss of attachment or osteoradionecrosis. These findings can vastly be encountered in studies which have had a long follow-up (ranging from 6 months to 10 years).[30–32] However, we tried to improve our study using various periodontal assessment parameters (Table 4). As mentioned earlier, for the periodontal breakdown Russell's PI was

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applied, which significantly increased from baseline examination. This result is comparable with the increased sulcus depth reported by Epstein et al. and Galler et al.[31,32] GI (gingivitis) slightly increased, probably due to irradiation but the change was not significant because most patients maintained an acceptable level of mechanical plaque control. This is consistent with the accepted idea that overall effect of the use of mechanical procedures is the reversal or control of inflammation and optimal oral hygiene must be maintained and reinforced during radiation treatment as microbial plaque is the main cause of gingivitis.[8,31]

Blood vessels in the periodontium and periosteum are also affected during radiation therapy. It has been observed that slight traumas may cause gingival and submucosal bleeding in patients under radiotherapy with poor oral hygiene worsening the bleeding.[1] PBI increased in our study but it should be remembered that this increased bleeding is the short-term result of radiation (what we could observe), because long-term studies have reported reduction in bleeding. The reason for this reduction in bleeding has been stated as fibrosis, hypovascularity and ischaemia due to irradiation.[5,30]

For optimal management of the patients and minimising the oral side-effects, integrated interdisciplinary collaborations among surgical, radiation, medical and dental oncologists as well as dental hygienists is essential. This study supports the need for dental assessment and treatment planning before radiation therapy. Since acute exacerbation of focal infection, e.g., periapical and periodontal infection, and severe mucositis occasionally may necessitate an adjustment or an interruption of the radiation treatment schedule, oral complications should be prevented or reduced to a minimum. Although with the implementation of new radiation schedules such as hyperfractionation, accelerated fractions, 3D conformal radiotherapy and intensity-modulated radiotherapy the late-radiation effects can probably be reduced,[8] the high pace of new discoveries and the large number of research directions make it increasingly complex to determine what constitutes the standard therapy for a variety of patient subsets. In situations where several treatment opinions can yield approximately the same local-regional tumour control rate, other determinants to be taken into account in selecting the treatment choice are cosmetic and functional outcome, acute and long-term morbidity (quality of life), cost, physician expertise, and patient convenience.[33]

The major drawback of our study was that the patients were not followed for a long time. However, as the study was a prospective one and all the measurements were done by one calibrated dentist (K.S.), it was not subject to inherent inaccuracies, including the inability to control bias and cofounders; so observation bias in the collection of the original data by different clinical observers has had little chance to occur. Another positive point in our study was the control of sex variable through GLM for the periodontal condition of the patients which showed no significant difference in any of the indices between the two sexes.

CONCLUSION

In this article, the oral and periodontal health status of head and neck cancer patients before and during radiotherapy has been described. The authors believe that prevention or reduction of side-effects of radiation should be an integral part of treatment as they may have tremendous effect on the patient's quality of life. Thorough command of the regional anatomy, technical bases of radiotherapy and awareness of available data on radiation effects on critical normal tissues are necessary for optimising the treatment outcome. Finally, authors emphasise that to develop the best pre-radiation treatment plan the provider must be knowledgeable and understand the basis of radiation therapy, the nature of the radiation treatment plan for the patient and oral status of the patient. This might be facilitated in part by on-site dental support of radiotherapy centers.

ACKNOWLEDGMENTS

We thank the office of the vice-chancellor for research of Mashhad University of Medical Sciences for financial support. We are deeply

indebted to Dr Chadani for her careful editing of the manuscript.

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