



The Dental Problems of Patients with Head and Neck Cancer Treated with CHART

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Between 1985 and 1990, 99 head and neck cancer patients were treated at Mount Vernon Centre for Cancer Treatment in a CHART pilot study. The aims of this retrospective review were to obtain baseline data for this population on their pretreatment dental status and to determine the extent to which our conservative policy of teeth preservation is being realised. This is of particular interest because of the believed sparing of late normal tissue effects by CHART compared with conventional fractionation. Prior to treatment, 40% of patients were edentulous, and prophylactic dental clearance was avoided in 59% of the remaining (dentate) patients. Following radiotherapy, only 21% of dentate patients subsequently lost all their remaining teeth. The proportion of patients with full or partial upper dentures increased from 61% pretreatment to 76% post-treatment; the corresponding increase in lower dentures was 46% to 66%. However, actual usage of dentures decreased somewhat. There was only one documented case of (minor) osteo-radionecrosis of the mandible which resolved with conservative care. The greater use in our patients of prophylactic measures, in particular, chlorhexidine and fluoride mouthwashes seemed indicated. Copyright © 1996 Elsevier Science Ltd

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INTRODUCTION

The bulk of saliva, particularly under conditions of stimulation by eating or drinking, comes from the parotids, purely serous glands which are very sensitive to radiation [1]. When radiotherapy (RT) to the head and neck area includes the salivary glands, particularly the parotids, the resultant decrease in salivary flow leads to an increased risk of caries and periodontal disease. This is thought to be due to "loss of the buffering, antibacterial, lubricating and cleansing properties of saliva" [2] resulting in a shift in the oral bacterial flora towards cariogenic organisms (especially *Streptococcus mutans* and lactobacilli) at the expense of non-cariogenic bacteria. The situation is worsened by a dietary increase in fermentable carbohydrates consequent to the xerostomia, again selecting for acidogenic bacteria [2]. In addition, high dose irradiation of the jaws predisposes to osteoradionecrosis. This is related to a decrease in osteocytes and vascularity of the bone rendering it susceptible to trauma and infection, especially if postradiation extractions are needed [2, 3].

In the past, removal of all teeth was undertaken prior to radical RT [4]. Subsequently, there was a move towards

removing only teeth within the high dose volume, together with any badly affected teeth outside that volume [5]; the patients were instructed as to good dental care to maintain existing teeth. If extractions had to be carried out in unirradiated bone, there was little risk of mandibular necrosis.

More recently, there has been a trend which we support *not* to remove any teeth even in the high dose volume, providing the teeth are in good order [6]. This requires careful restoration of salvageable teeth and strict adherence to dental hygiene measures during and after RT. Recent research has clearly shown that two very effective measures are the use of fluoride (which strengthens tooth enamel) and chlorhexidine (which favourably influences the balance of oral flora away from cariogenic organisms) [7–9].

Since 1985, a subset of our head and neck cancer patients has been treated with CHART (Continuous Hyperfractionated

Table 1. Age distribution of the 99 CHART pilot study patients (1985–1990)

Age	<50	50–59	60–69	70–79	>80
Number	12	20	38	23	6

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Dental morbidity - initial form

Name : _____ Date : _____

Hospital number : _____

<u>Upper dentures</u>	Prior to R/T				0 : Yes 1 : No 99 : Unknown
	Type				0 : Full 1 : Partial 99 : Unknown
	Worn				0 : All the time 3 : For cosmesis only 1 : All day only 4 : Never worn 2 : Only for eating 99 : Unknown
<u>Lower dentures</u>	Prior to R/T				0 : Yes 1 : No 99 : Unknown
	Type				0 : Full 1 : Partial 99 : Unknown
	Worn				0 : All the time 3 : For cosmesis only 1 : All day only 4 : Never worn 2 : Only for eating 99 : Unknown
<u>Upper teeth</u> (1) Pre-existing	Number missing				0-14 99 : Unknown
	Number filled				0-14 99 : Unknown
	Number carious*				0-14 99 : Unknown
<u>Upper teeth</u> (2) Dental work in preparation for R/T	Number extracted				0-14 99 : Unknown
	Number filled				0-14 99 : Unknown
<u>Lower teeth</u> (1) Pre-existing	Number missing				0-14 99 : Unknown
	Number filled				0-14 99 : Unknown
	Number carious*				0-14 99 : Unknown
<u>Lower teeth</u> (2) Dental work in preparation for R/T	Number extracted				0-14 99 : Unknown
	Number filled				0-14 99 : Unknown
<u>Initial prophylaxis</u> (dentate patients)	Attended hygienist				0 : Yes 1 : No 99 : Unknown
	Chlorhexidine mouthwash				0 : Yes 1 : No 99 : Unknown
	Fluoride treatment				0 : Yes 1 : No 99 : Unknown
	Brushing				0 : Daily 1 : Irregularly 2 : Never 99 : Unknown
	Additional cleaning aids: (floss, tooth sticks, bottle brushes etc.)				0 : Yes 1 : No 99 : Unknown
<u>Upper teeth in fields</u> (dentate patients)	Low dose volume				0-14 99 : Unknown
	High dose volume				0-14 99 : Unknown
<u>Lower teeth in fields</u> (dentate patients)	Low dose volume				0-14 99 : Unknown
	High dose volume				0-14 99 : Unknown
<u>Left parotid in fields</u> (dentate patients)	Low dose volume				0 : Completely 1 : Partly 2 : Not 99 : Unknown
	High dose volume				0 : Completely 1 : Partly 2 : Not 99 : Unknown
<u>Right parotid in fields</u> (dentate patients)	Low dose volume				0 : Completely 1 : Partly 2 : Not 99 : Unknown
	High dose volume				0 : Completely 1 : Partly 2 : Not 99 : Unknown

* Teeth carious and with filling(s) to be counted twice**Fig. 1. Pro-forma for initial dental assessment.**

Dental morbidity - follow-up form

Name : _____ Date : _____

Hospital number : _____

<u>Upper dentures</u>	Made following R/T	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown
	Type (if new)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Full 1 : Partial 99 : Unknown
	Worn (original or new dentures)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : All the time 99 : Unknown
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 : All day only
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2 : Only for eating	
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3 : For cosmesis only	
<u>Lower dentures</u>	Made following R/T	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown
	Type (if new)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Full 1 : Partial 99 : Unknown
	Worn (original or new dentures)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : All the time 99 : Unknown
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 : All day only
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2 : Only for eating	
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3 : For cosmesis only	
<u>Upper teeth</u>	Number missing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
	Number filled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
	Number carious*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
<u>Lower teeth</u>	Number missing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
	Number filled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
	Number carious*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0-14 99 : Unknown
<u>Prophylaxis (dentate patients)</u>	Attending hygienist	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown
	Chlorhexidine mouthwash	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown
	Fluoride treatment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown
	Brushing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Daily 1 : Irregularly 2 : Never 99 : Unknown
	Additional cleaning aids: (floss, tooth sticks, bottle brushes etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0 : Yes 1 : No 99 : Unknown

* Teeth carious and with filling(s) to be counted twice**Fig. 2. Pro-forma for follow-up dental assessment.**

Table 2. Distribution of the number of teeth missing at presentation and at last follow-up or death (n=99)

No. of teeth missing	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Not recorded
Upper teeth																
Before RT	54	0	0	1	1	2	0	1	6	3	6	4	3	4	4	10
After RT	74	0	0	0	1	1	6	2	2	1	0	1	0	3	1	7
Lower teeth																
Before RT	41	0	1	1	3	0	0	6	5	5	5	5	7	4	3	13
After RT	73	1	1	0	1	1	1	2	1	4	2	2	1	0	2	7

Each entry in the table represents the number of patients having that number of teeth missing.

Table 3. Dental status at presentation (n=99)

	Dentate	Edentulous
Upper teeth	45	54
Lower teeth	58	41
Upper and lower teeth	59	40

Accelerated RT), initially in a pilot study [10, 11], more recently most have been within the multicentre prospective randomised CHART trial which commenced in 1990. Related to the low dose per fraction with this regime, there has been a significantly reduced incidence of postradiation change in normal tissues [11]. In particular, formal measurement of salivary flow has confirmed that there is greater preservation of

saliva output after CHART than conventional radical RT [12, 13]. There is, therefore, the possibility of decreased dental complications with CHART.

Little work has been published in the radiotherapy literature on dental morbidity after treatment, or indeed on the pre-existing dental health in this population, whose lifestyle (which typically includes heavy tobacco and alcohol use) puts them more at risk of caries than the general population. Furthermore, with the current interest in unconventional fractionation schedules and the increasing number of older dentate patients, there would appear to be a need for more data on dental management in this group. We have reviewed patients given CHART for head and neck cancer at our centre with the objectives of:

- (i) obtaining some baseline data with regard to the state of teeth and use of dentures prior to treatment;
- (ii) ascertaining the extent to which the above treatment policy with regard to teeth preservation is being put into practice;
- (iii) determining the changes in teeth and in the wearing of dentures after RT; and
- (iv) establishing the incidence of osteoradionecrosis of the mandible.

PATIENTS AND METHODS

The study population consisted of the 99 patients included in the CHART head and neck cancer pilot study (1985–1990), the results having been reported elsewhere [10, 11]. In this regime, there are three treatments per day at 1.5 Gy/fraction on 12 consecutive days, the total dose to the small volume being 54 Gy in 36 fractions. All patients had biopsy proven squamous cell carcinoma of the oral cavity (33), pharynx (48) or larynx (18), most with advanced tumours (85% being either T3, T4 or N3). There were 72 males and 27 females (ratio 2.7:1) with median age 66 (mean = 64) and range 23 to 84 (Table 1). Follow-up was recorded from the date of commencement of radiotherapy to the time of death or last contact with the patient, median 2.2 years (mean = 3.0 years), range 1 month to 8.5 years. Data were gathered from review of Radiotherapy Department and Oral Surgery Department charts, from available radiology (including ortho-pantomograms and simulator films), clinical photographs and from interviews with the patients or surviving relatives, supplemented where necessary by contact with their general dental practitioners.

The standard means of measuring dental morbidity is to determine the number of teeth decayed (caries), filled and missing [6, 9]. However, accurate assessment of dental decay is a difficult process as the initial changes (colour and softening) prior to development of frank cavities are not evident radiologically, and are subject to inter-observer error clinically. Furthermore, such data were often not recorded in detail,

particularly in cases of poor oral health where multiple or full extractions were necessary. Hence, the only meaningful comparison that could be made with pre- and post-treatment dental status was the number of teeth missing. More detailed and hence, more sensitive data would require prospective assessment of teeth from the time of presentation.

To facilitate data gathering, pro-formas were developed, one for pretreatment, the other for follow-up visits (Figs 1 and 2). These contain binary (yes/no), multiple choice and numerical items.

For the purposes of this paper, the term “edentulous” means having no teeth, “dentate” means having at least one tooth, and these correspond respectively to “full” and “partial” (upper and/or lower) dentures. Wisdom teeth were not assessed, so that the total number of upper and lower teeth was 14 each. Because there is considerable variation from person to person in the use of (as distinct from possession of) dentures, and because this may relate to xerostomia or mucosal fragility after RT, the wearing of dentures was monitored and their use recorded as: all the time, all day only, only for eating, for cosmesis only, and never worn.

RESULTS

The distribution of the number of upper and lower teeth missing at presentation is shown in Table 2 and the number of dentate and edentulous patients in Table 3. Edentulous patients were not routinely referred to a dentist or dental hygienist prior to treatment but 48 of the 59 dentate patients (81%) *did* have a dental consultation. The extraction status in preparation for RT (where known) is shown in Table 4.

After dental prophylaxis there were 33 patients with remaining teeth at risk from the effects of subsequent RT. Unfortunately, information about dental prophylaxis (other than extractions) was somewhat limited, so the following data must be interpreted with caution. However, for those patients where the information was known, only 7/26 (27%) initially attended a dental hygienist, 5/25 (20%) used chlorhexidine mouthwash, 0/25 (0%) had fluoride treatment (other than fluoride toothpaste), 21/23 (91%) brushed daily, and 6/24 (25%) used dental aids.

There were 31 patients dentate at the time of last follow-up, and again, information about dental prophylaxis at that time was limited. Where the information was known, 1/21 (5%) was still attending a dental hygienist, 1/21 was using chlorhexidine mouthwash, 0/20 were having fluoride treatment, 2/19 (11%) used dental aids, and 16/17 (94%) and 1/17 (6%), respectively, brushed daily and irregularly.

As a crude measure of dental morbidity following RT, subsequent loss of teeth (by traumatic fracture/avulsion or extraction) is shown in Table 5. It can be seen that there were only minor differences between the upper and lower teeth.

Denture status at presentation and last follow-up is shown in Table 6. As would be expected, there was an increase in the number of dentures following extractions in preparation for RT and subsequent attrition of teeth after RT. By contrast, actual usage of dentures, where this could be determined, tended to decrease (Table 7).

There was only one documented case of osteoradionecrosis of the mandible in a 41-year-old female with a T2N3 squamous cell carcinoma of the tonsil/floor of mouth who had prophylactic extraction of an ipsilateral molar prior to RT. Four years later, she developed a 2 cm long by 2–3 mm wide

Table 4. Dental extractions (where known) in preparation for RT (%)

	Full clearance	Partial clearance	None
Upper teeth (<i>n</i> = 43)	33	33	34
Lower teeth (<i>n</i> = 55)	45	24	31
Upper and lower teeth (<i>n</i> = 56)	41	34	25

Table 5. Summary of outcome for dentate patients from initial presentation to death or last follow-up

	Dentate at presentation	Prophylactic extraction status known	Dentate at start of RT	Outcome known	All teeth lost	Some teeth lost	No teeth lost	Mean (range) of teeth lost
Upper teeth	45	43	29	25	6/25 (24%)	7/25 (28%)	12/25 (48%)	2.3 (0–12)
Lower teeth	58	55	30	27	7/27 (26%)	6/27 (22%)	14/27 (52%)	2.7 (0–10)
Upper and lower teeth	59	56	33	29	6/29 (21%)	9/29 (31%)	14/29 (48%)	4.4 (0–20)

Table 6. Denture status (where known) at presentation and at last follow-up (%)

	Full	Partial	None
Upper dentures			
Before RT (<i>n</i> = 98)	52	9	39
After RT (<i>n</i> = 90)	66	10	24
Lower dentures			
Before RT (<i>n</i> = 98)	40	6	54
After RT (<i>n</i> = 89)	58	8	34

region of necrosis in the posterior part of the lower gingiva on the same side, with underlying lucency in the body of the mandible. This lesion caused minimal symptoms and resolved conservatively over the next 4 months. A second episode at the same site 1 year later also settled. Review of the simulator films confirmed that this area of bone was in the high dose volume.

DISCUSSION

It was not possible to gain data from a comparable group of patients treated conventionally, so we cannot from this study make any definitive conclusions as to a reduction of dental complications after CHART. However, we have obtained baseline data on a typical set of 99 head and neck cancer patients during the period 1985–1990, which should be useful by way of comparison for future prospective studies. The proformas were found to be quick and easy to use, and it is felt that they would be suitable for prospective evaluation as well. It should be noted that the "Initial Form" seeks potentially relevant information regarding teeth and parotids included in the radiation portals. However, with limited details about pretreatment dental health, no attempt was made to relate this information to post-treatment data in this study.

Considering all teeth together, 40% of patients were edentulous prior to RT, 60% dentate (Table 3), 25% of whom had no prophylactic extractions and 34% some extractions (Table 4). Hence, teeth preservation was possible for nearly three-fifths of initially dentate patients. From the available data, almost half (48%) of these retained all of their remaining teeth (31% lost some and 21% lost all). On average, 2.3 upper teeth and 2.7 lower teeth were lost after RT, giving an overall mean of 4.4 (median = 3), range 0–20 (Table 5). There were too few patients using chlorhexidine (five) for a meaningful comparison to be made, but the corresponding figures for this group were 2.4, 2.7, 5.8 (median 5), range 0–13.

The percentage of patients with full or partial dentures increased after RT from 61 to 76% for the *upper* jaw, and from 46 to 66% for the *lower* jaw (Table 6). But as noted, actual use of the dentures decreased (Table 7). Reasons given included poor fit, discomfort on wearing, change to a soft diet or general deterioration associated with tumour progression/recurrence preceding death. On the other hand, it is noteworthy that at least 4 patients with advanced tumours actually involving the mandible were able to tolerate dentures following CHART.

Again acknowledging incomplete data, there appeared to be suboptimal use of ancillary dental prophylactic measures. A low proportion of dentate patients initially attended a dental hygienist (27%), only 20% used chlorhexidine mouthwash, none were known to have had fluoride treatment, and 25% used dental aids. However, the majority (91–94%) reported daily brushing prior to commencing and after finishing the course of RT. The figures relating to use of chlorhexidine and fluoride are of particular concern in view of their known effectiveness as prophylactic agents [7–9]. The main problem with the use of fluoride (e.g. daily in gel form using a customised plastic tray) relates to patient compliance [2]. Chlorhexidine can produce yellow teeth, but this is readily removed with conventional cleaning techniques by the dental practitioner [9].

The small amount of research on interdepartmental policies in dental management of head and neck cancer patients suggests that there is little consensus at present. For the twenty RT centres in The Netherlands, there was considerable variation in composition, indeed existence, of a specialised dental team, in the rate of initial referral, in the use of fluoride/chlorhexidine prophylaxis and in the frequency and duration of follow-up visits [14]. Jansma *et al.* propose a detailed protocol for prophylaxis and treatment in this setting [15]. Lizi found that only 13.2% of head and neck cancer patients had dental assessment and treatment at a British centre prior to RT. In 1990, of those dentally examined, 68% required immediate treatment, only 11.2% being regular dental attendees [16]. At our centre, 81% of dentate patients were referred to a dentist pretreatment. However, a case could be made for routine referral of *all* (including edentulous) patients, given the problems with mucositis during RT and with wearing of dentures after RT.

Since the advent of megavoltage RT, the unacceptably high rates of osteoradionecrosis in the kilovoltage era have progressively fallen from a reported 37% down to 5% or less recently with conventional fractionation [17, 18]. It is a problem almost totally confined to the mandible; the maxilla is resistant due its

Table 7. Use of full or partial dentures (where known)

Worn	All the time	All day only	Eating only	Cosmesis	Never
Upper dentures					
Before RT (n=45)	21	19	0	1	4
After RT (n=53)	21	18	1	6	7
Lower dentures					
Before RT (n=32)	14	13	0	1	4
After RT (n=48)	15	16	2	4	11

excellent blood supply [19]. Comparison of series is, however, complicated by differing criteria as to what constitutes osteoradionecrosis. Horiot reported a 2% incidence in 528 patients [7]. Coffin distinguished minor cases (radiologically occult but clinically evident spontaneously separating sequestra which cause easily controlled discomfort only) from major osteoradionecrosis (seen readily on X-ray, involving full thickness destruction of bone and typically causing severe pain). In his series of 2853 patients, there were 22 major mandibular necroses but only one case involving the maxilla, giving an overall incidence of 0.8% [19]. Marciani and Ownby found three cases involving the mandible out of 109 head and neck cancer patients (2.8%) treated at the Veterans Administration Medical Centre, Kentucky, U.S.A. between 1976 and 1984. By contrast, the incidence in 220 patients at the same institution treated prior to 1974 was 10.5% [20]. The absence of any major case of osteoradionecrosis in the current series with just one minor case in 99 patients, resolving conservatively, suggests that a further reduction in incidence may follow the use of CHART.

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