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BRACHYTHERAPY

Iodine-125 brachytherapy in the management of squamous cell carcinoma of the oral cavity and oropharynx

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ABSTRACT

PURPOSE: Brachytherapy is an acknowledged modality for treating head and neck cancers and has moved from low-dose-rate (LDR) to high-dose-rate remote afterloading to reduce staff exposure. Iodine-125 (^{125}I) is a low-energy source and can be used for LDR brachytherapy with minimal staff exposure. The results of treating with this isotope at Groote Schuur Hospital, Cape Town, are reported here.

METHODS AND MATERIALS: ^{125}I brachytherapy was used to treat 114 tumors from 1994 to 2010. Brachytherapy alone was used for 72 tumors, 39 postsurgery and 33 de novo. A brachytherapy boost together with external beam radiotherapy was used for 42 tumors, eight postsurgery and 34 de novo. Tumors were in the tongue, floor of mouth, soft palate, and tonsil, and mainly T1 or T2 classification. Brachytherapy was administered via an applicator or in plastic tubes implanted into the soft tissues or through the submandibular region.

RESULTS: Local control rates of 80.7% at 5 years and 80% at 10 years were comparable to LDR, pulsed-dose-rate, and high-dose-rate results with iridium-192, likewise the 5- and 10-year disease-specific survival rate of 74.3%. Complications of soft tissue ulceration occurred in 21 patients (18.4%) and healed spontaneously in 20 patients. There was no mandibular necrosis.

CONCLUSIONS: ^{125}I can be used as the sole treatment or as a boost to external beam radiotherapy, with or without surgery for early mouth cancer. It combines the radiobiological advantages of LDR brachytherapy with minimum staff exposure. It is a flexible system. Local control is excellent with acceptable morbidity, and the treatment time is short.

Keywords: Brachytherapy; Iodine-125; Head and neck cancer; Tongue cancer; Oropharyngeal cancer

Introduction

Brachytherapy is acknowledged as a valuable modality in the treatment of head and neck cancer. Its ability to restrict the radiation to a confined area reduces the dose to normal surrounding tissues. It can be given as the sole treatment or as a boost to external beam radiotherapy (EBRT) with or without previous surgery. The most experience in the head and neck region is with low-dose-rate (LDR) iridium-192 (^{192}Ir) (1−7), but subsequently high-dose-rate (HDR) and pulsed-dose-rate (PDR) afterloaders have been developed. These reduce staff exposure to radiation and allow optimization of the dose distribution (8−11).

Iodine-125 (^{125}I) has been used since 1974 to treat tumors in and around the eye (12, 13). The great advantage is the low energy of the sources (27−35 kV), which allows effective screening of surrounding sensitive structures. Apart from the use of ^{125}I seeds on and around the eye and orbit (14), they have been used for various other tumors, mainly as permanent prostate implants. The William Beaumont Hospital changed from LDR ^{192}Ir to ^{125}I in 1986 because of the increasing number of breast implants being performed and the concern for staff exposure (15, 16). They also treated

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Informed consent: All cases were discussed at a multidisciplinary meeting, the consensus recommendation for brachytherapy was explained to the patient, and informed consent was obtained.

Conflicts of interest: The authors have no proprietary interest in any part of the study.

Ethical considerations: Approval for the retrospective study has been granted by The Human Research Ethics Committee, Faculty of Health Sciences, University of Cape Town, Cape Town, Africa.

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base of tongue tumors with an ^{125}I boost to EBRT (17). Others have used ^{125}I seeds as a permanent implant alone for advanced recurrent tumors of the head and neck or as a boost to EBRT in surgical patients with positive resection margins (18–22). The individual seeds are expensive, but as they have a half-life of 60 days, they can be reused several times for temporary implants, thus making them cost effective. The Departments of Radiation Oncology, Medical Physics, and Ophthalmology at Groote Schuur Hospital and the University of Cape Town have been using ^{125}I to treat eye tumors since 1974 and changed from using ^{192}Ir to ^{125}I for tumors of the oral cavity and oropharynx as the seeds were readily available.

We report here on the results of using this isotope in the oral cavity and oropharynx.

Table 1
Tumor characteristics

Characteristics	Total no.	Full dose	Boost + EBRT
Patients	112		
Tumors	114	72	42
Site			
Tongue	54	37	17
Soft palate	29	15	14
FOM	21	17	4
Tonsil	10	3	7
TNM classification			
T1	46	43	3
T2	56	24	32
T3	12	5	7
N0	101		
N1	9		
N2	4		

EBRT = external beam radiotherapy; FOM = floor of mouth.

Methods and materials

This is a retrospective case series of patients treated from 1994 to 2010, with followup to 2012 and a median followup of 39 months. All patients were assessed in the Combined Head and Neck Clinic by head and neck surgeons and radiation oncologists before treatment.

Since 1994, 152 tumors that were suitable for treatment with brachytherapy in the oral cavity or oropharynx, as the whole or part of the management, were treated with ^{125}I seeds. This report is confined to those patients with squamous cell carcinoma of the tongue, floor of mouth (FOM), soft palate, and tonsil. Those with carcinoma *in situ* (7), salivary gland tumors (13), reported previously (23), and sarcomas (2) were excluded as were other sites, for example, lip, tracheal stoma (11), and those with no followup (5).

There were 112 patients, 82 males and 30 females, with a median age of 60 years (range, 4–92 years). Two patients had two tumors treated; therefore, there were 114 tumors (Table 1).

Tumors were classified according to the American Joint Committee on Cancer Staging Manual, Seventh Edition, for this analysis (24). Most of the tumors were T1 or T2 and node negative (Table 1). There were 12 recurrent tumors.

Brachytherapy can be given in a variety of ways depending on the site and volume to be treated. An ^{125}I applicator alone was used in 5 patients, combined with ^{125}I seeds in plastic tubes implanted interstitially into adjacent tissues in a further 4 patients; a single plane or volume implant was used in 50 patients; circles of seeds in 44 patients; and submandibular hoops in 11 patients (Figs. 1 and 2; Table 2).

Before surgery, the implant is designed according to the tumor volume, required dose, dose rate, and availability of seeds. The volume to be treated is the gross tumor volume with a 5–10-mm margin. Usually the trains of seeds are placed 1 cm apart. The applicator usually covers the tumor by 5–10 mm, and the dose is prescribed to 4–5 mm from its surface. The model of the volume is planned on the computer. The Brachy component of the Theraplan Plus Treatment Planning System (Theratronics International Limited, Kanata, Ontario, Canada) is used to plan the implant and the dose to be delivered from the applicator, together if required. Dose calculations at a point consist of the sum of doses at that specific point for each of the implanted sources (considered as point sources). Dose rates are calculated at each grid point of a cube lattice that contains the model. Thus, isodose curves may be generated in any arbitrary plane. The seed positions and activities are adjusted on the computer until optimum homogeneity is established. With an applicator, the surface dose is about three times the prescription dose. The applicator or plastic tubes are then loaded with the designated seeds according to the computer-generated plan.

The applicator consists of two layers of plastic made from a dental impression enclosing the ^{125}I seeds glued to one surface in their predetermined position and a layer of ash metal, a lead alloy, to protect adjacent structures (23).

The plastic tubing is prepared with 30 cm of filler inside the tube, and the end is sealed. The ^{125}I seeds are then inserted up to the filler according to the plan, with or without nylon spacers in between them. A further 30 cm of the filler is inserted up to the seeds to secure them, and the end is sealed. A curved needle is crimped on to the end of each tube for intraoral implants. Markings can be put on the filler material to assist positioning of the implant.

Circles of seeds are ideal for tongue tumors that are small or previously excised. Using curved needles, the tubes are placed at regular intervals (usually 1 cm) through the lateral tongue to encompass the tumor or scar with at least a 5-mm margin, and the two ends of each tube are crossed over and sutured together just beyond the seeds to form a circle. An active length of 3 cm will form a 1 cm diameter circle and 4 cm a 1.3 cm circle (Fig. 1). The surplus tubing is fastened to each cheek with transparent adhesive dressing.