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Radioactive seed migration following parotid gland interstitial brachytherapy

Yi Fan[1,2,3], Ming-wei Huang[1], Yi-jiao Zhao[4], Hong Gao[5], Jian-Guo Zhang[1,*]

[1]*Department of Oral and Maxillofacial Surgery, Peking University School and Hospital of Stomatology, Beijing, P.R. China*
[2]*Melbourne Dental School, University of Melbourne, Melbourne, Australia*
[3]*Murdoch Children's Research Institute, Melbourne, Australia*
[4]*Center of Digital Dentistry, Peking University School and Hospital of Stomatology; National Engineering Laboratory for Digital and Material Technology of Stomatology, Beijing, P.R. China*
[5]*Department of Stomatology, Fujian Provincial Hospital, Fuzhou, P.R. China*

ABSTRACT

PURPOSE: To evaluate the incidence and associated factors of pulmonary seed migration after parotid brachytherapy using a novel migrated seed detection technique.

METHODS AND MATERIALS: Patients diagnosed with parotid cancer who underwent permanent parotid brachytherapy from January 2006 to December 2011 were reviewed retrospectively. Head and neck CT scans and chest X-rays were evaluated during routine follow-up. Mimics software and Geomagic Studio software were used for seed reconstruction and migrated seed detection from the original implanted region, respectively. Postimplant dosimetry analysis was performed after seeds migration if the seeds were still in their emitting count. Adverse clinical sequelae from seed embolization to the lung were documented.

RESULTS: The radioactive seed implants were identified on chest X-rays in 6 patients. The incidence rate of seed migration in 321 parotid brachytherapy patients was 1.87% (6/321) and that of individual seed migration was 0.04% (6/15218 seeds). All migrated seeds were originally from the retromandibular region. No adverse dosimetric consequences were found in the target region. Pulmonary symptoms were not reported by any patient in this study.

CONCLUSIONS: In our patient set, migration of radioactive seeds with an initial radioactivity of 0.6−0.7 mCi to the chest following parotid brachytherapy was rare. Late migration of a single seed from the central target region did not affect the dosimetry significantly, and patients did not have severe short-term complications. This study proposed a novel technique to localize the anatomical origin of the migrated seeds during brachytherapy. Our evidence suggested that placement of seeds adjacent to blood vessels was associated with an increased likelihood of seed migration to the lungs.

Keywords: Brachytherapy; Seed migration; Parotid; 3D reconstruction

Introduction

Over the past decade, permanent radioactive seed implantation has been shown to be effective for the treatment of cancers of the prostate, breast, liver, parotid, and many other sites (1−4). The long-term persistence or stability of seeds implanted in the implant bed ensures a constant dosage delivery to target tissues and eradicates local disease. However, one of the risks associated with this approach is the migration of implanted seeds to the lungs through venous system, which occurs from 0.7% to 55% of seeds per patient and 0.19−0.98% per seed after prostate brachytherapy (5). Permanent I-125 seed implantation has been used in management of parotid gland malignant tumors with satisfactory local control rate and benefit in facial nerve preservation (6). But to our knowledge, seed migration to the lungs after parotid brachytherapy has not been reported in the literature.

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* Corresponding author. Department of Oral & Maxillofacial Surgery, Peking University School of Stomatology, 13th Floor, 22 Zhongguancun Nandajie, Haidian District, Beijing, China 100081. Tel./fax: +86 010 82195701.

E-mail address: rszhang@126.com (J.-G. Zhang).

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Alteration dosimetry on the target region and irradiation effects on the lung tissue are two potential problems arising from radioactive seed migration (7). Detecting the precise location and the number of the migrated seeds is critical for providing necessary feedback on personalized treatment planning and is important to ensure the sufficient dose coverage onto implanted region.

Therefore, this article reports the incidence of seed migration to the lungs after parotid brachytherapy and proposes a novel method to locate the migrated seeds from the target region.

Methods and materials

A total of 321 patients (186 males and 135 females) undergoing parotid cancer brachytherapy at the Peking University School and Hospital of Stomatology from January 2006 to December 2011 were retrospectively evaluated. Their ages ranged from 14 to 82 years (median 48 years; mean 46.3 years). Patients with a history of secondary surgery or trauma in a previously treated region were excluded. The study was approved by the Ethics Committee of the Peking University School and Hospital of Stomatology.

The procedure of brachytherapy

The brachytherapy treatment planning system (Beijing Astro Technology Ltd Co, Beijing, China) was used for I-125 seed implantation planning. The planning target volume was outlined to cover the lesion with a 5−10 mm margin. The planned dose (PD) was 120−160 Gy for patients without history of radiotherapy and 80−120 Gy for patients who had previously received radiotherapy. Dosages delivered to organs at risk were designed within acceptable limits of tolerance. In preplan, needles were implanted from different angles to avoid bone, major blood vessels, and important tissues (Fig. 1a). Based on the preplan, CT and/or a 3D-printed individual template were used to guide needle implanting and seed placement (Fig. 1b). All I-125 seeds were implanted as free seeds (0.8 mm wide and 4.5 mm long; Model 6711, Beijing Atom and High Technique Industries Inc, Beijing, China). The half-life of each seed was 59.6 days, and seed activity was 0.6−0.7 mCi. Postplan was performed immediately or 1 day after the implantation to verify seeds placement and dose distribution (Fig. 1c). The D90 (dose delivered to 90% of the target volume) ranged from 85.4 to 176.9 Gy with a median of 140.5 Gy, which was larger than PD in all patients. The V100 (the percentage of the target volume receiving at least 100% of the PD) of each patient ranged from 95.2% to 98.9% with a median of 97.6%. The V150 (the percentage of the target volume receiving at least 150% of the PD) of each patient was less than 50% (Fig. 1d).

Migration seed on chest radiographs

Routine head and neck CT scans and chest X-rays were taken following implantation for monitoring tumor

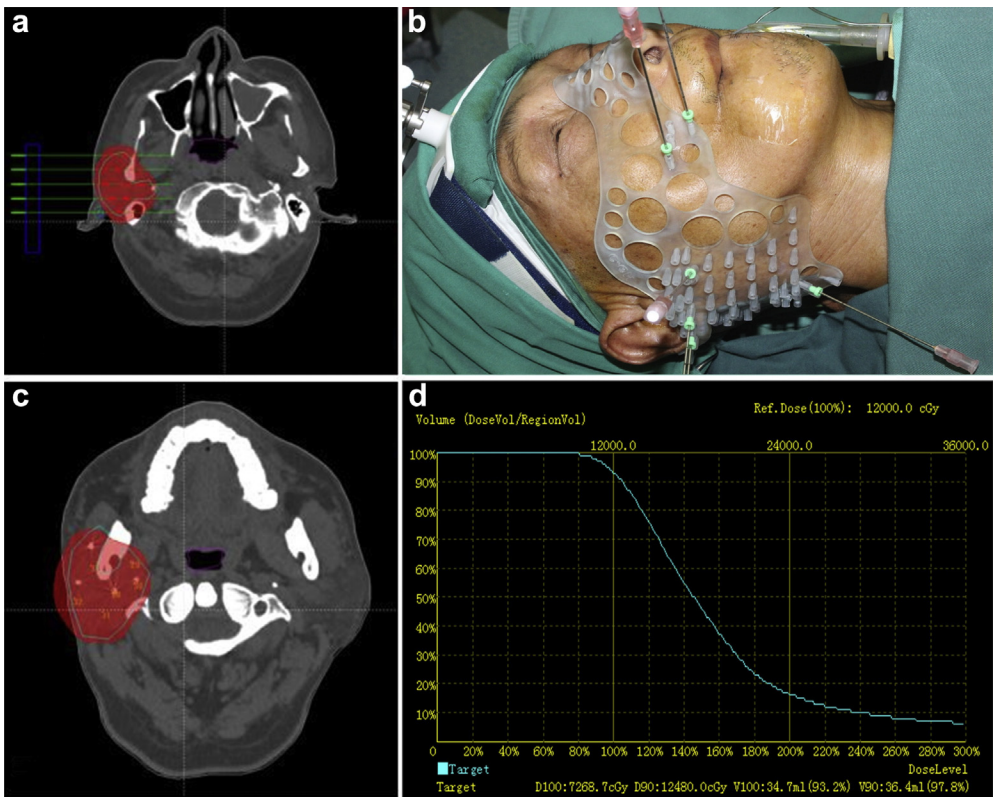

Fig. 1. The administration of iodine-125 seeds parotid brachytherapy. (a) The isodose curve in the implant plan from CT scan. (b) Hollow interstitial needles were inserted into the target region, and I-125 radioactive seeds were implanted permanently according to the preplan with customized template guidance. (c) The isodose curve after seed implantation from CT scan. (d) The dose-volume histograms of the planning target volume after seed implantation.