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Individual moulds for contact pulsed dose rate brachytherapy in head and neck cancer

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Summary

Aim	To present three cases treated with contact pulsed dose rate (PDR) brachytherapy using individually prepared moulds.
Materials/Methods	The study group included one case of hard palate cancer treated with brachytherapy, applied as a boost to external beam radical irradiation and two cases of recurrent ethmoid and maxillary sinus cancer in which we administered palliative brachytherapy as the sole treatment for tumours located within previously irradiated areas.
Results	Good fitting of the moulds to the target was obtained. Satisfactory local control, including complete hard palate cancer remission for six years, and acceptable side effects were achieved.
Conclusions	Contact PDR brachytherapy using individually constructed moulds allows for the treatment of anatomical structures with difficult access. This method seems to be an effective and relatively safe treatment option for tumours located within previously irradiated areas.
Key words	PDR brachytherapy • head and neck cancer • moulds

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BACKGROUND

Pulsed dose rate (PDR) treatment is a new brachytherapy technique that combines the physical advantages of high dose rate (HDR) technology (isodose optimization, radiation safety) and the radiobiological advantages of conventional low dose rate (LDR) brachytherapy.

In head and neck cancer, PDR brachytherapy can be performed as the sole treatment or as a boost to external beam radiotherapy (EBRT) [1–4]. PDR brachytherapy may be applied as an interstitial, or contact treatment. A remote afterloader contains a single ^{192}Ir source with the nominal activity of 0.5 or 1 Ci, whose stepped movement through the catheters, with dwell positions and times adjusted under precise computer control, provides the required dose distribution. The idea of PDR brachytherapy is to deliver the whole dose in a large number of small fractions within a few days, in order to approximate the advantageous radiobiological characteristics of LDR brachytherapy. This prolonged therapy, however, may result in undesirable catheter movement, increasing the risk of “geographical miss” in the target volume. The PDR technique maintains the main advantages of brachytherapy: the rapid dose fall off beyond the implant volume and the possibility of dose optimization, allowing for adequate sparing of surrounding healthy tissues. Therefore, PDR brachytherapy represents an effective therapeutic method in a number of cancer localizations, particularly in those within previously irradiated tissues [2,5–9].

Contact brachytherapy of head and neck cancer usually necessitates individual moulds. Precise adaptation of the mould is necessary, in order to avoid undesirable applicator movements during therapy [10,11]. Clinical experience with the use of moulds for PDR brachytherapy is scarce.

AIM

In this paper, we present three cases of contact PDR brachytherapy using individually prepared moulds in primary and recurrent head and neck cancer.

MATERIALS AND METHODS

In all cases, impressions of the tumour/tumour bed and surrounding tissues were taken using irreversible alginate hydrocolloid and, in two cases, with additional polyvinylsiloxane two-layer

material. From these, wax moulds were made on plaster models. The oncologist planned the location of flexible tubes which were temporarily fixed into the wax mould to provide an appropriate location for a dental technician. Finally, a mould with plastic tubes was constructed in the dental laboratory by replacing wax with heat-cured transparent acrylic resin (two cases) and temperature cured resin (one case).

Orthogonal x-ray films (two cases) and computed tomography (one case) of the moulds, with radiopaque markers positioned, were taken. Digitized data was entered into the computer planning system (PLATO, version 14.1). The target volume was defined as the volume encompassing the tumour/tumour bed with a margin of approximately 1–2 cm, specified by the participating physician. The dosimetry was calculated using volume optimization techniques.

In all cases, stable fixation of the moulds, preventing undesirable movements, was achieved. In one case, after the initial setting of the mould in patient’s mouth, the movement of a dummy source was blocked by a blood clot inside a catheter, which had to be replaced. The replacement of the perforated tube was possible without damaging the mould. There were no other problems with source movement.

CASE REPORTS

Case 1

K. G, a 71 year old woman, was diagnosed with locally advanced squamous cell carcinoma of the hard palate, T4N0M0 according to the UICC classification, underwent radiotherapy consisting of EBRT (60 Gy in 30 fractions). One week after EBRT completion a boost of contact PDR brachytherapy using an individually prepared mould – a palate plate containing three catheters - was administered (Figure 1). A dose of 15 Gy (0.6 Gy per pulse repeated every hour) was delivered.

Three weeks after radiotherapy completion the patient developed confluent fibrinous mucositis (Grade 3 according to RTOG Acute Morbidity Scoring Criteria). A significant reduction of this acute side effect was achieved with a local antiseptic mouth rinse and administration of antibiotics. Four months after treatment completion, the patient developed a severe complication (grade 4 according to RTOG/EORTC scale) – 1×2 cm necrosis of the mucous membrane in the central

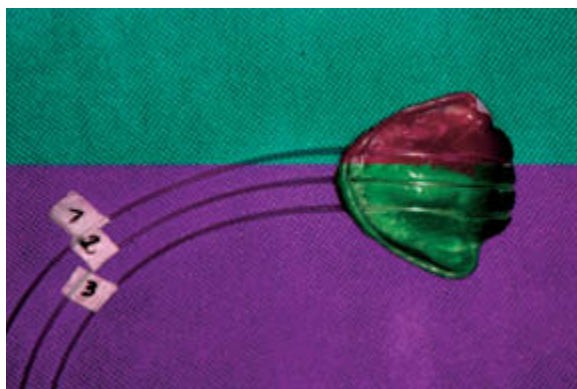


Figure 1. Individually prepared mould – palate plate with three catheters for BT PDR.



Figure 3. Prosthetic rehabilitation patient K.G.



Figure 2. Teleangiectasia grade 3 in the first year after irradiation, patient K.G.



Figure 4. Recurrent squamous cell carcinoma of the maxillary sinus, patient D.H.

part of hard palate. Histological examination of the excised tissue revealed no cancer cells. No recurrence was observed during subsequent five years. Teleangiectasia, grade 3 in the first year after irradiation (Figure 2), which subsequently decreased to grade 2, was the only observed late side effect. No bone changes were observed at a radiological examination performed three years after therapy.

The patient underwent prosthetic rehabilitation using an acrylic denture with a special underlying tissue conditioner on the palatal side (Figure 3). Once annually, denture correction with replacement of the conditioner was necessary, owing to undesirable hardening of the material and because of its porosity, facilitating bacterial and fungal colonization.

Case 2

D. H, a 77 year old man, developed recurrent squamous cell carcinoma rT4N0M0 of the maxillary sinus five years after EBRT, of total dose 70 Gy

(Figure 4). Due to being in poor general condition, radical tumour resection was impossible. The patient underwent contact PDR brachytherapy with the use of an individually prepared palato-maxillary mould (plate) with 7 plastic tubes located in appropriate order inside (Figures 5,6). The patient received a dose of 50 Gy, 0.6 Gy per pulse, repeated every hour. There was no tumor progression within the first 6 months after re-irradiation. No serious acute or late side effects were observed, however the patient's quality of life was poor owing to difficulties in eating and speaking caused by a huge tumour bed perforating the nasal cavity. Prosthetic rehabilitation with a special obturating denture is in progress.

Case 3

D. J, a 61 year old man, was diagnosed with local recurrence of squamous cell carcinoma of the left ethmoid sinus two years after definitive EBRT at a dose of 66 Gy (Figure 7). The patient underwent surgical resection of relapsed tumour, but clear margins were not achieved. Salvage PDR contact



Figure 5. Individually prepared palato-maxillary mould (plate).



Figure 7. Local recurrence of squamous cell carcinoma of the left ethmoid sinus, patient D.J.



Figure 6. Individually prepared palato-maxillary mould (plate), patient D.H.

brachytherapy using an individually constructed mould and a dose of 30 Gy (0.6 Gy/puls/hour) was performed (Figures 8,9). No serious acute or late side effects were observed and neither was there any local recurrence of the tumour. Six months after completion of brachytherapy, the patient died of a second primary malignancy (lung cancer).

DISCUSSION

Salvage treatment options for previously irradiated head and neck cancer patients are limited. Radical tumor resection with clear resection margins is difficult to accomplish, and repeated EBRT carries a high risk of severe side effects.

In the cases presented here, individually constructed moulds for contact brachytherapy allowed the treatment of anatomical structures with difficult



Figure 8. Individually constructed orbit mould.

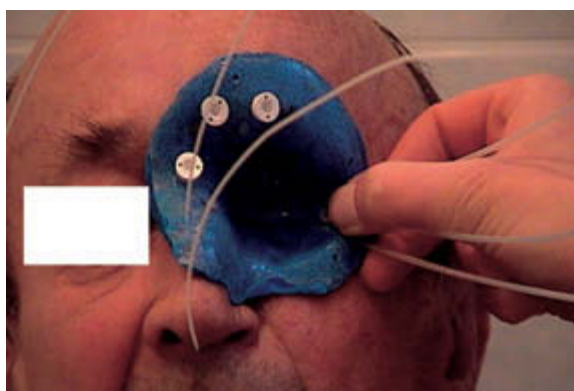


Figure 9. Individually constructed orbit mould, patient D.J.

access. The use of this method necessitates the close cooperation of oncologists, oral surgeons and prosthodontists. Modern dental impression materials allow for the preparation of precise plaster models of the tumor bed and for the preparation of moulds with stable adaptation. Appropriate catheters embedded in a mould, good fitting of the mould to the target, and optimization of treatment planning provide good dose distribution and safety in cases of contact PDR brachytherapy.

CONCLUSIONS

Contact PDR brachytherapy using individually constructed moulds allows for the treatment of anatomical structures with difficult access. This method seems to be an effective and relatively safe treatment option for recurrent or persistent tumours located within previously irradiated areas.

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