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Use of High Dose Rate Surface Mould Brachytherapy in Oral and Skin Malignancies: A Single Institute Retrospective Study

Dipshi Agrawal[1] Amresh Kumar[2], Ashar Iqbal Lodi[3], Virendra Bhandari[4], Neha Singh Rajput[5]

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Abstract

Aim: Use of Surface Mould Brachytherapy in the treatment of skin and oral malignancies at our institution.

Background: SMB offers a good therapeutic ratio helping in dose escalation of irradiationand higher Biologically equivalent doses. In this study, we share our institutional experience with SMB in different types of cancers.

Materials and Methods: 15 Patients with oral, skin, and penile malignancies treated with SMB were analyzed from Jan 2019 to Sept 2023. Treatment was delivered using HDR Co 60 source with a customized mouldto a median dose of 48Gy in the radical setting and 15Gy as a boost with 2.5-3Gy/# twice a day. The treatment-related toxicities and response were noted.

Results: 15 patients with various malignancies were evaluated. Eight patients received SMB alone while 7 patients external beam radiotherapy with SMB Boost. A Complete: Partial response ratio of about 80:20 was achieved. There were 3 local failures all in hard Palate patients. The acute toxicity outcomes were as follows - 12 patients of Grade 1 and 3 patients of Grade 2 toxicities. Late toxicities reported were Grade 1 in six patients, Grade 2 in 5 patients, and Grade 3 in one patient.

Conclusion: Surface mould brachytherapy provides maximum local tumor control, is well-tolerated, and is a non-invasive, outpatient procedure for treatment in both radical settings and as a boost. It results in organ and function preservation and is a good alternative option for patients who are unwilling for surgery and who present with comorbidities.

Keywords: HDR Brachytherapy, Surface mould, oral cancers, skin malignancies

INTRODUCTION

Surface mould brachytherapy (SMB) is a very well-established modality used in the treatment of various early-stage head and neck cancers particularly in the superficial cancers of the oral cavity, palate, and skin malignancies. SMB is nowadays mainly used both as a radical setting and as a salvage procedure. It is based on the

Author's Affiliation: [1-5]Registrar, Department of Radiation Oncology, Sri Aurobindo Medical College & PG Institure, Indore, Madhya Pradesh, India.

Corresponding Author: Virendra Bhandari, Registrar, Department of Radiation Oncology, Sri Aurobindo Medical College & PG Institure, Indore, Madhya Pradesh, India.

E-mail: virencancer@yahoo.co.in

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inverse square law, which results in rapid dose fall-off such that only the tumour is targeted while sparing the normal structures therefore resulting in an overall shorter treatment duration time. SMB is particularly a non-invasive technique and an outpatient procedure that allows for acceptable survival rates, and improved therapeutic ratio with minimal toxicities. The purpose of our paper is to add to the knowledge regarding the use of SMB in today's era. SMB has shown excellent treatment outcomes using HDR Brachytherapy. In this article, we share our institutional experience with SMB in various types of malignancies concerning treatment outcomes and toxicities.

MATERIALS AND METHODS

We performed a retrospective review of 15 patients treated consecutively at our institution between Jan 2019 to Sept 2023 using high-dose-rate surface mould brachytherapy for various intra-oral and skin malignancies.

In all cases, the treatment protocol and the approach were followed after reviewing the disease-site and discussing the procedure in detail with the Prosthodontics department, the medical physicist, the radiation oncologist, and the mould room technician. All patients were treated with a curative intent following an integrated treatment approach. The Medical records were complete and were available for all the patients that were included in the study. Clinical Response to the brachytherapy treatment was assessed using the RECIST criteria while the treatment related toxicities were classified through the CTCAE versionalong with the use of clinical photographs of the patients taken before, during, and after the treatment.

The patients were first evaluated through a multidisciplinary approach which consisted of a team that was led by the radiation oncologist, followed by the medical physicist and the prosthodontics department for the localization of the lesion and the anatomy. A customized surface mould was made for each patient. Dental and oral prophylaxis was done before the start of the treatment in Every patient having head and neck cancer. The Gross tumor with around 1 cm margin was considered as CTV and was marked on the mould prepared. The majority of the head and neck cancer patients were sent to the prosthodontics department, for preparation of the impression and anindividualizedcustom mould was designed for each patient that was made up of PMMC (Polymethyl Metha acrylate).(*Fig. 1*)

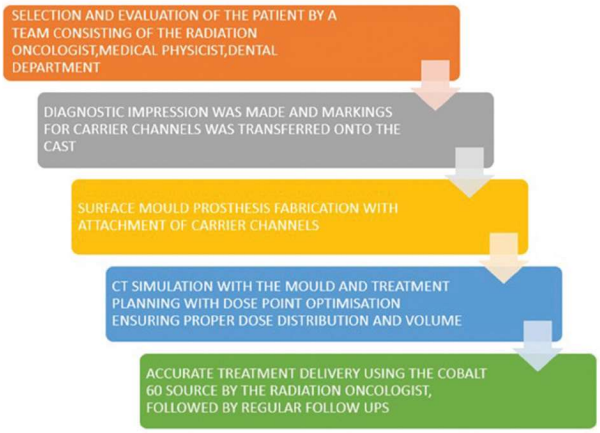

Fig. 1: Procedure of Surface Mould Brachytherapy

The surface moulds that were used contained supra-flab-containing channels for the placement of the brachytherapy catheters. In cases of oral malignancies like the hard and the soft palate, an impression of the mandibular and the maxillary arches was taken while in cases of Ca Penis and BCC Nose disease-specific site impressions were taken. Infant feeding tubes were used which acted as channels carrying the wires containing the radioactive source. The number of tubes that were to be used was determined based on the lesion size, location, and in to cover maximum tumor volume. These tubes were spaced 1 cm apart from each other and were adhered to the cast using an adhesive and then a cast fabrication was done which was assessed by the radiation oncologist and the medical physicist. Also, a lead sheet was embedded in an acrylic tongue depressor that was used to protect the tongue from radiation during the brachytherapy session. The cast was then placed at the disease-specific site and metallic wires made up of lead were inserted in the carrier tubes during CT-Scan for localization.They were used as Dummy in the carrier tubes. (*Fig. 2, 3*)

Fig. 2: Markings of the Carrier Tubes on the Cast, Infant Feeding Tube Assessment

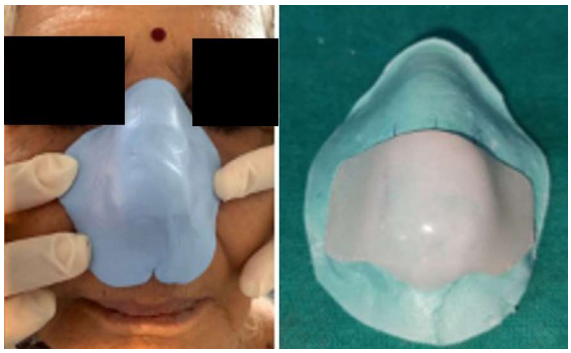

Fig. 3: Preparation of Cast and Markings in BCC ALA of Nose

Brachytherapy planning and treatment

A Computed Tomography scan of the specific region was taken in the supine position with the carrier mould fitted to the disease site. CT Scan slices of 3mm were prepared on the PHILIPS CT Scan machine. To ensure the proper localization of the tumor, lead wires were placed near the edges of the tumor and within the tubes. The simulation CT-Scans were taken after fitting the mould inside the patient's oral cavity in cases of head and neck cancers and specific disease sitesfor the others and were repeated if any air gaps were found between the mould and the treatment site.

The images were then transferred to the Treatment planning system and contouring of Clinical target volume, Planning target volume, and organs at risk was done. Planning was done using BEBIG and treatment was delivered using the HDR Cobalt 60 source Multi-Channel Gynaec After Loader Brachytherapy machine (Eckert and Ziegler Bebig, Germany). During the treatment, the patient was routinely positioned in the left lateral position close to the brachytherapy machine (in cases of head and neck cancers) with the neck extended such that the tubes were very well placed without resulting in any Kinking or obstruction. In Carcinoma Hard Palate patients, Brachytherapy was used as Boost RT to a dose of 15Gy/5# after an EBRT dose of 50Gy with photons while in cases of Ca Penis and BCC Nose Treatment was completely delivered by SMB to a dose of 48Gy/16# at a dose of 300cGy/# treated twice daily with a gap of 6 hours in between with a BED of 62.4Gy. (*Fig. 4*). The treatment duration for all the patients was completed in less than two minutes. Response to the treatment was assessed using the RECIST criteria while the radiation-related toxicities were classified according to the Radiation Therapy Oncology Group (RTOG) Grading system. Pre and post-radiotherapy cosmetic outcomes were evaluated for all the patients. (*Fig. 5*)

Fig. 4: Patient of Ca Penis Treated by Surface Mould Brachytherapy

Fig. 5: Pre Treatment and Post Treatment Images in Bcc Ala of Nose

RESULTS

In 8 patients, SMB was used as the primary treatment modality, and in 7 patients as a boost after EBRT. Of these 7 patients had lesions in the hard and soft palate, 6 lesions over the skin, and 2 over the penis. The median gap between the EBRT and SMB was 7 days in patients boosted after EBRT. Concurrent weekly chemo with EBRT was used in 4 patients. For the lesions treated with brachytherapy, after a median follow-up of 10.5 months, the assessment and toxicities reported were as follows, (*Table 1, 2*)

Complete response was achieved in 80% of patients and partial response was seen in about 20% of the patients. There was local control in 12 patients. (*Fig. 6*) There were 3 local failures (- hard palate) and the median time to recurrence was 5 months. Of the 2 local recurrences, one patient underwent successful salvage surgery and one was planned further for metronomic chemotherapy. (*Table 3*)

Pre Treatment **Post Treatment**

Fig. 6: Clinical Outcome of Ca Hard Palate Patient Treated with Surface Mould Brachytherapy

Grade 1 subcutaneous fibrosis was seen in 6 patients, 6 developed hypopigmentation (all for nose primary). Grade 1 xerostomia was not observed in our patients. Surface Mould Brachytherapy resulted in organ and function preservation in nearly all the patients. The cosmesis was excellent in patients having skin tumours (BCC Nose).

Table 1: Patient and Treatment Related Characteristics

	Factors	Number / Frequency	(%)
Age	Median	56 years	
Sex	Male	7	47
	Female	8	53
Histology	Squamous	9	60
	BCC	6	40
Site	Hard Palate	5	39
	Soft Palate	1	6
	Nose	6	40
	Penis	2	13
Tumour size	Median	2 cm	
Treatment	Radical	8	53
	Boost	7	47
Dose	EBRT (Median)	50Gy	
	SMB (Radical)(Median)	48Gy	
	SMB (As Boost) (Median)	15Gy	
	Catheters (Median)	3	
V80%		98.5	
V90%		97.4	
V100%		95.2	
EQD2 of Radical SMB(Median)		57.6Gy	
EQD2 of Boost SMB(Median)		18Gy	
Karnofsky performance status	100	14	
	90	1	
	80	0	
	70	0	
Comorbidities		In 1 Patient	

Table 2: Treatment Outcomes and Toxicities

Parameters	Number	Percentage
Response to Brachytherapy		
Complete response	12	80
Distant Metastasis	0	0
Local recurrence	3	20
Acute Toxicity		
Bleeding	0	0
Dermatitis	0	0
Dysesthesia	0	0
Dysphagia	0	0
Fatigue	2	13
Infection	0	0
Mucositis	4	27
Odynophagia	0	0
Xerostomia	3	20
Acute toxicity grade as per CTCAE version 5		
Grade 1	12	80
Grade 2	3	20
Grade 3	0	0
Late toxicity grade as per CTCAE version 5		
None	12	80
Grade 1	11	73
Complication	0	0
Fibrosis	6	40
Telangiectasia	0	0
Trismus	5	33
Wound Healing	0	0
Xerostomia	0	0
Grade 2	1	7
Osteoradionecrosis	1	7

Table 3: Management and Treatment of Recurrence in Ca Hard Palate Patients

Recurrence (Months)	Treatment of Recurrence	Response
4	MCT	Alive
5	Planned for surgery	Progression
4	Surgery	Alive with NED

DISCUSSION

Surface mould brachytherapy is a useful, non-invasive technique offering significant dose escalation, good tumor control, and excellent cosmetic outcomes. Amongst the previously published data most of the studies have focused mainly on the use of SMB for skin malignancies. Still, in our study there were 7 patients with intraoral, 6 patients with skin, and 2 patients with penile malignancies which shows the variety of cancers in which SMB can be used.[1-4]

In our study, For the preparation of the mould, we used an individualized custom surface mould that was designed according to the patient's anatomy and the lesion location. This resulted in proper fitting of the mould to the disease site allowing adequate coverage of the tumour volume and avoiding underdosage. Similar techniques for the treatment of skin and intraoral malignancies were adopted by the other authors.[1-4]

In the study done by Maronas *et al*,[4] 5 patients had a recurrence of the total 48 patients treated concerning the tumors that were located on the nose, but in our study, there was no recurrence noted in all of the 6 patients treated with skin malignancies which ensures the proper technique used for fitting the mould also over a curved surface without compromising adequate dose and volume coverage.

For palatal tumors, special preparation was done with the help of the prosthodontics department. Several authors have reported a similar technique for achieving this.[5,6] We adopted individualised CT Based treatment planning followed by the advantage of optimisation while panning for faster treatment delivery using the HDR Brachytherapy. The compliance of the patients was excellent due to the overall shorter treatment durations and all the patients completed the treatment well without any gap in between.

Prior single institute retrospective studies showed response rates. That range from 80-100% depending on the tumor size, location, and the exact technique used. Our study had a complete response rate of 80%. Ariji *et al*.[6] reported tumor control in nearly all of the patients treated. In our study tumour control was achieved in about 90% of patients. In the published literature, there are very few reports regarding the use and the response associated with SMB. This article describes our institutional experience regarding the use of Surface Mould Brachytherapy, concerning its response and toxicities evaluated.

Mukherji *et al*.[7] noted grade 1-2 radiation mucositis acutely in all the patients while in our study, acute side effects were of grade 1-2 in 80% of patients. The low toxicities are also seen in several other studies conducted earlier. Mukherjee *et al*.[7] also reported that all of their nine patients had achieved local control with only one nodal recurrence. In our study there is local control in about 80% of the patients with palatal cancers with only 2 patients having local recurrence and none of them having nodal recurrence.

A study done by Takeda *et al*.[8] showed that more than half of treated patients with oral cancers developed bone exposure after brachytherapy, but in our study, no patient had such features. Of significant late toxicities, necrosis of the palate was seen in one patient for which he was sent for salvage surgery. Restricting the depth of prescription can be a possible way to prevent this. The cosmesis seen was excellent for all patients with only patients of BCC developing hypopigmentation.

In the previously published studies,[6,7,9] various dose fractionation schedules were used that varied from 12Gy in 2 fractions to 52.5Gy in 15 fractions either one or two fractions daily. Also, brachytherapy was used both as a single modality and as a boost to EBRT. In our patients, 8 patients were treated radically, while 7 patients received chemotherapy in combination with EBRT.The median EBRT Dose given was 50Gy in 25 fractions, while the Median SMB dose in the radical setting was 48Gy and 15Gy in boost.

In our study, acute toxicities as expected were mainly of grade 1-2. The low toxicity profile that we reported is consistent with the previous studies.

Budrukkar *et al*[9] reported one case of grade 3 palatal perforation and one case of bone exposure. In our study, no such instances were reported. No serious late complications were studied by Nishimura *et al*.[10] Unetsubo *et al*[11] reported one case of grade 3 palatal mucosal ulceration and fistula formation in the buccal primary while no such findings were found in patients treated at our institution.

In a study done by Marina *et al*[12] HDR Brachytherapy used in selected patients for T1-T2 penile SCCs provided the advantage of penile organ preservation with local tumor control. In our study also, the penis being an easily accessible site, SMB resulted in Delivering high dose without minimal

setup errors and excellent tumor control. As traditional management of early stage was surgical but also affected the quality of life, SMB remains an excellent and also a cost-effective technique in the treatment of early stage penile cancers.

Clark CM, Bath Hextall FJ, Perkins[13] in their studies done on the management of basal cell carcinomas, stated that radiotherapy was the therapeutic modality of choice for patients who were unfit for surgery. In our cases also, for the patients who were deemed to be unfit due to difficult reconstruction and facial morbidities, Surface mould brachytherapy was planned for them.

Delishaj D, Rembielak[14] in their studies reported good tolerance to brachytherapy with high local control rates for basal cell carcinomas. In our studies for BCCs, no recurrence was found for these patients with complete response achievement which tells us about the use of SMB in these cases.

CONCLUSION

Surface mould Brachytherapy remains an indispensable modality used in the treatment of various superficial cancers, resulting in improved therapeutic ratio and dose escalation. This results in excellent local control rates and cosmesis along with the benefit of organ and function preservation. Therefore, it is a safe and effective techniquein patients who are unfit for surgical excision, unwilling or unable to undergo surgery, and difficult reconstruction. Doses to the organs at risk are negligible and a proper boost can be given for better results. In our study, this treatment method has offered reasonable local control and a low toxicity profilewhich was very well tolerated.

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