Successful treatment of squamous cell carcinoma of the lip with electron beam therapy: a symphony of medicine and physics

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DESCRIPTION

A female aged 57 years, a professional flautist by occupation presented with a history of non-healing 'pimple' on her left upper lip, which was gradually increasing in size over 6 months. There was history of occasional yellowish discharge and bleeding, provoked by her attempts to remove it. On examination, there was a firm non-tender swelling with fine, white crusting, measuring 5 mm at its widest along with surrounding induration of 1 cm (figure 1A), without involvement of the inner mucosa of lip.

An edge biopsy revealed squamous cell carcinoma (stage I) and the case was discussed in our tumour board. Keeping in mind her profession and the need to preserve occlusal function of the lips, she was treated with en face electron beam therapy to a total dose of 70 Gy in 35 fractions over 7 weeks, delivered to the surrounding 2 cm of the upper lip

Figure 1 Pretreatment and post-treatment images. (A) The visible lesion (black arrow) was surrounded by a 1 cm circumferential region of induration (white arrow) appreciated on palpation. These were marked on patients skin and a 2 cm margin (blue arrow) was also marked to serve as the planning target volume. Care was taken to exclude the nasal ala from this volume. To ensure reproducibility a custom treatment setup was devised by our radiation technologist, which included a sterile styrofoam block to keep the mouth open. A sterile rubber-coated flexible lead shield of 5 mm thickness was then placed over the teeth, snugly fitting the gingivo-buccal sulcus. Finally, a custom-moulded sterile wax sheet measuring 1 cm in thickness was interposed between the mucosa of upper lip and the lead shield. Care was taken to ensure that the treatment surface was as even as possible. Finally, the patient's head was turned to the right to ensure that the electron beam and the treatment surface were perpendicular. (B) Post-treatment image taken 2 months after treatment completion. Other than mild erythema at the treated site, there were no noticeable cosmetic or functional sequelae.

Figure 2 A diagrammatic representation of internal shielding. (A) Cross-sectional diagram of the cheek with a tumour arising from the skin. (B) When the electron beam strikes the surface of tumour, it immediately starts depositing energy (1) and as the beam penetrates deeper it loses energy at the rate of 2 MeV/cm (2). However if the thickness of tissue is insufficient, as in the case of cheek, there will be transmitted radiation emerging from the inner mucosa which would subsequently deposit energy on underlying tissues like teeth and gingiva, leading to side effects (3). (C) In order to protect underlying tissue, a high atomic number shielding material can be placed over them to protect them (3). The thickness of this shielding material (usually lead or lead equivalent) in millimetres is determined by the energy of transmitted radiation divided by 2. However, even though the underlying tissue is protected, the electrons are backscattered (3) from the surface of the shield, resulting in energy deposition back into the inner mucosa (4) and consequently severe mucositis. Backscattered electrons also increase dose to the tumour and outer skin. (D) To mitigate the problem posed by backscattered electrons, low atomic number material (absorber) is interposed between the mucosa and shielding material, which effectively absorbs them (4). The thickness of low atomic number material needed to completely absorb backscattered electrons depends on the electron energy used.

and cheek. We used a beam energy of 6 million electron volts (MeV) with source-to-surface distance of 100 cm prescribed to the 85% isodose line. The patient developed grade 3 acute skin toxicity and grade 2 mucositis during treatment. She achieved a

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complete clinical response on examination (figure 1B) as well as radiological imaging 2 months after treatment completion with satisfactory cosmesis and complete resolution of toxicities. She is disease-free after 2 years of follow-up and has successfully resumed work.

The probability of cure is similar with surgery or radiotherapy (RT) for early stage squamous cell carcinoma of the skin.¹ Factors that influence the selection of one modality over the other are cosmesis, function, age, convenience, cost, availability of RT expertise and RT equipment. RT techniques that could potentially be used to treat these tumours are varied. These can be external beam techniques (orthovoltage RT, megavoltage RT or electron beam RT), brachytherapy techniques (interstitial implant or surface mould) or a combination of both.¹

Although appearing deceptively simple, electron beam therapy demands a sound understanding of radiation physics on the part of the treating physician and close collaboration with the medical physicist.² A full discussion of the principles of electron beam physics is beyond the scope of this article, but the concept of internal shielding is worth highlighting (figure 2). Briefly, when treating lesions of lip and buccal mucosa, it is necessary

to protect the underlying tissues (teeth, gingiva, tongue) from transmitted radiation. This can be achieved by placing high atomic number shielding material (eg, lead or lead equivalent material) over the structures to be spared. However, this results in backscatter of electrons from the shield and inadvertently leads to a higher dose being delivered to tissue in contact with the shield.³ This dose enhancement may approach levels of 30%–60% (depending on shielding material used and the energy selected for treatment) and results in severe clinical reactions.² To prevent this, a low atomic number material (eg, wax) is interposed between the shield and tissue, which absorbs the backscattered electrons.²

In conclusion, an optimal combination of medicine and physics allowed our patient to continue her professional vocation of bringing music into people's lives.

Contributors IA is the treating senior resident (radiotherapy), author of the paper, responsible for drafting the manuscript and revising it. He is the guarantor. KSC is the supervising treating consultant (radiotherapy) and participated in article formulation, editing and oversight. CPB is the medical physicist, responsible for generating the radiation treatment plan, performing quality assurance of delivered plan and also participated in article editing. SR is the radiation technologist, responsible for creating the treatment setup, ensuring reproducible setup and treatment delivery during the course of treatment. He also participated in article editing.

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Learning points

- Localised skin cancers can be treated successfully with either surgery or radiotherapy and several factors determine the pros and cons of proceeding with either approach.
- Electron beam therapy is a widely available radiotherapy technique, which can be employed to treat these superficial tumours.
- Safe and effective treatment requires a thorough understanding of the properties of electron beams with close collaboration between the radiation oncologist, medical physicist and radiation technologist.

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