A simple solution to create a custom scalp-sparing helmet to prevent alopecia in patients undergoing total skin electron beam therapy for cutaneous T cell lymphoma

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ABSTRACT

Total skin electron beam therapy (TSEBT) is effective for patients with refractory or diffuse skin involvement of cutaneous T cell lymphomas (CTCL). A common concern for patients undergoing TSEBT is the development of alopecia. Patients are already burdened with the physical symptoms associated with their disease; therefore, mitigating additional physical side effects of treatment, including cosmetic concerns, is important. As such, the purpose of this study is to evaluate a novel technique to prevent alopecia after TSEBT. Prior scalp sparing techniques have relied largely on materials found in the radiation department (e.g., lead, Superflab bolus), but in this report, we utilized a custom blue wax polyethylene material to create a custom scalp-sparing, dose attenuating, helmet. The priorities that lead to investigating this solution included patient comfort, full scalp protection, and practicality. We wanted to find a light weight, snug fitting, helmet to protect the entire hair line, that could be easily fabricated for any patient. In the end, we found success in our efforts to minimize radiation to the scalp for indistinguishable hair volume changes.

Introduction

Background

There are about 3,000 new cases of cutaneous T-cell lymphoma a year in the U.S. with Mycosis Fungoides (MF) as the most common type [1]. TSEBT is currently the most effective treatments for this disease, with response rates from 87 to 100% [2,3]. Common radiation toxicities are dose dependent, and can include loss of fingernails, erythema, desquamation, hypohidrosis, edema, and alopecia. Over the past decade, there has been widespread adoption of a low dose TSEBT regimen giving 12 Gy [3]. Using a 12 Gy prescription, patients experience decreased radiation toxicity, promising overall response, and retreatment opportunity if necessary [4]. Despite the lower dose and improved toxicity, patients universally develop temporary alopecia, and hair regrowth may take months [5]. It is easily understood that oncologic treatment that leads to alopecia can have effects on a patient’s self-image and possible psychologic well-being [6]. Prior and current patients who do not have scalp involvement have inquired about possible modifications to avoid hair loss. Since most courses of TSEBT are designed to provide long-term disease control/palliation (rather than true cure), it makes sense to take patient priorities into account when designing their treatment.

Case presentation:

A 79-year-old female with CTCL was referred to our facility with symptoms of widespread plaque lesions, intense pruritis, and scattered ulcerated tumors on her extremities. After careful assessment of the patient’s skin involvement, the modified severity weighted assessment tool (mSWAT) score was determined to be roughly 40 %. Prior to seeking treatment from our facility, she tried topical steroid treatment, systemic therapy (romidepsin), and had received 3 courses of focal radiation treatments to doses of 44 Gy in 22 fractions with complete response in those fields. Upon initial discussion of TSEBT the patient...
expressed hesitation, as she did not want to lose her hair. She had no past or current clinical evidence of scalp involvement, and we assured her that accommodations were possible. We created a customized helmet using high-quality blue wax polyethylene material manufactured by .decimal (dotdecimal.com) to create a bolus type structure that would attenuate the majority of dose, and spare the underlying scalp.

Our beam is commissioned using 6 MeV electrons, and the expected energy at the patient’s surface is roughly 4 MeV. Using commissioning data and percent depth dose curves, we estimated a 1.5 cm thick bolus helmet would be adequate to reduce the dose to the scalp to less than 10 percent.

Our patient underwent computerized tomography (CT) simulation to obtain the exact contour of her head. Her hairline was wired during the simulation. The CT scan was imported into our treatment planning system; and a standard body contour was created, with a 1.5 cm uniform expansion. From this, a 1.5 cm thick false structure was formed using the previously wired hairline for reference (Image 1). This false structure contour was then transferred to .decimal for manufacturing. Within five business days, we received the milled polyethylene helmet in two pieces. These pieces were combined using adhesive and tape to form the final helmet (Image 2). The patient presented the day before treatment for a dry run and the helmet fit snugly. We use the modified Stanford technique with 6 standing positions and eye shields, so we added a chin strap to ensure the helmet did not fall or move when the patient changed positions during treatment [7].

On the first day of treatment, two nanoDot optically stimulated luminescence dosimeters (OSLDs) were placed on top of the bolus helmet and two OSLDs under the bolus helmet. The readings from these were 84–86 % for the two OSLDS placed on top of the helmet versus 3.9–4.1 % for the two OSLDs placed immediately under the helmet. Using these measurements, the estimated total dose to her scalp was less than 0.5 Gy over the six fractions of treatment.

The patient completed radiation treatment with good tolerance. She returned to the clinic one month and 6 months later with nearly a complete response of her skin disease (MSWAT 5 %) and no alopecia (Image 3).

Discussion

We found that our customized helmet provided a practical and efficient solution to reduce the physical burden of alopecia that comes with TSEBT radiation treatment. Previous case studies like ours have explored different techniques and materials to reduce alopecia risk for patients undergoing TSEBT. Multiple studies have used non-customized
approaches, including a motorcycle helmet with lead and a thermoplastic mask with Superflab bolus. The downsides of these methods include weight of the helmets (4.2–4.8 lbs); in-clinic molding requiring prolonged time from the radiation oncology team and patient, as well as difficulty providing uniform and full coverage of the scalp. Williams et al. utilized a motorcycle half helmet wrapped with lead [8]. The helmet weighed 4.8 lb and lacked complete scalp coverage. A later study reported by Patel used a posterior thermoplastic mask and Superflab material [9]. This material was slightly lighter in weight (4.2 lb) and had more overall coverage, but requires in-clinic molding, which can be both labor-intensive and less precise in creating a uniform thickness material that sits flush to the scalp. A more modern approach, comparable to ours, done by Hoppe et al. utilized a 3-D camera and printer to create a custom printed helmet [10]. This method relies on the capability and availability of a 3D printer in the radiation oncology department, which currently is not widely available. Even with the 3D printer, the helmet weighed 3.7 lbs, modifications were needed after printing, and they noted a less uniform fit with voluminous hair styles.

Unlike the previously mentioned studies, our helmet was the lightest; weighing 2.9 lb, making it more comfortable to wear during prolonged standing (which is required during TSEBT). Also, given its custom fit to the individual patient based on CT simulation, we found that the helmet fit snugly all the way around the scalp; and the chin strap we added was completely unnecessary, as the helmet did not shift during treatment. Aside from fixing the two pieces together, no modifications were needed. The primary downsides of our technique are the need for CT simulation and the cost associate with outsourcing a custom dose-modifying bolus helmet. Our institution plans to continue using this practical scalp-sparing method for future patients undergoing TSEBT who wish to avoid alopecia.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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