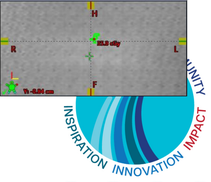

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Custom made skin flap for HDR treatment of skin lessions

Georgios Kalantzis, PhD, Frank T. Godlewski, MBA, Debra Linzer, MD, Nicolas Kuritzky, MD , Kenneth C. Chu, PhD
Mount Sinai Medical Center, Miami Beach, FL 33140

Mount Sinai
MEDICAL CENTER
Braman Comprehensive Cancer Center

CONTACT

Kenneth Chu, PhD, P.Eng,
Chief Physicist
Mount Sinai Medical Center
Radiation Oncology,
Braman Comprehensive
Cancer Center
4310 Alton Road
Miami Beach, FL 33140

Kenneth.Chu@MSMC.COM

305-674-2121 ext 57440

INTRODUCTION

Purpose:
The incidence of skin cancers keeps rising with estimates from the World Health Organizaiton (WHO) that 2-3 million non-melanoma skin cancers (NMSC) occur each year with one in every three cancers diagnose being a skin cancer.

Studies in the past have proposed custom made skin applicators for HDR skin treatment utilizing thermoplastic molds or 3D-printed applicators which are more task and expertise demanding.

The aim of the current study is to describe the development of a novel custom skin flap (CSF) for HDR treatment of skin lesions, as well as, assess the usability and planning technicalities of our CSF on a clinical setup rather than the excessive dosimetric valuation of the catheters employed since these are well studied and used extensively in other applications such as commercial skin flaps, source exchanges and bronchial treatments. The main advantages of our proposed method are: Firstly, Its low cost. Second, Its rotational flexibility on all three planes.

METHODS AND MATERIALS

Our custom skin flap (CSF) was constructed by acrylic bids easily available online with an outer diameter of 10mm and a 2mm hole, and bronchial catheters 5F from Varian. Each catheter was inserted through the beads of the desired length and a button shape plug was placed on the tip of the catheter to stop the beads removal. For the same cause a thin tape was applied at the other end of the CSF and once the desired shape of the CSF was defined both sides were taped and wrapped with a clear plastic stretch wrap to support its rigidity and preservation of its shape.

A total set of 5 tests were conducted to validate the accuracy of dose delivery and usability of our method on a clinical setup. Firstly, a positioning test confirmed the correct digital reconstruction of the catheters and positional accuracy of the source on a Perma-Doc Phantom (VariSource HDR). The next two tests aim to assess the accuracy of dose delivery for a small treated area (i.e. nasal lesion) [Figure 2a] and a larger area with irregular L-shape (i.e. shoulder lesion) [Figure 2b]. End-to-End measurements and γ analysis were performed with the MapCheck 2 array.

RESULTS

The catheter length in the plan was set to 130.8 cm in agreement with the manufacturer recommendation. We also physically verified this length using a dummy wire with a Varisource length measuring device. In Brachyvision, the tip of the catheter was easily delineated and the dwell positions were placed with 1 cm step size with the first position at 129.8cm, and a fixed dwell time of 6 sec each (Figure 1).

DISCUSSION

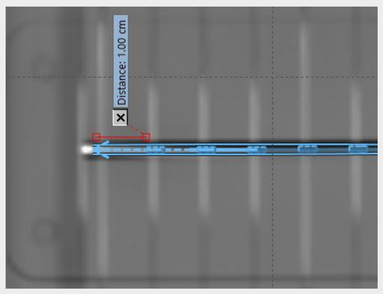

Figure 1: Catheter digitization and depiction of dwell positions relative to the Perma-Doc phantom

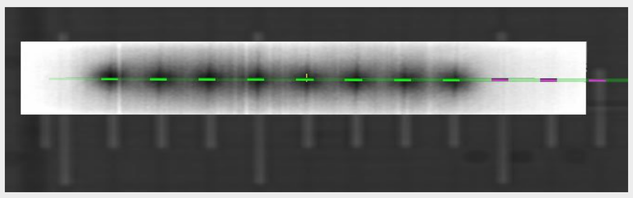

Figure 2: Composite image of the registered radiographs of the film and the DRR of the phantom with the catheter reconstructed.

Dose delivery verification was based on the γ index with (3mm, 3%) criteria and a threshold of 15%. The γ rate was 90.6% for the small treatment area and 90.9% for the L-shape area. We further investigated the effect of inhomogeneities on dose calculations. Accuros BV was employed and dose difference between calculations with and without inhomogeneities were constructed for both plans at four different depths. From Figure 3 we may observe that the area with a dose difference equal to 30 cGy (4.2% of prescription dose) is minimal at depth of 2 mm and dissipates beyond 3 mm depth. Particularly the V_{30cGy} of the dose difference is 10% of the treated volume V_{700cGy} of the original plan while the V_{40cGy} and V_{50cGy} were practically zero (less than 0.1 cm^3) .

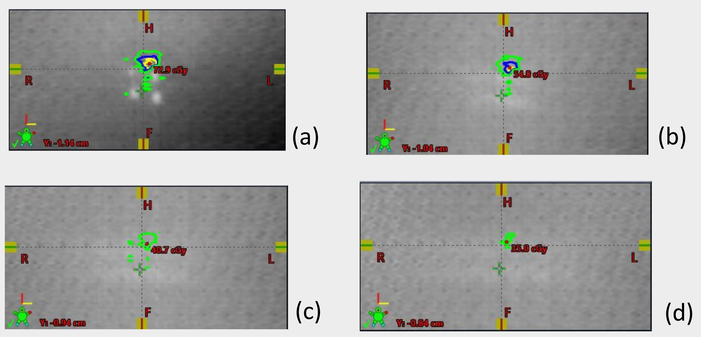

Figure 3: Dose differences for the small treatment area at (a) 0mm (b) 1mm (c) 2mm (d) 3mm (e) 4 mm and (f) 5mm depth respectively. Isodose lines corresponds to 30cGy (green), 40cGy (blue) and 50cGy (yellow).

Similar analysis for the L-shaped treatment plan discerned to slightly different remarks regarding the extent of the low dose difference volume [Figure 4]. Specifically, the V_{30cGy} was 32.3% of the V_{700cGy} while V_{40cGy} and V_{50cGy} was 4.8% and practically zero of the treatment volume respectively. However the radiological impact of that spatial dose difference between the two dose calculation engines should be insignificant.

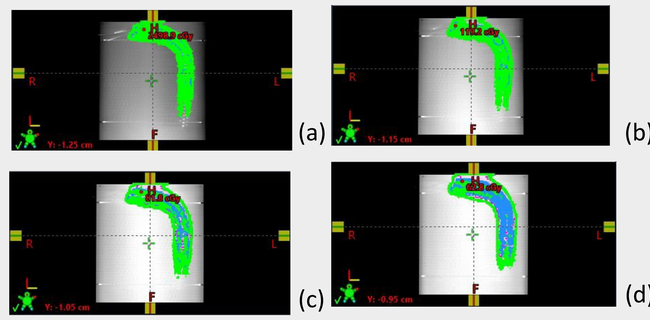

Figure 4: *Dose differences for the small treatment area at (a) 0mm (b) 1mm (c) 2mm (d) 3mm (e) 4 mm and (f) 5mm depth respectively. Isodose lines corresponds to 30cGy (green), 40cGy (blue) and 50cGy (yellow). The white rectangle is the MapCheck2 array.*

Finally, we utilized our CSF for the treatment of skin lesions with satisfactory results. Figure 5 illustrates the photos and the 3D rendering of the treatment of 2 actual clinical cases.

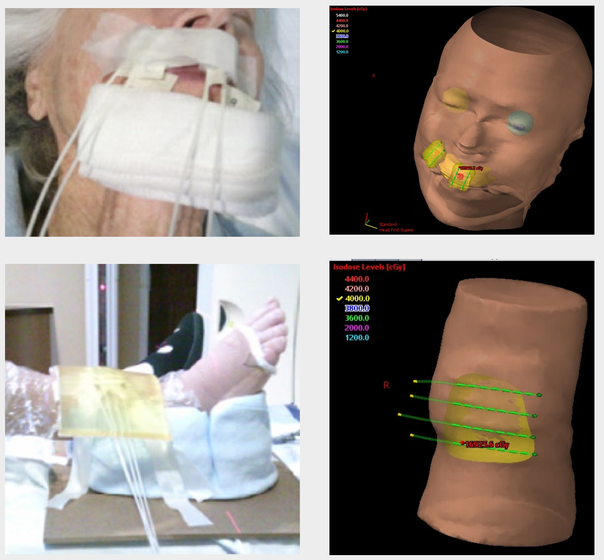

Figure 5: examples of clinical treatments of 2 patients with our CSF.

CONCLUSIONS

The studies indicated that our proposed CSF was practicable for a set of cases covering a wide spectrum of planning challenges. We validated their dosimetric properties and verified their adequacy for treatment on 2 clinical setups, so far. Both patients upon their follow-up exhibited satisfactory results and recovery without any skin side effects. We anticipate in the near future we shall verify our CSF advantage over commercial skn flaps for larger and more irregular-shaped keloid lesions.