ACE FOR SKIN BRACHYTHERAPY

The dosimetric impact of a model-based dose calculation algorithm (TG-186) in HDR skin brachytherapy for the treatment of large, curved surfaces

Eleanor Ivy*, Eleanor Holden & Emma-Louise Jones, **Guy's and St Thomas' NHS Foundation Trust** *eleanor.ivy@nhs.net

BACKGROUND

HDR surface brachytherapy is used to treat mycosis fungoides, a type of cutaneous T-cell lymphoma which responds well to radiotherapy and often involves extensive lesions on curved skin surfaces.

It is suspected that the widely used TG-43 formalism [1] for brachytherapy dose calculations is unsuitable for large, curved skin treatments due to the significant presence of air in the calculation volume and resulting lack of scatter.

ACE (Elekta, Stockholm, Sweden) [2] is an Advanced Collapsed Cone Engine that models dose deposited by primary and scattered photons in a medium defined by the user and provides the option of assigning mass density based on CT image data.

To assess the dosimetric impact of treatment planning using ACE, doses calculated by ACE were compared against those calculated with the TG-43 formalism for a range of skin plans (surface area >25cm^2) treated with the Freiburg flap applicator (Elekta, Stockholm, Sweden).

The Freiburg flap arrangement for a heel (left) and a hand (right) treatment.

METHODS

Using Oncentra® Brachy (version 4.6.0), dose distributions were re-calculated with ACE for 15 treatment plans which had previously been calculated with the TG-43 formalism and optimised to achieve PTV coverage of 80-120% of the prescribed dose.

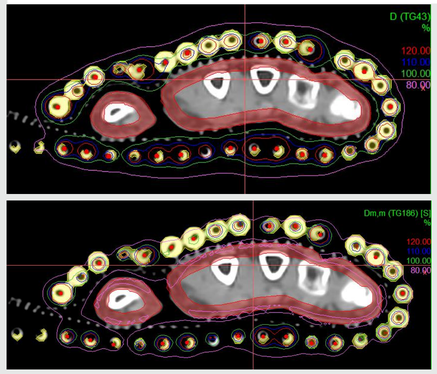
The Freiburg flap and patient volume were delineated and assigned as silicone and soft tissue respectively, with HU-based densities. All other volumes were assigned by default as air with uniform density.

PTV V80% was compared for the two calculation methods. For a heel plan and a hand plan, where bone had also been delineated and assigned as cortical bone with HU-based density, point doses at various depths were compared.

RESULTS

For all plans, ACE calculated a reduction in PTV V80% compared with the original TG-43 plan. Most of these reductions were significant, ranging from 9.2% to 65.7% less than the original coverage, with the exception of two plans where reductions were 1.1% and 1.2%. Reduction in dose coverage was dependent on the curvature and extent of the PTV, with hand plans exhibiting the largest decrease in PTV V80%.

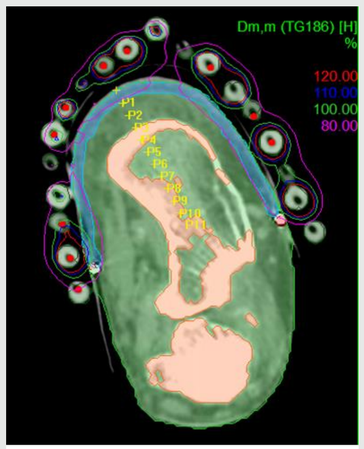
Point doses for the heel and hand plans were found to be lower when calculated with ACE than with TG-43 by 6.6-11.1% and 6.4-13.3%, respectively.



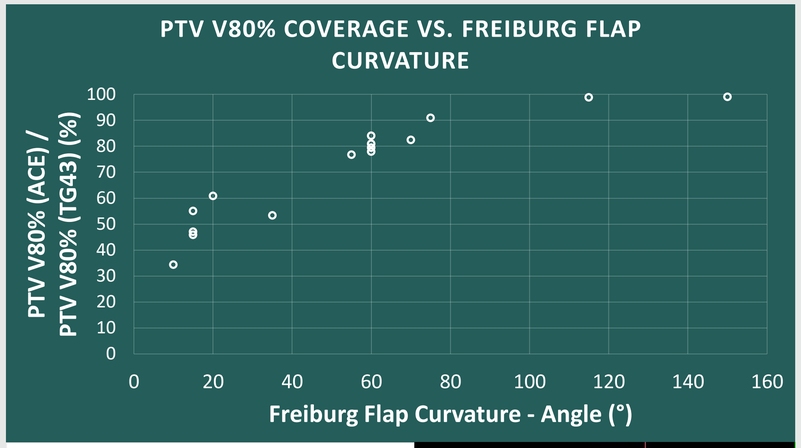
The largest and smallest PTV V80% reductions were seen in the most (left) and least (right) curved treatments, respectively.

Point Depth (mm)	% Difference $D_{m,m}$ (sACE) vs. D_w (TG-43)	
	Heel Plan	Hand Plan
0	-8.3	-11.2
5	-6.6	-6.4
10	-7.9	-8.7
15	-8.5	-9.5
20	-10.6	-10.2
25	-9.6	-11.7
30	-9.6	-11.2
35	-9.4	-11.9
40	-10.1	-12.1
45	-10.6	-13.3
50	-11.1	-13.2

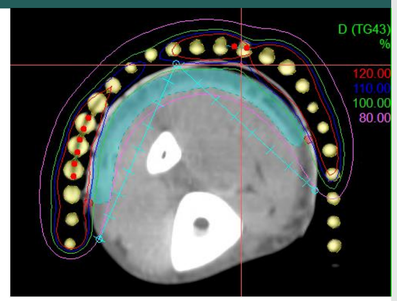
Percentage difference between point doses calculated with standard accuracy ACE and TG-43



Dose calculation points for the heel plan (yellow)



A crude method of quantifying Freiburg flap curvature (shown on the right) involved marking the centre and extreme edges of the Freiburg flap on a central image slice and calculating the angle subtended by these points. PTV V80% was calculated with ACE and quantified as a percentage of PTV V80% (TG-43). This percentage was plotted against curvature (angle) and indicated that as the angle decreases and treatments become more curved, PTV coverage is reduced more significantly.



CONCLUSIONS

Discrepancies between doses calculated with ACE and TG-43 increase with curvature of the treatment site in skin brachytherapy for large volumes. Following guidance from the AAPM report TG-186 [3], treatment should continue to be optimised based on the TG-43 formalism; however doses should be calculated with ACE in parallel until sufficient data have been obtained to inform any changes in the approach to treatment planning.

REFERENCES

[1] M. J. Rivard, B. M. Coursey, L. A. DeWerd, W. F. Hanson, M. S. Huq, G. S. Ibbott, M. G. Mitch, R. Nath, and J. F. Williamson, "Update of AAPM Task Group No. 43 Report: A revised AAPM protocol for brachytherapy dose calculations," 2004.
[2] ACE: Advanced Collapsed Cone Engine. White paper, Elekta Brachytherapy; 2014.
[3] L. Beaulieu, Carlsson Tedgren, J. F. Carrier, S. D. Davis, F. Mourtada, M. J. Rivard, R. M. Thomson, F. Verhaegen, T. A. Wareing, and J. F. Williamson, "Report of the Task Group 186 on model-based dose calculation methods in brachytherapy beyond the TG-43 formalism: Current status and recommendations for clinical implementation," 2012.