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Clinical impact of metallic surgical clips in superficial radiative hyperthermia

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Introduction
Mild hyperthermia (HT) aims to heat tumour tissue to 40-44℃ for 1 h and has proved to increase the therapeutic effect of radiotherapy (RT) with, among others, excellent clinical results for local recurrence of breast cancer. Two patients in our department with breast cancer recurrences were good candidates for combined RT-HT, but had surgical clips in the region to treat. Metallic implants are a contra-indication for radiative HT because of a risk of localized hot spots near the metal, with possible overheating and damaging of surrounding tissue. The sparse literature on the subject prompted us to investigate the difference in heating pattern caused by the clips, using a specific HT phantom.
Material and Methods
Patient 1 (P1) had eight 6-mm long titanium clips (type T1), implanted in the breast, at depth ranging from 2.5 to 3.5 cm. P2 had a single 7.1-mm long clip of type O'Twist axillar (type T2), made of a nickel-titanium alloy, implanted at 3 cm depth in an axillar node. In both cases, the clips were located in the central region of the HT field. Superficial HT in our department is delivered with the microwave (MW) Alba HT system operating at 434 MHz. The machine is equipped with different size antennas. The antennas we used in this study were the ones used for the treatment of P2 and P1, i.e. alpha and beta respectively (with effective thermal field size of 4x16 and 8x12 cm2, respectively, and thermal penetration depth of 3 cm). Measurements of the difference in temperature rise (TR) caused by the clips presence compared to a setting without clips were performed at 1 cm depth (depth of the max of TR) in slabs of a home-made Agar muscle-equivalent phantom. We used 12 T1 clips positioned in different configurations (clips aligned, clustered, etc.) and a single T2 clip. Temperature measurements were performed real-time (i.e. while heating) with thermocouples (TC) positioned next to the clips, and after heating intervals of 6 and 20 minutes with a calibrated thermal camera. The maximum power (100 W) was used for all measurements.
Results
TC provided limited point information and interpretation of results was complicated by the intrinsic inhomogeneity of TR across the antenna. In contrast, the thermal camera gave 2D thermal measurements with high resolution, but required the removal of the antenna from the phantom. TC measurements were sufficient to exclude a significant MW absorption (leading to a $\Delta TR>2℃$) for any clips types and configurations, while camera results allowed to exclude the occurrence of local hotspots ($\Delta TR>0.5℃$). Based on these results, we evaluated the risk of serious adverse effects for patients to be negligible. P1 and P2 were treated with 5 and 3 HT sessions, respectively, with no noticeable effects related to the clips.
Conclusion
Results suggest that superficial radiative HT is safe in patients with implanted surgical clips of the tested types. Two patients with implanted clips benefited from HT in our department.

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