Purpose:
Dose over/underestimation is a common problem for highly irregular fields or around tiny and heterogeneous tissues such as the mucosa/epidermis near teeth/false teeth, skin, bone marrow, vestibulocochlear nerve, and pituitary glands, leading to unexpected normal tissue complications or tumour recurrence. Owing to the limitation of computer efficiency and RAM capacity, it is impossible at present to construct a very high-resolution phantom for calculating tumour/organ dose together with realistic and accurate dose estimation for tiny and heterogeneous tissues in one simulation. This study aimed to develop dull resolution CT-based phantoms for Monte Carlo simulation against small-field irradiation in tiny/heterogeneous tissues.

Methods:
A homemade VC++ 6.0 code was developed to translate DICOM CT images to dual resolution CT-based phantoms in the format of an egs-phantom used in DOSXYZnrc. This code uses regular spatial resolution to define the tumour/organ, but enhances the resolution around the region of interest. This dual resolution phantom can be used for patient treatment evaluation and dose distribution around tiny and heterogeneous tissues in one simulation.

Results:
A dual resolution pure water phantom will not impact the outcome of MC simulation under large uniform field irradiation. However, the results of this pure water phantom under small field irradiation showed dose underestimation of more than 30% owing to the partial volume effect of not using enhanced resolution. Another dual resolution heterogeneous phantom was used to investigate the interface dose distribution near the boundary of different materials. Finally, a dual-resolution CT-based phantom, BigMouse, was created to study the dose distribution around teeth. Isodose curves and PDD/profile comparisons showed that enhanced resolution doses were higher when irradiation fields or phantoms were not uniform.

Conclusions:
Dose underestimation due to over-sized voxels can cause severe damage to mucosa in the oral cavity.

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