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# A phantom-based and theoretical comparison of lung tumour planning target volumes between 4D-CT and 3D-CT

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Lung tumor motion due to respiration necessitates using large margins when creating a planning target volume (PTV). As tumor movement of up to 5 cm has been reported by several investigators, accurate investigation of the internal margin (IM) to 3D CTV is necessary. The purpose of this study was to compare differences in volume between PTVs generated using 4D-CT (4D PTV) and 3D-CT (3D PTV) and the extents of their overlap for varying degrees of tumour motion (from small to large displacements), both experimentally and theoretically. A movable phantom was used to simulate lung movement. Three blocks of rubber were attached to the phantom and a 3D-CT and a 4D-CT were taken. Then, PTVs were delineated and compared. Also, investigation of varying displacements of lung tumor was done using four blocks of rubber attached to a movable phantom with different known displacements. By the way, we carried out an investigation of the dose coverage between 3D PTV and 4D PTV mathematically for different used IMs in 3D PTV and different tumour displacement. The average reduction in PTV volumes using 4D-CT was 33.8%. Investigation of varying displacements of lung tumor shows that if tumors move more than 4 cm, the 4D PTV may be equal to or larger than the 3D PTV. Conversely, tumors with large displacement during respiration may have larger PTVs when planned using 4D-CT compared with conventional methods. In these circumstances, the use of a 4D PTV may reduce the chance of a geographical miss, with an inherent improvement in tumor control probability. According to the mathematical results using a large IM (1 cm) may ensure coverage of 4D PTV by 3D PTV for tumours moving by ≤2 cm.