Image analysis of a quality assurance phantom for cone beam CT

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Introduction

There is a lack of tools for quality assurance (QA) testing of cone beam CT (CBCT).

Objectives

To perform an extensive evaluation of a prototype head-sized QA phantom for CBCT.

Materials and methods

A prototype phantom with inserts for image quality analysis was developed by Leeds Test Objects Ltd. The phantom was scanned on 6 CBCTs (3D Accuitomo ®, SCANORA 3D®, GALILEOS®, ProMax 3D®, Picasso Duo®, Kodak 9000 3D®), one MSCT (SOMATOM Sensation 16®) and a high resolution microCT (SkyScan 1172®). Different image quality

parameters were evaluated using the phantom's inserts: spatial resolution, point spread function, line spread function, contrast resolution, image homogeneity, geometric accuracy, and metal artefacts.

Results

Spatial resolution proved to be dependent on voxel size, but also on the orientation of the inserts in the beam. Point spread function and line spread function estimation using, respectively, a steel wire and a Teflon® cube showed its potential for the analysis of spatial and contrast resolution. Further contrast resolution analysis on hydroxyapatite, aluminium and air in PMMA surrounding showed similar results for all CBCT scanners. Analysis of homogeneity of all previously mentioned materials proved to be dependent on voxel size, exposure (mAs), and the position of the ROI (central vs. peripheral). Geometric accuracy analysis using a 2D grid proved to be as useful as by means of a helix or another three-dimensional shape. Metal artefacts originating from titanium rods proved to be highly device-dependent in their manifestation, showing the need for an objective and clinically relevant artefact analysis.

Conclusions and discussion

All preliminary analyses of this first prototype QC phantom showed its potential for routine quality assurance on CBCT. Based on the initial evaluations, the phantom can be further developed, together with a software analysis tool for (semi-)automatic QA testing.