Performance evaluation of a peripheral cone-beam CT scanner With Weight-bearing Capabilities
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**Introduction:** Joint space narrowing can be caused by inflammatory or degenerative musculoskeletal conditions such as rheumatoid arthritis or osteoarthritis. Previous studies have shown that weight-bearing images improve detection of joint space narrowing more reliably than supine views. Furthermore, weight-bearing imaging provides functional information about joint biomechanics. Weight-bearing imaging of the lower extremity has been limited to the supine position by scanner design in conventional clinical CT scanners. Due to recent advances in cone beam computed tomography (CBCT), true 3D weight-bearing CT is available for clinical evaluations of patients in a health care setting. The Verity CT scanner (Planmed Oy) is a CBCT imaging system optimized for imaging upper and lower extremities. The system acquires high-resolution volumetric images of the target and includes a motorized gantry that allows for weight-bearing CBCT imaging of the knee, ankle, and foot. The purpose of the present study is to perform a quantitative analysis of a peripheral cone-beam CT scanner with weight-bearing capabilities.

**Methods:** Performance of the Verity CBCT system was evaluated using both a quality-control phantom provided by the manufacturer (8 cm diameter) and a custom-built phantom (15 cm diameter). These phantoms were used to assess the noise, resolution, and uniformity. The manufacturer’s phantoms were scanned using predetermined positioning and scan parameters for all performance evaluations. Upon completion of the scan, the performance results are automatically calculated and outputted by the scanner. The custom-built phantom was examined using the same exposure settings and image volumes (11 cm length, 16 cm diameter), and reconstructed at an isotropic resolution of 0.2 mm. Afterwards, these images were analyzed using in-house software.

**Results:** Analysis of slanted-edge image indicated limiting spatial resolution of 1.32 lp/mm, compared with 1.35 lp/mm obtained with the manufacturer’s phantom. The noise values were evaluated as the standard deviation within a uniform region, over a range of exposures. Minimum standard deviation of 60 HU was observed at the highest exposure setting. The uniformity of the system (calculated as the average difference in signal intensity values between the peripheral and central regions) was 174 HU. Over the central region, the uniformity was observed to be 34 HU (± 6 HU).

**Conclusions:** The performance evaluation of the peripheral CBCT scanner shows the Verity meets the manufacturer’s specifications for high-resolution scan mode. The analysis of spatial resolution yielded a limiting resolution exceeding 1.25 lp/mm. The noise characteristics were within the manufacturer’s guidelines, where the HU standard deviation is less than 100 HU. Uniformity performance was excellent over the central region and within the limits of 50 HU set by the manufacturer. The uniformity test displayed a large difference in the average HU from the centre to the periphery, which can be attributed to beam hardening and scatter. The performance of the peripheral CBCT scanner demonstrates the potential for use in future clinical studies to understand how various musculoskeletal conditions impact joint biomechanics.