# Cone Beam CT-arthrography of the wrist: high resolution images at low radiation dose

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| **Authors:** | L. H. L. De Beuckeleer, K. Carpentier, B. De Foer, M. Pouillon; Antwerp/BE |
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## Purpose

Cone beam Computed Tomography (CBCT) has been widely adopted for dental 3D-imaging since the late 1990s [1]. Compared with multi-detector computed tomography (MDCT) imaging, CBCT offers higher resolution with a relatively low radiation dose.

Besides use in dental and ORL applications on the first commercially available CBCT systems, modern CBCT units afford examinations in seated or lying position, therefore permitting high resolution CBCT imaging of other body parts, such as the wrist, the elbow, foot or ankle [2,3].

MDCT is a well established imaging modality to investigate the wrist for ligamentous tears, TFCC tears, cartilage abnormalities and bony lesions [4,5].

In our department, the CBCT system has been used for musculoskeletal CT studies of extremities since its installation.

We examine the role of CBCT in arthrography of the wrist, and more specifically illustrate the dose reduction achieved in comparison to MDCT.

## Methods and Materials

Forty-one patients were sent to our department for CBCT-arthrography of the wrist.

Firstly, the patient is seating near the X-ray table, with the dorsal aspect of the wrist prepared sterilely and positioned horizontally upon the table.

Under fluoroscopic guidance, puncture of the radiocarpal joint was performed on the waist of the radius and 4 ml of iodinated contrast agent was injected. Local anaesthetic was not used.

Plain radiographs were performed and immediately afterwards, a CBCT examination was realized using a NewTom 5G CBCT scanner (QR srl, Verona, Italy). The patient was seated with the arm in horizontal position through the gantry opening, with wrist and hand fixated in order to prevent motion artifacts. Anode voltage is maximum 110 kV at 3 mA current. Measured field of view is 8x8 cm. The scan time is about 7 seconds.

The CT images are generated by rotating an x-ray source around the wrist creating a series of flat panel detector radiographs with the patient sitting behind the gantry. This results in an axial data set of 659 raw data images. The reconstructed 3D-volume is displayed on a 19" screen, which is used to manage image acquisition and

data processing/reformatting. Coronal, sagittal and axial orthogonal 1 mm slices are reconstructed and sent by DICOM communication to a PACS system (Impax, AGFA Healthcare, Belgium).

In a previous study, a high overall accuracy (82-86%) and specificity (81-91%) was found for evaluating wrist ligaments and radiocarpal cartilage [6]. Due to the small number of patients in our study, we do not report on accuracy, positive and negative predictive value for cartilage lesions or ligamentous tears.

The main purpose of our study however was to compare radiation dose of the CBCT examinations compared with MDCT studies. Therefore, we compared the doses of the 41 CBCT studies with dose reports of 20 MDCT examinations of the wrist, performed on a GE Brightspeed system (General Electric Medical Systems; Waukesha, WI, USA) with 120 kV at 100 mA, 0.625 mm thickness, 0,3 mm interval, pitch 0.5.

## Results

Back projection calculation algorithms allow a volume dataset to be created that describes the examined region with an isotropic CT data set, with a resolution of 0.125 x 0.125 x 0.125 mm. Hence, high resolution images were achieved (Fig.1,3,4).

The CBCT examination was performed with a mean dose $CTDI_{vol}$ of 2.98 mGy (range 2.28 - 4.08) (Fig.1,3,4), whereas the mean dose ($CTDI_{vol}$) of MDCT-arthrography (GE Brightspeed system with 120 kV at 100 mA, 0.625 mm thickness, 0,3 mm interval, pitch 0.5; as performed before the CBCT system was installed in our department) of the wrist was 29.73 mGy (Fig.2).

**Images for this section:**

**Fig. 1:** Cone beam arthro-CT image of the left wrist in a 45-year old woman, showing a Palmar type 1A lesion of the TFCC.

**Fig. 2:** Multi-detector arthro-CT image of the left wrist in a 45-year-old woman, showing a Palmar type 1A lesion of the TFCC.

**Fig. 3:** Cone-beam arthro-CT of the right wrist (coronal reformatted image)in a 28-year-old man, demonstrating a complete tear of the lunotriquetral ligament with filling of the midcarpal joint compartment. A TFCC tear type 1A was also present (not shown on this coronal reformatted image).

**Fig. 4:** Cone-beam arthro-CT of the left wrist (coronal reformatted image) in a 33-year-old man, demonstrating a complete tear of the scapholunate ligament with filling of the midcarpal joint compartment.

## Conclusion

CBCT-arthrography is a high resolution imaging modality, readily available and highly effective in detecting ligamentous pathology of the wrist.

The achieved radiation dose reduction is approximately 90 % as compared with CT-arthography performed on MDCT, and may e.g. eventually open perspectives for dynamic CT-arthrographic examinations without excessive radiation dose in the appraisal of wrist instability [7].

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## Personal Information