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Capabilities of Cone-Beam Computed Tomography in the Assessment of the Structure of Wrist and Hand Bones

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Abstract

An analysis of the capabilities of cone-beam computed tomography (CBCT) in the assessment of the form and structure of wrist and hand bones was the aim of the research. Cone-beam CT of wrist and hand was conducted in a group of voluntary patients, which included 40 members aged 22- 68 years. Magnetic resonance imaging (MRI) was carried out in 80.0% (n = 32) of cases, multislice computed tomography (MSCT) in 40.0% (n=16) of cases. In 62.5 % (n=25) of cases, digital microfocus radiography on X-ray unit Pardus (Russia) and standard radiography of wrist and hand were conducted. According to the results of the research, CBCT shows a high efficiency in detection of form, measurements and structural changes of bones of the anatomic region.

***Keywords*:** *cone-beam computed tomography, wrist injuries and diseases, hand injuries and diseases.*

Introduction

The wrist and hand are unique parts of a human body in functional aspect and the most opened region for injuries and for number of diseases [8]. Pathology of this region becomes a cause of incapacitation of working-age persons aged 25-60 years in 15-60% of cases [7, 10].

Only one-fifth of cases of incapacitation with wrist and hand pathology could be associated with severity of injury or disease, as mentioned by a number of researchers. Most incapacitation is a consequence of mistakes and after-effects arising in the process of diagnostics and treatment. Until recently**,** any examination of the changes of wrist and hand with injuries and diseases was limited by the use of standard X-rays in many Russian medical-diagnostic institutions. The diagnostic capabilities of the pathology of structures of this anatomical region were enhanced considerably with the implementation of MRI, MSCT, and ultrasound in regular clinical practice [1–4, 7, 9, 11].

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With a new generation of cone-beam scanners, it has become possible to obtain high-quality images without exposing the patient to a high dose of radiation, thus facilitating examinations in orthopedics and traumatology [2-4,6,9].

Scanning the area by pulsed X-ray cone beam is the basis of getting images in CBCT examination. A distinctive feature of this methodology is the possibility of getting primary three-dimensional images with high spatial resolution and the subsequent opportunity to build multiplanar reconstructions according to the developer's information.

However, there are few publications among available literature sources on the possibilities of using CBCT in wrist and hand bone injury and disease diagnostics. [2-3, 5-6, 9].

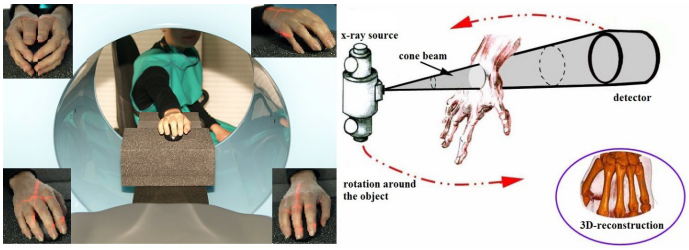
An analysis of the capabilities of cone-beam computed tomography (CBCT) in the assessment of the form and structure of wrist and hand bones was the aim of the research.

Material and Methods

In total, 40 patients between the ages of 22 and 68 years were examined. Cone-beam CT of the wrists and hands was conducted to all patients on NewTom5G (QR Verona, Italy). Patients were placed in a sitting position behind gentry during the acquisition time. The hand was on a special stand in the medium

physiological position (it varied with the task of the researcher) (**Pic. 1, a-b**).

In 80.0 % (n=32) of cases, MRI was completed on Centauri MPF 3000 (XinAO MDT, China), and in 40.0 % (n=16) of cases, MSCT was performed using Brilliance 64 (Philips, Holland). Digital microfocus radiography using Pardus X-ray unit (Russia) and standard radiography of the wrists and hands were carried out in 62.5 % (n=25) of cases.



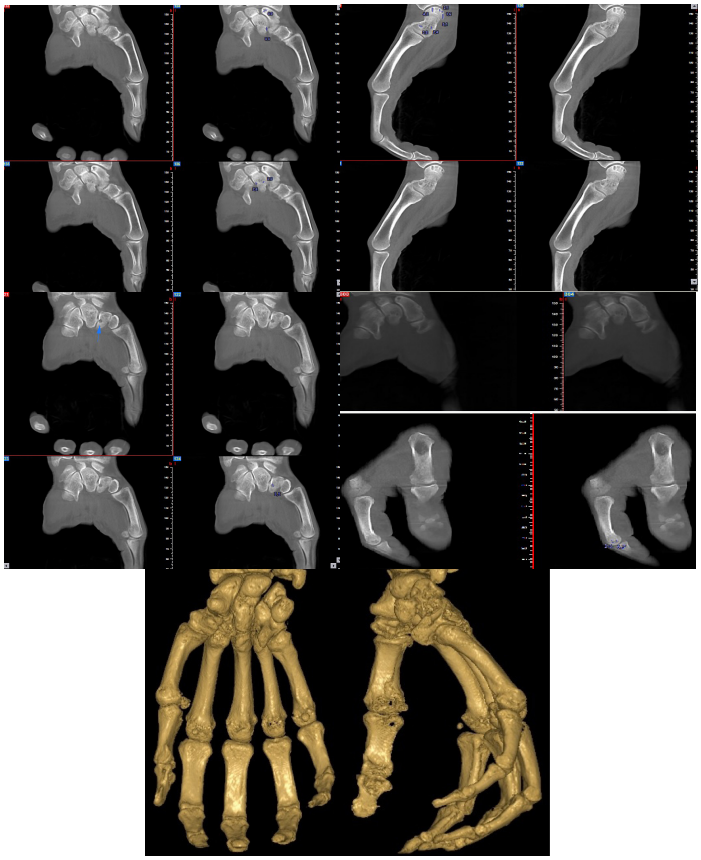
a b

Pic. 1. *(a) Upper extremity position for CBCT-examination of the wrist and hand and (b) the principle of acquisition of the primary three-dimensional image.*

Results

Structural changes of wrist and hand bones were detected in 31 (77.5 %) cases, and consolidated fractures and false joints of bones were detected in 4 (10.0 %) cases.

Received cone-beam CT images of wrists and hands were distinguished by high-resolution with detailed mapping of bone structure. In addition, accurate differentiation of bone trabeculae and minor structural changes and defects, no more than 3-5 mm in size, were observed in the CBCT-images (Pic. 2).

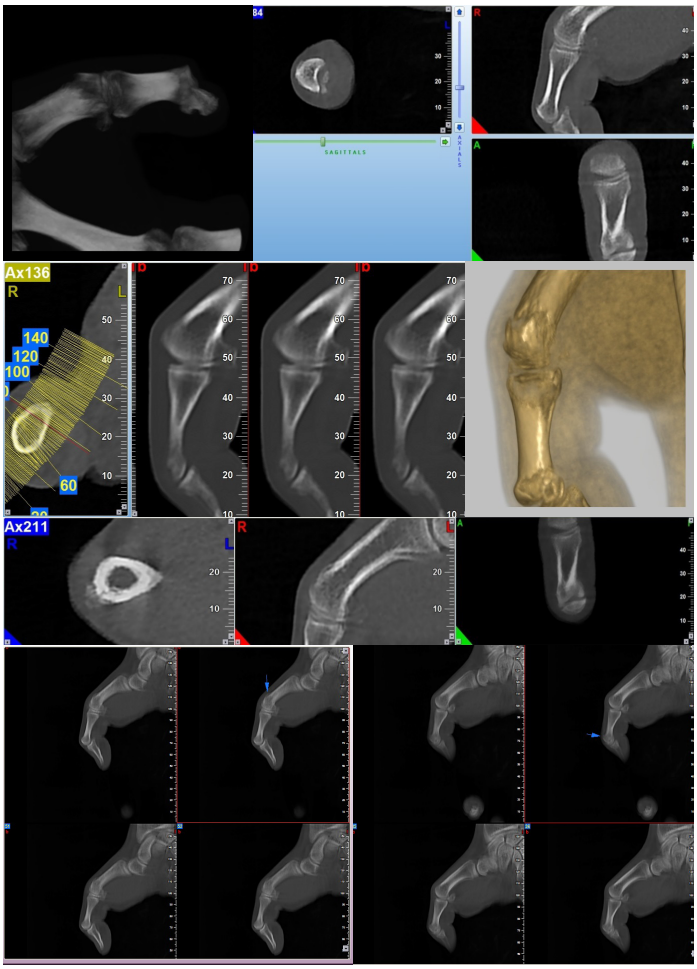


Pic. 2.

Cystic restricting areas and trabecular structure of the right wrist and hand bones are visualized reliably on the CBCT- images.

All the changes mentioned above were visualized reliably on the MSCT-images and on digital microfocus X-ray images; however, they were not defined on standard X-ray images. The images quality was comparable with those taken using digital microfocus X-ray and MSCT.

Consolidated fractures were visible reliably in cone-beam computed tomograms with subsequent building of multiplanar and 3D-reconstructions (Pic.3).



Pic. 3.

Signs of the consolidated fractures of the distal epiphysis of the first metacarpal bone and the proximal phalanx of the thumb of right hand are visualized reliably in cone-beam computed tomograms.

The conducted research allows making the following ***conclusions:***

- CBCT is the method of choice for the assessment of small (lesser than 5.0 mm) pathological remodeling areas and posttraumatic changes in bone tissues, as well of such segments having a compound anatomical structure, such as the wrist, where summational effect is marked mostly on standard X-ray images.

- Considering the low dose of radiation and high image quality, CBCT could be used as a priority method of choice to assess the structure of wrist and hand bones and be done as the first step in diagnostics, replacing standard radiography.

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