Opportunities of cone-beam computed tomography in diagnostics of wrist pathology

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Purpose

Wrist is a unique part of a human body, which is functioning actively in various types of his vital function. At the same time wrist is the most opened region to injury, systemic diseases of connective tissues (rheumatoid arthritis), degenerative processes, metabolic and neurogenic disturbances [1]. Injuries of wrist and wrist joints account for 25-65% of all damages of musculoskeletal system, for 1% of population in subpopulation degenerative and inflammatory processes were reported [10].

Injuries and diseases of this region become a cause of development of incapacitation of working-age persons aged from 25 to 60 years for 15-60% [1, 10].

Only one fifth of cases of incapacitation with wrist pathology could be associated with severity of injury or disease as mentioned by a number of researches. Most part of it is a consequence of mistakes and aftereffects arising in the process of diagnostics and treatment.

Up to date an examination of changes of wrist and wrist joints with injuries and diseases limited by a standard x-rays in many Russian medical-diagnostic institutions. Diagnostic capabilities of structures of this anatomical region were enhanced considerably with MRI, MSCT and US implementation in clinical practice [2-4].

Application capabilities of Cone-beam CT (CBCT), which was cosigned for examination in oral surgery, dentistry and otolaryngology were presented by #. Mozzo et al. in 1998 for the first time [8].

It became possible to study in orthopedics, traumatology and rheumatology with obtaining high-quality images and low dose for patient at the same time thanks to the emergence of a new generation of cone-beam scanners [5-7, 9].

Scanning the area by pulsed x-ray cone beam lies in the basis of getting images in CBCT examination. A distinctive feature of the methodology is a possibility to get primary three-dimensional image with high spatial resolution and subsequent opportunity of building of multiplanar reconstructions according to the developer`s information.

There are few publications among the available literature sources, which cover only some possibilities of using CBCT in bone`s and joint`s injuries and diseases diagnostics [5, 7, 9].

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

Methods and Materials

Cone-beam CT of bones and joints of wrist was conducted on NewTom 5G (QR Verona, Italy) to 38 patients at the age from 22 to 68 years old. Patient was in sitting position behind gentry during acquisition time. Hand was on a special stand in the medium physiological position (Fig. 1, Fig. 2).

In 84,2 % (n = 32) cases MRI was completed on Centauri MPF 3000 (XinAO MDT, China), in 42,1 % (n = 16) cases - MSCT on Brilliance 64 (Philips, Holland). Digital microfocus roentgenography was carried out on «Pardus» (Russia) and standard roentgenography of wrists and wrist joints for 65,8 % (n = 25).

Images for this section:

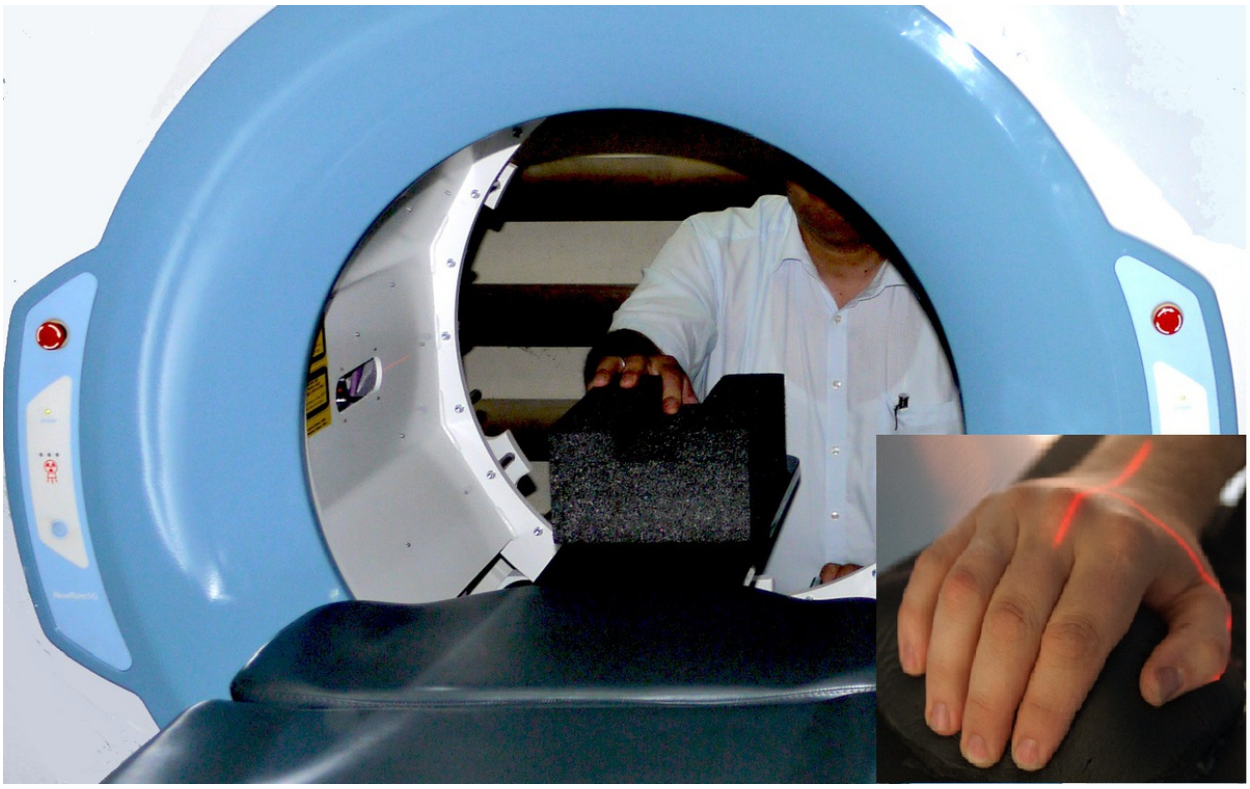

Fig. 1: upper extremity position for the CBCT of wrist and wrist joints

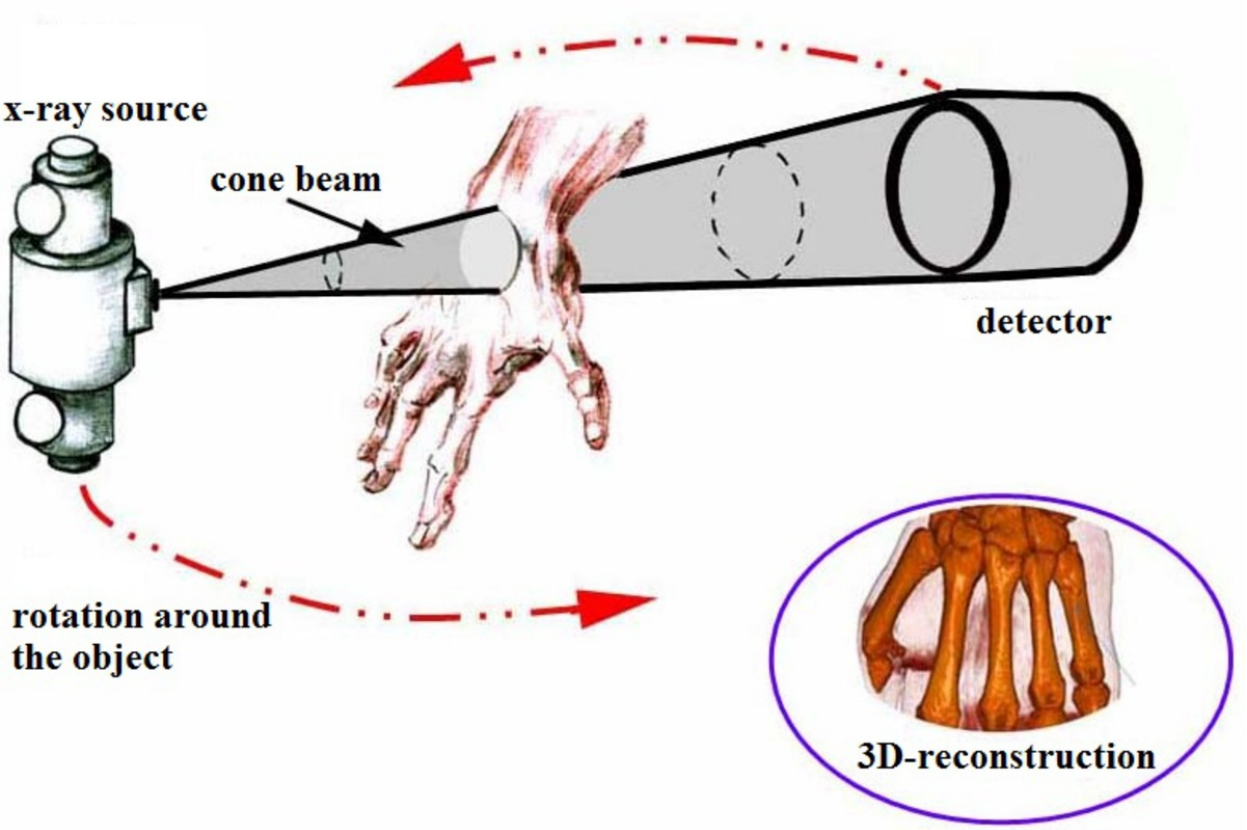

Fig. 2: principle of acquisition of the primary three-dimensional image

Results

Symptoms of degenerative and inflammatory changes of wrist joints were detected in 31 (81,6 %) cases, consolidated fractures and false joints of bones - in 4 (10,6 %) cases, fibrous-cicatricial changes of palmar aponeurosis, tendinitis of the flexor tendons, ligamentitis were revealed for 3 (7,8 %) patients.

Received cone-beam tomography images of wrists and wrist joints were distinguished by high-resolution, with a detailed mapping of the bone structure. Quality of images was comparable in terms of spatial resolution with digital microfocus x-ray and MSCT (Fig. 3).

A decisive importance in assessment of form, contours and structure of bones in traumatology and orthopedics in planning and control of results of treatment of extremity's injuries and diseases is minimum artifacts from the metal structures or foreign bodies with metal density was a prime advantage of CBCT to MSCT (Fig. 4).

In addition, accurate differentiation of bone trabeculae and minor structure changes, bone fractures and defects, which size was no more than 3-5 mm, were observed on CBCT-images. These changes were also well rendered on MSCT-images and on digital microfocus roentgenograms, but were not defined reliably in the standard x-ray (Fig. 5).

CBCT gives a possibility to assess condition of dense soft-tissue structures: capsular-ligamentous apparatus, tendons and fasciae, to reveal an accumulation of over fluid in joint cavity (synovitis and tendovaginitis) (Fig. 6).

Images for this section:

Fig. 3: CBCT-images of left wrist, digital microfocus x-ray image, MSCT-image - areas of cystic restricting in wrist bones (arrows). Cystic restricting areas and trabecular structure of the wrist bones visualized reliably on cone-beam images

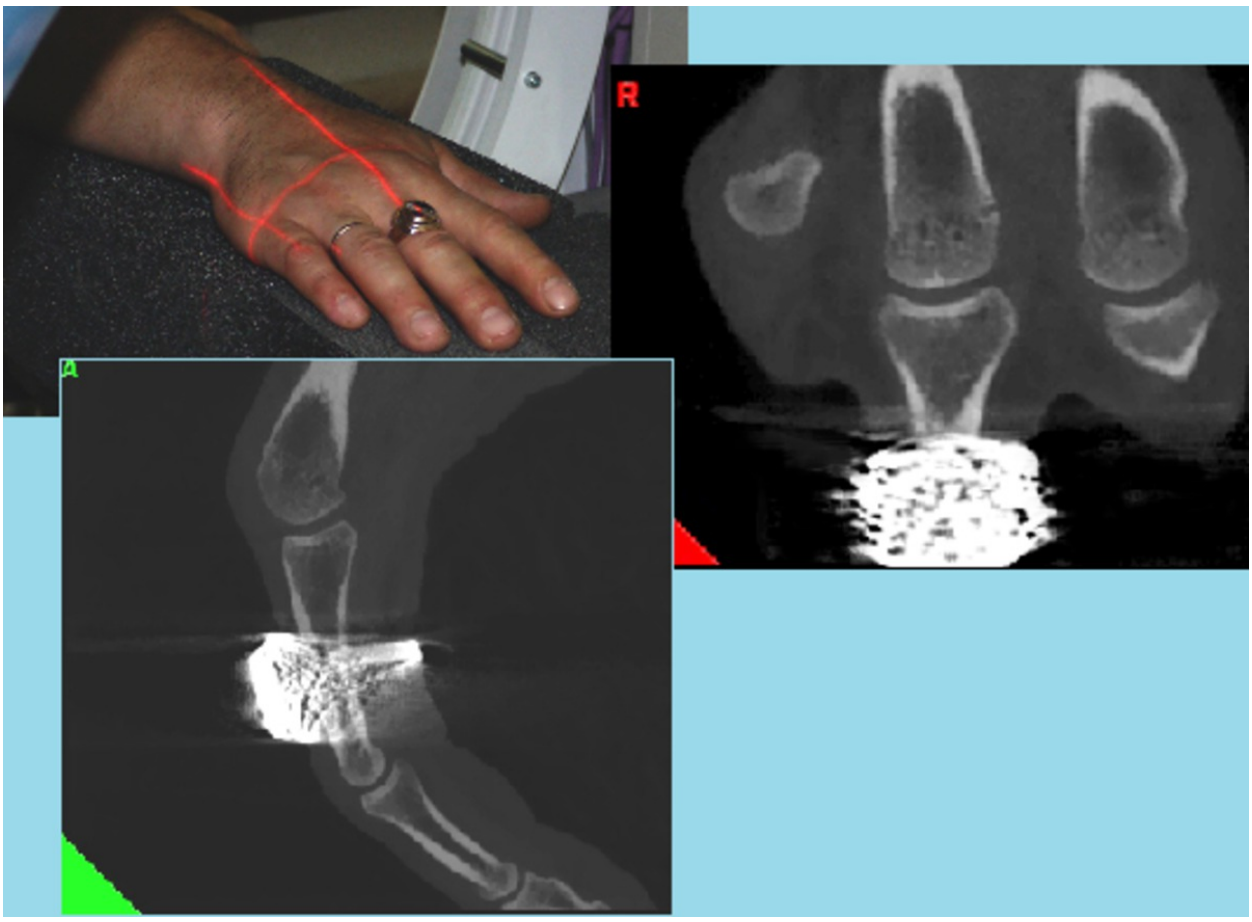

Fig. 4: CBCT-images of wrist with difficult to remove jewelry rings - there are artifacts from metal objects, for which it is possible to trace the contours of the cortical shell and bone-marrow canal

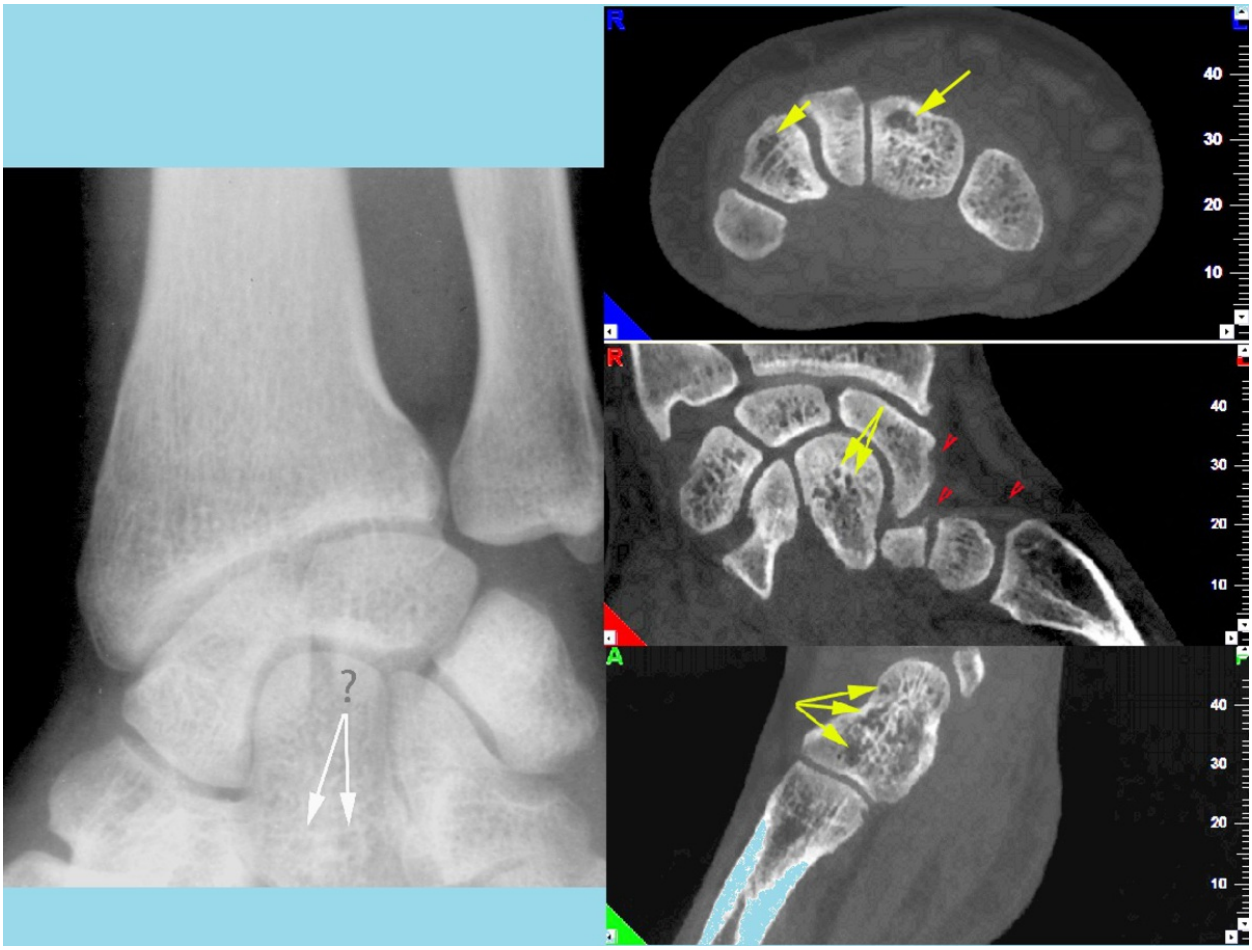

Fig. 5: there is no convincing data about restructing of bone tissue on the digital standard roentgenogram of a wrist; vacuum foci sized from 1,0 to 6,0 mm, which are relevant to cystic restructuring of the spongy substance of bones (yellow arrows), small (under 2,0 mm) channalings of articular surfaces, thickening and calcification of attachment location of a pulm metacarpal ligament (heads of red arrows), are visualized on multiplanar CBCT-images

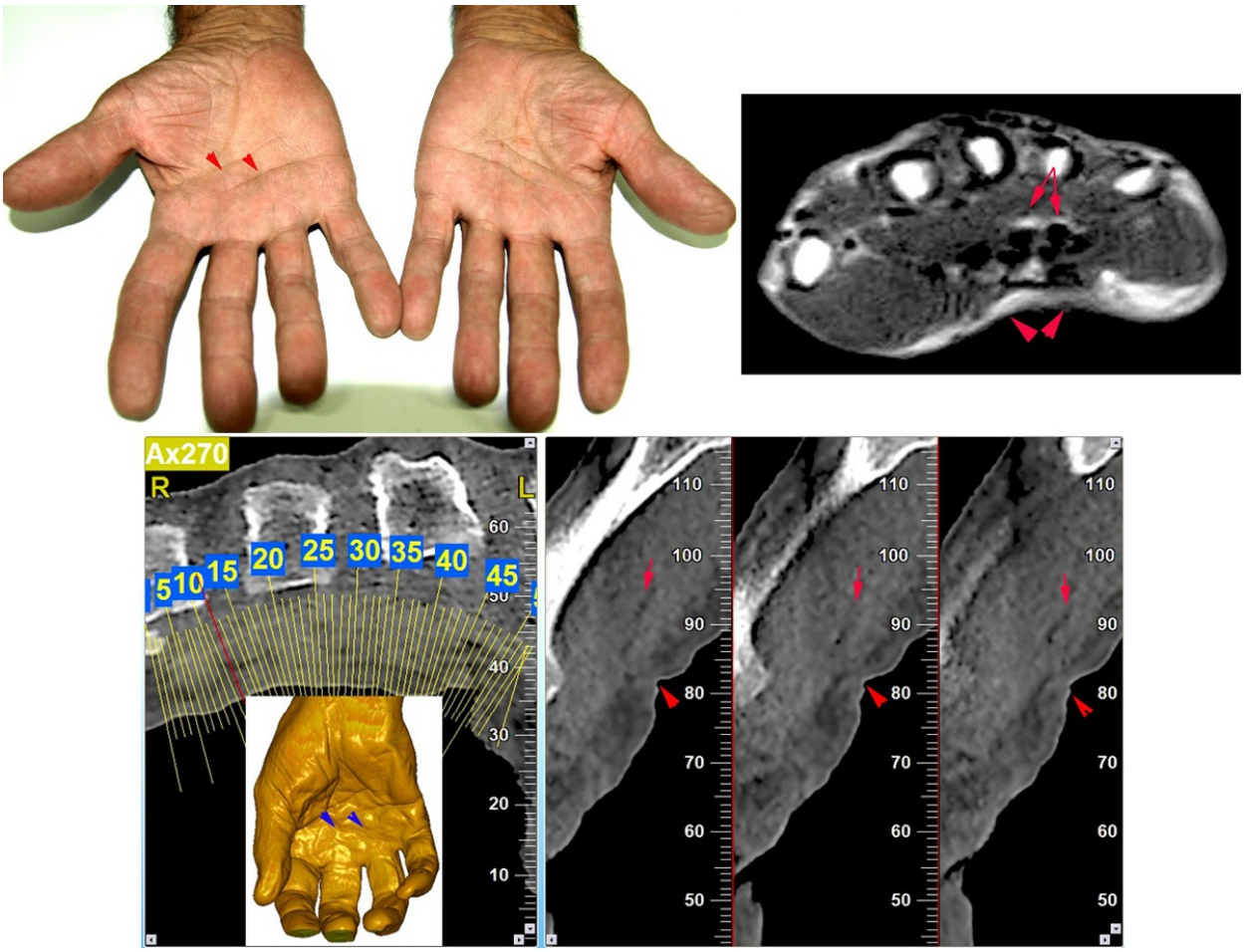

Fig. 6: patient with Dupuitren`s contracture: photo, CBCT-images (cross-sections and 3D-image) and MRI (GRE T1 WI) - scar restructuring of skin, subcutaneous fat, palmar fascia in the projection of the middle third of the diaphysis of III and IV of metacarpal bones with derangement of differentiation of tissues (heads of big colored arrows), tendinitis symptoms, accumulation of over fluid in synovial vaginas of finger`s flexor tendons (thick red arrows)

Conclusion

Clinical testing of CBCT detected the range of possibilities and indications for its use in diagnostics of injuries and diseases of wrists:

- CBCT is a method of choice in assessment of small pathological remodeling areas (under 5,0 mm), posttraumatic changes of bone tissues, segments with compound anatomical structure, where summational effect is marked mostly on standard roentgenograms;

- it gives an opportunity to assess condition of dense soft-tissue structures, to reveal an accumulation of over fluid in joint cavity, synovial bursae and tendon vaginas;

- CBCT with its low dose and high quality images could be used as a priority method on the first step of diagnostics, instead of standard roentgenography;

- narrow artifacts of steel-works and steel-density foreign bodies don`t reduce a quality of images and its opportunities in dynamical monitoring in aftertreatment control.

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