Normal cone-beam anatomy and cone-beam computed tomography study technique of distal extremities

Poster No.:	C-0848
Congress:	ECR 2014
Type:	Scientific Exhibit
Authors:	A. Vasilyev, N. Blinov, E. Egorova, D. V. Makarova, E. G. Gorlycheva, M. Dutova, M. V. Egorov; Moscow/RU
Keywords:	Tissue characterisation, Computer Applications-Detection, diagnosis, Cone beam CT, Musculoskeletal system
DOI:	10.1594/ecr2014/C-0848

Aims and objectives

Despite the cone-beam computed tomography (CBCT) is a very prospective method of diagnostics in traumatology and orthopaedics, there were found a few publications concerning on application of it in clinical practice [1, 2, 3, 4]. There is no complete data about physicotechnical conditions, scanning modes and normal CBCT-anatomy in the accessible sources. In the framework of our study it was elaborated for unification of CBCT-examinations.

Methods and materials

CBCT was carried out to 18 persons with suspected pathological changes of bone structure (7 men and 11 women at the age from 19 to 45 years) on NewTom 5G (QR S.l.r., Italy). CBCT of wrist was conducted to 6 patients (33 %), of hand - to 4 patients (22 %), of foot - to 5 patients (28 %) and of ankle - to 3 patients (17 %). Moreover, the photos of zones of interest were taken with a digital camera.

Results

The physicotechnical conditions for scanning of distal extremities were worked up taking into consideration the minimization of an equivalent dose (Fig. 1).

	Hand	*Wrist*	*Foot*	*Ankle*
Imaging mode	Patient scan	Patient scan	Patient scan	Patient scan
Scan type	Regular scan	Regular scan Enhanced scan	Regular scan	Regular scan Enhanced scan
Anode voltage	110 kV	110 kV	110 kV	110 kV
Anode current	0,6 mA	0,6 – 0,8 mA	0,6 mA	0,6 – 0,8 mA
FOV	18 x 16 cm 15 x 12 cm	18 x 16 cm	18 x 16 cm 15 x 12 cm	18 x 16 cm
Exposure time	3,6 s	3,6 – 4,8 s	3,6 s	3,6 – 4,8 s
Scan time	18 s	18 – 24 s	18 s	18 – 24 s
Axial thickness	0,3 mm	0,3 mm	0,3 mm	0,3 mm

Fig. 1: CBCT-scan settings for distal segments of upper and lower extremities
References: - Moscow/RU

All the CBCT-examinations were completed with the preliminary selection of the most comfortable patient's extremity positioning with an application of special x-ray negative positioning trays.

The examinations of hand and wrist were made while a patient was in sitting position behind the gantry using the special positioning trays. The wrist was in the middle physiologic position. The forearm and the wrist were adjacent to the table by its dorsal surface. The decussation of laser beams for CBCT of the wrist is on the thirdmetacarpophalangeal articulation, for examination of the hand - in the centre of the wrist joint (Fig. 2).

Fig. 2: Positioning of an upper extremity for CBCT-examinations of wrist and hand
References: - Moscow/RU

The examinations of the foot and the ankle were conducted when a patient's position is sitting on the table. For the foot scanning the extremity was standing on the plantar side on the positioning tray. The decussation of laser beams is on the basis of the third metatarsal bone. For the ankle examination a crus should be placed in parallel with the table. In this case the decussation of laser beams is 1 cm upper the medial ankle-bone (Fig. 3).

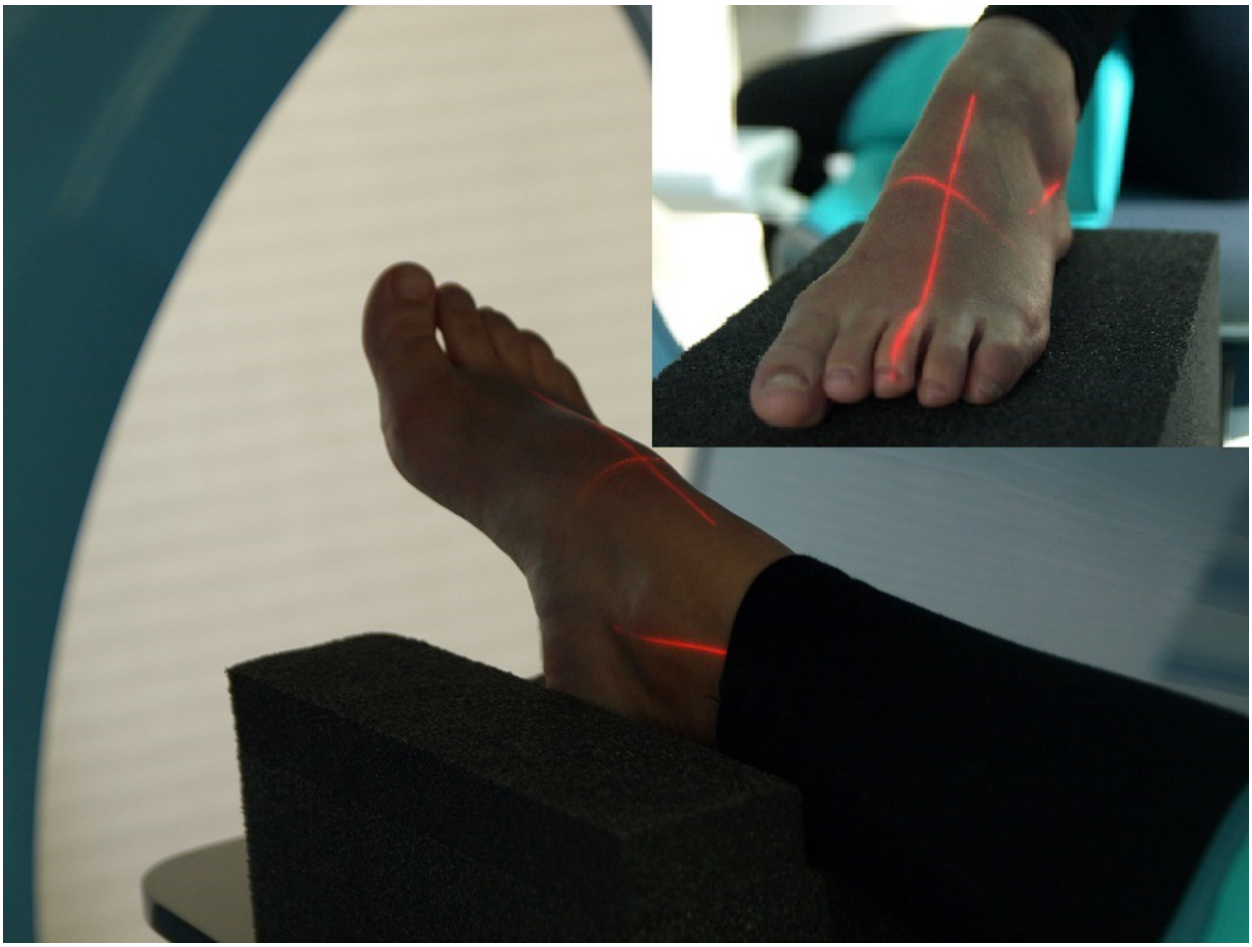

Fig. 3: Positioning of a lower extremity for CBCT-examinations of foot and ankle
References: - Moscow/RU

Thereby, the developed extremities positionings allowed to scan in the most informative, physiologic and comfortable position. The CBCT permits certainly visualize the soft tissues structures: muscles, tendons, ligaments, aponeurosises, big vessels,subcutaneous fatand skin. Due to this fact the normal cone-beam anatomy of distal region extremities was elaborated (Fig. 4, 5).

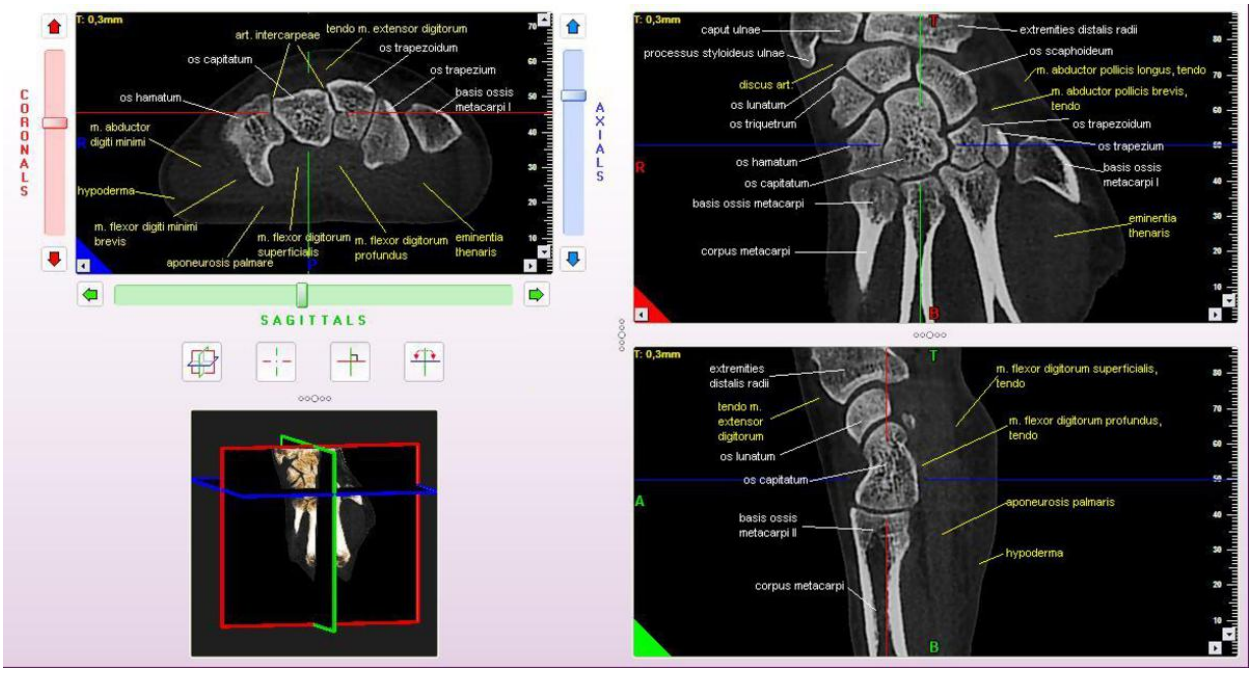

Fig. 4: CBCT. MPR, 3D. Left wrist. Normal cone-beam anatomy. White inscriptions - the bones, yellow inscriptions - the soft tissues.
References: - Moscow/RU

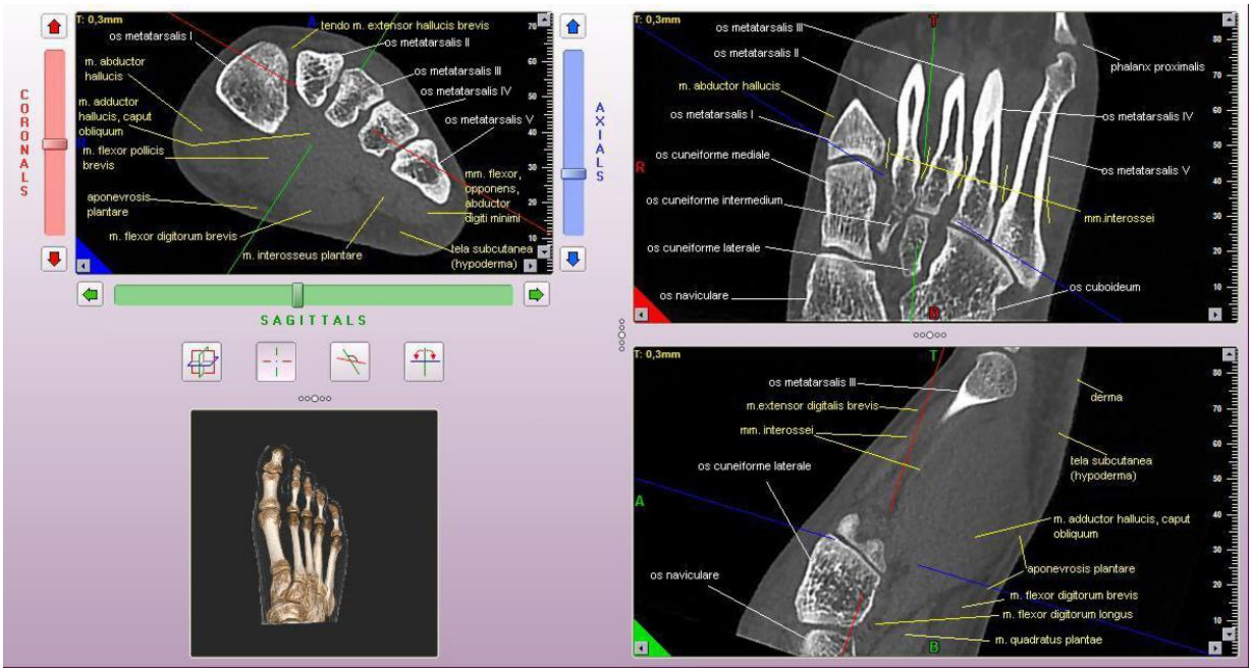

Fig. 5: CBCT. MPR. 3D. Right foot. Normal cone-beam anatomy. White inscriptions - the bones, yellow inscriptions - the soft tissues.
References: - Moscow/RU

3D-visualization allows to determine the accessory bones avoiding the diagnostic faults that are possible using the two-dimensional radiography. There are the locations of its possible disposition (Fig. 6, 7, 8, 9).

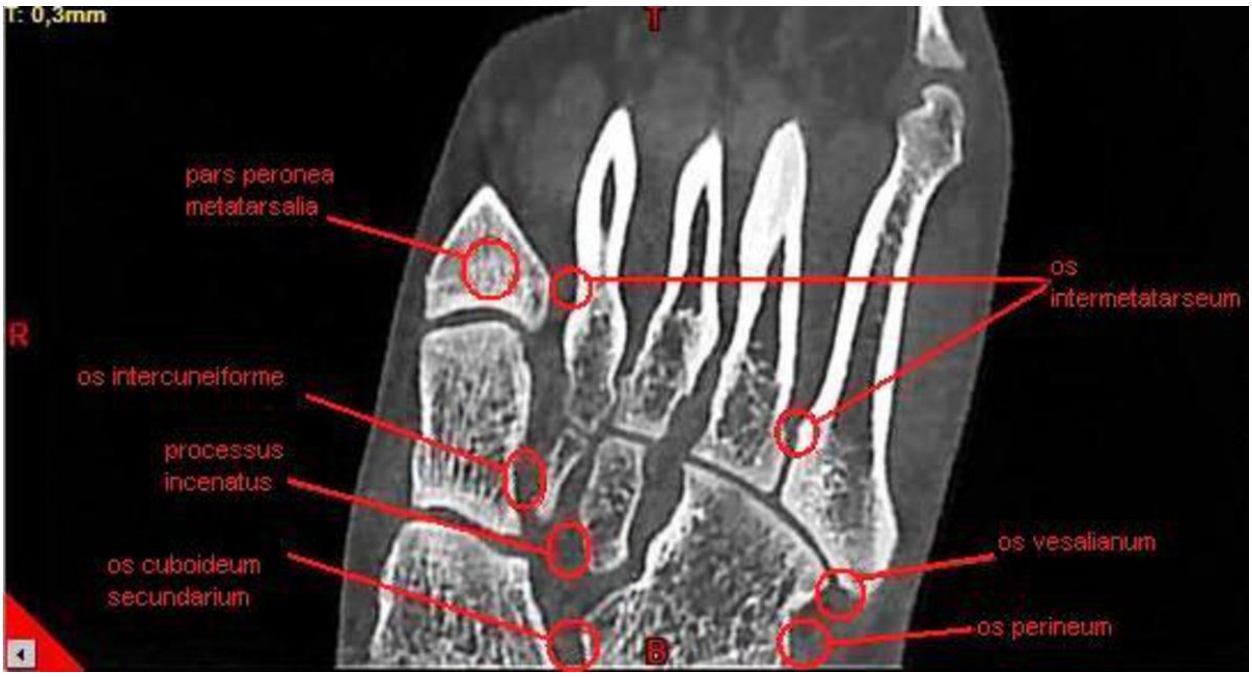

Fig. 6: CBCT. MPR, frontal view. The possible disposition of accessory bones of foot.
References: - Moscow/RU

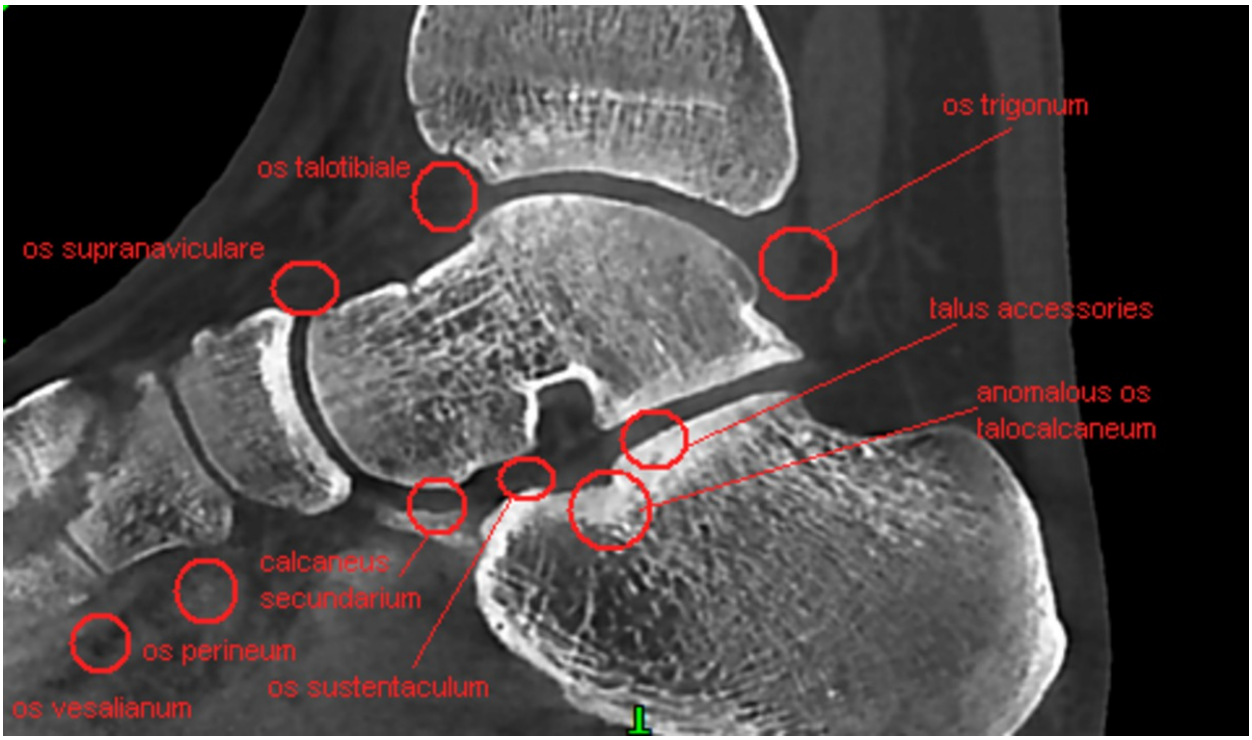

Fig. 7: CBCT. MPR, sagittal view. The possible disposition of accessory bones of foot.
References: - Moscow/RU

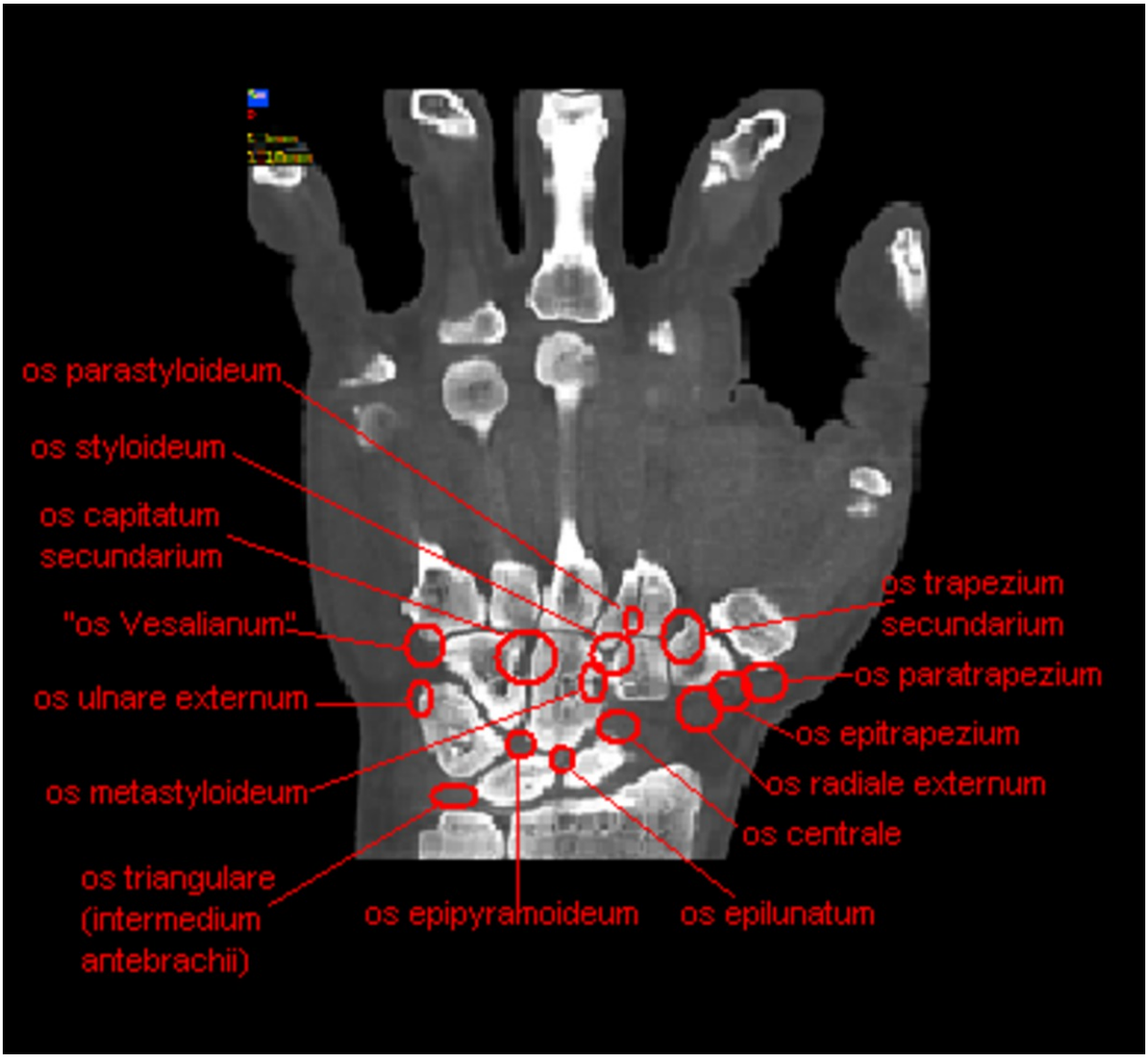

Fig. 8: CBCT. MPR, frontal view. The possible disposition of accessory bones of wrist.
References: - Moscow/RU

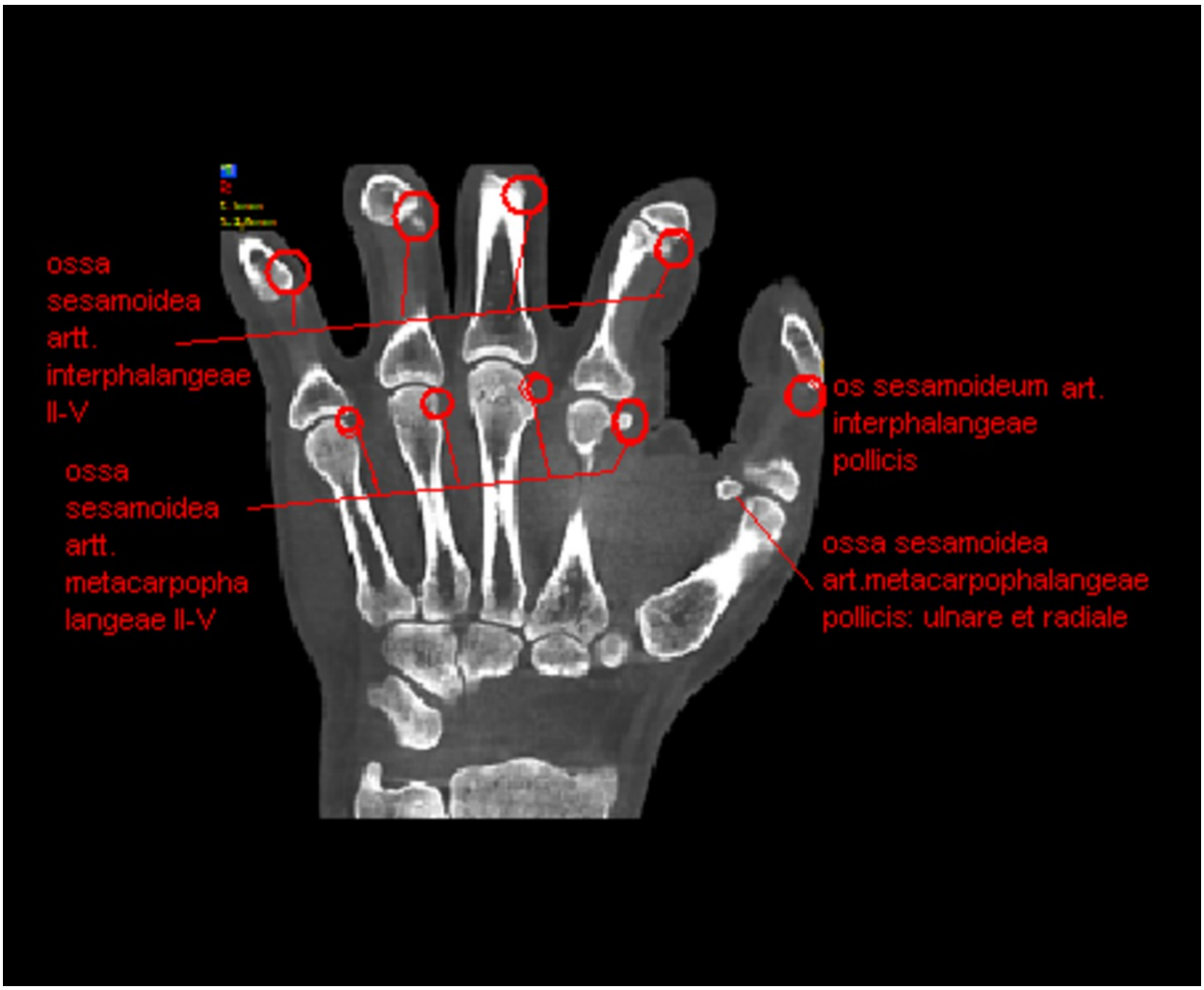

Fig. 9: CBCT. MPR, frontal view. The possible disposition of accessory bones of wrist.
References: - Moscow/RU

Images for this section:

	Hand	*Wrist*	*Foot*	*Ankle*
Imaging mode	Patient scan	Patient scan	Patient scan	Patient scan
Scan type	Regular scan	Regular scan Enhanced scan	Regular scan	Regular scan Enhanced scan
Anode voltage	110 kV	110 kV	110 kV	110 kV
Anode current	0,6 mA	0,6 – 0,8 mA	0,6 mA	0,6 – 0,8 mA
FOV	18 x 16 cm 15 x 12 cm	18 x 16 cm	18 x 16 cm 15 x 12 cm	18 x 16 cm
Exposure time	3,6 s	3,6 – 4,8 s	3,6 s	3,6 – 4,8 s
Scan time	18 s	18 – 24 s	18 s	18 – 24 s
Axial thickness	0,3 mm	0,3 mm	0,3 mm	0,3 mm

Fig. 1: CBCT-scan settings for distal segments of upper and lower extremities

Fig. 2: Positioning of an upper extremity for CBCT-examinations of wrist and hand

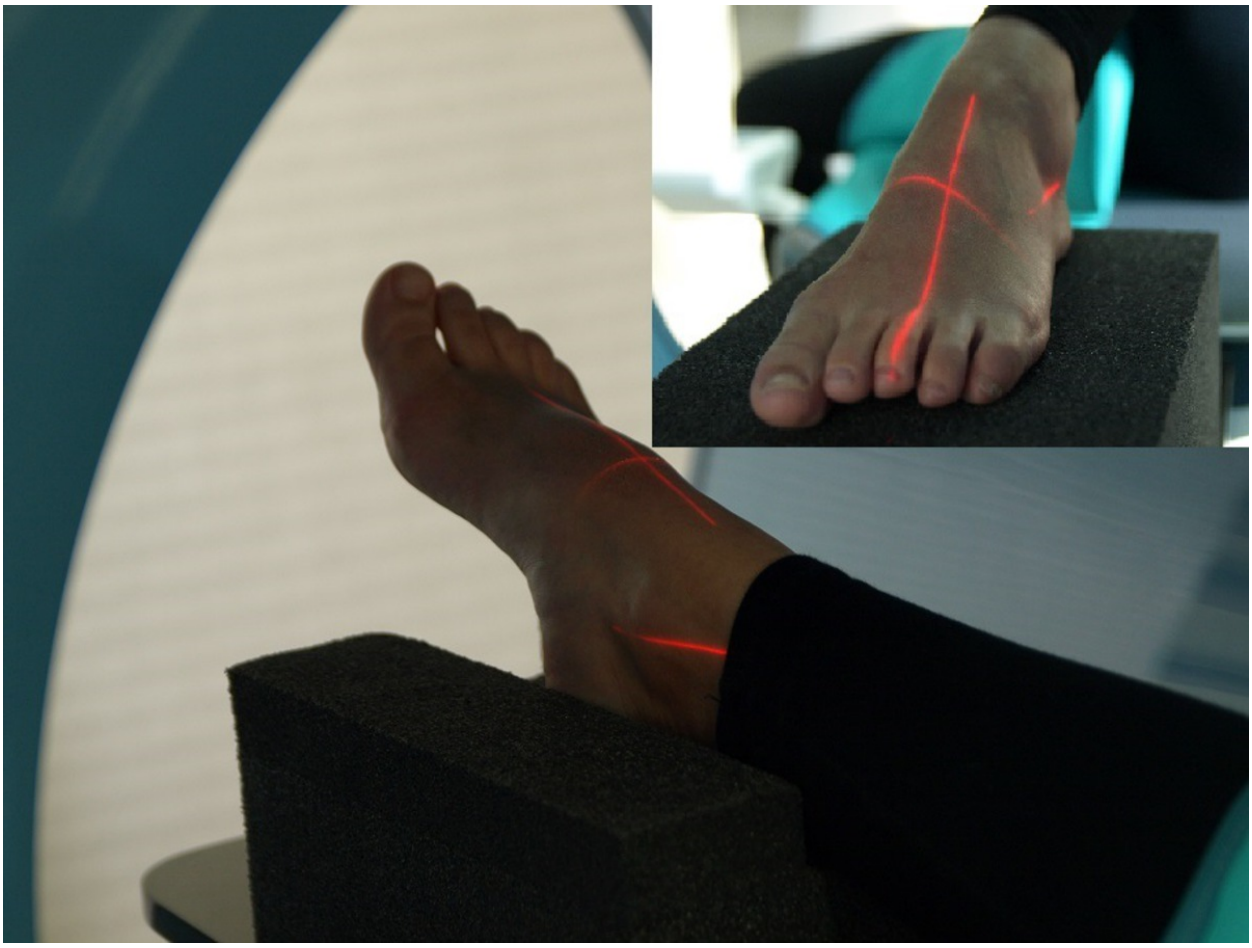

Fig. 3: Positioning of a lower extremity for CBCT-examinations of foot and ankle

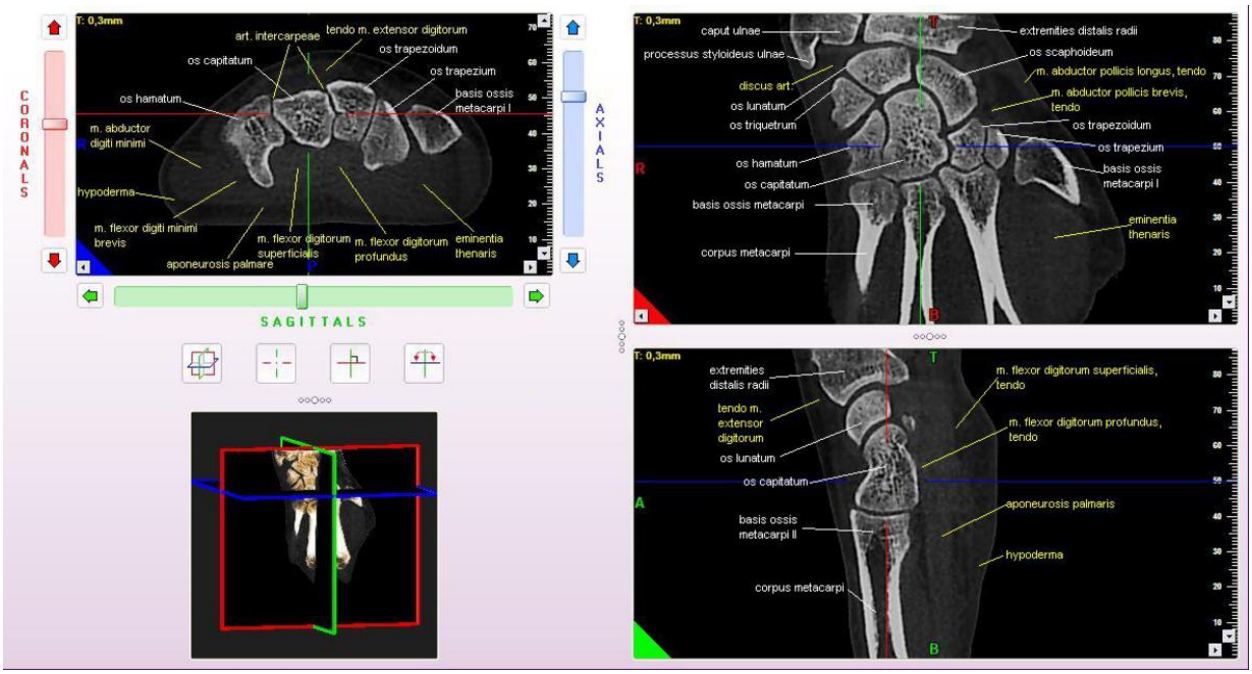

Fig. 4: CBCT. MPR, 3D. Left wrist. Normal cone-beam anatomy. White inscriptions - the bones, yellow inscriptions - the soft tissues.

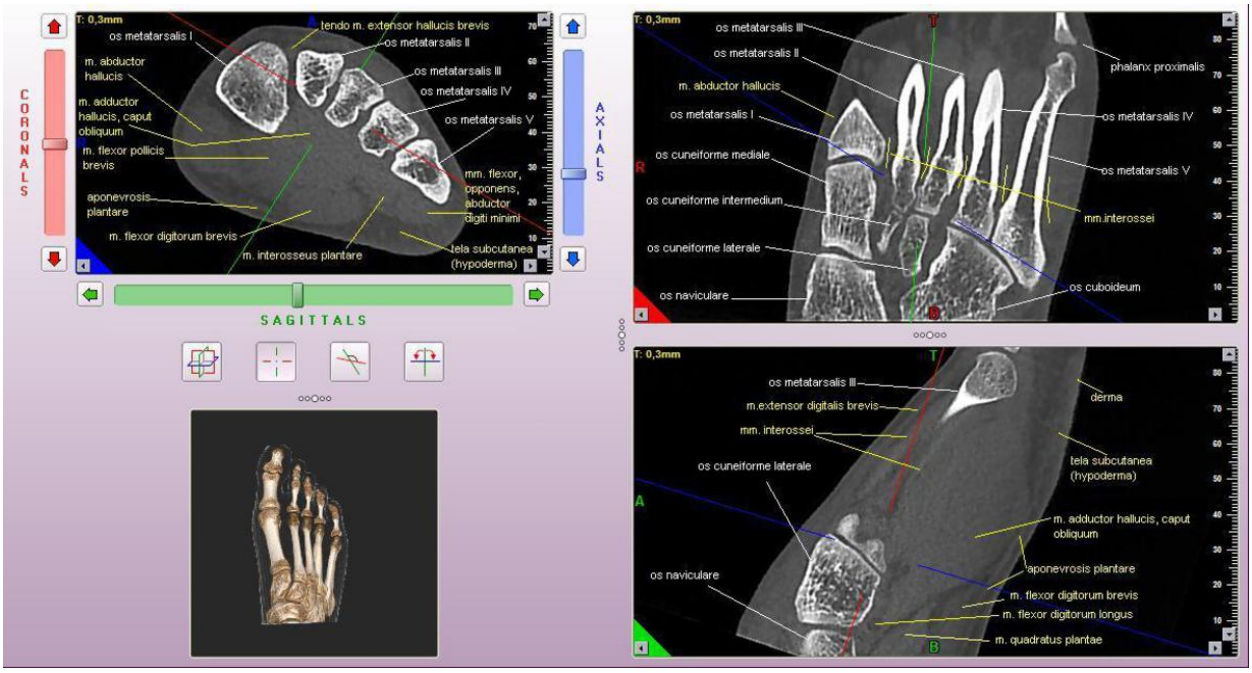

Fig. 5: CBCT. MPR. 3D. Right foot. Normal cone-beam anatomy. White inscriptions - the bones, yellow inscriptions - the soft tissues.

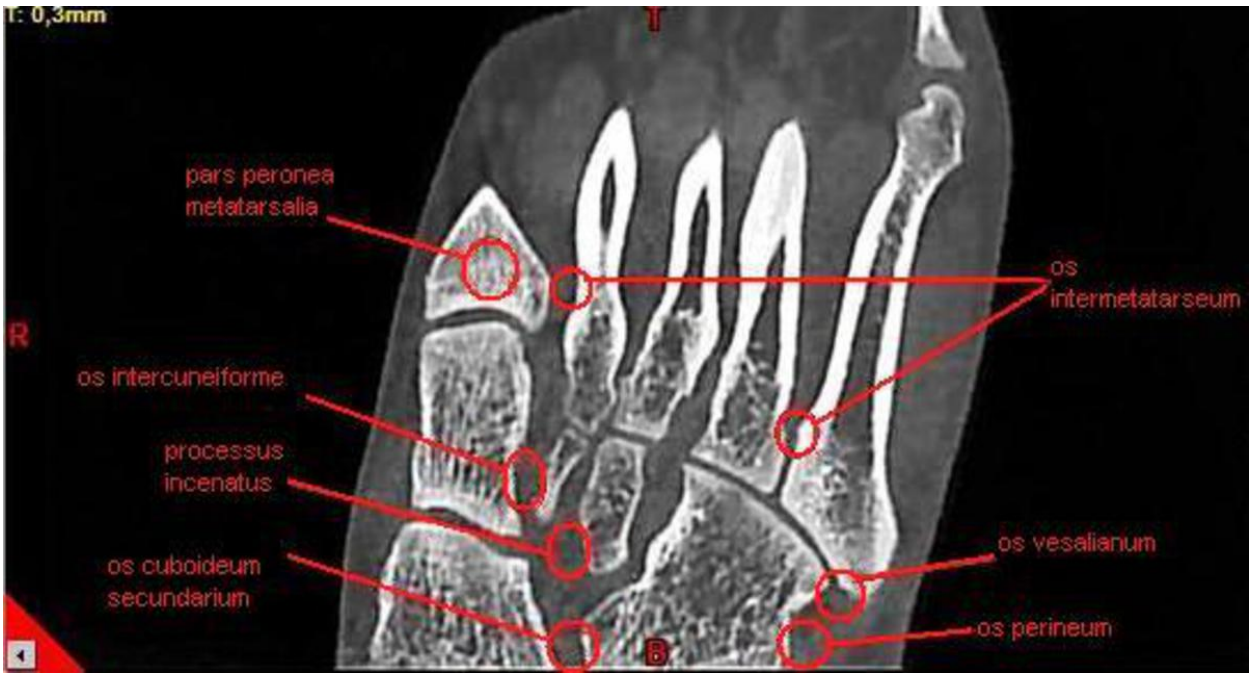

Fig. 6: CBCT. MPR, frontal view. The possible disposition of accessory bones of foot.

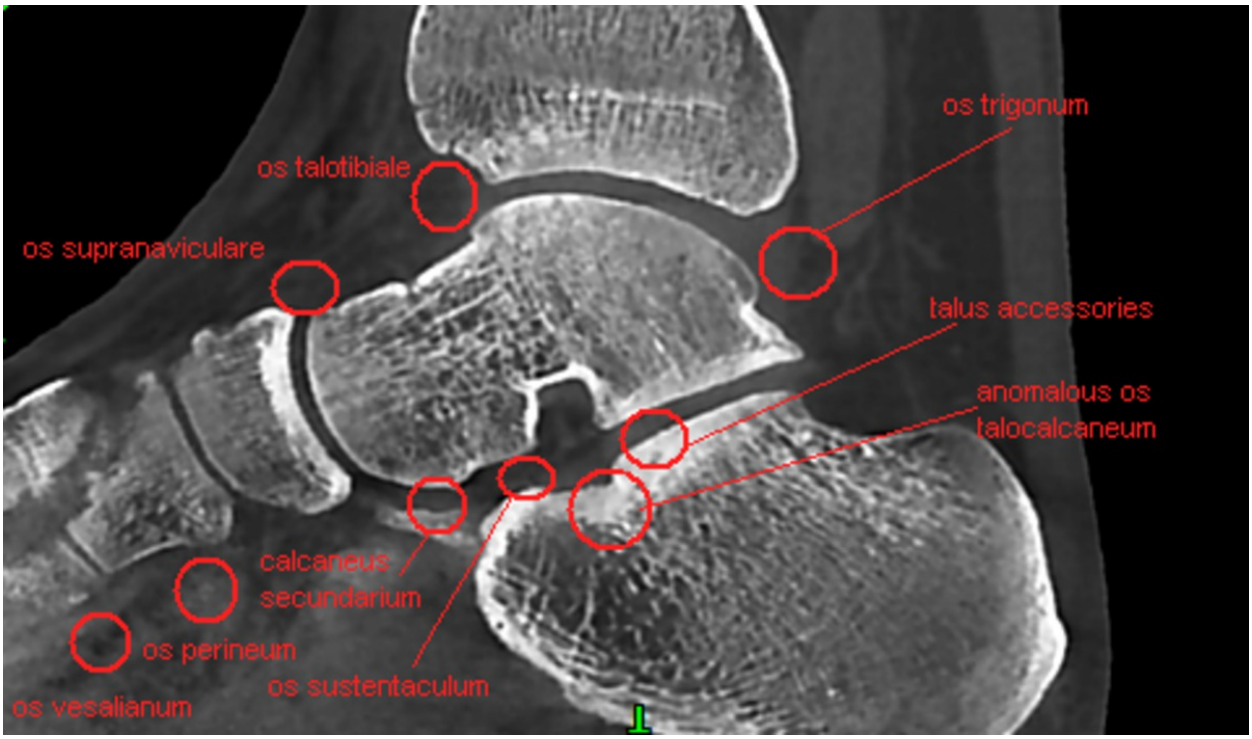

Fig. 7: CBCT. MPR, sagittal view. The possible disposition of accessory bones of foot.

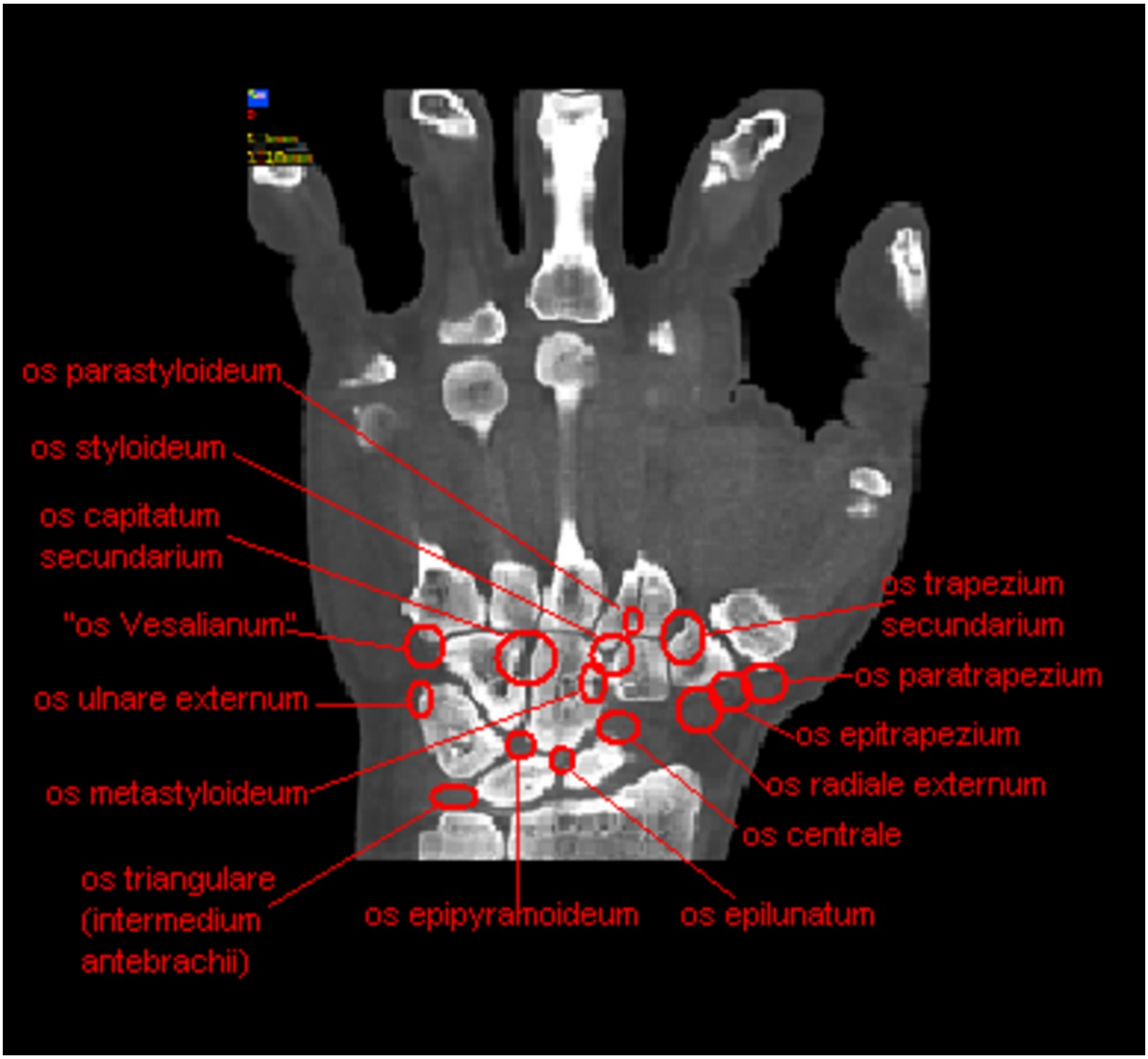

Fig. 8: CBCT. MPR, frontal view. The possible disposition of accessory bones of wrist.

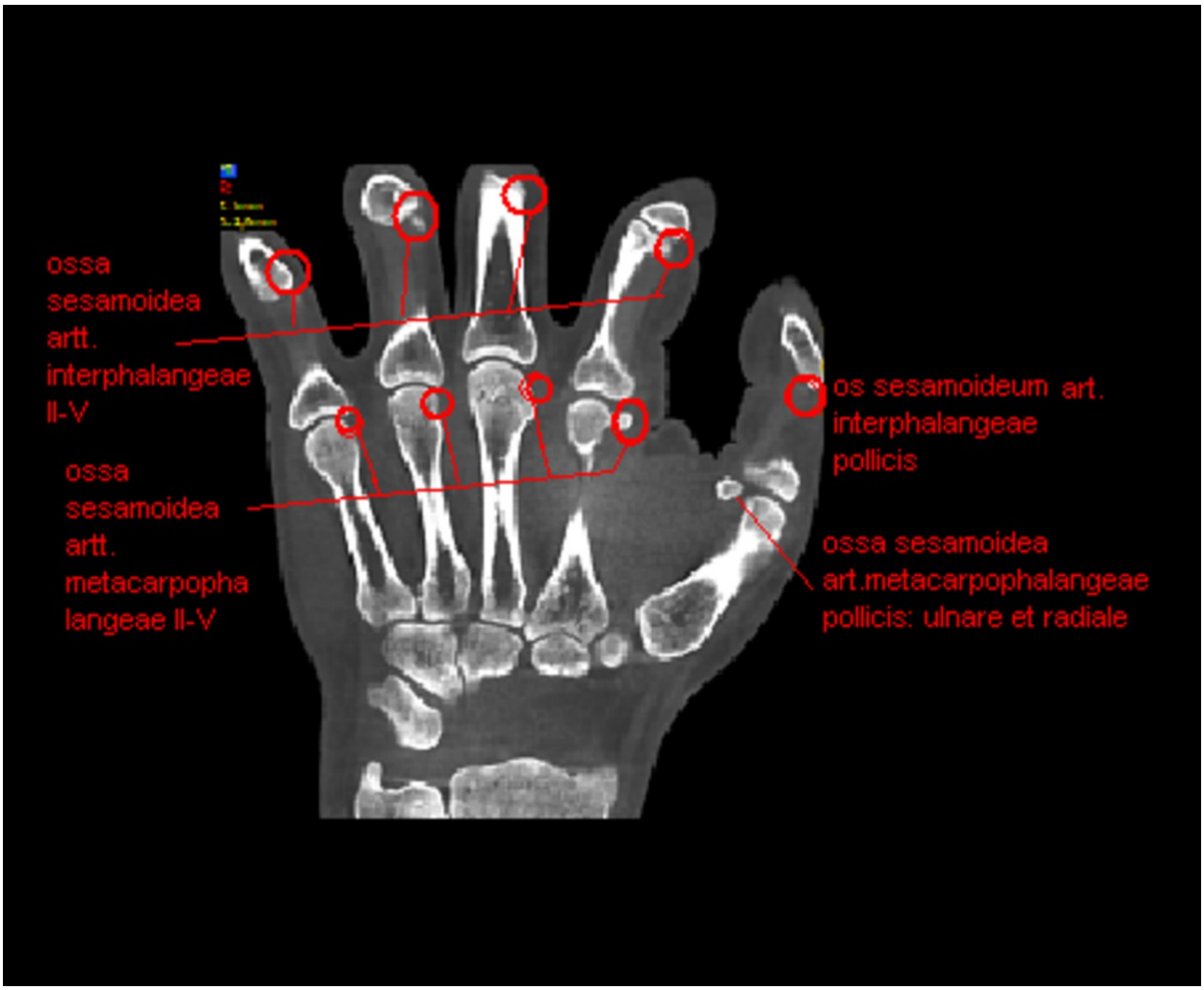

Fig. 9: CBCT. MPR, frontal view. The possible disposition of accessory bones of wrist.

Conclusion

The physicotechnical conditions and positionings for scanning of distal extremities allow to receive the images of high quality.CBCT permits a detailed study of distalextremities normal anatomy, to definethe structureof bones and soft tissues, to determine the direction of the bone beams, toestimate the spaces between them, to observe the cortical plates and the medullary canals of the segments with so difficult anatomical structure: wrist, hand, ankle, foot.

Personal information

Aleksandr Vasilyev, MD, Professor, Chief of Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, President of Moscow Association of Radiology, Russia, Moscow

KLD@msmsu.ru

Nikolay Blinov, Professor, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

Elena Egorova, Professor, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

Darya Makarova, assistant, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

Elena Gorlycheva, resident, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

Margarita Dutova, resident, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

Maksim Egorov. resident, Department of Radiology, Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Russia, Moscow

KLD@msmsu.ru

References

1. *De Cock J., Mermuys K., Goubau J., Van Petegem S., Houthoofd B., Casselman J. W.* Cone-beam computed tomography: a new low dose, high resolution imaging technique of the wrist, presentation of three cases with technique. // Skeletal Radiol. 2012. V. 41. P. 93 - 96.
2. *Koskinen S.K., Haapamäki V.V., Salo J., Lindfors N.C., Kortesniemi M., Seppälä L., Mattila K.T.*CT arthrography of the wrist using a novel, mobile, dedicatedextremitycone-beam CT (CBCT). // Skeletal Radiol. 2013. V. 42. # 5. P. 649 - 57.
3. *Ramdhian-Wihlm R., Le Minor J. M., Schmittbuhl M., Jeantroux J., Mac Mahon P., Veillon F., Dosch J.-C., Dietemann J.-L., Bierry G.* Cone-beam computed tomography arthrography: an innovative modality for the evaluation of wrist ligament and cartilage injuries. // Skeletal Radiol. 2012. V. 41. P. 936 - 969.
4. *Tuominen E.K., Kankare J., Koskinen S.K., Mattila K.T. Weight-bearing CT imaging of the lower* extremity. //AJR Am J Roentgenol. 2013. V. 200. # 1. P. 146 - 8.