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### *Spiral CT in diagnostics of complicated elbow region fractures*

X-ray examination is a basic and final technique in diagnostics of most elbow region fractures (17). Nevertheless, some of these fractures are complicated injuries and need to be carefully evaluated before deciding on the most appropriate course of treatment. In complicated elbow's joint fractures identification and location of the broken fragments and their origin encounter significant difficulties. Therefore x-ray examination is only a preliminary method, especially in case of fractures of joint surface (9, 10, 16).

The main goal of this paper is evaluation of usefulness of spiral CT scanning in diagnostics of complicated elbow region fractures.

#### MATERIAL AND METHODS

Research is based on the data of 28 patients with elbow's joint fractures. Sixteen male and 22 female patients at the age 16–58 were evaluated in the study. CT scan was done directly or no longer than 4 weeks after injury. The scanning was performed with Helical CT scanner Somatom Emotion by Siemens. Axial CT section was assessed, as well as MPR reconstructions in sagittal and coronal plane and VRT (Volume Rendering Technique) and SSD (Surface Shaded Display) 3D image of bone structures. The results were compared to plain elbow radiograms.

The objective of the study was to evaluate the extent, location and type of fractures.

#### RESULTS

Following an analysis of the fractures, the injuries were classified in three categories defined below. Fracture of the coronoid was found among 12 patients (42.9%). In 9 patients (32.1%) fracture of the head and neck of the radial bone was observed. Supracondylar fracture of the humerus was noticed in 7 patients (25%).

In CT scans of 7 patients we found 3 types of fractures, which were missed during ordinary x-ray examination: fracture of coronoid, fracture of olecranon and fracture of the capitulum of the humerus. Multifragment fracture of the elbow joint was observed in 12 patients (Fig. 1). In 3 cases during x-ray examination we suspected the presence of fracture. However, it was assumed as false-positive diagnosis after CT scan. Axial scans were a valuable tool to describe morphology of multifragment fractures of the elbow joint (composite fractures, multiple fractures), especially those located in a distal part of humerus (Fig. 2).

In 2 patients with coronoid fractures CT scanning was completed with 3D reconstruction. The results of 3D reconstruction showed fracture of joint surface and contributed to the establishing of the indications for surgical treatment. In 6 patients axial CT scanning together with 3-dimensional CT reconstruction of the image (3D SSD, VRT) demonstrated dislocation of tiny fragments of fractured bones (Fig. 3). In 4 cases of intrarticular fractures those fragments were missed during ordinary plane radiography.

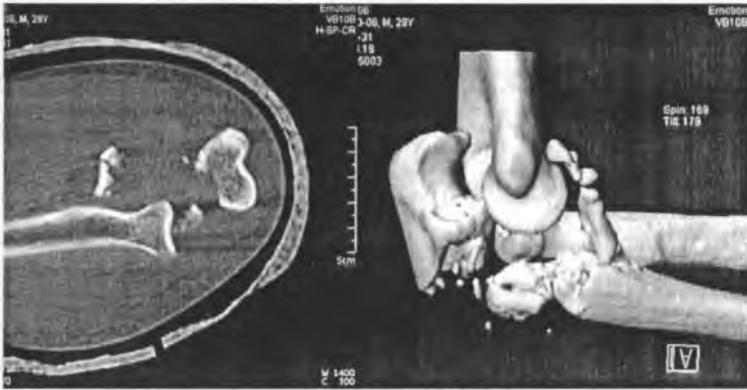


Fig. 1. Multifragment fracture of the proximal ulna (plane scan and 3D reconstruction)

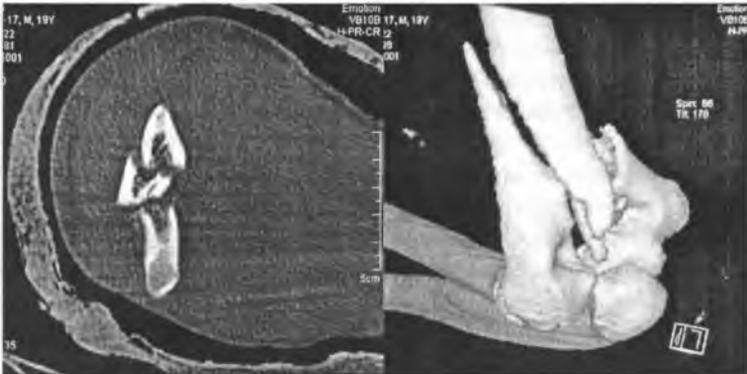


Fig. 2. Multifragment fracture of condylus of the humerus (plane scan and 3D reconstruction)



Fig. 3. Olecranon fracture with free bone fragment (plane scan and 3D reconstruction)

## DISCUSSION

The usual "terrible triad" of the elbow consists of posterior dislocation of the elbow, radial head fracture, and coronoid fracture with the presence of tiny fractured bones' fragments. This term was used in recognition of high rate of complications such as instability, malunion, nonunion, arthrosis and proximal radioulnar synostosis that this osteoligamentous injury was prone to (1, 15). Varus and posteromedial rotation of the elbow joint with its instability requires operative treatment (13).

In coronoid fracture the size of broken bone fragments assures of the joint stability (1, 4, 12). Anteromedial fractures of the coronoid process which causes instability of the elbow requires Three-Dimensional Computed Tomography reconstruction. It has been demonstrated to be helpful for diagnosis of posteromedial rotation subluxation. Clinical findings include the existence of oblique and vertical courses of the line of fracture (19). Sanchez-Sotelo (18) singles out 3 forms of coronoid fracture: type I (tip avulsion), type II (less than 50% of the process) and type III (more than 50% of the process). The coronoid acts as the anterior buttress of the greater sigmoid notch of the ulna. It provides attachment to the anterior band of the medial collateral ligament (MCL) and middle portion of the anterior capsule. As a result of active muscle motion about the elbow, broken fragments are dislocated during injury. In those cases a small, isolated coronoid fragment may be critical to elbow stability (18).

According to our data analysis coronoid fracture was the most frequent. Tiny fragments of fractured bones were often misdiagnosed as a fracture of the head of the radial bone. Elbow joint instability is caused by dislocation of bone fragments or as a consequence of posterior dislocation of the elbow (1, 5, 6, 8). Misdiagnosed coronoid fracture which occurred during forearm fractures might often lead to chronic luxation or subluxation of the elbow joint (14, 21).

In situations where a coronoid fracture was suspected but was not obvious on CT scan, a precision Three-Dimensional Computed Tomography reconstruction was very helpful. Among 4 patients with a questionable origin of fragment bone 3D reconstruction surely confirmed the diagnosis. Fracture of the head and neck of the radial bone was the second most frequent type of fracture in our clinical setting (3, 20). The smallest visible lesion in injured areas is considered difficult to be explored radiologically, especially in case of compressed fractures.

The secondary symptom as "fat pad sign" might be only a hint to perform accurate diagnostics but is often critical to achieve the best outcome (2). A clue to fracture in the elbow is another fat pad sign known as the "spinnaker sign" It is generally considered to be suggestive of an intracapsular fracture (2, 7).

3D reconstruction is used in image complex fractures, especially the ones around joints, because of its ability to reconstruct the area of interest in multiple planes (2). We affirmed that CT and MRI scan allow computer systems to integrate the data of the moving individual slices to generate three-dimensional volumetric information (3D-CT scan), in turn viewable from multiple different perspectives on attached CT workstation monitors (2). MRI is also very useful in case of medial or lateral collateral ligament injuries or triceps muscle injury (MCL, LCL, TM) (2, 11). Nevertheless, ultrasonography is also a method of great value in the diagnosis of muscle and tendon injuries about the elbow region.

## CONCLUSIONS

Plain radiography is a basic and initial technique in case of fractures of the elbow joint, although spiral CT scan can provide more clinical data, especially in multifragment fracture of the elbow joint. VRT and SSD 3D reconstruction is another very useful method in evaluation of displacement of bone fragments in displaced intra-articular fractures.

The fat pad sign indicates the presence of an intrarticular hemorrhage, which in turn is often associated with an intrarticular skeletal injury. In adults, subcutaneous haematomas might be observed in the region of *bursa olecrani* without any pathological changes in encapsulated adipose tissue of the elbow joint.

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### SUMMARY

X-ray examination is a basic and final technique in diagnostics of most elbow region fractures. Nevertheless, some of these fractures are complicated injuries and need to be carefully evaluated before deciding on the most appropriate course of treatment. In complicated elbow's joint fractures identification and location of the broken fragments and their origin encounter significant difficulties. The main goal of this paper is evaluation of usefulness of spiral CT scanning in diagnostics of complicated elbow region fractures. Research is based on the data of 28 patients with elbow's joint fractures. Sixteen male and 22 female patients at the age of 16–58 were evaluated in our study. CT scan was done directly or no longer than 4 weeks after injury. Following an analysis of the fractures, the injuries were classified in three categories. Fracture of the coronoid was found among 12 patients (42.9%). In 9 patients (32.1%) fracture of the head and neck of the radial bone was observed. Supracondylar fracture of the humerus was noticed in 7 patients (25%). Plain radiography is a basic and initial technique in case of fractures of the elbow joint, although spiral CT scan can provide more clinical data, especially in multifragment fracture of the elbow joint. VRT and SSD 3D reconstruction is another very useful method in evaluation of displacement of bone fragments in displaced intra-articular fractures.

### Spiralna TK w diagnostyce złożonych złamań łokcia

W złożonych złamaniach łokcia ocena rozległości uszkodzeń, identyfikacja oraz określenie pozycji i pochodzenia fragmentów kostnych, określenie udziału i zakresu uszkodzeń powierzchni stawowych napotyka w radiografii na trudności. Celem pracy jest ocena użyteczności spiralnej TK w złożonych i trudnych diagnostycznie urazowych uszkodzeniach łokcia. Materiał stanowi grupa 28 chorych (16 mężczyzn i 12 kobiet w wieku 16 – 58 lat) z urazowymi uszkodzeniami łokcia, u których wykonano badanie TK bezpośrednio po urazie lub w okresie do 4 tygodni od urazu. W analizowanym materiale wyróżniono trzy główne typy złamań. U 12 chorych (42,9%) złamanie dotyczyło wyrostka dziobiastego kości łokciowej, u 9 (32,1%) główki i szyjki kości promieniowej, u 7 (25%) stwierdzono złamania nadkłykciowe kości ramiennej. Radiografia jest podstawową i wyjściową techniką diagnostyczną w złamaniach łokcia. Natomiast spiralna TK jest wartościowa w diagnostyce złamań złożonych, z obecnością małych, przemieszczonych fragmentów kostnych, ocenie ich położenia oraz ocenie uszkodzeń powierzchni stawowych. Rekonstrukcje MPR są przydatne w ocenie pozycji fragmentów kostnych. Uniesienie i uwidocznienie poduszeczek tłuszczowych jest objawem wysięku stawowego.