Charcot neuro-osteoarthropathy - a challenge for radiologist.

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Authors:    V. Aznaurov, E. Belousova, E. Kondratyev, P. davydenko, V. Shirokov, G. Karmazanovsky; Moscow/RU
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Learning objectives

- to describe and to illustrate the radiological signs of different stages of diabetic osteoarthropathy;

-to clarify advantages and limits of imaging techniques available up-to-date.
Background

Charcot neuro-osteoarthropathy is degenerative disease with progressive destruction of the bones and joints of foot. It is rare and devastating complication of diabetic neuropathy, associated with high morbidity and extensive healthcare costs. Recognition, especially in the earliest stage, and differentiation between Charcot neuro-osteoarthropathy and osteomyelitis remains problematic, with many cases being misdiagnosed.

WHO predicts that diabetes will be the 7th leading cause of death in 2030 [1]

2. Diabetic osteoarthropathy (DOAP) is one of late complications of diabetes mellitus (DM) which is associated with aseptic destruction of bone skeleton of foot beside the expressed diabetic neuropathy and vessel calcinosis. DOAP frequency fluctuates from 1.5% among all patients with DM to 30% among patients with diabetic neuropathy.

3. According to WHO and International Working Group on the Diabetic Foot, diabetic foot is defined as the foot of DM patient with ulceration, infection and/or destruction of the soft tissues, associated with neurological abnormalities and various degrees of peripheral vascular disease of the lower limb [2].

The most apparent is that formation of osteoarthropathy is directly bound to existence of damage of peripheral nerves and trauma. Cavanagh P. R. et al. defined that patients with diabetic neuropathy had the larger frequency of bone and joint changes, than patients without neurologic complications [3]. Thus, the leading role of peripheral neuropathy in development of Charcot's foot is confirmed once again.

Stages of DOAP pathogenesis:

I - the incipient stage - acute destruction of joint with osteochondral fragmentation, stretching of a capsule of a joint, distortion of the copula and incomplete dislocations;

II - the consolidation stage - resorption of the majority of bone fragments and their consolidation with a adjacent bone;

III - the reconstruction stage - bone remodeling resulting in sclerosis reduction and partial restitution of a joint.

Clinical stages of DOAP:

I - acute;

II - chronic.
Findings and procedure details

Plain film was the initial imaging modality in standard coronal, sagittal and oblique planes. As a rule, patients are being hospitalized in chronic stage of the disease. The classical X-ray allows to visualize pathological fractures of bones of midfoot (fig 1.) the considerable osteofits in hindfoot, midfoot and forefoot, a porosity of bones of midfoot and forefoot. It allows to estimate an angle of deviation of 1st foot finger (ref. <14 °) and size intermetatararsal I-II fingers (ref. 8-12 °) and I-V fingers (ref. 21-32 °) angle. The most common complication of diabetic osteoarthropathy is Hallux Valgus (HV) (fig 2.)

DOAP is strongly associated with the incomplete dislocation of the 1st metatarsophalangeal joint accompanying HV.

Ulcers, wound defects, fistulas are also being detected in soft tissues of foot (fig. 3). Calcified vessels of foot and shin are frequent signs of DOAP especially in ischemic and neuroischemic diabetic foot (fig. 4).

The chronic stage is characterized by simultaneously occuring bone destruction and consolidation, along with joint deformity, dislocation and rocker-bottom deformity (fig.5). Unlike osteoarthropathy, osteomyelitis is primarily the bone disease, which is most commonly located in forefoot and hindfoot.

The computed tomography (CT) expands possibilities of DOAP diagnostics. It is always possible to precisely visualize cysts in bones structure at native study. Frequently the cysts are found in calcaneus and talus bones (fig.6). CT shows positioning of the fragments precisely.

Chronic stage of DOAP is associated with rocker bottom foot deformity (fig. 7). The cuboid bone becomes the main bone to bear all weight of body. It results in callosity and subsequently in ulceration of the soft tissues of plantar surface of foot. Hypostasis of soft tussues appear only at a later stage (in active Charcot), however swelling of bone marrow could be found in MRI study pre-clinically. MRI in chronic Charcot will reveal soft tissue swelling, but not the bone marrow edema.

In MRI it is possible to make rather precisely differential diagnostics between DOAP and osteomyelitis [4]. It is necessary to remember that DOAP in acute stage affects joints, instead of bones, unlike osteomyelitis. In MRI subchondral hypostasis of marrow at the midfoot is revealed while visible soft tissues defects are not.

Ulceration of soft tissues is dangerous because of increased risk of infection, including osteomyelitis. MRI allows to find to diagnosis DOAP complicated by osteomyelitis: a
course of fistula to a bone is traced and the change of the signal of the bone marrow may be estimated (fig. 8,9). The osteomyelitis in such patients usually affects midfoot.
Fig. 1: Incomplete dislocation of the first metatarsophalangeal joint, destruction of bone structures of the 4th finger, multiple fracture of the 2nd metatarsal bone basis. Calcaneal spurs at sagittal plane.

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Fig. 2: Hallux Valgus - typical complication of a diabetic osteoarthropathy. Foot soft tissues defect.

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Fig. 3: Fistula in foot soft tissues (plantar surface). Ulcer on dorsal surface.

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Fig. 4: Calcified vessel in shin soft tissues. Total destruction of midfoot bones.

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Fig. 5: The 2nd and 3rd metatarsal bones osteolysis, 1st metatarsophalangeal joint destruction, 4th metatarsal bone fracture with consolidation.

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Fig. 6: Cysts in calcaneus and talus

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Fig. 7: Rocker-bottom deformity. Ulcer at plantar surface. Calcified vessel. Cuboid bone fracture. Cavity at calcaneus bone.

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Fig. 8: Small cutaneous defect and subcutaneous edema at the metatarsals. A secondary sign, an abscess, is shown in the forefoot, with high signal intensity on STIR, low or intermediate signal on intensity T1W, and ring-enhancement of the borders showing high signal intensity on T1+Gd.

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Fig. 9: Acute Charcot neuro-osteoarthropathy. The bone marrow edema typically is not restricted to one or two bones, but is seen in the entire midfoot. Bone marrow edema and its enhancement are typically centered in the subchondral bone, suggesting articular disease. The subcutaneous tissues are relatively normal and there is no ulcer or other signs of infection.

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Conclusion

The diabetic Charcot foot is rare, but a life-changing condition affecting quality of life and resulting in a high risk of amputation. However early changes in the foot can be evaluated and irreversible outcomes can be prevented with implication of modern imaging modalities.
References