CHAPTER 1:
ASEPTIC/AVASCULAR OSTEONECROSIS:
DEFINITION, ETHIOLOGICAL FACTORS

Through osteonecrosis we understand the death of the cellular components from the compact and trabecular bone which results through a local ischemic phenomenon.

Avascular/aseptic osteonecrosis (AVO) represents a generical term which refers to the ischemic death of the osseus structures; the term AVO is reserved for the subcondral lesions, while the term of osseus infarct denominates the necrosis of the medulla/trabecular bone.

The ethiology of aseptic osteonecrosis is insufficiently known. Its cause can not be precisely determined, however certain predisposing factors were to blame:

- toxic causes: steroids, antiinflammatory substances, alcoohol, immunosupresives;
- traumatic causes: idiopatical, fractures, frost bites, radiotherapy, fatty embolisms
- inflammatory causes: PR, LED, sclerodermia, infections, pancreatitis
- metabolic / endocrine causes: pregnancy, diabetis mellitus, Cushing, hiperlipidemia, gout
- hematological causes: sicle cell disease, policytemias, Gaucher disease, haemophillia
- trombotical/ embolic causes: chesoniers’ disease, arteritis

CHAPTER 2:
EMBRIOLOGICAL AND ANATOMICAL DATA OF HIP JOINT

The ossification centres of hip joint: At the level of hip joint the ossification presents the following particularities: the hip bone/ coxal bone has three ossification centres for the ilium, the ischium and the pubis. The primary ossification centre for the ilium appears in the VIIIth week of intrauterine life and is situated in a superior position to the great ischium notch. The primary centre for the ischium appears in the IVth month at the level of the body and the primary ossification centre for the pubis appears in the IV-Vth months at the basis of the superior branch.

2.3. DATA ABOUT THE BIOMECHANICS OF HIP JOINT

The resitence structure –the trabecular system
The osseus substance is structured in two trabecular systems: one situated at the level of the femur head and another at the level of the great trochanter.

The femoral head represents the maximum resistance piece of the femoral proximal extremity, maintaining its characteristics even in the elderly, its resistance being partially decreased.

The second trabecular system is situated at the level of the trochanterian zone and represents the maximum resistance zone, the more accurate location being at the joint of the femoral cervix with the great trochanter. Between the two resistance systems can be found a low resistance zone (Ward’s triangle). This zone has a low density of osseus trabecules, it is the zone of choice for the fractures of the femoral neck.

**Artrokinetics – the movements in the hip articulation** are classified as follows:

- Flexion/extension – 90-130° / 120
- Adduction/abduction - 10° / 80-140°
- Internal/external rotation - 35° / 15-120
- Circumduction

## CHAPTER 3:

**THE ASEPTIC OSTEONECROSIS OF THE FEMORAL HEAD**

**THE LEGG-PERTHES-CALVE DISEASE**

**Definition:** The Legg-Calvé-Perthes (LCP) disease is an avascular idiopathic necrosis of the proximal femoral epiphysis at growing children.

**Incidence/Epidemiology**

The prevalence of this disease is 1/1000-3000, mainly in boys (85%), with a report M/F:4/1 and is less frequent in black people (an osteocondritis in black people prompts an analysis of the hemoglobinopathy). The maximum incidence is between 4 and 10 years but it can also appear beyond these limits, the approximate median being 7 years [130,231]. The unilateral forms prevail in approximatively 90% of the cases, without a predominant location.

**The physiopathology of LCP disease**

Regarding the pathogenesis of LCP, up to the present, there is no fully satisfactory unique theory. The existing theories partially explain the mechanism of occurrence of osteocondritis and there are basically more arguments against than in favor of each theory.
1. The first theory is based on static causes and accuses the femoral anteversia. Coxa valga, underlined by Sundt is not constant. Some well defined and central forms occur on a preresistent coxa valga.

2. The traumatic theory asserts that epiphysary microtraumas can favor or even cause the disease. To sustain this theory there is also the hyperactivity of boys at this age, thing which leads to frequent trauma.

3. The inflammatory theory claims that the acute transitory inflammation of the sinovium can disturb the epiphysis vascularisation either through tamponade phenomena, or through an oedema of the joints cartilage at the level of the epiphyzo-metaphyzary jonction, with a constant compression of the nutritive vessels.

4. The vascular theory At times, the venous injury is incriminated as cause, but the perturbation of arterial circulation is usually considered the cause of the LCP disease.

*The evolution of the disease*

Interpreted as an ischimical necrosis of the superior femural epiphysis, the LCP disease represents, for a child, the equivalent of the idopathic necrosis of the femural head for an adult. Unlike the latter, LCP will have severe particularly complex repercussions on the growing mechanisms, of the superior extremity of the femural bone. The evolution of this disease is variable, from cases in which the reshaping of the femural head can go smoothly up to cases in which the growing lesions are irreversible with severe architectural damage (coxa plana). The LCP disease can not be resumed only to the radiological evolution in three phases (condensation, fragmentation, reparing) but it goes through a much longer evolutive period.

CHAPTER 4:

**METHODS OF RADIO-IMAGISTIC DIAGNOSIS IN ASEPTIC OSTEOENCEHROSIS**

**4.1 RADIOLOGICAL – TECHNICAL EXAMINATION, VALUE, LIMITS**

*The radiologial aspect* is many times the only exam used to diagnose the disease, patients usually being in constituted stages, with obvious changes in the subcondral osseus cephalic structure, from incipient demineralization to mixed changes, with a detaching of the osseus mass, then compaction of the articular surface and enlargement of the articular space, followed by the coxae-femural arthrosys, with a late envolvement of the acetabulum.

**4.3. COMPUTED TOMOGRAPHY**
Computed tomography has not initially been a frequently used method in the diagnosis of osteonecrosis, mainly because of the axial acquisitions being too approximate, incomplete, the multiplanar reconstructions, because of the long duration for acquisition and the ionizing radiation. Nowadays, multi-detector helical/spiral computed tomography (MDCT or usually CT) is an additional method for the X-ray, useful in osteometric evaluations of inferior limbs and in multiplanar reconstructions and 3D.

4.4. OSSEUS SCINTIGRAPHY

Osseus scintigraphy has also a high sensitivity (~ 85%), comparable with the one of NMR examination and superior to the standard radiological and CT examination.

The intake Tc-99m diphosphorus is high in the metaphysis of long bones and in the equivalents of flat bones. The physiological intake decreases with the age but it can persist even after the growing zones closed from a radiological point of view.

4.5. THE NMR EXAMINATION

The NMR examination visualises lesions at the level of the femoral head in accordance with the stage of the affection. The NMR examination has the greatest accuracy in the diagnosis of NACF in an incipient stage with a sensibility of 71 - 100% and specificity 94 - 100%. Because there is a high rate of bilateral involvement, both coxae-femoral joints have to be included in the examination protocol.

4.6. THE ECOGRAPHY/ ULTRASONOGRAPHY (US) EXAMINATION

The ultrasonography (US) represents one of the best imagistic techniques in the diagnosis of musculoskeletal pathology, as it has a low cost, it offers an optimum spatial resolution, higher than of RMN and CT examinations; moreover this method has a great availability and it is well tolerated by patients, practically not having any contraindications, as it is based on using ultrasonic waves which are not ionizing, in the same way as X-rays are in conventional radiology and CT [171].

Echography represents an ideal technique both for the diagnosis but also for the examinations of evolution of the musculoskeletal pathology, particularly for the LPC disease which affects child patients.

CHAPTER 5:

THE POSITIVE AND DIFFERENTIAL RADIO-IMAGISTIC DIAGNOSIS IN

THE LEGG-CALVÉ-PERTHES DISEASE
The standard X-ray can emphasise the same aspects with those of avascular osteonecrosis, but with the presence of conjugation cartilages specific to childhood age.

The precocious signs on the X-ray film are:
- the asymmetrical length of the proximal femoral epiphysis, a smaller epiphysis on the affected part
- an apparent increased density (osteocondensation) of the femoral proximal epiphysis
- the enlargement of the internal joint space
- irregularities in the shape of the metaphysis surface
- The enlargement of the zone of the proximal femoral metaphysis growing cartilage

CHAPTER 6
THE AIM OF THE PAPER

In this paper we would like to present from a modern perspective given by the improvement of the diagnosis techniques, an integrated vision of aseptic osteonecrosis also known as avascular necrosis, both concerning the positive and differential diagnosis and concerning the monitoring of the evolution of treated cases and some neglected cases up to advanced stages. Due to the development of examinations through sectional imagistics, as examinations through NMR, helicoidal multidetector CT and Doppler echography, one can interpret the pathology of avascular osteonecrosis as a local disease, in which are also affected the capsule-ligamentary and muscular-tendinous structures, with effects on the „pair” bone of the affected articulation and, then, of the close articulations.
MATERIAL AND METHOD

7.1. THE SELECTION OF CASES

For the study on the diagnostical contribution of the radio-imagistic examinations of avascular osteonecrosis and with the aim of pathological illustration, I selected the cases in the Radiology and Imagistic Department of the County Clinic Emergency Hospital Craiova, during the period January 2006- August 2012. These cases, due to the rarity of aseptic osteonecrosis, came either from the ambulatory, or from various clinical sections of the hospital: Ortopaedy, Rheumatology, Physical therapy, Medical Oncology and Radiotherapy, being used in the study as demonstrative material in the general description and classification of osteonecrosis and as reference diagnosis material for the analysed groups, as we will specify below.

CHAPTER 8:

1. THE RESULTS OBTAINED AND THEIR INTERPRETATION

2. THE PRESENTATION AND RADIO-IMAGISTIC ILLUSTRATION OF LCP DISEASE

AND OF THE THERAPEUTIC RESULTS ON THE STUDIED GROUPS

From the study of the distribution according to gender, we noticed a prevalence of the cases of LCP disease at male subjects, while the rest of the avascular osteonecrosis and other pathological cases related to the hip joint do not present a significant difference between the two genders. (Picture 8.21).

The radiological examinations represented the basic positive and differential diagnosis method in all the cases, allowing to establish the stage of the disease.

CASE 1: The Legg-Calvé–Perthes Disease - Classical Aspects


**Picture. Case 1: CD, 4,5 year olds:** Radiological aspect in LPC disease at the level of the right hip: weak compaction with osteocondensation of the femoral head, the widening of the articular coxae-femural right space, without acetabular changes, with an insignificant shortening of the right femur.

**Case 4: Aspect of neglected, complicated LCP disease**

![Image]

**Picture. Case 4: DI, B, 9 years:** X-ray of pelvis antero-posterior view, in a case of coxo-femural Osteoarthritis on the right, complicated with the necrosis of the femoral head, underlining the compaction with fragmentation and osteocondensation of the femoral head, associated with the widening of the proximal metaphysis just like in LPC disease, but with the presence of irregular shrinking of the articular space with severe acetabular demineralisation and secondary super-external subfracture of the femoral head. The inclined but partially simmetrical pelvis excludes the primary congenital subdislocation/luxation of the hip.

**CHAPTER 9**

**DISCUSSIONS**

**THE ILLUSTRATION OF RADIO- IMAGISTIC METHODS IN ASEPTIC OSTEONECROSIS IN GENERAL**

In the positive diagnosis of osteonecrosis we must understand that the lesions which go beyond the strict limitation to the bone, with the involvement of capsulo-ligaments and musculo-tendinous structures more than someone would have imagined on the single basis of the classical radiological diagnosis. This thing could be demonstrated through the development of
the sectional imagistic, which led to a more accurate vision over the mechanisms of the disease and the treatment possibilities. The study of the local osteo-articular vascularization allowed the development of the vascular factor in determining osteonecrosis, but also the monitorization of the evolution during the treatment.

**Echography** has the advantage of an accessible non-irradiant exploration with a low cost, therefore repeatable, which can be done anywhere, in the Emergency Room, in the hospital ward or in the operating room; although its applications in the musculoskeletal pathology were reduced in the past, the improvement of devices and the presence of well-prepared echographists allowed using echography on a larger scale, as an additional method to the radiological examinations, useful as a survey examination, allowing the development of explorations through CT, which are more expensive and irradiant, or those through NMR which are more expensive and less accessible. Moreover, Doppler echography can offer data about the vascularization of soft, articular and periarticular parts and of the peripheral pathological osseus zones.

The NMR examinations are, however, indispensable for the global balance of the musculoskeletal pathology, because they allow the complete visualisation of the lesions of soft articular and periarticular parts, on one hand, with a sensibility superior to echography for the depth details, as well as for the osseus ones, with the separation of osteonecrotic modifications from the oedematous ones and from the reactive-productive ones represented by the granulation tissue with the determination of the sign of “double line” on the ponderated acquisitions T2 și STIR.

The differential diagnosis was often necessary in the case of chronic, primary or secondary, specific (bacilary) or nonspecific osteoarthritis, usually associated with avascular osteonecrosis, from the point of view of the complications. (Picture 9.16).

One of the differential diagnosis of the femoral head epiphyseolysis was the congenital hip dysplasia (Picture 9.19), while the bacilary osteoarthritis is often suspected in the cases of local diffuse demineralization, especially for the patients with personal or positive familial antecedents (Picture 9.20).

The diagnosis through NMR, thanks to the high sensitivity, can detect the osseus oedema in an early stage and the differential diagnosis must be made with the differential idiopathic transient osteoporosis, with similar modifications. (Picture 9.21).
CONCLUSIONS

1. From the study of the cases prevalence according to gender on the number of patients at the hospital in Craiova, we noticed the frequency of the Legg-Calvé-Perthes disease cases in men, representing 82% of the cases, in accordance with the data in the sources which estimate that the disease is 4 times more frequent in boys; in the same time the other cases of avascular osteonecrosis and other pathologies of the hip joint did not present a significant difference between the two genders.

2. For the same group of people I noticed an obvious frequency of the avascular necrosis of the femoral head in children at the level of the left hip, no matter the etiology, meaning 37/52 of the cases representing more than 71% of the operated patients, in comparison with 13/52 (25%) in the right hip and less than 4% cases bilateral. This interesting observation could be explained through the fact that most people are right-handers, the right limbs presenting a frequent active function with isotonic contraction, while the left limbs are generally used for support with isometric contraction, which reduce the blood flow through the growth of the intramuscular pressure.

3. The radiologic examinations represented the method for a positive and basic differential diagnosis in all the cases, allowing to establish the stage of the disease, using the standard incidences, in the case of coxo-femurale joints, making the antero-posterior incidence in adduction or abduction and the „urologic“ incidence, for the evaluation of the congruence of the articular surfaces. Our recommendation is for the usage of digital radiological equipment which allows the optimisation of the image regarding the contrast and the reducing of the irradiation level, with possibilities of processing and stocking the image, reducing the additional irradiations and allowing a more efficient monitorization of the evolution of the cases during the treatment.

4. According to the data and the results obtained, I consider the objectives of this thesis have been reached and the conclusions are reflected in the results that I found in the reference materials. The contribution of the radio-imagistic examination was significant in the positive diagnosis of avascular osteonecrosis as well as in the supervision of the disease evolution during treatment. The data which resulted from this study and the iconography can be useful
for doctors of various specialities: radio-imagist doctors, family doctors, pediatricians, surgeons, kinetotherapists.

REFERENCES


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