Plain Photo Overview of Legg Calve Perthes Disease

Anggita Putri Kantilaras

Universitas Muhammadiyah Yogyakarta, Departemen Radiologi, Fakultas Kedokteran dan Ilmu Kesehatan, Universitas Muhammadiyah Yogyakarta, Bantul, Indonesia

*Corresponding author:

Email: anggita.p.kantilaras@gmail.com

Abstract.

Legg-Calvé-Perthes disease (LCPD) is a condition affecting the hip joint in children, characterized by avascular necrosis of the femoral head due to impaired blood flow. The disease primarily affects children aged 2–8 years, with a higher incidence in males. The exact cause of the disease remains unknown, but potential factors include trauma, vascular compromise, and coagulation abnormalities. LCPD is diagnosed through clinical symptoms, physical examination, and imaging, with plain radiographs being the primary diagnostic tool. The disease progresses through four stages: ischemia, fragmentation, rheoossification, and remodeling, each with characteristic radiographic features. In the early stages, plain radiographs are often normal, which can lead to misdiagnosis. Treatment aims to prevent arthritis and deformity, with conservative approaches such as physiotherapy or surgical intervention depending on the severity and age of the patient. This review aims to provide an overview of the radiographic features and clinical stages of LCPD, emphasizing the importance of early detection for more effective management and improved outcomes.

Keywords: *Legg-Calvé-Perthes disease; avascular necrosis and Perthes disease.*

I. INTRODUCTION

2.1 Anatomy of the hip joint

The ossification center in the femoral head in infants begins to form at 4 months of age and grows over time. During growth, the epiphysis of the femoral head becomes visible as a flattened fovea. PelvisThe hip joint is formed by the fusion of the thigh bone (femur) with the three bones that make up the pelvis: the ilium, pubis (pubic bone), and ischium. Like the shoulder, the hip is a ball-and-socket joint (acetabulum), but it is much more stable. Stability in the pelvis is due to the deep acetabulum. Stability is enhanced by the joint capsule and the strong muscles and ligaments surrounding it. The hip capsule is a dense, fibrous structure that includes the iliofemoral, pubofemoral, and ischiofemoral ligaments. These ligaments, along with the ligamentum teres and the labrum, provide pelvic stability.

The femoral head is covered by several ligaments from the superior, medial, anterior and posterior sides.The iliofemoral ligament is also called the "Y" ligament because the fibers form an inverted Y. The iliofemoral ligament strengthens the anterior joint capsule. The pubofemoral ligament consists of small bundles of fibers in the anterior and lower medial portions of the joint capsule. The ischiofemoral ligament is a strong, triangular ligament at the back of the capsule..[4.5]

The femoral head is covered by cartilage tissue that serves as a cushion when pressure occurs and lubricates the joint when the pressure occurs. The articular cartilage covering the femoral head is not evenly distributed. In the fibrous capsularis of the joint connected to the ileo-femoral ligament is very thick, under the tendon m. psoas thin in the bursa psoas among thin.6 The inside of the joint is lubricated by a slippery substance called synovial fluid. Bursa is a small sac filled with a very slippery fluid. Bursa acts as a lubricant between tendon and bone. This is useful to prevent tendon damage when moving over bone.6 The arteries that supply blood to the hip joint are: The deep femoral artery branches two blood vessels that enter through the capsule of the hip joint. These blood vessels vascularize the femoral head. As mentioned earlier, the ligamentum teres contains small blood vessels that provide a very small supply of blood to the upper part of the femoral head6.

2.2. Reason

The exact cause of this disease is still unknown. Children with LCPD experience delayed bone maturation, disproportionate bone growth, and short stature. It can be idiopathic, or may result from trauma to the femoral epiphysis, steroid use, synovitis or congenital hip dislocation, joint effusion, cartilage hypertrophy, congenital vascular hypoplasia, or blood coagulation disorders.(7)

2.3 Pathophysiology

Although the EtiologyWhile the cause of LCPD remains unknown, clinical findings and experimental evidence support the idea that impaired blood flow to the femoral head is the cause. Some histopathologists have shown that the pathological process in LCPD affects the articular cartilage, epiphysis, physis, and metaphysis. There are many theories about what causes this impaired blood supply. Some appear to be related to nutrition. Malnourished children are more likely to develop the condition. Children with abnormal blood clotting (a condition called thrombophilia) are at higher risk of developing Perthes disease. Children with abnormal blood clotting have blood that clots more easily and more quickly than normal. This can lead to blood clots that block blood flow to the femoral head. There is some emerging evidence that LCPD is genetic, resulting from mutations (abnormal changes) in type II collagen (a fiber that forms the structure of soft tissue).7 Changecartilage in joints is found mainly in the middle and in the sectionDeep. These changes include necrosis, endochondral ossification, separation of cartilage from subchondral bone, and blood vessels. The exact mechanism of this disease is unknown. The most common cause is vascular disorders, a lack of bone nutrition due to blockage of arteries or veins.

This diseasegoes through 4 stages within 2 to 4 years, namely:

Stage1. Ischemia/Early/Necrosis

On plain radiographs, the femoral head sometimes appears normal. In this early stage, the bone core does not grow due to avascular necrosis, but cartilage continues to grow, receiving nutrition from synovial fluid. Subsequently, the femoral head begins to collapse. The femoral epiphysis stops growing for a period of 6 to 12 months. The continued growth and thickening of the cartilage in the joint is seen as a "Waldenstrom sign" (increased joint space and mild pseudosubluxation) on x-ray. The pathology here (at least in animal models) is that osteoclasts remove dead bone.

Stage2. Resorption, fragmentation.

At this stage, a normal mechanism occurs where bone resorption is replaced by fibrous tissue which may undergo calcification.This results in a radiographic appearance of a central sequestrum that continues to mineralize and solidify, with lytic areas surrounding the unossified bone. Finally, neo-ossified bone forms. – *cartilage*In the femoral head, endochondral ossification occurs with blood vessel invasion followed by osteoblasts.FinallyAll dead bone is removed and replaced with new bone. Bone resorption causes changes in the bone structure of the proximal femoral epiphysis. This causes deformation of the epiphysis. The bone is revascularized with new lamellae forming in the dead trabeculae, resulting in a fragmented necrotic bone core. Reabsorption is usually complete after 12 to 18 months. Cysts appear in the proximal femoral metaphysis; increasing severity can lead to osteolysis of the superolateral femoral head (Gage sign on x-ray).

Stage3, Reossification and resolution.

Reossification usually begins at the epiphyseal margin (paraphyseal ossification). Occasionally, reossification through the physis results in a bony bridge, causing growth in the femoral neck. Resolution is usually complete within 6 to 24 months, resulting in healing or, in more severe cases, disfigurement.

Stage4. Remodeling

HeadThe femoral head is damaged during remodeling, which can cause flattening and distortion of the femoral head. Structural changes in the hip joint, based on the sphericity of the femoral head and acetabular congruence, are divided into five classes, each of which is closely related to the final prognosis. An aspherical femoral head with good joint congruence causes moderate hip osteoarthritis. However, an aspherical joint with poor congruence will cause severe osteoarthritis at a younger age.8

2.4. Clinical Signs and Symptoms

2.4.1 Complaints.

The anamnesis requires information about a history of trauma to the hip joint or the presence of several diseases suspected as secondary causes of Legg-Calve-Perthes disease. Pain in the hip joint and a limp are present. Limitations of hip motion depend on the stage of the disease. Hip motion is good in the early stages, but hip irritability can occur due to persistent synovitis. Some patients' movement improves during the reossification stage but may remain limited by residual deformity. Depending on the duration of the disease, thigh and calf muscle atrophy may occur.9

2.4.2. Physical examination

On examinationHip movement is abnormal and limited. The roll test involves the patient lying supine and performing a pelvic examination of the affected extremity, performing external and internal rotations. This test elicits muscle spasms, particularly with internal rotation, and may cause pain. This usually indicates an inflamed hip and the presence of inflammatory fluid (called an effusion) in the hip joint. The main problem with LCPD is changes in the structure of the hip joint, which affect how the hip joint functions depending on the extent of the hip joint involvement. Muscle weakness and atrophy of the thigh and calf muscles can develop over time. The affected leg may shorten as a result of the changes in the hip, resulting in a leg length discrepancy.10

2.5. Classification

Caterall's classification is based on epiphyseal involvement on anteroposterior and lateral plain radiographs. There are four groups based on epiphyseal involvement:

Group 1: The anterior aspect of the epiphysis is only minimally involved, there are no metaphyseal changes and the prognosis is good.

Group 2: The anterior aspect of the epiphysis is significantly affected, with involvement of both the medial and lateral aspects of the epiphysis. Small cysts are visible in the metaphysis, with a subchondral fracture line visible, but they do not extend beyond the tip of the epiphysis and are located in the anterior aspect. The prognosis is good, especially in young children.

Group3: The entire epiphysis is involved. Plain radiographs from the AP plane typically show the “head-within-a-head phenomenon” of a widened femoral neck. The prognosis is much worse.

Group4: The entire epiphysis becomes necrotic, and the femoral head takes on a mushroom shape. A triangular shape can be seen medially and laterally, and there is general metaphyseal involvement. The prognosis is very poor.

2.6. Diagnosis

DiagnosisThe diagnosis of Legg-Calve-Perthes disease is based on a combination of symptoms, signs, physical examination, and imaging. Plain radiographs remain the primary modality for evaluating LCPD and staging the disease. Scintigraphy is a useful technique for early diagnosis if plain radiographs are normal; with scintigraphy, abnormalities become apparent before the disease is discovered on plain radiographs.

Computed tomographyA CT scan can diagnose early bone abnormalities and early sclerosis in curvilinear zones. While plain radiographs are less sensitive, a CT scan can show changes in the trabecular bone pattern.

Ultrasonographyuseful in the early diagnosis of transient hip synovitis and early LCPD. Hip effusion with capsular distension can be depicted on sonographic images.

LimitationsThe imaging techniques are:

FindingsPlain radiographs may be completely normal in the early stages. Although abnormalities become apparent with scintigraphy, these findings are nonspecific; they may be positive in patients with trauma, synovitis, and infection. The use of CT scanning is limited by the relatively high radiation exposure. Ultrasonographic diagnosis of LCPD is based on the appearance of a hip effusion, which is a specific finding. On MRI scans, changes seen as bone marrow edema and joint effusion are nonspecific. Angiography, venography, and arthrography are invasive procedures and do not provide significantly better information for guiding therapy.11

2.7. Hip Joint Plain X-ray Technique

Plain photos of the hip joint in sufferers of this disease haveThe purpose of this procedure is to diagnose, evaluate, and prevent premature arthritis. A complete radiograph can reveal the characteristics of this disease. Routine plain radiographs of the hip joint include anteroposterior, lateral, and lateral views. The lateral view is often unsatisfactory, or even impossible, because it is technically difficult due to limited range of motion, especially during the early stages.

PhotoA plain hip joint X-ray can help find the cause of common signs and symptoms of pain, swelling, or deformity in the pelvic area. A plain hip joint X-ray can detect fractures or dislocations, and can also help detect bone cysts, tumors, infections of the hip joint, or other diseases of the hip bone. Plain X-rays have a sensitivity of 97% and a specificity of 78% in detecting LCPD. A plain hip joint X-ray is a safe and painless examination that uses a small amount of radiation to create images of a person's hip joint. During the examination, an X-ray machine sends a beam of radiation through the pelvic bone and hip joint, and the images are recorded on a computer or special film. These images show the soft tissues and bones of the pelvis and hip joint. X-ray images are black and white. Dense parts of the body, such as bones, block the X-ray beam from passing through the body, so they appear white. Soft body tissues, such as skin and muscle, allow the X-ray beam to pass through, so they appear black (dark).

A plain pelvic X-ray examination requires no special preparation. The patient is simply asked to change clothes and remove jewelry or any metal objects that might interfere with the results.

Patient ProceduresYou will be asked to enter a special room containing a table and a large X-ray machine suspended from the ceiling. Parents may accompany their child for reassurance. The patient's reproductive organs are protected by a lead shield. The technician or radiologist will position the patient on the table. X-rays will be taken in two positions: with the legs straight (AP) and with the knees apart and the lower legs together (frog position). The patient will be asked to remain still for a few seconds while the X-ray is taken; this is important to prevent blurring of the image.13

2.8. Plain photo illustration of Legg calve Perthes Disease

Findingswhat is seen on a plain radiograph of the hip joint depends on the stage of the disease.

1. Early stage.
- Sizefemoral epiphysis (smaller on the affected side).
- Increased density of the femoral epiphysis head.
- Wideningmedial joint space blurred from the physeal plate
- Radiolucencyfrom the proximal metaphysis.

2. Phase II: fragmentation
- Subchondrallucency*(crescent sign*).
- Femoralepiphysis fragmentation.
- *Mottled density*
- Trabeculae thicken.

3. Stage III: reossification
- Ossification begins
- The shape of the femoral head is better.
- Bone density begins to return

4. Stage IV: Healing

At this stageThe dead bone is completely absorbed and replaced with new bone. This new bone is weak, resulting in deformities. These deformations can result in changes in shape, such as becoming oval.Changes depending on the severity of the femoral head may be or nearly normal or may show a flattened joint surface, especially widening of the superior aspect of the femoral head and femoral neck.[15]

2.9. Differential Diagnosis

Based on the clinical symptoms of pelvic pain and the appearance of plain radiographs, experts have determined a differential diagnosis of Perthes disease. In general, the differential diagnosis can be distinguished in unilateral cases as septic arthritis and transient synovitis, while in bilateral cases it is multiple epiphyseal dysplasia.

2.9.1. Septic arthritis hip joint.

Septic arthritisSeptic arthritis is the presence of microbes in the joint space. Delayed diagnosis or treatment of septic arthritis in the hip can result in permanent joint damage. Septic arthritis is more common in children than in adults, but the exact cause is unknown. Microorganisms enter the synovium by hematogenous spread. Septic arthritis rarely occurs immediately after penetrating trauma or contiguously

with adjacent osteomyelitis. It primarily affects children aged 3-6 years. In children, because the bone cortex is relatively thin, the periosteum is loose, and blood vessels connect the metaphysis and epiphysis, the infection can easily reach the joint space. Sepsis can have direct and indirect consequences on one or both sides of the joint. The direct consequence is damage to the joint cartilage, which can be partial or complete, leading to ankylosis (fibrous) or instability from subluxation/dislocation. Indirect consequences of physeal damage and avascular necrosis Although a small number of patients with septic arthritis are asymptomatic, the most common complaints are gait and pain or both. This gait occurs due to shortening of the involved limb, soft tissue contraction and fibrotic. Early radiological examinations may show soft tissue swelling or distension of the hip joint capsule (widening of the joint space or even subluxation), in the proximal femoral metaphysis which may indicate adjacent osteomyelitis. 11,19

2.9.2. Transient synovitis

SynovitisTransient synovitis of the hip is an acute inflammatory condition of the lining of the pelvis. Transient synovitis (TS) is the most common cause of acute hip pain in children aged 3-10 years. This disease causes arthralgia and arthritis secondary to transient inflammation of the hip synovium. Unilateral groin and hip pain are the most common symptoms, but some patients with transient synovitis (TS) experience pain radiating from the thigh to the knee. Transient synovitis has the highest incidence among nontraumatic causes of hip pain in children.11 A history and physical examination are essential tools doctors use to diagnose transient hip synovitis. Movement is usually limited and painful.

X-rayRadiographs are usually used, although they do not show synovitis, but they can help rule out tumors and fractures. In the first month, plain radiographs may be normal. The medial joint space may be slightly widened. Half to two-thirds of patients with transient synovitis may have pericapsular shadows. In one study, 58% of patients with transient synovitis had Waldenstrom's sign (i.e., lateral displacement of the femoral epiphyses with a flat surface). More sophisticated imaging such as an MRI or scan is needed to rule out other, more serious problems. Blood tests will show mild inflammation. If necessary, a pelvic ultrasound can be performed. This test will show an effusion (fluid collection) in the hip joint. Needle aspiration of the fluid will reveal pus.12

2.9.3. Multiple epiphyseal dysplasia (MED)

is an abnormalityA rare genetic disorder occurring in 1 in 10,000 births that affects the ends of bones (the epiphyses). Normally, bones grow in length by a process involving cartilage in the epiphyses, called ossification. This cartilage then mineralizes and hardens into bone. In MED, this process is impaired. MED usually manifests in late childhood. At birth, the patient's external appearance is normal, and clinical symptoms appear in late childhood. Symptoms include joint pain and stiffness, short, stout legs. The disease is not associated with visceral anomalies, and the patient's intelligence is within the normal range. Other accompanying clinical symptoms include coxa vara, including a short neck and widening of the femoral head. Plain radiographs show small, irregular epiphyses, mild metaphyseal irregularities, and striations. In addition, the femoral head is fragmented and flattened, and the acetabulum may be involved in patients with MED.16

2.10. Management

The goals of Perthes disease management are to reduce pelvic irritation and pain, restore and maintain pelvic mobility, prevent the femoral head from extruding or breaking, reposition the femoral head into the acetabulum, and restore the rounded shape of the femoral head to form a good joint. Management ranges from rest, observation only, every 6-12 months, range of motion (ROM) exercises, and the use of a splint.'Slings and springs', plaster brommstick, up to surgical intervention, namely femoral/acetabular osteotomy with internal fixation (17).

In childrenChildren under 5 years of age with mild Legg-Calve-Perthes disease usually recover well without special treatment. Children should be monitored, undergo physiotherapy, and undergo home exercises. Home exercises help maintain hip mobility and maintain proper position in the acetabulum. Swimming is recommended (to maintain active hip movement).

A number ofthe child required hospital treatment for the installation'Slings and springs'.'Slings and springs'usedTo support both legs on the bed, this allows the affected leg to relax and move more freely to the

side. The goal is to improve abduction of the affected hip and also ensure proper positioning of the femoral head within the acetabulum.

*Brommstick plaster*isA long leg cast from the groin to the ankle is formed into an A-shape using a broomstick. During this therapy, the child will be mostly in a wheelchair. With adult supervision, they can stand and walk short distances. For older children, crutches may also be used, depending on their individual abilities.

There are three typesSurgical procedures for Perthes disease include pelvic osteotomy, femoral osteotomy, or external fixation. The type of surgery will depend on the orthopedic surgeon's preference and the results of clinical and x-ray examinations.18

Diagram B: The Use of 'Slings and Springs' for Perthes Disease

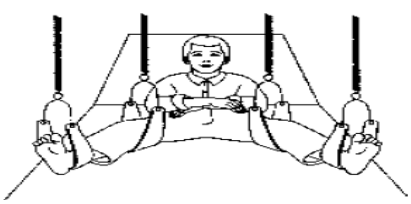
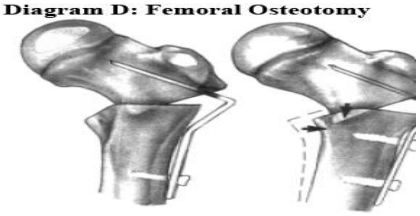


Diagram D: Femoral Osteotomy



2.11. Prognosis

The prognosis of this disease is determined by several things, including:

a. Age.

The younger the person is when they develop Perthes disease, the better the prognosis because there is still time for the hip joint to repair itself before the growth period is over.Children affectedPerthes' disease ...

b.Gender

For eachAt a certain age when the condition develops, boys have a better chance than girls. This is because girls' bone growth tends to complete earlier than boys'.

c. Tlevel of femoral head involvement

Minimal epiphyseal involvement and short duration are favorable prognostic factors. Greater epiphyseal involvement, lateral subluxation of the femoral head, and longer duration are some of the poor prognostic factors (17)

II. DISCUSSION

Legg calve perthes disease is also known as osteochondrosis or osteochondrotis of the epiphyse caput femoris, the choice of the name osteochondritis can cause confusion of meaning, because in this disease there is no infection or inflammation process and also does not involve cartilage components, but rather a disease that occurs due to disruption of the supply of nutrients to the epiphyse caput femoris due to disruption of blood vessel flow to the caput femoris.

DiagnosisLegg-Calve-Perthes diagnosis is often based on a combination of: Symptoms and signs, physical examination and imaging.2.3

PerthesIt is almost always diagnosed solely on a plain X-ray of the pelvis, usually performed after a child is brought to the doctor complaining of hip or leg pain or a limp when walking. Plain X-rays in the early stages of the disease can sometimes appear normal, so other imaging modalities such as MRI, ultrasound, or pelvic scintigraphy are used to confirm the plain X-ray and assess the extent of damage to the femoral head. In some cases, a bone scan is also useful.

Some things that can be measured to establish a diagnosis of this disease from the plain radiograph of the hip joint (AP, Lateral and frogly view) are the distance between the lateral edge of the pelvis and the medial edge of the femoral head (tear drop distance) which is wider than normal, namely greater than 11 mm or 2 mm wider than the other side.2

Septic arthritis of the hip joint shares clinical symptoms with Perthes disease, including hip pain and limited mobility. However, the key difference lies in the additional clinical signs supported by laboratory findings. Radiologically, the similarity is in the presence of abnormalities in the femoral head epiphysis (in patients undergoing growth), in the form of ossification disorders in the femoral head epiphysis. However, the difference is in the involvement of the articular capsule accompanied by extensive osteoporosis in arthritis.11

Transient synovitis of the hip joint is the most common cause of joint pain. The radiological findings are nonspecific but can rule out tumors and fractures, unlike Perthes disease. Ultrasound will reveal an effusion, and needle aspiration will reveal pus.

Multiple epiphyseal dysplasia occurs due to mineralization of cartilage. Radiologically, it is generally foundcoxaVariations include a short femoral neck and a widened femoral head. MED typically occurs in late childhood. Additionally, the femoral head is fragmented and flat, and there is involvement of the acetabulum.

	LCPD	Septic arthritis	Transient synovitis	MED
Age	2-18 years	3-8 years	3-10 years	Late childhood
Cause	Vascularization obstruction	Microbial agents	Inflammation	Genetics
Clinical	Pelvic pain and limping	A small proportion are asymptomatic. The most common complaints are gait or pain.	Pain from the groin to the knee	pain and stiffness in the joints, legs become short and fat
Plain Photo	According to the stages	Soft tissue swelling. Joint space widening. Subluxation. Adjacent osteomyelitis	1/2 -2/3 shows pericapsular shadow. 58% of patients have Waldenstrom's sign	Small, irregular epiphyses, mildly irregular metaphyses.The femoral head is fragmented and flat, and the acetabulum may be involved.

III. CONCLUSION

Perthes disease, also known as osteochondrosis, is a disease that occurs due to disruption of the supply of nutrients to the epiphyse of the femoral head due to disruption of blood vessel flow to the femoral head.

This diseaseprogresses through 4 stages within 2 to 4 years after initial presentation: stage 1, Ischemia; stage 2, Resorption, fragmentation; stage 3, Reossification and resolution; stage 4, Remodeling. The findings seen on plain radiographs of the hip joint depend on the stage of the disease.

REFERENCE

[1]. Renton P, Avascular Necrosis of Bone: osteochondrosis: Miscelaeous Bone lesion, Sutton D, editor, Text book of Radiology and medical Imaging, Vol I, London-Churcil livingstone, 1993, pp. 60-84.

[2]. Meschan I, X-ray signs in Diagnostic Imaging, Philadelphia-Saunders, 1985 pp. 262-272.

[3]. Silvermenn F, The Limbs in: pediatric X-ray Diagnosis: An Integrated Imaging approach, Vol 2, 1993, pp 1821-1823.

[4]. Anonymous,Biomechanics of the Hip Joint,downloaded fromhttp://ardiaja58.blogspot.com/, August 13, 2011.

[5]. Anonymous, Hip anatomy, function and common problems available fromhttp://healthpages.org/anatomy-function/, 8 July 2011

[6]. David A, HIP Anatomy, downloaded fromhttp://www.eorthopod.com/July 30, 2011.

[7]. George D, Pathophysiology of Legg Calve Disease, downloaded fromhttp://www.eorthopod.com/content/perthes-disease) May 2011,
[8]. Anonymous,Legg-Calvé-Perthes'disease, downloaded fromhttp://bestpractice.bmj.com/, October 2010
[9]. Foster B, Johnstone E, Legg Calve Perthes Disease, downloaded fromwww.bgf.asn.au/, May 2000.
[10]. Geofrey N, Legg-Calve-Perthes Disease in Emergency Medicine Clinical Presentation, downloaded fromhttp://emedicine.medscape.com/, April 14, 2011.
[11]. Ali N, Legg calve disease Imaging, downloaded fromhttp://emedicine.medscape.com/. May 27, 2011
[12]. Kevin Y*Transient synovitisof the hip in child*, downloaded fromhttp://www.orthopaedicclinic.com.sg/May 2010 .
[13]. Kate M conan, X Ray : HIP downloaded fromhttp://kidshealth.org/November 2006
[14]. Anonymous, HIP Joint, downloaded fromhttp://www.aceproindia.com/ July 20, 2011.
[15]. Anonymous, Staging Perthes Disease downloaded fromhttp://radiopaedia.org/, August 18, 2011.
[16]. Treble N, Jensen A, Brankier A, Development of the hip in multiple epiphyseal dysplasia, J Bone surg 2001 :72 : 1061-4.
[17]. Anonymous, Conservative Management of Legg-Calve-Perthes Disease,downloaded from http://www.cincinnatichildrens.org/ October, 2010
[18]. Anonymous Perthes disease, downloaded from www.gptt.com.16 August 2011.
[19]. David,A, Norgrove,P, Ashok,K, Shresta, Sequale septic arthritis, Glob HELP Org, 2007,4-5.