بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# " وَقُل رَّبِّ زِدْنِي عِلْماً"

**صدق الله العظيم**

سورة طه .أية ١١٤

# Recent trends in management of legg-Calve'-Perthes' disease

Essay

Submitted for fulfillment of the Master Degree

In Orthopedic Surgery

By

AMR ABD ELRAHMAN ELBATOUTY

M.B.B.CH

Supervised by

**PROF.DR.EHAB NEGM**

Professor of Orthopaedic Surgery

Cairo University

**DR.ABD ALLAH MOHAMED AHMED**

Lecturer of Orthopaedic Surgery

Cairo University

Faculty of medicine

Cairo University

2010

# ABSTRACT

In the beginning of the 19th century, **Arthur Legg** in the United States, **Jacques Calve'** in France and **George Perthes** in Germany described independently a non-tuberculous condition of the child hip leading to osteoarthritis, now known as Legg-Calve'-Perthes disease.

Legg-Calve'-Perthes disease (Perthes' disease) is a self limiting condition of the hip in children characterized by avascular necrosis that affects the ossification center of femoral capital epiphysis which is ultimately resorbed and replaced by new bone resulting in various degree of deformity and restricted joint motion and may lead to degenerative arthritis in young adult life (***Kealy et al., 2004***).

The optimal treatment of Perthes' disease remains a challenge; various methods of treatment have been used ranging from observation to surgical intervention.

The main goals of treatment is to obtain containment of the femoral head inside the acetabulum and to maintain a good range of motion at the hip joint to prevent deformity and incongruity of the hip and delay the onset of degenerative joint disease later in the adult life (***Joseph et al., 2003***).

**Key words:**
**Perthes disease**
**Asvascular necrosis**

# Acknowledgment

I always feel indebted to **ALLAH** whose blessing on me can not be counted.

I would like to express my deepest gratitude and sincere appreciation to **PROF. DR. EHAB NEGM** professor of orthopedic surgery, faculty of medicine, Cairo University for his valuable supervision and generous help. It was a privilege to work under his constructive guidance and supervision.

I am deeply grateful and indebted to **DR. ABD ALLAH MOHAMED AHMED** lecturer of orthopedic surgery, faculty of medicine, Cairo University for his sincere advices, sustained support enriching me with his fruitful help.

Finally, a tribute to those who never save their effort to support and encourage me through my life, my family.

# Introduction

In the beginning of the 19th century, **Arthur Legg** in the United States, **Jacques Calve'** in France and **George Perthes** in Germany described independently a non-tuberculous condition of the child hip leading to osteoarthritis, now known as Legg-Calve'-Perthes disease.

Legg-Calve'-Perthes disease (Perthes' disease) is a self limiting condition of the hip in children characterized by avascular necrosis that affects the ossification center of femoral capital epiphysis which is ultimately resorbed and replaced by new bone resulting in various degree of deformity and restricted joint motion and may lead to degenerative arthritis in young adult life (***Kealy et al., 2004***).

The optimal treatment of Perthes' disease remains a challenge; various methods of treatment have been used ranging from observation to surgical intervention.

The main goals of treatment is to obtain containment of the femoral head inside the acetabulum and to maintain a good range of motion at the hip joint to prevent deformity and incongruity of the hip and delay the onset of degenerative joint disease later in the adult life (***Joseph et al., 2003***).

# Anatomy of the pediatric hip

- The hip joint is a ball and socket articulation, the femoral head is completely covered with articular cartilage except a small roughened pit to which the ligament of head (ligamentum teres) is attached. The cartilage is thickest at the center and thinnest at the periphery.
- The acetabulum is a deep cup shaped cavity in the center of the lateral surface of the hip bone that is directed laterally downwards and forward. The articular surface of the acetabulam forms an incomplete ring broadest at the upper part where the pressure of the body falls, the ring is deficit inferiorly at the acetabular notch which is closed by the transverse ligament. The depth of the acetabulum is increased by a fibrocartilage rim (labrum actabulare). The floor of the acetabular fossa is devoid of articular cartilage and contains a mass of fat covered with synovial membrane.
- The capsule of the hip is attached proximally to the margins of the acetabulum, outer margin of the labrum and the transverse acetabular ligament. Distally it is attached along the trochanteric line, the bases of the greater and lesser trochanter and to the femoral neck posteriorly about one cm above the trochanteric crest. From the distal attachment capsular fibers are reflected on the femoral neck as retinacula which provide pathways for blood supply for the femoral head.

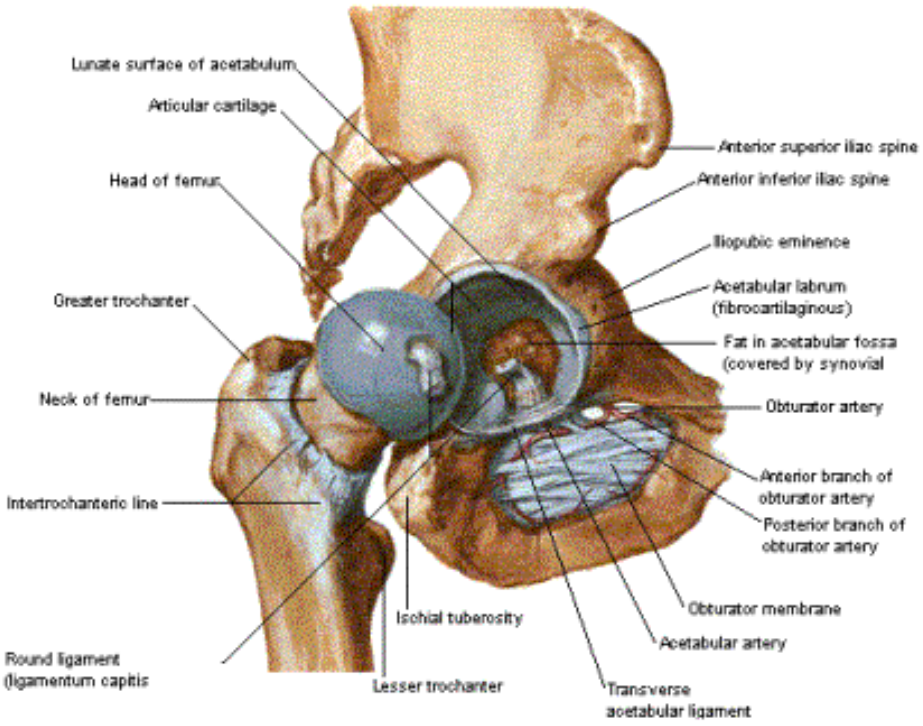
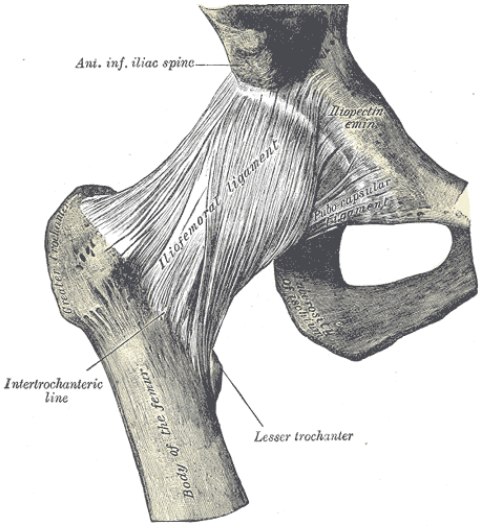



*Figure (1): Anatomy of the acetabulum.(Netter, 1991)*

- Three ligaments reinforce the capsule:
  1. The iliofemoral (ligament of Biglow): Y-shaped its apex is attached to the anterior inferior iliac spine, its base bifurcate to be inserted at each end of the trochanteric line.
  2. The pubofemoral: triangular, its base is attached to iliopectineal eminence, superior pubic ramus, obturator crest and obturator membrane. Distally it blends with the capsule and the medial band of iliofemoral ligament.
  3. The ischiofemoral ligament: it is attached to the ischium and directs upwards and laterally over the femoral neck to attach to base of the greater trochanter, some fibers are continuous with zona orbicularis.



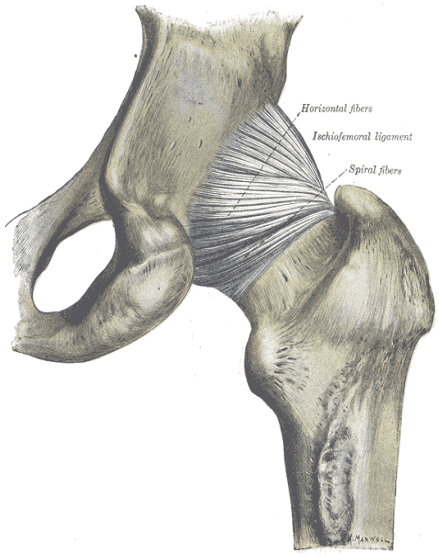




*Figure (2): The ilio-femoral ligament.* *The ischeo-femoral ligament.*

# Vascular pattern of the femoral head

- ## Arterial supply:

The arteries of the femoral vessels have been studied by several investigators and gave a picture of the modification of the vasculature of the human femoral head from birth to maturation (***Trueta, 1957***).

They concluded that there are five main phases:

1. **At birth phase:** during the first four months of life the vessels coming from the lateral side of the head proceed horizontally towards its medial side while other vessels emerge almost vertically from the top of the ossified femoral shaft. Vessels are seen coming from the ligamentum teres but they are not constant.

2. **Infantile phase:** from four months to four years, characterized by disappearance of the penetrating vessels from the ligamentum teres, the predominant blood flow arise from lateral epiphyseal vessels and the metaphyseal vessels entering the epiphysis after crossing the outer perimeter of the growth plate.
3. **Intermediate phase:** from four to seven years, the epiphyseal plate establishes a firm barrier between the epiphysis and the metaphysis. The metaphyseal blood vessels decrease, and the only source of blood supply is the lateral epiphyseal vessels which are branches of the distal part of the medial circumflex artery, all of them tightly grouped on the lateral aspect of the femoral head.
4. **Pre-adolescent phase:** from seven to twelve years, the growth plate is an isolating barrier between the femoral epiphysis and the rest of the bone. At the age of nine or ten, the penetration of vessels from ligamentum teres increases reaching the depth of the epiphysis making anastomosis with branches of the lateral epiphyseal arteries.
5. **Adolescent phase:** up to seventeen years, the barrier of the epiphyseal plate begins to break down and anastomosing vessels cross over between the epiphyseal vessels, ligamentum teres vessels and metaphyseal vessels, giving the femoral head the adult vascular interwoven pattern. The arterial supply to the proximal end of the femur in human during childhood plays an important role in understanding Legg-Calve'-Perthes disease (***Chung, 1976***). The arterial supply of the proximal end of the femur is described as follows:

I. The extracapsular arterial ring of the femoral neck: It is formed mostly by the medial and lateral circumflex arteries.

II. The ascending cervical branches of the extracapsular arterial ring on the surface of femoral neck: These arteries give rise to metaphyseal and epiphyseal branches.

III. The arteries of the ligamentum teres.

**I) The extracapsular arterial ring of the femoral neck:**

The medial and lateral femoral circumflex arteries arising in the femoral triangle were found to be the primary arteries of the developing proximal end of the femur. These two arteries form an extra capsular ring surrounding the base the femoral ring.

a) **Medial femoral circumflex artery:** arises from the medial or posterior aspect of the femoral artery. It passes in antero-posterior direction in the interval between the iliopsoas and pectineus muscles and then between the medial capsule and the obturator externus muscle. Then it gives rise to the medial ascending cervical branches which traverse the capsule and progress subsynovially up to the femoral ring. Posteriorly at the intertrochanteric line posterior ascending arteries traverse the capsule, while other small arteries comminucate with the superior gluteal artery in this area. As in adults the lateral portion of the arterial ring (the termination of the medial femoral circumflex artery) provides most of the arterial supply to the femoral head, neck and trochanter.

b) **Lateral femoral circumflex arteries:** arises from the upper end the profunda femoris artery. It runs laterally, anterior to the iliopsoas and divides in to several terminal branches. The ascending branches runs

laterally and superiorly giving the anterior ascending cervical branches to the femoral head and neck.

**II) Ascending cervical arteries:**

They traverse the anterior, medial, posterior and lateral surface of the capsule along its attachment to the base of the femoral neck. The numerous epiphyseal and metaphyseal of the lateral ascending cervical artery supply the greatest volume of the femoral head and neck, but all of these vessels arise from a single arterial stem which crosses the posterior trochanteric fossa. The interval between the trochanter and the capsule in children less than eight years old is very narrow because of the shorter neck through which the important single lateral ascending cervical artery passes and may be a possible site of vascular compression.

On the surface of the femoral neck the ascending branches of the extracapsular arterial ring are also known as retinacular arteries, the medial metaphyseal and lateral epiphyseal arteries. They traverse the capsule along its femoral attachment, pass beneath the synovium then branch to supply the metaphysis and epiphysis. The epiphyseal branches cross the epiphyseal plate at the surface of the junction of the femoral head and neck, pass through the peripheral perichondrial fibriocartilagenous complex, and then supply the secondary center of ossification. These arteries do not penetrate the central portion of the epiphyseal plate at any age. The four ascending cervical arteries (anterior, medial, posterior and lateral) form a subsynovial anastomotic ring on the surface of the neck at the margin of articular cartlige and may be complete or incomplete. When incomplete, the missing part is

classified as being anterior or posterior or combined. Incomplete anastomosis is more common in males and this may explain the greater susceptibility of boys to Perthes' disease (***Wertheimer et al, 1971***).

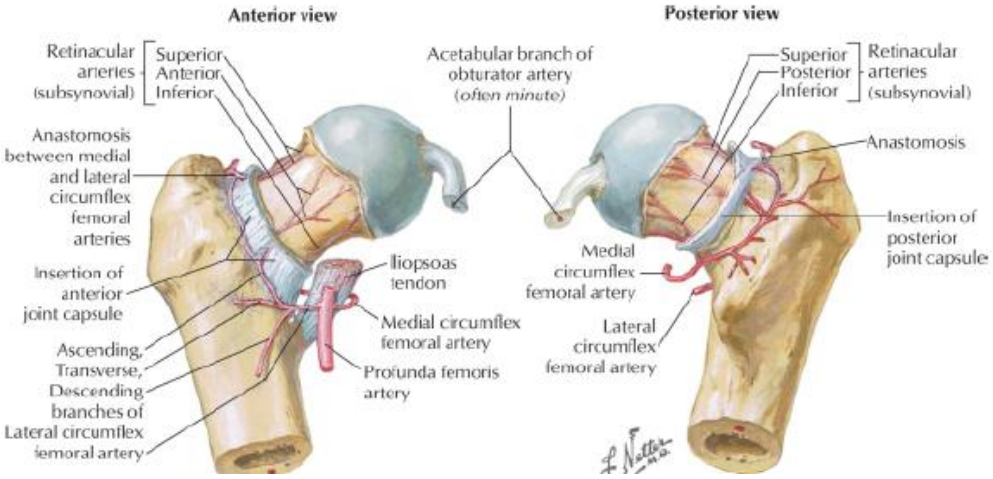



*Fig (3): arterial supply of the head and neck of the proximal femur. Note the extracapsular arterial ring on the surface of the capsule, the ascending cervical arteries on the neck of the femur and the intra articular subsynovial arterial ring at the articular cartilage margin (Netter, 1991).*

The intraosseus blood supply originates from the ascending cervical vessels which form part of the intracapsular intraarticular ring. These vessels branch into short ascending cervical arteries which penetrate the bone and terminate in the metaphysis, and long ascending cervical arteries which extend to supply secondary center of ossification, which may be in the form of multiple ossified centers each is supplied with a separate artery. These arteries appeared to coalesce into anastomotic network, making it difficult to determine whether these boundaries are still present between these multiple ossification centers or not.

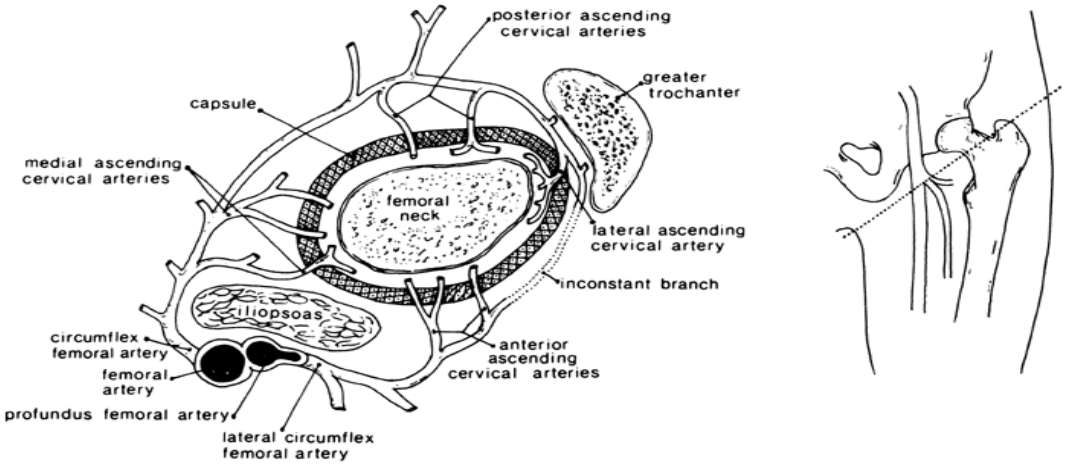



*Fig (4): to the normal proximal femur blood supply (Chung, 1976).*

## III) Artery of ligamentum teres:

It is a branch of the acetabular artery which may arise from the obturator artery or medial circumflex artery. The supply of this artery to the epiphysis is small in children between ages of four and eight years. On studying 123 specimens recorded the following variations:

a) No artery could be detected in 10 specimens.
b) The artery was present only in the ligament but not in the femoral head in 78 specimens.
c) One deep vessel passing to the head center was found in 20 specimens.
d) Two or more deep vessels passing to the head center were present in 15 specimens. In these specimens the arteries of the ligamentum teres provided much but not most of the femoral head supply (***Chung, 1976***).

- **Venous drainage:**

Venous drainage normally flows through the medial circumflex vein. However in Legg-Calve'-Perthes disease, there is increased venous pressure in the affected femoral neck and associated venous congestion in the metaphysis, and the outflow exit more distally through diaphyseal veins (***Liu et al, 1991***).

# Biomechanics of the hip joint

The hip joint is composed of the head of the femur and the acetabulum of the pelvis. The hip joint is one of the most stable joints in the body at the expense of some reduction in mobility. The stability is provided by the rigid ball-and-socket configuration.

## Geometry of the Articulating Surfaces:

The femoral head is spherical in its articular portion that forms two thirds of a sphere. The diameter of the femoral head is smaller for females than for males. In the normal hip, the center of the femoral head coincides exactly with the center of the acetabulum. The rounded part of the femoral head is spheroidal rather than spherical because the uppermost part is flattened slightly, this causes the load to be distributed in a ring like pattern around the superior pole.

The head is supported by the neck of the femur, which joins the shaft. The axis of the femoral neck is obliquely set and runs superiorly, medially,

and anteriorly. The angle of inclination of the femoral neck to the shaft in the frontal plane is the neck-shaft angle. In most adults, this angle is about 130◦. An angle exceeding 130◦ is known as coxa valga and an angle less than 130◦ is known as coxa vara ***(Hamill et al, 2009).***

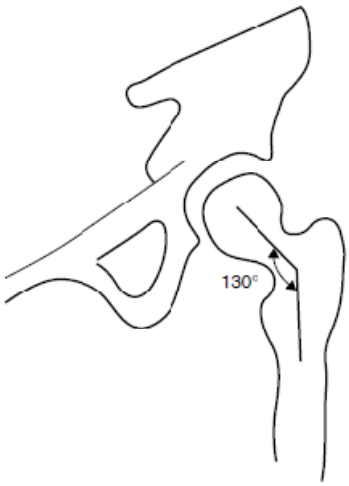



*Fig (5): diagram shows the neck shaft angle, this angle is about 130* ***(Hamill et al, 2009).***

The femoral neck forms an acute angle with the transverse axis of the femoral condyles. This angle faces medially and anteriorly and is called the angle of anteversion. In the adult, this angle averages about 7.5◦.

The acetabulum receives the femoral head and lies on the lateral aspect of the hip. The acetabulum of the adult is a hemispherical socket. Together with the labrum, the acetabulum covers slightly more than 50% of the femoral head. Only the sides of the acetabulum are lined by articular cartilage, which is interrupted inferiorly by the deep acetabular notch. The central part of the cavity is deeper than the articular cartilage and is nonarticular. This part is called the *acetabular fossae* and is separated from the interface of the pelvic bone by a thin plate of bone.