



# **Blood supply to the femoral head**

Wael M Husain

# The normal vascular anatomy of the femoral head in adult man

J. Trueta and M.H.M. Harrison Oxford  
,England 1953

This study was undertaken to research the vascular changes accompanying osteoarthritis of the hip joint

The study was concentrating on description of vessels from where they are about to enter the bone



# Historical review

Palletta (1820), Cooper(1823),  
Sappey(1869) and Langer(1876)

Studied vessels bringing blood into  
the upper end of the femur

From 1904- 1950 the finer vessels  
within the the bone of the femur  
were investigated



# Materials and methods

Human specimens obtained after death

36 specimens

2 20-30

2 31-40

1 41-50

1 51-60

12 61-70

11 71-80

5 81-90

2 91-100

From these specimens 15 injections were studied



# Materials and methods

## *Vessels injected*

Medial femoral circumflex artery

Common iliac

Common femoral

Vessels were studied by microscope  
and radiological analysis



# Results

Vascular patterns established during the the phase of growth persist throughout life

The epiphysis and metaphysis receive there blood supply from separate sources



# Results

Vessels were named in accordance with their destinations and referenced to the site of entry to bone

Epiphysial arteries named medial and lateral

Metaphysial arteries named superior and inferior



# Results

The lateral Epiphysial and both Metaphysial arteries usually arise from the medial femoral circumflex artery

The medial Epiphysial is a continuation of the artery within the ligamentum teres which comes from the acetabular branch of the obturator artery



# Results

Lateral Epiphysial arteries  
predominate in the epiphysis

Supplied  $4/5$  of the epiphysis in 7  
specimens

Supplied  $2/3$  of the epiphysis in 7  
specimens

Supplied more than  $1/2$  in 1 specimen



# Results

The inferior Metaphysial arteries were found to supply  $2/3$  of the Metaphysial tissue

These proportions represent the more usual arrangement and must be subject to considerable variation



# The lateral Epiphysial arteries

Enter the head superiorly and posero-superiorly

2-6 in number

Spiral for a short distance when they enter bone

Lie within a thick fibrous sheath

They follow the line of growth plate they run downwards, medially and anteriorly



# The medial Epiphysial artery

Its main branch runs laterally on the same level as the fovea capitis

The branch meet and anastomose with the main lateral Epiphysial vessels

The length of the course is proportional to size



# Epiphysial vessels

The direction of distribution of these branches is into the epiphysis and towards the joint surface

The outflow to the metaphysis from these vessels is small



# Superior Metaphysial arteries

2,3,or 4 vessels

Enter the superior aspect of the femoral neck some distance from the margin of the articular cartilage

Give origin to the lateral Epiphysial group

They supply the site previously occupied by the Epiphysial plate



# Inferior Metaphysial arteries

Frequently one vessel

Enter bone close to the inferior margin  
of the articular cartilage

The largest vessel in these groups

Run up towards the epiphysis



# Anastomoses

There is a free anastomosis inside both the epiphysis and the metaphysis

There is anastomosis between the vessels of the two territories at the site previously occupied by the growth plate

No evidence of the nutrient artery of the femur extending its area of supply up to the Metaphysial region as has been so frequently stated



# Changes with age

Ages from 20 -100 were studied no change in vascular pattern was noticed



# Arterioles of marrow

There arrangement depends on the type of marrow

Red marrow is restricted to 2 areas the metaphysis and a zone of epiphysis underlying the articular cartilage and the fovea capitis

Yellow marrow occupy most of the epiphysis

A sharp line of demarcation is seen between these 2 areas

Yellow marrow have capillaries while red marrow have sinusoids



# Arterioles of marrow

Microscopically there is no clear cut separation of the marrow into red and yellow

The 2 merge gradually from very cellular to the completely fatty

Circulation in this area is by small capillaries and sinusoids



# Articular cartilage

Normal articular cartilage is avascular  
Come into contact with capillary  
vessels in 2 situations

- *On deep attached surface*
- *Peripheral margin*



# Clinical importance

Higher incidence of AVN with fractures disrupting the lateral Epiphysial arteries



# The normal vascular anatomy of the human femoral head during growth

Joseph Trueta, Oxford, England 1953

An attempt to explain the evolution of the vasculature of the head and neck of the human femur from the last 4 weeks of fetal life up to the fusion of the upper epiphysis at age of 17



# Material and methods

Human specimens after death

Same injecting method as used in  
previous paper

46 specimens 21 males 25 females

23 from 3 weeks fetal life to 3 years

10 from 3 to 6 years

1 from 6 to 9 years

12 from from 9 to 17



# Vascular arrangement at birth

Vascular pattern at this stage is most constant

Vessels coming from lateral of the head proceed horizontally towards its medial side

Other vessels emerge almost vertically from the top of the ossified shaft

Vessels are seen coming from the round ligament but they are not constant



# Vascular arrangement from 4 months to 4 years

Predominant blood flow arises from the Metaphysial vessels crossing the area later to be occupied by the growth plate

Lateral Epiphysial vessels are also important at this phase

There is no penetrating vessels coming from the ligamentum teres even if in early days some large vessels are seen they soon disappear



# From 4 to 7

The Epiphysial plate has established a firm barrier between epiphysis and metaphysis

The Metaphysial blood flow decreases to become negligible

Round ligament has not yet provided vessels that penetrate the epiphysis

At this stage the only blood supply comes from the lateral Epiphysial vessels

All tightly grouped on the lateral aspect of the head



# Preadolescent

Growth plate acts as a closed barrier to the vessels

The arteries from the ligamentum teres finally reach the depth of the epiphysis and become anastomosed to other vessels of the lateral Epiphysial arteries

At this stage the epiphysis receives blood from 2 main sources



# Adolescence

Here the barrier of the Epiphysial plate begins to break down and vascular anastomosis cross over



# Clinical importance

1-3 years of age the delay in appearance of the ossification center in DDH because the lateral Epiphysial vessels are occluded by the capsular pull

4-7 years Legg-Perthes' disease the only blood supply at this age is the lateral Epiphysial which may be abstracted by trauma or inflammation

11-15 years slipped epiphysis great vascular activity in the Metaphysial side of growth plate preceding the fusion of the epiphysis



# Changing patterns of proximal femoral vascularity

By John A. Ogden

Yale university school of medicine  
1974



# Materials and methods

36 hips

Age range from 7 months of gestation to 3 years of age

Causes of death not related to MSK system

8 injected via the abdominal aorta

10 hips from fetal cadavers ages from 7 to newborn were injected by umbilical artery

The remaining of the hips were initially dissected and the course of blood vessels towards the hip with relation the soft tissue and muscles were studied



# Results

Proximal part of the femur blood supply comes from

Deep femoral (profunda)

Gives 2 branches

Lateral and medial circumflex arteries

Both came from the deep femoral except in 3 cases which the medial circumflex took origin from the common femoral artery

The origin was at the level of tendinous portion of the iliopsoas muscle



# Lateral circumflex artery

Ascending and descending branches supply adjacent muscles

Transverse branch inters near the insertion of the capsule into the anterior intertrochanteric notch

The lateral circumflex supplies the antrolateral growth plate, the majority of the greater trochanter and the anteromedial femoral head



# Medial circumflex artery

Anteromedial growth plate

Posteromedial chondroepiphysis

Posterior growth plate

Posterior greater trochanter



# Artery of the ligamentum teres

This vessel arose from the medial circumflex artery in 5 cases but in 23 cases it arose from the obturator artery

Small medial area of the femoral head



# Discussion

Blood supply of the femoral head is derived from 2 vascular systems the posterosuperior and the posteroinferior

From multiple small vessel supply at birth these two vascular system evolve over 18-24 months

These are from the medial circumflex artery



# Discussion

The Metaphysial arteries enter the metaphysis directly along the anterior and posterior capsular insertions with few branches intra-articularly

These arteries are from the lateral circumflex artery

In this study it showed that there are numerous vessels arteriosinusoidal in appearance crossing the growth plate

As the ossification center formed in the epophysis there was reduction of the number of vessels crossing the growth plate



# Discussion

Along the intertrochanteric notch the blood vessels both veins and arteries are external to the joint capsule

A few small branches coursed within the capsule but these small vessels had no role in the blood supply of the femur



# Clinical importance

Capsulotomy per se will not affect the blood supply of the proximal part of the femur as long as the underlying and anatomically separate posterosuperior and posteroinferior vessels are not damaged and as long as the capsular incision is not carried down to the intertrochanteric notch



# Clinical importance

During the transition phase from multiple to limited vessel supply, the capital femoral epiphysis is quite susceptible to vascular compromise

Compromise of the medial circumflex artery may occur between

1. Acetabular labrum and the intertrochanteric groove
2. Iliopsoas tendon and the adductor longus muscle
3. Iliopsoas tendon and the pubic ramus



# The arterial supply of the developing proximal end of the human femur

Stanley M. K. Chung, MD  
Philadelphia, Pennsylvania  
1976



# Materials and methods

235 hips from 147 autopsied fetuses and children

Satisfactory perfusions were obtained on 150 specimens

109 white

38 black

102 males

48 females

Age from 26 weeks gestation to 14 years



# The extracapsular arterial ring

The medial and lateral circumflex arteries are the primary arteries

They form extracapsular ring surrounding the base of the femoral neck

The medial, posterior and lateral parts of this ring were continuation of the medial circumflex artery

The anterior portion of the ring is from the lateral circumflex artery



# Medial femoral circumflex

Deferent origins from the femoral artery or from profunda artery

The artery passed in posterior direction in the interval between the iliopsoas and the pectineus muscle and then between the medial capsule and the obturator externus muscle

Branches which traversed the capsule progressed subsynovially up to the femoral neck

In adults the termination of the medial circumflex artery provided most of the arterial supply to the femoral head, neck and trochanter



# Lateral femoral circumflex artery

Mostly from profunda artery

It ran laterally ,anterior to the iliopsoas and dividing into several terminal branches

The ascending branch ran laterally and superiorly and was the source of the anterior ascending cervical branches to femoral head and neck



# Ascending cervical arteries

Anterior from lateral circumflex

Posterior from medial circumflex

These arteries are traversing the capsule

The lateral ascending which is from lateral circumflex artery supplies the greatest volume of femoral head and neck

The capsule in the trochanteric fossa at the site that the lateral ascending artery cross was very narrow especially in less than 8 years and was noticed to have more space in the older specimens because of longer neck



# Intra-osseous arterial supply

Originates from ascending cervical vessels

These vessels branch into short ascending arteries that penetrate the bone and terminate in the metaphysis whereas the long ascending arteries extend upward to supply the secondary center of ossification



# Barrier between epiphysis and metaphysis

The epiphysial plate constituted an absolute barrier to blood flow between the epiphysis and metaphysis

However the epiphyseal and metaphyseal branches of the ascending cervical arteries supplied both areas therefore there is anastomosis between the epiphyseal and the metaphyseal arteries on the bone but not within the bone



# Artery of the ligamentum teres

The artery was filled in 113 of 123 specimens

10 specimens no artery seen

78 specimens the artery only in the ligament

20 specimens provided 1 deep vessel to the center of the head

15 specimens 2 or more vessels to center of the head seen



# conclusion

2 collateral arterial rings supply the femoral head and neck

One ring is extracapsular the other is subsynovial and intra-articular

The intra-articular was more often incomplete in specimens from males than in females



# What do you need to know

## extracapsular arterieal ring

at the base of the femoral neck

Formed posteriorly by large branch of

MFCA

Formed anteriorly by smaller branches

of LFCA

The superior & inferior gluteal artery

have minor contributions



# What do you need to know

## Epiphyseal blood supply

arises primarily from lateral epiphyseal vessels that enter head posterosuperiorly and vessels from medial epiphyseal artery entering thru ligamentum teres

**Epiphyseal arterial branches arise as arteries of**

subsynovial intraarticular ring



# What do you need to know

**metaphyseal blood supply:**

arises from extracapsular arterial ring

- ascending cervical arteries
- subsynovial



# What do you need to know

## Medial circumflex artery

arises from posteromedial aspect of deep femoral artery or sometimes from femoral artery

supplies majority of blood supply to femoral head;

Branches of MFCA enter capsule of hip joint near its distal insertion and course proximally along femoral neck toward femoral head



# What do you need to know

Lateral circumflex artery usually arises from lateral side of deep femoral artery

lateral circumflex of femoral artery is principal source of blood to the trochanteric area & inferior part of femoral neck

It anastomoses to limited degree with branches of medial circumflex and nutrient artery of femur sends branches to metaphysis or neck but does not contribute significantly to head



# What do you need to know

Artery of ligamentum teres

Derived from obturator

inadequate to supply femoral head  
with displaced fractures

forms the medial epiphyseal vessels only  
small & variable amount of the femoral  
head is nourished by artery of ligamentum  
teres



# What do you need to know

Ascending cervical branches

Arise from the extracapsular ring

These give rise to retinacular arteries

gives rise to subsynovial intra articular ring

anteriorly, they penetrate capsule of hip joint intertrochanteric line

posteriorly, they pass beneath the orbicular fibers of capsule

- ascending cervical branches may be divided into 4 branches

- anterior, medial, lateral, posterior;

- of these lateral provides most of blood supply to femoral head

