The fracture of the neck of the femur: A review of the relevant aspects as a guide in clinical practice

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PROLOGUE
No single article or a textbook has been able to cover all important aspects of the femoral neck fractures. It has been realized that such matter as said needs to reach the residents as well as those who are in clinical practice covering most of these aspects, if not all. This is easier said than done. A thumbnail sketch has been prepared from different course lectures, textbooks and journals with a view to meeting this demand as precisely as possible. This article is based on known facts to many, yet it is intended to help one remind the same as a guide which has received commendation in the yearly meeting at the University of Birmingham, England in 1996.

INTRODUCTION
Fractures of the neck of the femur (FNOF) were recognized over 400 years ago by Ambrose Pare, the famous French Surgeon, but Sir Astley Cooper (1768-1841) of Guy's Hospital, London was the first to delineate clearly between fractures of the femoral neck, or intracapsular fractures, and other fractures and dislocations about the hip.

There has been a defeatist attitude in the management of these fractures, which has long been reflected by the quotation, "we come into the world under the brim of the pelvis and go out through the neck of the femur".

CONSIDERATION OF ANATOMY RELEVANT TO HIP FRACTURES:

In Adults

THE HIP JOINT

The capsule is attached anteriorly at the intertrochanteric line, however, posterior the lateral half of the femoral neck is extracapsular. The followings are some essential features of note:

1) The intracapsular portion has essentially no cambium layer in its fibrous covering to participate in peripheral callus formation, therefore, healing in the femoral neck area is dependant on endosteal union alone.

2) Unless the fracture fragments are carefully impacted, synovial fluid can lyse blood clot formation and thereby destroy another mode of secondary healing by the prevention of the formation of cells and scaffolding that would allow for vascular invasion of the femoral head.

3) The pattern of the vascular supply also has some bearing on the complications occurring after having sustained the fracture. The vascular supply to the proximal end of femur:

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The vascular supply to the proximal end of femur:
The proximal femur is supplied by three groups of arteries:
a) An Extracapsular Arterial Ring located at the base of the femoral neck formed by:
- The ascending branch of the lateral circumflex femoral artery anteriorly,
- A large branch of medial circumflex femoral artery posteriorly and
- Inferior division of the superior gluteal artery and inferior gluteal artery of the Internal, Iliac artery.
b) Ascending Cervical Branch of the Extracapsular arterial ring and
c) Arteries through the Ligamentum Teres (supply a small area of subsynovial circulation but often inadequate to assume the major nourishment of the femoral head following a displaced fracture if all other sources of supply are interrupted); also known as Medial Epiphyseal Artery.

The Ascending Cervical Branches from the Extracapsular Ring pass upward under the synovial reflections and fibrous prolongation of the capsule toward the articular cartilage that demarcates head from neck. These are known as Retinacular Arteries. This close proximity of the Retinacular Arteries to bone puts them at risk of injury in any fracture of the neck;

The Retinacular arteries are -Anterior, Posterior, Medial and Lateral. The Lateral Retinacular provides most of the blood supply to the femoral head & neck. The blood supply to the head thus comes from chiefly the Retinacular vessels, arteries through the Ligamentum Teres and the interosseous cervical vessels.

When a femoral neck fracture occurs the interosseous cervical vessels are disrupted and the supply depends on the rest of two sources. The Retinacular vessels are very important but are also at risk during an injury that accounts for a high incidence of avascular necrosis in case of neck fractures, esp. when displaced.

In Children

They are extremely rare, as compared to hip fractures. In adults with osteoporotic bone, it has been estimated that
incidence of children's hip fractures is less than 1% of adult hip fractures. Trueba's observations refined and augmented by Chung and Ogden about the blood supply in case of children are as follows:

1. At birth, the femoral head is supplied by the metaphyseal vessels that come from the medial and lateral circumflex vessels.
2. Vessels through the ligamentum teres; the supply is virtually negligible until the age of 8 years, after this age the supply is only 20% as an adult.
3. Between birth and the age of 4:
   a) Diminution of metaphyseal vascular supply by the medial and lateral circumflex arteries as the cartilaginous growth plate develops, which is virtually non-existent at age 4.
   b) The predominant supply starts being in existence by the postero-superior and postero-inferior branches of the medial circumflex artery, which constitute later, the retinacular arterial system as described in the adult part.
4. At the age of 3 or 4 the lateral of the postero-superior vessels appear to predominate and to supply all the anterior and lateral portions of the head of the femoral epiphysis, although both the postero-superior and postero-inferior vessels persist throughout life to supply the head.
5. Between 4 and 8 years of age, the head is supplied by:
   a) Retinacular vessels.
   b) Vessels through the Ligamentum Teres.

So, the retinacular supply is the only dependable supply to the head after the age of 3 or 4 since the supply through Ligamentum Teres is negligible and cessation of supply by the metaphyseal vessels. For this reason, this age group is vulnerable to avascular necrosis if there is any vascular insult.

MECHANISM CAUSING FEMORAL NECK FRACTURE

The fracture may be brought about by sudden violence or oft-repeated stress. Although the latter has not yet been fully accepted, cyclical loading of the femoral neck has been seen to cause it (Urovitz, Clin Orth 1977; Todd JBJS 1972).

The violence causing the fracture may be a direct one as in direct blow to the greater trochanter or an indirect one sustained by an external rotation mechanism (Kocher 1896) as depicted below:

INDIRECT MECHANISM CAUSING FEMORAL NECK FRACTURE:

TRAUMA: Major and minor injuries are both responsible for fracture causation.
AGE: Most commonly in elderly patients with the average age of 76 years. It is rare in children.
SEX: Females are three times more frequently affected than males.
RACE: Black people, especially the American Negroes and South Africans suffer less.
BONE QUALITY: Poor bone quality pre-disposes to failure with even minor trauma.
PHYSICAL ACTIVITY: Stress fractures in joggers or military recruits.
IRRADIATION DISEASES: Osteoporosis, Osteomalacia, Osteoarthritis (fracture protective disease for the neck i.e. OAo I/FNOF), Paget's
Review Article

diseases, Parkinson’s disease, Paralytic conditions i.e. hemiplegia, Renal osteodystrophy, Unicameral bone cyst, Fibrous dysplasia, Neglected septic arthritis and Metastatic disease. **CONVULSIONS:** These may predispose to bilateral affection as does the vigorous physical activity and also the effect of hypoparathyroidism.

**DIAGNOSIS**

1. History
2. Pain: This may be slight in case of stress and impacted fractures.
3. Inability to bear weight: The pt. may still walk with a limp if the fracture is undisplaced.
5. External rotation: Less obvious in undisplaced fractures or displaced ones than extracapsular fractures.
6. Radiographic evidence of fracture:
   - 50% young patients with FNOF have sustained multiple trauma and may have other serious injuries.
   - 20% of the young patients with FNOF have an ipsilateral femoral shaft fracture.
   - FNOF may be missed in 40% patients who have been attended for femoral shaft fracture. (Kyle RF mJs 76-A 1994 June)

**SURVIVAL/MORTALITY**

1. In the past mortality from FNOF was as high as 40%. Recently, this ranges between 3% and 40%.
2. Survival is best measured at the one-year level. If the patient survives the first year, his longevity becomes equal to that of the normal population of the same age group.
3. Factors affecting survival or mortality are: -a) Age, b) Mental status and c) Postoperative confusion.

**DEFINITION OF AN IMPACTED FRACTURE DEFINITION BY TRONZO**

It is an incomplete fracture with intact cortex usually inferior one rendering an inherently stable fracture complex by a firm jamming of the proximal fragment into the distal one causing an abduction displacement without any radiographic evidence of such displacement on the lateral view.

**CRITERIA TO DECLARE A FRACTURE AS IMPACTED FOR THE PURPOSE OF NONOPERATIVE (CRAWFORD) TREATMENT**

1. X-Ray evidence of abduction on AP and no displacement on lateral view.
2. No shortening of the limb
3. No external rotation of the limb
4. No discomfort on active and passive range of motion (ROM) of the hip
5. Ability to perform active internal rotation of the limb
6. Cooperative patients who are agile and alert

**OVERALL MORTALITY RATE:** 16%-26%
**LOSS OF REDUCTION DESPITE SELECTION OF PTs.** From 8% to 20%

**MANAGEMENT OF FRACTURE NECK OF FEMUR**
CLASSIFICATION

A number of classifications are available which again denotes existence of debates in the field. The followings are some examples:

**AETIOLOGIC CLASSIFICATION**
- Single violence-produced fracture
- Violence of insufficient magnitude to produce fracture of a normal bone
- # by soft-tissue injury
- Stress/Fatigue if of a normal bone
- Fracture of bone already weakened by disease (Pathological #)

**ON THE BASIS OF PT’S AGE**
- In children (4% of adults)
- In adults

**ON THE BASIS OF FRACTURE CHARACTERISTICS**
*On the basis of anatomic location*
- Cooper’s classification
- Bank’s classification
- Intracapsular
- Extracapsular/Basilar
- Subcapital
- Transcervical
- Classical subcapital
- Intraacetabular
- Wedge subcapital
- Fractured neck
- Transcervical (65-69%)
- Cervico-medullare (30-40%)
- Intertrochanteric (10-20%)

*On the basis of the direction of fracture (Pauwells’ classification)*
- Type I 30 degree angle
- Type II 90 degree angle
- Type III 120 degree angle

*Default: 1. Direction of Line could be altered by changes in the limb or body position,
2. Most (80%) of fractures surfaces are between 65° and 110°*

*On the basis of displacement of fracture fragments*
- Garden’s classification
- Garden I: a) Complete or impacted
  b) The trabeculae of the inferior neck are still intact (Abducted impact fracture)
- Garden II: a) Complete fracture
  b) No displacement
  c) Trabeculae are interrupted by a fracture line across the entire neck
- Garden III: a) Complete fracture
  b) Partial displacement < 50% according to Kyle
  c) Trabeculae do not line up with those of the acetabulum
- Garden IV: a) Complete fracture
  b) Complete displacement (>50% displacement according to Kyle)
  c) Trabeculae of the head line up with the acetabulum

*On the basis of location and displacement (AO/ASIF alpha-numeric classification)*
- Subcapital
  - Slightly displaced
  - Markedly displaced
- B1
- B2
- B3
- Moderately displaced
- Transcervical
  - Slightly displaced
  - Markedly displaced
- Transcervical
  - Slightly displaced
  - Markedly displaced

*It includes:*
1. General Management
2. Definitive Management
3. Rehabilitation
DEFINITIVE MANAGEMENT

The options for treatment of a fracture neck of the femur are as follows:

In Children:
1. Hip spica
2. Closed reduction: Hip spica, Internal fixation
3. Open reduction and internal fixation.

In Adults:

NON-OPERATIVE TREATMENT

In the developed countries, this form of management is rarely adopted unless dictated by absolute contraindications such as medical conditions and very stable impacted fractures. If, adopted, rest in bed is immediately followed by non-weight bearing (NWB) as soon as comfortable for 8-12 weeks (until radiographic evidence of healing). Nonetheless, fixation is again chosen if secondary displacement (delayed operation after secondary displacement does not affect the rate of mortality, nonunion or avascular necrosis) occurs.

OPERATIVE TREATMENT

1. Closed reduction
2. Open reduction Evaluation of reduction → Internal fixation (AO screws, Knowle’s pins, DHS)
3. Hemiarthroplasty
4. Excision arthroplasty (Girdlestone)
5. Total hip replacement.

The definite management plan has to be individualized. A schematic presentation of options has been proposed (flow chart page 14).

COMPLICATIONS

In Children:
1. Avascular necrosis
2. Coxa vera
3. Nonunion
4. Premature closure of epiphysis

In Adults:
1. Avascular necrosis
2. Nonunion
3. Malunion/Coxa vera/Coxa valga
4. Thrombo-embolism
5. Infection
CONCLUSION

A concise description of the femoral neck fractures covering most areas of it is difficult. The attempt here is a reminder of known facts from a single article that would otherwise make one browse many such articles. Conclusively, femoral neck fractures have to be individualized in terms of the type, extent of displacement, patient's age, activity level and physical condition as well as functional demand expected. For the same, one has to be familiar with its anatomic aspects and the likely outcome. This understanding has successfully reduced morbidity and mortality of the patients with fracture neck of femur.