Pinning Versus Plating in Treatment of Fracture Neck Femur in Skeletally Immature Patients: A Systematic Review and Meta-analysis

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Sameh Nagy Helmy

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List of Abbreviations

Abb.	Full term
LCCP	Low contact compression plate
MIPO	Minimally invasive plate osteosynthesis
CT	Computed topography
MRI	Magnetic resonance imaging
AVN	Avascular necrosis
AP	Antero-posterior
SCFE	Slipped capital femoral epiphysis
SHS	Sliding hip screw
ORIF	Open reduction and internal fixation
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
NS	Non-significant
S	Significant
HS	Highly significant
SD	Standard deviation
IQR	Inter-quartile range
SMD	Standard Mean Difference
OR	Odds Ratio
SE	standard error
CI	confidence interval
DF	Degree of freedom
I^2	Inconsistency
Vs.	Versus
SAE	Serious adverse events
Fig.	Figure
SHS	Sliding hip screw
AP	Anteroposterior

INTRODUCTION

Fractures of the femoral neck in children are rare injuries that account for less than 1% of all pediatric fractures. This low incidence attributed to the thick and strong periosteal cover and to the tough strong bone of children. As a result, most of these fractures (80% to 90%) are due to high-energy trauma. These injuries are associated with a high rate of complications, including osteo-necrosis of the femoral head, malunion with the coxa vara, nonunion, and limb length discrepancy because of early physeal closure. The most serious complication after femoral neck fractures in children is osteonecrosis. (1,2)

Delbet classified these fractures into four types: 1, transphyseal; 2, transcervical; 3, cervicotrochanteric; and 4, intertrochanteric **Figure (1)**. Immediate reduction and pinning are recommended for all types except for undisplaced cervicotrochanteric (type 3) and intertrochanteric (Type 4), which may be treated by spica casting in some patients. [3]

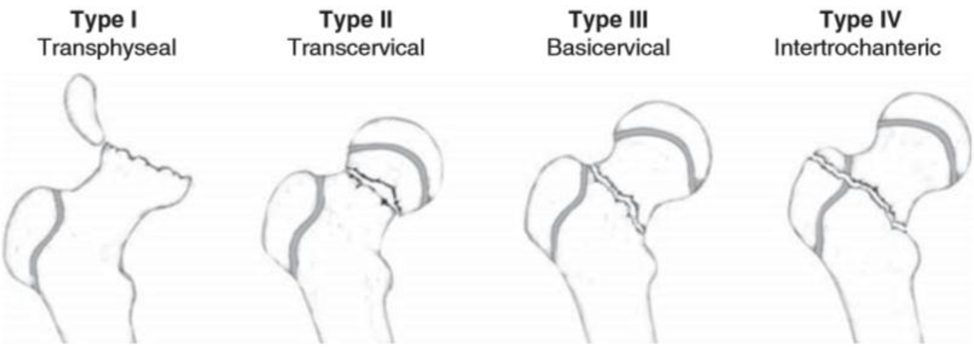


Fig. (1): Delbet classification [3]

Many studies have shown that fractures of the femoral neck are orthopedic emergencies which need reduction and internal fixation within 24 hours to get the best results. [4,5]

Although most of pediatric fractures heal without difficulty using conservative treatment methods, fractures of the femoral neck require a different approach for management. The patient must be closely monitored from the time of the fracture until complete bone union, as the complications mentioned above lead to functional disability. [6]

Many different procedures are described for operative treatment, including open reduction and internal fixation using K-wires, cannulated screws or nails. There is no evidence so far that implant type influences the rate of postoperative complications, such as avascular femoral head necrosis or coxa vara. However, Canale and co-workers found evidence that the use of a smaller number of pins seems to reduce the complication rate. [4]

Selection of the method of fixation varies by fracture type and skeletal maturity of the patient. Fixation with K-wires or cannulated screws in Delbet types I, II fractures can be placed under image intensifier or through an open incision. Delbet type III and IV fractures can be treated by open reduction and internal fixation by plates or dynamic hip screws. There are also newer generation locking plates which allow locking screws to be placed into the femoral neck. These come with varying degrees of screw plate angle. In these patients with type III, IV fractures with stable fixation with plates, can be carried out for earlier mobilization. [7,8]

With the advent of good implants and ancillary aids like image intensifier, new techniques are emerging. Low contact compression plate (LCCP) applied with the minimally invasive plate osteosynthesis

(MIPO) technique is also one of them. These plates provide an early, stable internal fixation. MIPO technique is a good option for treating comminuted fractures. As this technique helps in retaining the soft tissue envelope around the fragments and prevents the loss of fracture hematoma which in turn dramatically reduces the chance of infection, delayed union or non-union. [9]

Aim of the Work

Comparing between pinning and plating as an operative treatment options for fracture neck femur in skeletally immature patients regarding functional outcomes and complication rate.

ANATOMY

DEVELOPMENTAL ANATOMY OF THE PROXIMAL FEMUR

VASCULAR ANATOMY

Before age 4 years **Figure (2)**, the blood supply to the head of the femur is the medial and lateral femoral circumflex arteries and the artery of the ligamentum teres. Traversing the femoral neck, blood flow to the proximal femur is mostly provided by the circumflex vessels, with equal contributions from each. [10]

The anterior, posterior, and medial aspects of the proximal femoral physis, the posterior greater trochanter, and the posteromedial metaphysis vascularized by the medial femoral circumflex artery. The greater trochanter, small areas of the physis and anteromedial metaphysis supplied by the lateral femoral circumflex artery. The epiphysis supplied by both arteries.[10,11]

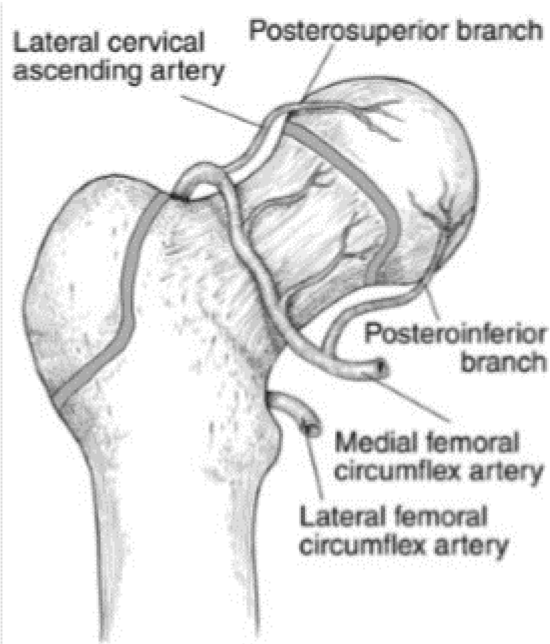


Fig. (2): Posterior view of the vascular supply of the developing proximal femur. The Capital femoral epiphysis is supplied by the medial femoral circumflex artery and its two retinacular vessels, the posterosuperior and posteroinferior branches. The greater trochanter, lateral proximal femoral physis, and anteromedial metaphysis supplied by lateral femoral circumflex artery.[11]

After age 4 years, the blood supply through the artery of the ligamentum teres diminishes. The lateral femoral circumflex system regresses, and its flow into the physis and epiphysis diminishes significantly, so that it becomes the predominant blood supply to the metaphysis. [12]

While the medial femoral circumflex artery provides the principal blood supply to the proximal femur via its posterosuperior and posteroinferior retinacular branches. The posterosuperior branch is the predominant contributor, supplying the anterior and lateral aspects of the femoral head.[12]

The retinacular vessels traverse the capsule at the intertrochanteric notch, and branches of these vessels course along the posterior femoral neck to supply the epiphysis.[12]

So the surgeon must be mindful when performing open reduction of intra-capsular fractures or hip capsulotomy to avoid incision of the capsule across the intertrochanteric line and extensive posterior dissection of the femoral neck to preserve the blood supply.[12]

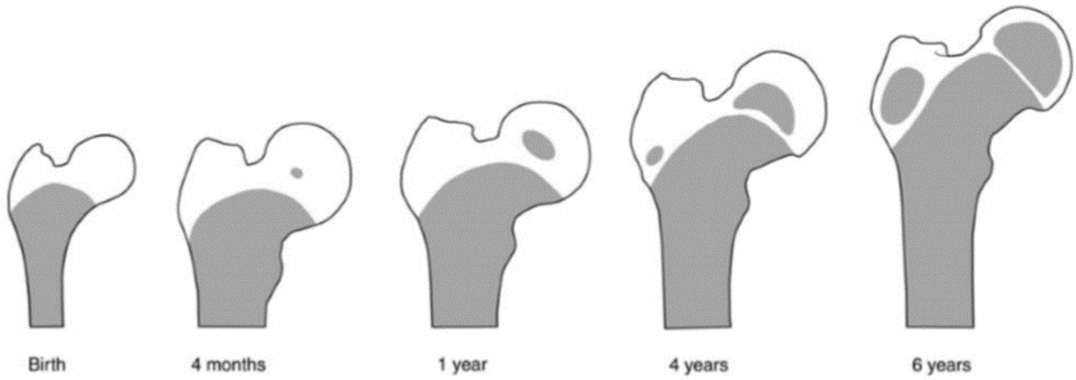
After age 10 years, the epiphysis supplied mainly by the end arterial flow of the retinacular vessels and with some contributions from the artery of the ligamentum teres. [13]

At skeletal maturity, the vascular anatomy of the adult proximal femur attained by developing anastomoses between the vessels of the ligamentum teres, metaphysis, and epiphysis. [13]

Improved vascularity of the adult hip and a decreased reliance on end-arterial blood flow is the cause of the lower incidence of osteonecrosis after hip fractures in adults compared with children. [13]

OSSEOUS ANATOMY

In infancy **Figure (3)**, the proximal femoral epiphyseal cartilage includes the cartilaginous anlages of the proximal femoral epiphysis, the



metaphyseal intertrochanteric femur and neck, and the greater trochanteric apophysis. [11]

Fig. (3): Illustrations, based on radiographs, demonstrating the osseous development of the proximal femur from infancy to age 6 years. Note the growth of the epiphyseal nucleus. [11]

The proximal femoral epiphysis begins to ossify at age 4 to 6 months in girls and at age 5 to 7 months in boys. The trochanteric apophysis begins to ossify at age 4 years in both sexes and is responsible for appositional growth of the greater trochanter and some growth of the metaphyseal intertrochanteric femur and femoral neck. The proximal femoral physis contributes to growth of the metaphyseal proximal femur, femoral neck, and epiphysis. [11]

Differential growth of the central portion of the physis of the the proximal femur results in the elongation of the femoral neck. [11]