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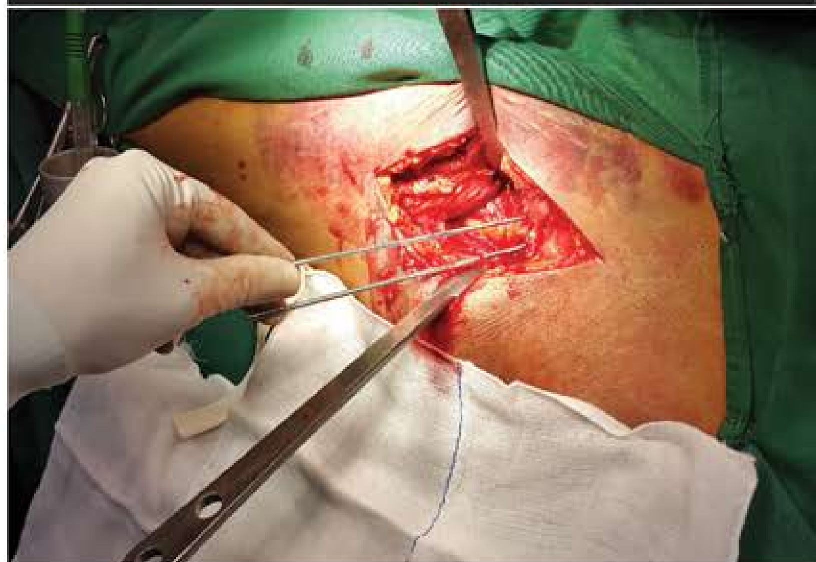

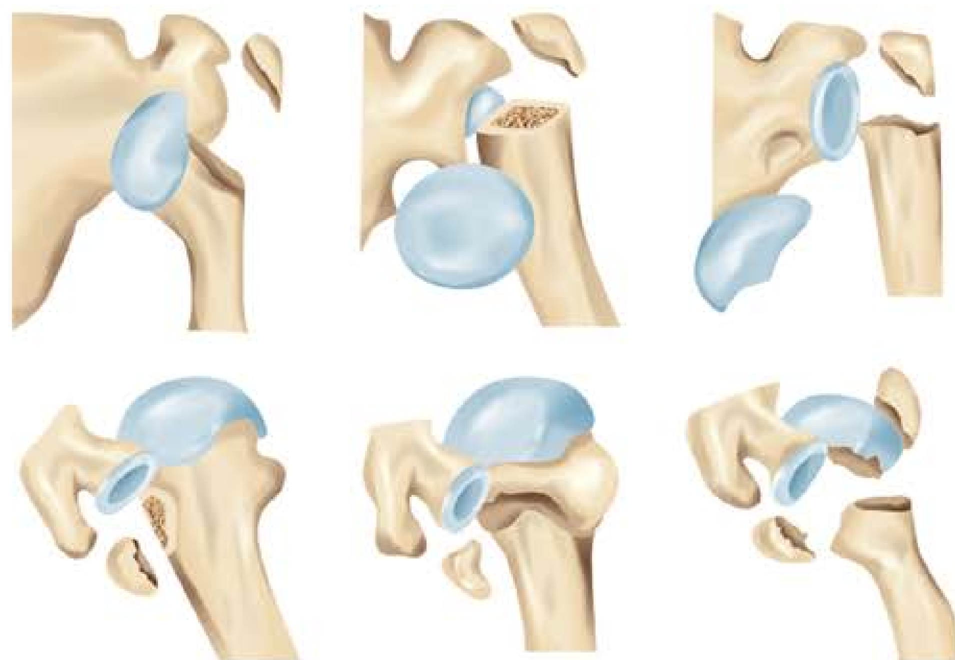

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Hardikar's
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Text and Atlas

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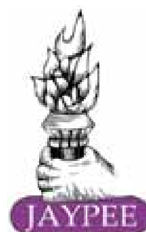

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CHAPTER 10

Pediatric Fracture Neck Femur

Avi Pranay Shah, Sandeep Vaidya, Mandar Agashe

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INTRODUCTION

Fractures of the neck of the femur in pediatric and adolescent age group are quite rare injuries. In fact, these injuries constitute less than 1% of all fractures in the pediatric population. This low incidence is attributed to the thick and strong periosteum cover and to the tough strong bone of children. Hence, as a result, most of these fractures (80–90%) are due to high-energy trauma and associated with other injuries. Despite their rare occurrence, these fractures are associated with a high complication rate, which make it an important clinical entity to understand.

Fractures of the hip in children are orthopaedic emergencies, requiring prompt and aggressive management within the first few hours after presentation. The anatomy of the pediatric hip differs from the anatomy of adult hips and this accounts for differences in treatment and complications. A thorough understanding of anatomy is important to ensure proper treatment and to understand associated complications to prevent high morbidity rates.

PATHOPHYSIOLOGY

The proximal femoral physis contributes greatly to the metaphyseal growth of the femoral neck with a minimal growth of the femoral head. The trochanteric apophysis also contributes to an extent toward the metaphyseal growth. The most important anatomy to understand is the blood supply of the proximal femur which is derived from two main arterial supplies: the medial circumflex artery and its branches being the main supply and the lateral circumflex artery and its branches. Extracapsular arterial ring is formed at the base of the femoral neck, the ascending cervical branches of the arterial ring at the surface of the femoral neck, and the arteries of the ligamentum teres. There is significant anastomosis among the various arteries in the proximal femur in approximately two-thirds of the cases (Fig. 1).

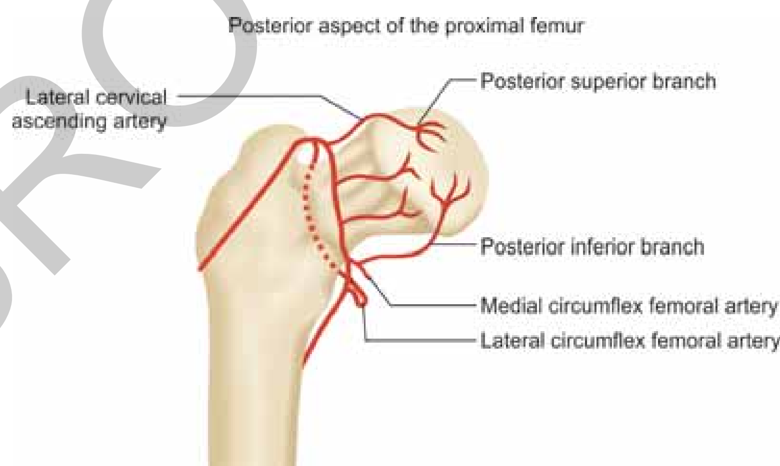

Fig. 1: Schematic diagram showing the blood supply of the proximal femur.

CLASSIFICATION

Delbet was the first person to classify pediatric neck of femur fractures and is the most widely used and acceptable classification. Colonna modified this classification and this is still being used extensively to describe the anatomical location of the fracture. This classification backed by literature gives excellent correlation with the rates of complications, especially AVN with type I having an AVN rate of as much as 80–100% while type IV has an AVN rate of as less as 1–2% (Fig. 2 and Table 1).

CLINICAL FINDINGS

Children are unable to bear weight on the injured extremity. The extremity may be shortened and externally rotated. These fractures may be associated with other polytrauma injuries (head injuries, abdominal injuries, etc.) due to the high velocity required for such injuries.

IMAGING STUDIES

Plain radiographs are the primary standard imaging modality to diagnose and classify a pediatric femoral neck fracture. When attempting a cross-table lateral radiograph, care should be taken

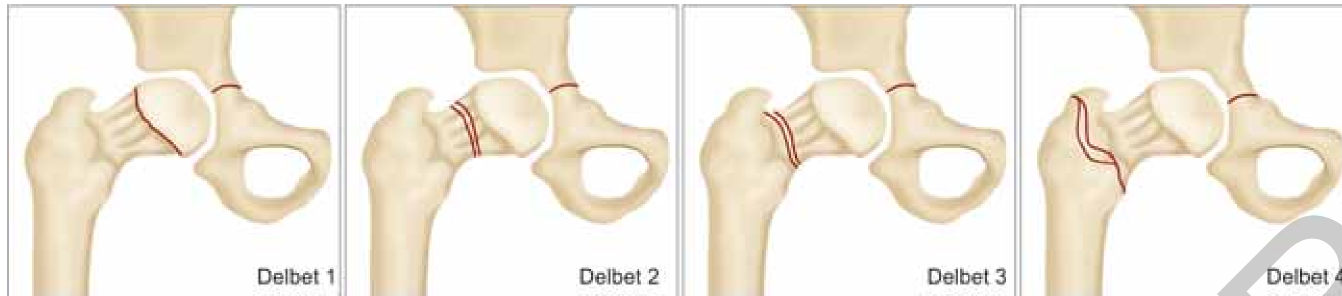

Fig. 2: Schematic representation of the Delbet classification.

TABLE 1: Delbet classification.

Type	Description	Incidence	AVN	Nonunion
Type I	Transphyseal IA—without dislocation of epiphysis from acetabulum IB—with dislocation of epiphysis	<10%	38% (AVN 100% in type IB)	
Type II	Transcervical	40–50%	28%	15%
Type III	Cervicotrochanteric (or basicervical)	30–35%	18%	15–20%
Type IV	Intertrochanteric	10–20%	5%	5%

(AVN: avascular necrosis)

to move the uninjured limb so as not to significantly displace the fracture on the injured side. CT or MRI may play a role in diagnosing undisplaced or stress fractures or concurrent femoral neck fracture-dislocations to better define the pattern of injury. They also have a role in diagnosing pathologic fractures.

TECHNIQUES

Nonoperative treatment can be used in children less than 1 year may be by using either a Pavlik harness or abduction brace. Spica cast in abduction can also be used with radiographs at weekly interval.

In older children treated nonoperatively by a spica cast the plaster should be applied past the knee. There are no outcome studies on spica or brace treatment but a spica cast should only be considered in younger children up to 5 years with nondisplaced fractures.

Nonoperative and spica cast treatment alone is not optimal in older children as the potential for nonunion is too great as well as high incidence of coxa vara after conservative methods. A supplemental spica cast is recommended for children that are not near skeletal maturity.

CAPSULOTOMY

Emergent reduction and capsulotomy (<24 h) may diminish risk of AVN by restoring blood flow through kinked vessels. Aspiration with large bore needle through sub-adductor approach or anterior hip approach can be done to reduce the tamponade effect and reduce the risk of AVN.

Open capsulotomy also can be done by performing a hip arthrotomy through the anterior approach using the smith Peterson interval.

Surgical Steps (Capsulotomy)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw insertion.
- *Fluoroscopy location*: Opposite surgeon
- Mark the anterior incision with hip in 90° flexion to develop. Draw a line that is in line with the skin crease of the anterior hip. The incision should be 2 cm medial and 2 cm lateral to the anterior superior iliac spine (ASIS).
- Perform sharp dissection through the skin and subcutaneous tissue.
- Externally rotate the leg and identify the sartorius.
- Identify the interval between the sartorius and tensor fascia lata (Smith–Petersen interval)
- Open the interval using use Metzenbaum scissors, small blunt retractors, or a hemostat
- Expose the joint capsule with a Cobb elevator for blunt dissection to expose this deeper layer
- Retract the head of the rectus femoris muscle medially this exposes the capsular iliacus and deep capsule of the hip joint
- Create arthrotomy window
- Drain the hip effusion.

CLOSED REDUCTION AND PERCUTANEOUS PINNING/ INTERNAL FIXATION

The child is placed on a radiolucent table with a small radiolucent bump under the ipsilateral buttock. Before draping, it is essential to check whether good-quality AP and frog-lateral C-arm pictures are easily obtained. The entire leg is draped free. The prominent bony markings such as ASIS, greater trochanter, and the lateral femoral condyle are marked with a sterile marking pen. Gentle closed reduction is attempted either by the assistant or the fracture table apparatus to give traction and internal rotation. Once the reduction is checked under fluoroscopy pinning can be done. Depending on the age of the child and type of fracture the choice of implant can be chosen. In younger children aged 2 years, 2-mm smooth pins should be used crossing the physis. The children older than 3 years, 4.5-mm cannulated cancellous (CC) screws can be applied in standard configuration keeping in mind not to cross the physis. Older children and adolescents 6.5-mm or 7.3-mm CC screws can be used in standard configuration.

If reduction cannot be achieved open reduction can be done. The choice of approach depends on the fracture displacement. The standard Watson Jones approach is the most commonly used

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approach but if posterior displaced femoral head is present which is more commonly seen with type 1b then a posterior approach can be used.

Surgical Steps (Closed Reduction and Percutaneous Pinning)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw insertion or placing the patient on a fracture table.
- *Fluoroscopy location*: Opposite surgeon
- Closed reduction of fracture by adduction and internal rotation.
- Mark position of guidewire using fluoroscopy on AP and lateral views
- Stab incision and place guidewire in standard position using fluoroscopy
- Insert smooth pins and cross physis (do not penetrate articular surface of femoral head). In older children or adolescents use appropriate screw length. Avoid crossing the physis in children younger than 10 years.

OPEN REDUCTION AND INTERNAL FIXATION

The child is placed on a radiolucent table with a small radiolucent bump under the ipsilateral buttock. Before draping, it is essential to check whether good-quality AP and frog-lateral C-arm pictures are easily obtained. The entire leg is draped free. The prominent bony markings such as ASIS, greater trochanter, and the lateral femoral condyle are marked with a sterile marking pen. After failure of gentle closed reduction open reduction is attempted using the Watson–Jones (anterolateral approach. A lateral incision is made over the proximal femur, slightly anterior to the greater trochanter. The fascia lata is incised longitudinally. The innervation of the tensor muscle by the superior gluteal nerve is 2–5 cm above the greater trochanter, and care should be taken not to damage this structure. The tensor muscle is reflected anteriorly. The interval between the gluteus medius and the tensor muscles will be used. The plane is developed between the muscles and the underlying hip capsule. If necessary, the anterior-most fibers of the gluteus medius tendon can be detached from the trochanter for wider exposure. After clearing the anterior hip capsule, longitudinal capsulotomy is made along the anterosuperior femoral neck. A transverse incision can be added superiorly for wider exposure. Once the hip fracture is reduced, guidewires for cannulated screws can be passed perpendicular to fracture line. 4.5-mm screws are used for children under 8 years and 6.5-mm or 7.3-mm screws used for older children and adolescents.

Displaced type IV fractures in all children more than 3 years should be treated with internal fixation with a pediatric or juvenile compression hip screw or pediatric locking hip plate placed into femoral neck short of the physis. It is important to place an antirotation wire before drilling and tapping the neck for the dynamic hip screw.

Surgical Steps (Open Reduction and Fixation)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw insertion or placing the patient on a fracture table.
- *Fluoroscopy location*: Opposite surgeon
- Attempt gentle closed reduction of fracture by adduction and internal rotation.
- A lateral incision is made over the proximal femur, slightly anterior to the greater trochanter.
- *Watson–Jones approach*: The interval between gluteus medius and the tensor muscles made.
- Under direct visualization reduction of fracture done.
- Once the hip fracture is reduced, guidewires for cannulated screws can be passed perpendicular to fracture line. Screws inserted in standard fashion.
- In older children and adolescents pediatric dynamic hip screw (DHS) system used with three hole plate or proximal femoral locking plates can be used.

Fixation with Dynamic Hip Screw and Cannulated Cancellous Screws/130 degrees Proximal Femur Locking Plate (Technical Steps) (Figs. 3 to 7)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw insertion or placing the patient on a fracture table
- *Fluoroscopy location*: Opposite surgeon
- Applicable in older children and adolescents
- Gentle closed fracture reduction is carried. If unable to correct open reduction can to done.
- If is reduced, it is provisionally fixed using two thick K-wires.
- Lateral approach to hip used and dissection done in layers.
- Once reduction is obtained, the guidewire for the proximal screw is placed in the inferior quadrant on the AP view and central on the lateral view. This will allow either one more screw above the first screw.
- The screw is predrilled and kept slightly loose and not completely seated in the bone.
- Cannulated cancellous screw just superior and parallel to the central screw for added stability and compression.
- Standard pediatric DHS is applied in standard fashion.
- Similarly after reduction, guidewire for 130° proximal femur locking plate inserted.
- 130-degrees proximal femur locking plate inserted in standard manner.

Fixation with Dynamic Hip Screw/Proximal Femoral Locking Plate with Valgus Osteotomy (Technical Steps)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw insertion or placing the patient on a fracture table.
- *Fluoroscopy location*: Opposite surgeon
- Applicable in older children and adolescents with delayed presentation and high Pauwel's angle.

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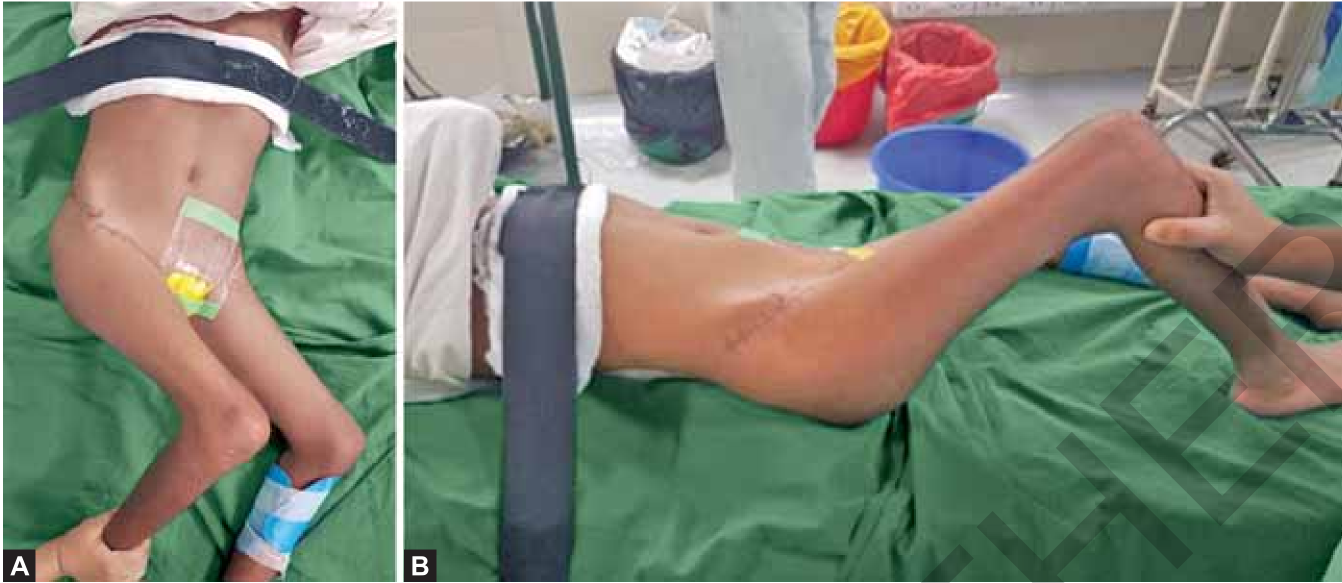


Figs. 3A and B: Position of the child. The authors preferred method is a simple radiolucent table with a small "bump" under the ipsilateral buttock. The C-arm would be from the opposite side. The limb can be gently taken to the frog-leg position for a lateral view. A fracture table can be used for bigger adolescent kids.

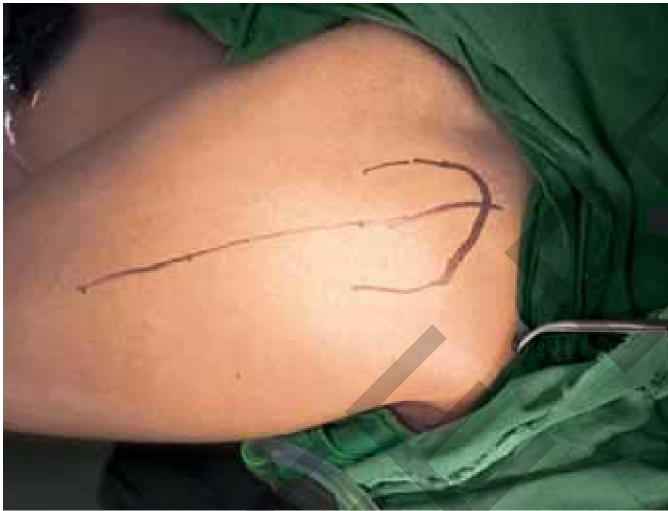
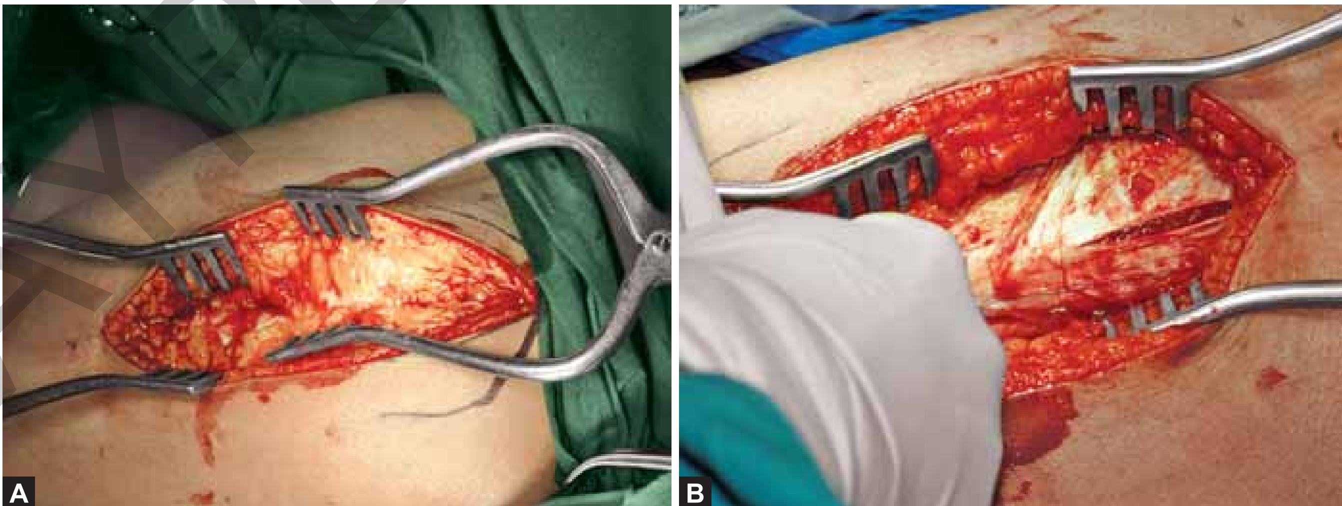


Fig. 4: The reduction is obtained by flexion, abduction and external rotation and once the reduction is obtained, it becomes stable by keeping in extension. The incision is a straight incision from the greater trochanter going distally for about 10–15 cm.



Figs. 5A and B: After the skin, subcutaneous tissue and the fascia lata are incised in the direction of the skin incision, the vastus lateralis muscle is exposed. At the level of the lesser trochanter but on the posterior aspect, the insertion of the gluteus maximus on the linea aspera is identified (also known as the gluteal sling). The entire vastus lateralis can be lifted off the femur safely by inserting a Homann spike at this level under the vastus lateralis and cutting the vastus lateralis distally just anterior to the lateral intermuscular septum, taking care to identify and coagulate the perforators which arise from the posterior compartment and come anteriorly. The proximal end of the vastus is lifted off the vastus ridge over the GT by an L-shaped incision.

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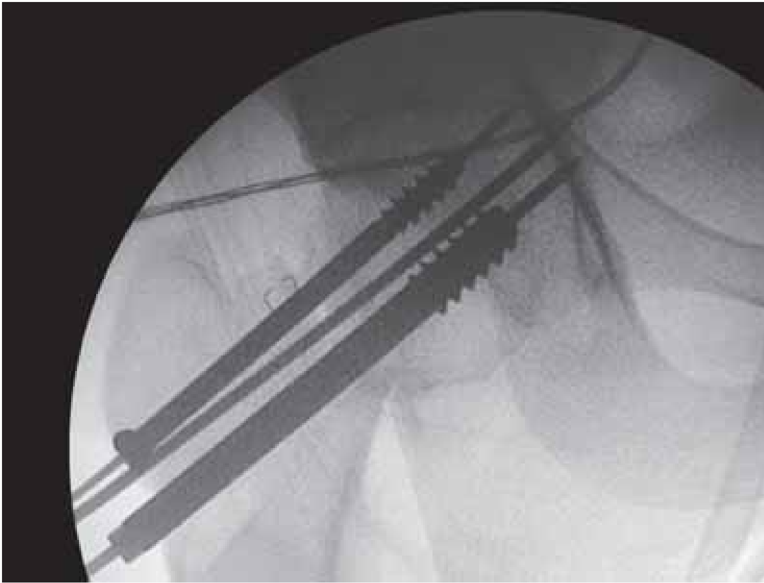


Fig. 6: The guidewire for the dynamic hip screw (DHS) is placed parallel to the neck but slightly inferior to the center deep into the femoral head. It may sometime be advisable to transfix the wire especially in subcapital fractures.

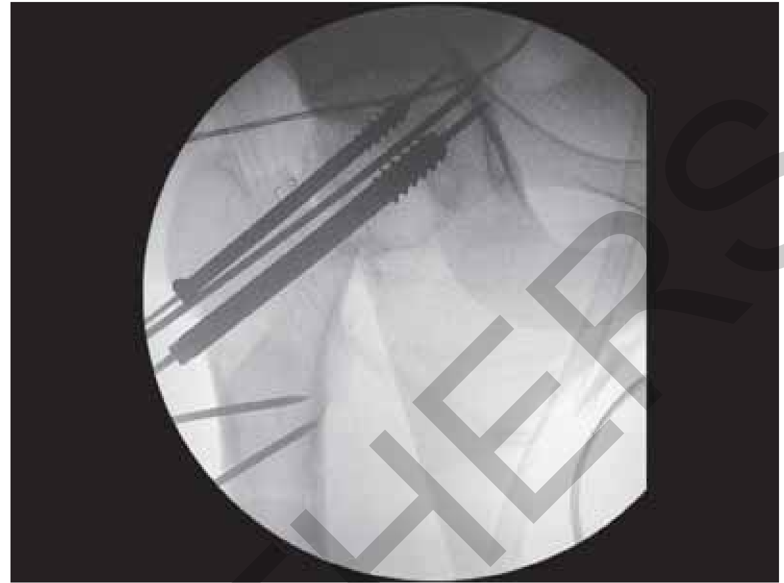
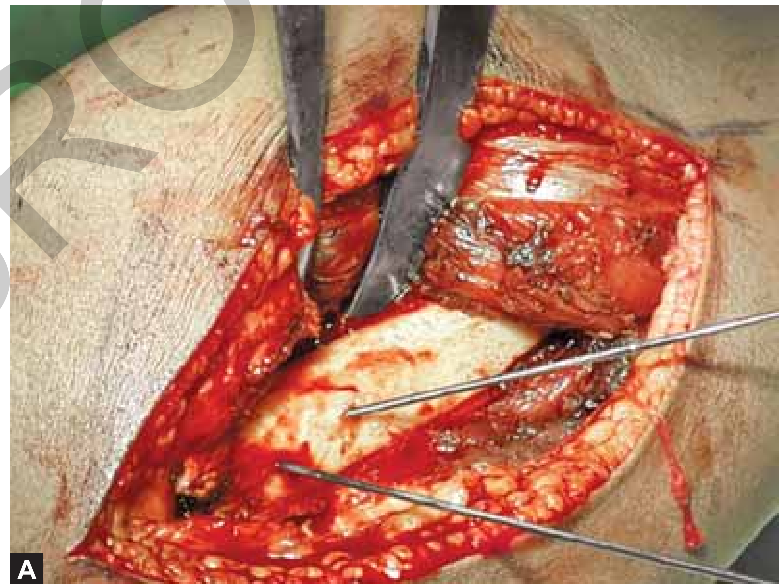


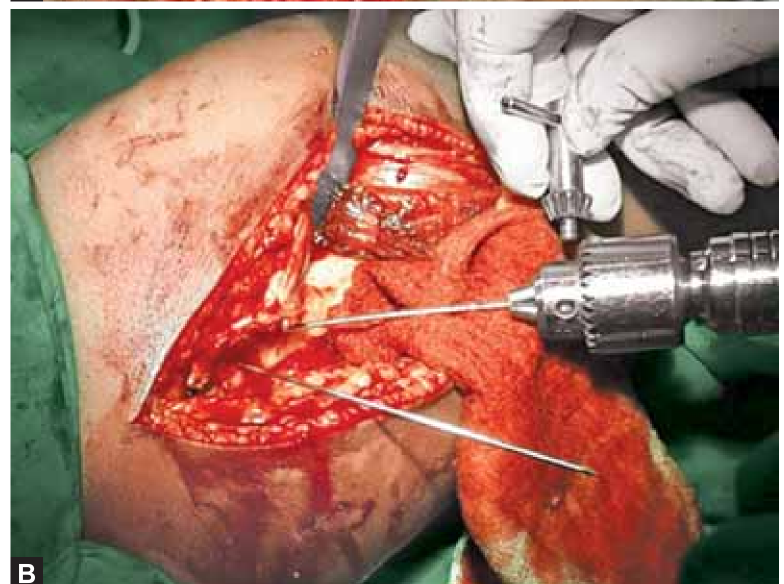
Fig. 7: One or two more wires are placed parallel to the dynamic hip screw (DHS) wire—one for the cannulated cancellous (CC) screw and one if required for the fibula. The DHS is triple reamed and DHS placed according to size, along with the CC screw.

- Gentle closed fracture reduction is carried. If unable to correct open reduction can to done.
- If reduced it is provisionally fixed using two thick K-wires.
- Standard lateral approach to hip used and dissection done in layers.
- Once reduction is obtained, the guidewire for the proximal screw is placed in the central quadrant on the AP view and central on the lateral view if using the DHS system or centrally 5 mm below superior border of the neck. When using the locking plates.
- 140°–150° degrees locking plates are used for valgus osteotomy.
- A subtrochanteric osteotomy is done below lesser trochanter. A lateral closing wedge can be removed with an angle to recreate the required the neck shaft angle when using a DHS system or a transverse osteotomy when using the locking plates.
- Standard pediatric DHS or proximal femoral locking plate is applied.
- It is important to lateralize the distal segment to keep the mechanical axis aligned.

Fixation with Dynamic Hip Screw/Proximal Femoral Locking Plate with Valgus Osteotomy and Nonvascularized Fibula Graft (Technical Steps) (Figs. 8 to 12)

- *OR table*: Radiolucent
- *Position/positioning aids*: Supine with a "bump" under the thoracolumbar spine to the posterior-superior iliac spine to access the greater trochanter for screw.
- *Fluoroscopy location*: Opposite surgeon
- Applicable in children and adolescents with delayed presentation/ nonunions and high Pauwel's angle.
- Gentle closed fracture reduction is carried out. If unable to correct open reduction can to done.
- If is reduced, it is provisionally fixed using two thick K-wires.
- The femur is exposed using the standard lateral approach incision
- Once reduction is obtained, the guidewire for the proximal screw is placed in the inferior quadrant on the AP view and central on the lateral view. This will allow either one more screw or fibula just above the first screw.





Figs. 8A and B: If required, a valgus osteotomy is performed. The first marking wire is just subtrochanteric and parallel to the dynamic hip screw (DHS) wire and the second wire at an angle which is the angle for correction.

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Figs. 9A to C: Once the angle is confirmed, osteotomy is performed using oscillating saw.

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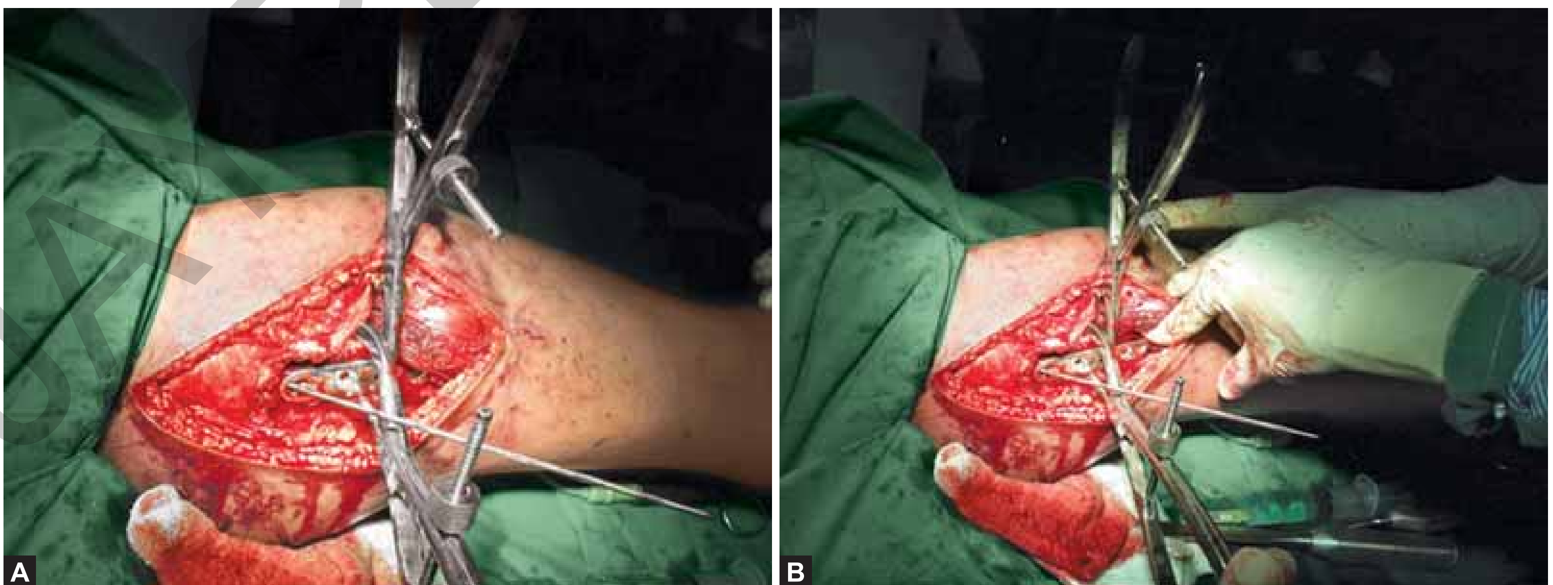
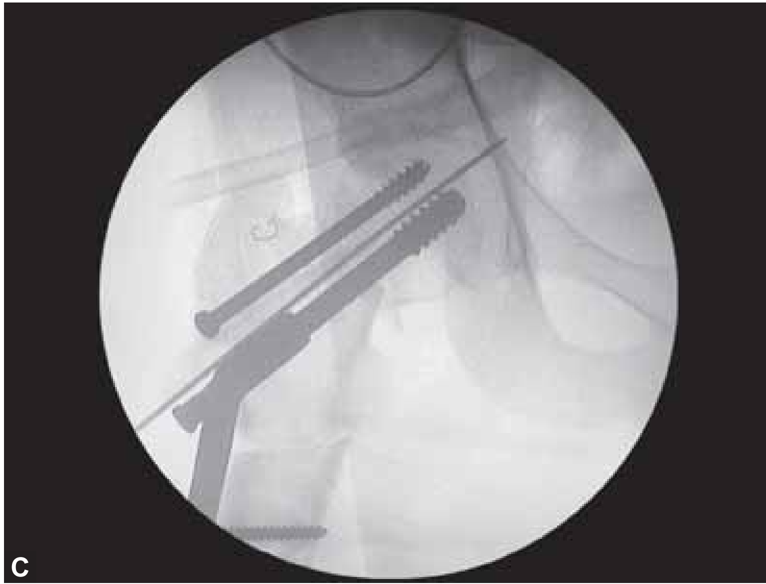


Figs. 10A and B



Figs. 10A to C: The proximal fragment is then abducted and the shaft is lateralized in order to align it with the plate which is of an angle of around 140–145°. The plate is then fixed using cortical screws.

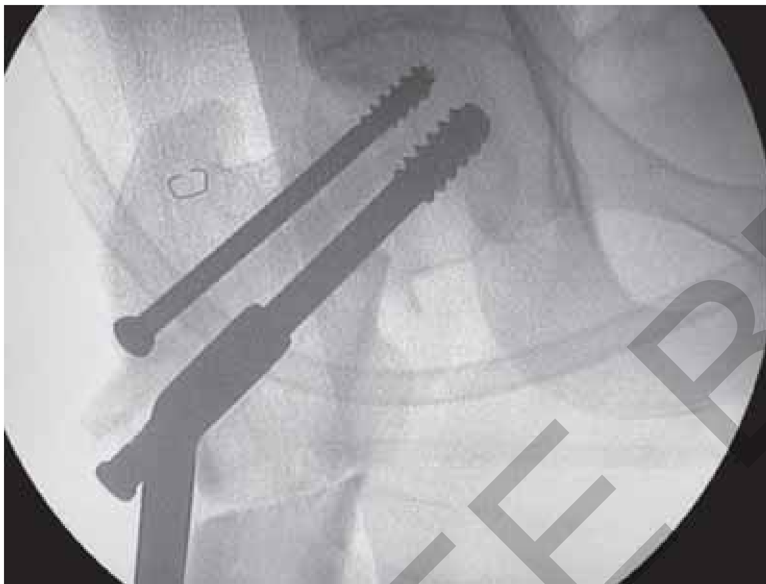


Fig. 11: A segment of nonvascularized fibula is then hammered in the proximal wire which has been reamed with a triple reamer. This fibula should reach the subchondral bone.

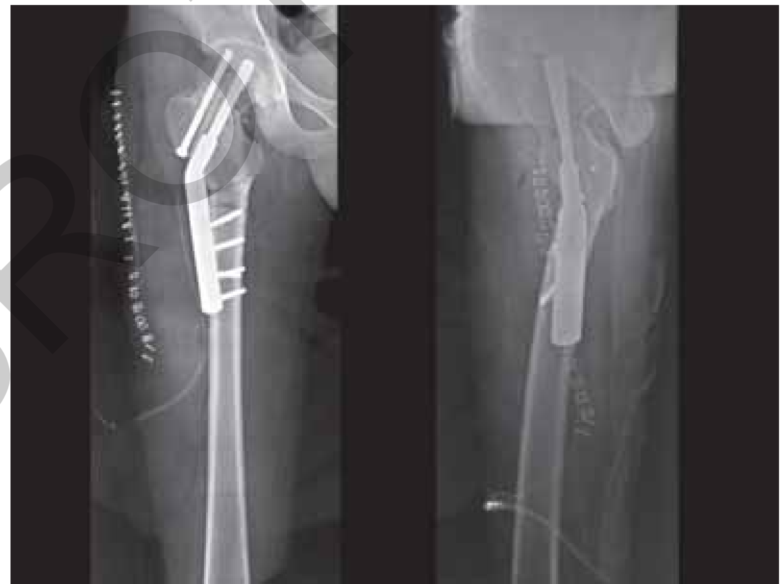


Fig. 12: Final postoperative X-ray after dynamic hip screw (DHS) fixation, valgus subtrochanteric osteotomy and fibula grafting.

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- Subtrochanteric osteotomy is then planned just below the lesser trochanter. A wedge equal to the angle of correction is osteotomized and lateral-based wedge is closed.
- The distal fragment is then lateralized and the side plate or locking plate is placed.
- About 6–8 cm of fibular graft is harvested from the middle third. The graft width and length is measured. The size of the expected fibular graft is exactly measured and it is cut to that size. The width (diameter) of the graft is usually 6–7 mm, and if thicker than that, the graft is shingled to that size.
- To prepare the tract at the superior border of the femoral neck, sequential reaming is performed using cannulated drill bits and finally by a triple reamer so as to make the canal of adequate size.
- It is very important to see to it that the canal is dilated adequately
- The fibula is passed over the guidewire and gently tapped using a bone punch.
- The seating of the graft is ensured till approximately 5 mm of the subchondral surface.
- The extra portion of the fibular graft is cut
- If gap between the fracture fragments is too large, it is sometimes necessary to fill the graft using iliac crest cancellous bone grafts.
- DHS or pediatric hip locking plate placed in standard manner.

POSTOPERATIVE CARE

Supplementary casting should be considered for the majority of patients with proximal femoral fractures. Casting is indicated in all type I fractures in younger children. Type II and III fractures, it is recommend to use a hip spica cast for at least 6 weeks, especially in patients whose implants do not cross the femoral physis.

Children older than 12 years can be treated with transphyseal fixation that is stable enough to avoid cast fixation. But, the use of a postoperative cast depends on the stability of fracture fixation and the patient's compliance.

Fractures treated with a hip screw and side plate do not require cast immobilization. Formal physiotherapy usually is not required unless persistent limp, stiffness is seen which is rare.

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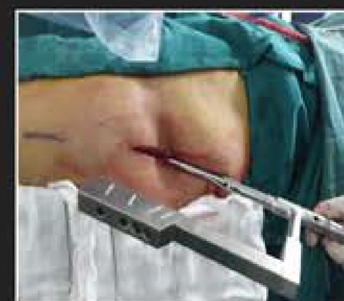

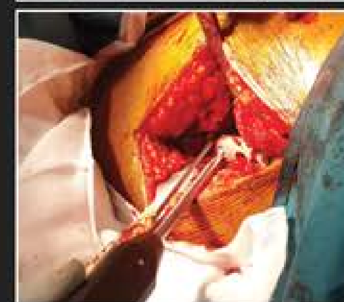

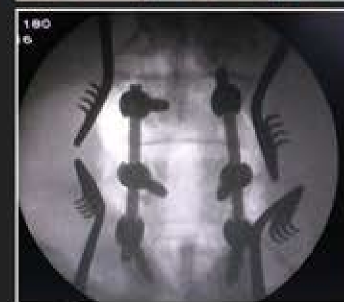

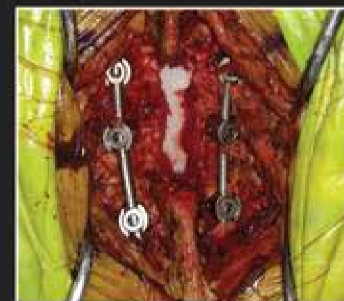

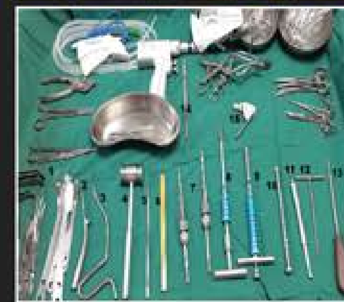

This will be a unique book for junior and senior Orthopaedic Surgeons. It should be part of library of every practicing Orthopaedic Surgeon. This book covers all common orthopaedic operations in all subspecialties of orthopaedics. Each procedure has serial photographs of the operations starting with trolley, position of patient, till closure of the wound. There will be step-by-step description of the procedure corresponding to the photographs. Each operation will have brief relevant text and possible complications. Each chapter will have important suggested further readings at the end.

The purpose of the book is that any Orthopaedic Surgeon should be able to do the operation by looking at the serial photographs. Some of the procedures in the book will require assistance of an expert.

It is proposed that the entire book and some extra operations will be available online also.

Sharad M Hardikar after qualifying FRCS (Edin) worked as Senior Lecturer and Consultant Orthopaedic Surgeon in New Mulago Hospital, Kampala—a teaching hospital of Medical College, Uganda. He has worked as Honorary Professor in Sassoon General Hospital and BJ Medical College for almost three decades, more than 250 Orthopaedic Surgeons have been trained by him in Sassoon General Hospital and Hardikar Hospital, Pune, Maharashtra, India.

In 1971, he started Hardikar Hospital (Orthopaedics and Accident) which over the years has expanded to a popular brand name as a leading 120 beds Orthopaedic and Accident Hospital with all allied amenities, the postgraduate teaching center and a referral center for all types of trauma and orthopaedic cases for the entire Western Maharashtra and beyond.

He has published several scientific articles in national and international orthopaedic journals. He has written several short books including those on Poliomyelitis, Spine Surgery, Knee and Shoulder Surgery, Osteoporosis and Surgical Rehabilitation of Spastic Children.

He is Ex-President—Association of Spine Surgeons of India and Founder Member of 'World Orthopaedic Concern'. He was honoured as a Fellow of Indian Orthopaedic Association in Bhubaneswar Conference 2009. He was awarded DLit Honour by Tilak Maharashtra Vidyapeeth, Pune. The Government of Maharashtra in recognition of these outstanding services has honoured him with status of Professor Emeritus Orthopaedics. He was awarded 'Padma Shree' by President of India in January 2004 for his outstanding contribution in medical and social fields.

He is actively involved in Clinical and Applied Research in various orthopaedic and allied subjects and have, completed Research Project on role of Ayurvedic Drugs in Fracture Healing. He is credited along with Dr S Prakash in Design of Instruments such as: Wagner's external fixator, implant for fixation of fracture neck humerus, implant for fixation of fracture of distal end of radius and implant for removal of broken screw.

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He has performed Interlocking Nailing Surgery without C-arm with innovatively using wire mesh together with Dr Sharad M Hardikar. He has published many papers in state, national and international journals and has presented many papers in various conferences. He has worked as Joint Organizing Secretary for IOACON, Pune and as Secretary of Pune Orthopaedic Society.

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