OUTCOME ANALYSIS OF SUBTROCHANTERIC

FRACTURES FIXED WITH DYNAMIC CONDYLAR SCREW, DYNAMIC

HIP SCREW AND RECONSTRUCTION NAIL

By

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Dissertation submitted to
THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY, CHENNAI,

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY IN ORTHOPAEDICS

Under the guidance of

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COIMBATORE

2012

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"OUTCOME ANALYSIS OF SUBTROCHANTERIC FRACTURES FIXED WITH DYNAMIC CONDYLAR SCREW, DYNAMIC HIP SCREW AND RECONSTRUCTION NAIL"** is a bonafide and genuine research work carried by me under the guidance of **Dr.B.K. Dinakar Rai, M.S Ortho**, Prof and HOD, Department of Orthopaedics, PSGIMS & R, Coimbatore.

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ACKNOWLEDGEMENT

At the outset, I thank the god for giving me the strength to perform all my duties.

It is indeed a great pleasure to recall the people who have helped me in the completion of dissertation. Naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a selected few who have helped me in diverse ways.

I acknowledge and express my humble gratitude and sincere thanks to my beloved teacher and guide **Dr. B.K.Dinakar Rai, M.S (Ortho),** Professor & HOD, Department of Orthopaedics, PSGIMS&R, Coimbatore for his valuable suggestion, guidance, great care and attention to details, that he has so willingly shown in the preparation of this dissertation.

I owe a great deal of respect and gratitude to my professor, **Dr.Shyam Sundar M.S (ortho)** for his whole hearted support for completion of this dissertation.

I also express my sincere thanks to Associate **professors Dr.Arvind Kumar M.S (ortho)** and Assistant professors, **Dr.N.Venkatesh Kumar D.ortho, DNB, Dr.Chittaranjan M.S (ortho), Dr.Sreeramalingam M.S (ortho), Dr. Vijayanth M.S (ortho)** and **Dr.Suka Sekar D.ortho,** department of orthopaedics, PSGIMS&R, Coimbatore for their timely suggestions and all round encouragement.

I am immensely indebted to my grandparents and parents who have inculcated the proper habits and characters in me.

My sincere thanks to the staff, post graduate colleagues and my friends for their whole hearted support.

Finally I thank my patients who formed the backbone of this study without whom this study would have not been possible.

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LIST OF ABBREIVATIONS USED

#	Fracture
AO	Arbeitsgemeinschaft fur osteosynthesefragen
ASIF	Association of study of internal fixation
AP	Anteroposterior
DHS	Dynamic hip screw
DCS	Dynamic condylar screw
S_x	Surgery
LIF	Lost in follow up
A	Absent
P	Present

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INTRODUCTION

INTRODUCTION

Subtrochanteric fractures of the femur account for 10–34% of all hip fractures. (1) These fractures are known to be difficult to treat successfully. (2) Certain anatomic, biologic and biomechanical features make this area a unique proposition for the treating surgeon.

The subtrochanteric region of the femur is mainly cortical due to which the area of healing as well as the vascularity is poorer, prolonging the healing time. The forces in this area are up to 1,200 pounds/square inch on the medial cortex leading to immense stresses in the area. The strong muscles on either side of the fracture causes shear at the fracture site. (3)

There has been a near-complete elimination of nonoperative treatment in adults and a corresponding increase in the operative treatment of subtrochanteric fractures. (4)

The goal of operative treatment is restoration of normal length and angulation to restore adequate tension to the abductors. (5)

No single implant is universally recommended for the internal fixation of these fractures, and hence periodically new fixation devices are introduced. (1)

Only recently better understanding of biology, reduction techniques, biomechanically improved implants and improved fracture fixation techniques allowed for these fractures to be addressed with consistent success.

This study was based on the results of a retrospective study conducted in our hospital on a consecutive group of 28 patients presenting with subtrochanteric fractures to the casualty department. All 28 fractures were fixed with DCS/DHS or RECONSTRUCTION NAIL. The idea of the study is to determine the choice of implant in different subtrochanteric fractures.

AIMS & OBJECTIVES

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1. To determine the rate of union, complications, operative risks and Functional outcome in subtrochanteric fractures treated with DCS, DHS and RECONSTRUCTION NAIL.
2. To create an algorithm for surgery of choice in various Subtrochanteric fracture patterns.
3. To determine the complications involved in the management of Subtrochanteric fractures.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Definition:

"Subtrochanteric fractures are femoral fractures where the fractures occur below the lesser trochanter to 5 cms distally in the shaft of femur" (6)

These fractures occur typically at the junction between the cancellous and cortical bone where the mechanical stress across the junction is highest in the femur, which is responsible for their frequent communition. These fractures account for 10% to 34% of all hip fractures. (1)

Koch demonstrated that compression stress exceeds 1200 lb/inch^2 in the medial subtrochanteric area 1 to 3 inches distal to the level of the lesser trochanter which is the cause for communition in these fractures. (7)

Age distribution:

These fractures have got bimodal age distribution.(8, 9, 10, 11)

Waddell found a 33% incidence of subtrochanteric fractures in patients 20 to 49 years old and a 67% incidence in patients between 50 and 100 years old in their review of proximal femoral fractures. (11)

Michelson and associates reported that 14% of hip fractures in patients older than 50 years were subtrochanteric fractures. (12)

Mechanism of injury:

The femoral neck shaft anatomy is one of the key factors which determine the specific configuration of subtrochanteric fractures. The transition from the cortical compact bone in the diaphysis to the cancellous trabecular bone in the proximal femur also explains the characteristic communition with proximal and distal extensions.

Biomechanically, the differential distribution of the compression and tensile stress (7) also determines the unique features of the fracture pattern as well as complications after treatment.

The mechanism of injury varies with age. In younger patients, the fracture is more commonly caused by high-energy trauma and in older age group due to low energy trauma as in a trivial fall. (13)

Bergman and colleagues, in a study noted an average age of 40 years in the high-energy trauma group and 76 years in the low-energy trauma group. (8)

Low energy trauma usually results in a minimally comminuted oblique or spiral fracture, frequently in osteopenic bone. Fractures from high energy trauma are often communited, posing the risk for significant damage to the soft tissues as well as devascularization of the fracture fragments.

The subtrochanteric region of the femur is also frequently the site of pathologic fracture arising from neoplastic disease, these accounts for 17-35% of subtrochanteric fractures. (14)

Commonly associated injuries:

High velocity injuries are mostly associated with injuries to the pelvis, long bones, spine and viscus. (8)

A high incidence of ipsilateral patellar and tibial fractures are associated with high-energy subtrochanteric fractures which compromise the functional ability of the patient. (11)

SURGICAL ANATOMY

Subtrochanteric fractures are femoral fractures where the fractures occur below the lesser trochanter to 5 cm distally in the shaft of the femur. (6)

They are unique in their fracture characteristics. They occur typically at the junction between trabecular bone and cortical bone where the mechanical stress across the junction is highest in the femur which causes frequent fracture communition due to both the material property changes and the mechanical environment.

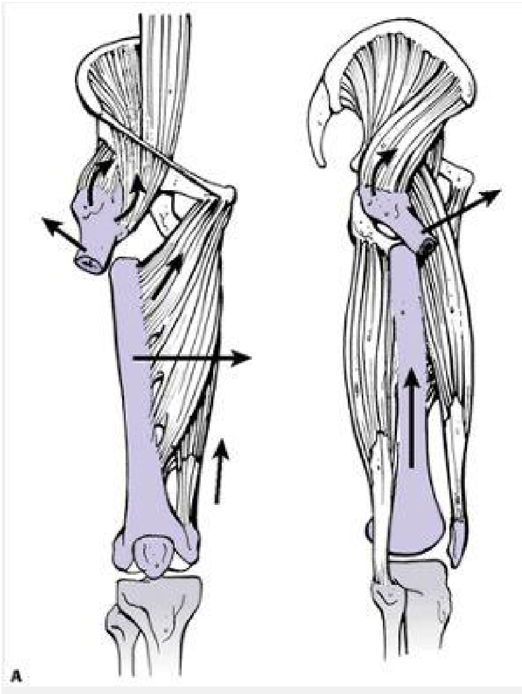
The proximal segment of the fracture is composed of the femoral head, neck, and the trochanteric region. The greater trochanter is a large bony eminence at the proximal femur that provides insertion of the powerful hip abductors (gluteus medius and minimus) and short external rotators (piriformis, gemellus superior, and gemellus inferior and obturator internus) of hip.

The lesser trochanter (trochanter minor; small trochanter) is a conical eminence, which projects from the lower and back part of the base of the neck. The summit of the trochanter is rough and gives insertion to the tendon of Psoas major.

Strong muscle forces act across the fracture site. In the proximal fragment, the iliopsoas and short abductors causes the proximal segment to become externally rotated, flexed and abducted.

The distal segment, due to the strong pull from the adductor magnus, displaces medially and further aggravates the deformities of the two fracture fragments.

Figure: 1



Surgical exposure of subtrochanteric region involves either splitting the vastus lateralis or reflecting it from lateral intermuscular septum.

During surgical exposure, there may be profuse bleeding from perforating branches of the profunda femoris artery.

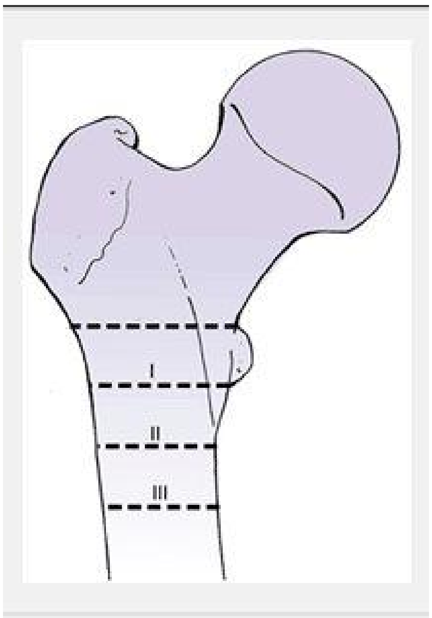
Surgical exposure for open reduction and internal fixation could cause a major vascular devitalisation at the fracture site more so when fracture is communited.

CLASSIFICATION OF SUBTROCHANTERIC FRACTURES

Through the years, numerous classification systems have been proposed for subtrochanteric fracture {Boyd and Griffin 1949, Watson 1964, Fielding and Magliato 1966, Zickel 1976} which have a prognostic importance and are of benefit in planning treatment.

FIELDING AND MAGLIATO'S CLASSIFICATION (1966) (15)

Figure: 2



They defined subtrochanteric area as an area three inches in length extending from the proximal border of the lesser trochanter to an area two inches distal to the lesser trochanter. They then classified subtrochanteric fractures on the basis of three anatomic locations.

Type I: Fractures occuring at the level of lesser trochanter.

Type II: Fractures occuring in an area one to two inches (2.5- 5.0) below the upper border of the lesser trochanter.

Type III: fractures occuring in an area two to three inches below the lesser trochanter.

Transverse fractures fit in this classification well but not oblique comminuted fractures which involve more than one of the levels described. As a rule fractures at the upper level have a better prognosis for union than at the lower level and incidence of complications increase as the fracture becomes more distal.

This classification does not address the problem of comminution, which is critical in assessing fracture stability.

SEINSHEIMER CLASSIFICATION: (16)

Seinsheimer described the classification of the types I till V based on fracture pattern, with subgroup A, B, C based on the stability and comminution.

Type 1: non displaced fracture; any fracture with less than 2 mm of displacement of the fracture fragments.

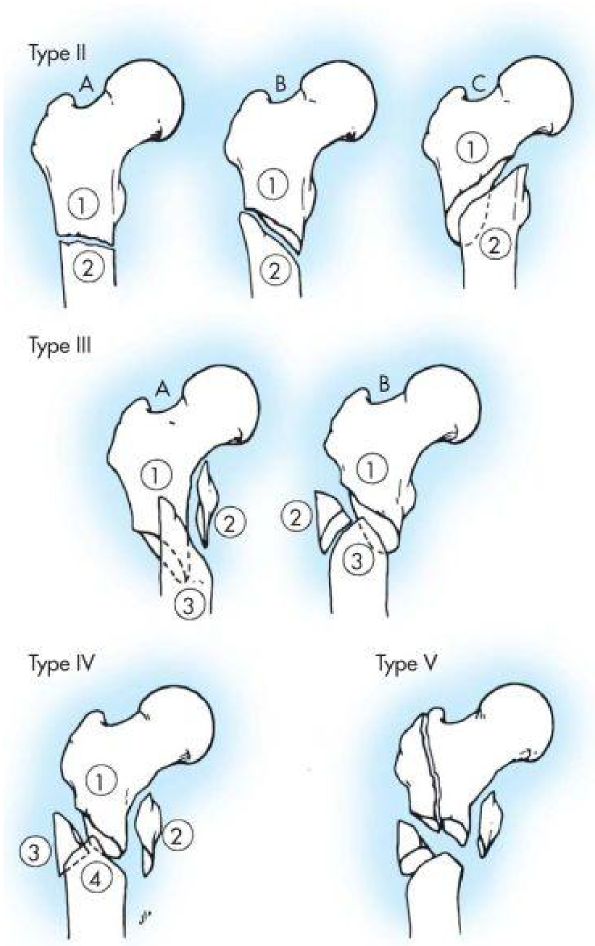
Type 2: two part fracture (A) transverse fracture; (B) spiral fracture with lesser trochanter attached to the proximal fragment; (C) spiral fracture with lesser trochanter attached to the distal fragments.

Type 3: three part fracture

(A) Spiral fracture in which the lesser trochanter is a third fragment, which has inferior spike of cortex of varying length.

(B) Fracture of the proximal one third of femur with a third part a butterfly fragment

Figure: 3



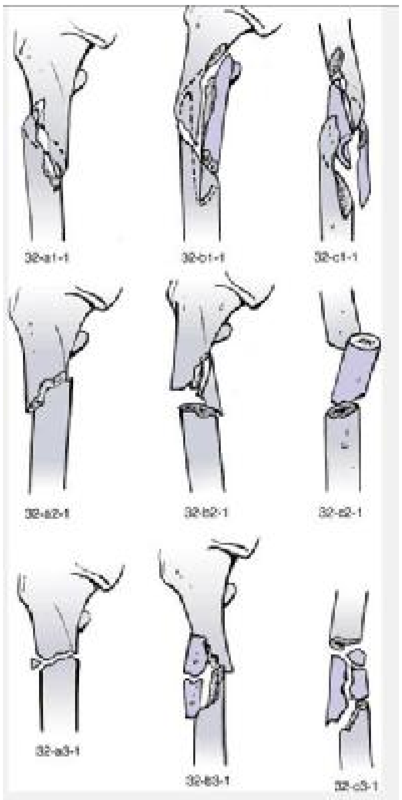
Type 4: comminuted fracture: 4 or more fragments.

Type 5: Subtrochanteric- Intertrochanteric fracture: subtrochanteric fracture with extension through the greater trochanter.

This classification offers guidelines for management and prognosis. According to Rockwood and Green, this Seinsheimer classification is the most useful of the available classifications for decision making and predicting prognosis in these fractures.

AO classification: (17)

Figure: 4



Subtrochanteric fracture described as 32-(X-#)-1

Femoral shaft identified by No 32

X sub classified as a, b, c

- a- Simple fracture
- b- Wedge fracture
- c- Complex fracture

Numeric description # – Degree of communition

This classification did not consider about the trochanteric extension.(19)It has different degree of inter and intraobserver reliability.

RUSSELL AND TAYLOR CLASSIFICATION: (18)

Russell and Taylor devised a classification scheme based on lesser trochanteric continuity and fracture extension posteriorly on the greater trochanter involving the piriformis fossa, the major two variables influencing the treatment.

Type I: fractures do not extend into the piriformis fossa

Type I A: communition and the fracture lines extend from below the lesser trochanter to the femoral isthmus; any degree of communition may be present in this area, including bicortical communition.

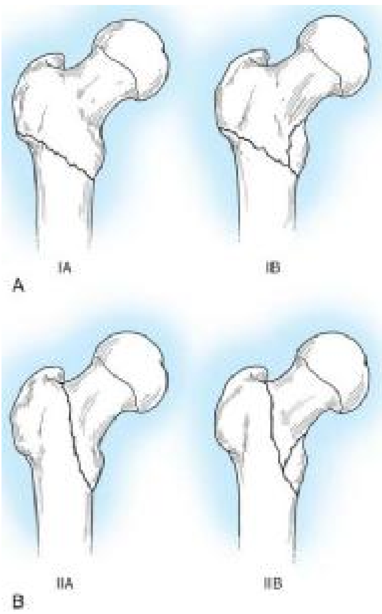
Type IB: have fracture line and communition involving the area of the lesser trochanter to the isthmus.

Type II: fractures extend proximally into the greater trochanter and involve the piriformis fossa, as detected on the lateral roentgenogram of the hip, which complicates closed nailing techniques.

Type II A: fracture extend from the lesser trochanter to the isthmus with extension into the piriformis fossa, as detected on lateral roentgenograms, but significant communition or major fracture of the lesser trochanter is not present.

Type II B: the fracture extends into the piriformis fossa with significant communition of the medial femoral cortex and loss of continuity of the lesser trochanter.

Figure: 5



Availability of implants with improved designs has reduced the importance of integrity of the piriformis fossa for nailing

MANAGEMENT OF SUBTROCHANTERIC FRACTURES

Subtrochanteric fractures of femur remain some of the most challenging fractures facing orthopaedic surgeons. (5) The unique fracture characteristics lead to frequent communition in this region, due to both material property changes and the mechanical environment. (6)

Frankel and Burstein demonstrated the importance of asymmetric high stress loading pattern in this region in the selection of an internal fixation device and in understanding the causes of fixation failure and healing disturbances. (6)

Koch and Ryddl in their study have shown the magnitude of the mechanical stresses in the subtrochanteric region and this directly influences the rate of failure of internal fixation. (7)

Furthermore the cortical bone in the subtrochanteric region is less vascular than the cancellous bone in the Intertrochanteric region increasing the risk of healing complications like non union with subtrochanteric fractures.

The muscle attachments to the fracture fragments causing displacement at the fracture site as described by Formison (14) makes treatment of subtrochanteric fractures exceedingly difficult by traction or other non operative methods.

Allisin 1981, recognized the complications of shortening, angular deformity and rotational malalignment following this fracture.

Systemic complications related to the effect of injury and immobilization also stress the importance of surgical management of these fractures.

Local complications include early loss of fixation, delayed union, late fixation failure usually to non union, infection and late hardware complications. (14)

Closed interlocking nailing and open indirect reduction techniques emphasizing preservation of the blood supply to the fracture fragments have decreased the incidence of nonunion and permitted earlier functional return to the patients.

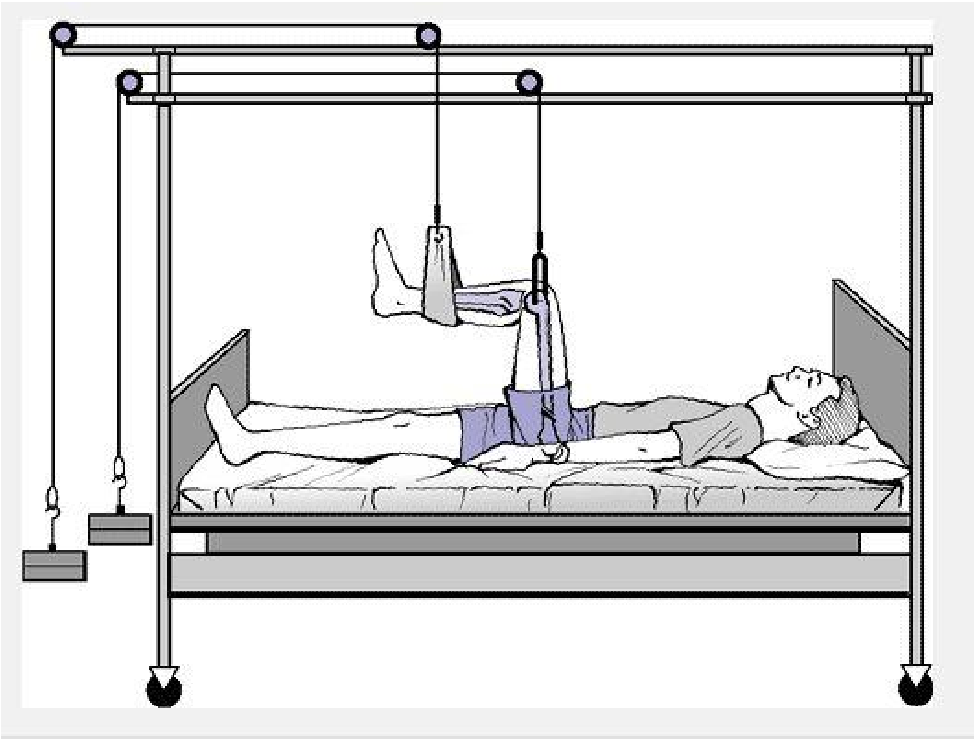
Improved engineering and manufacturing techniques have yielded implants of greater strength and longer fatigue life. Optimal treatment can be selected for each patient with a thorough understanding of the variants of subtrochanteric fractures and various treatment options available.

Various modalities of subtrochanteric fracture management:

Non operative treatment (6)

Non operative treatment with 90-90 deg traction has been described for subtrochanteric fracture management. With the advent of operative treatment and development of new implants, non operative treatment for subtrochanteric fractures has become obsolete.

Figure: 6



Operative treatment:

Subtrochanteric fracture is one type of diaphyseal fracture of femur. Diaphyseal fractures in the long bones of lower limb are best treated by internal fixation for early mobilisation and early weight bearing.

In fracture healing mechanics, proper biomechanical conditions and biology play an essential role and therefore determine the outcome.(20)The onus is now on preserving biology while providing stability (not rigidity) to the fracture and allowing it to unite under protected loading. (21)

Hence the technique of internal fixation must follow the guidelines of minimizing the trauma to the soft tissues and the osseous fragments to facilitate fracture healing.

Angular deformity correction and restoration of length are the primary goals of reduction since the varus collapse seen in subtrochanteric fractures will cause an abductor lurch and significant limp if not corrected. (23)

Biomechanically, it must be strong enough to counteract the stress across the subtrochanteric region, which can best be achieved by restoring the posteromedial cortical continuity. (6)

Open method:

The AO group has advocated the open technique since the early 1960's. (17) Anatomical reduction and rigid fixation to achieve immediate mechanical stability were the aims of treating these fractures.

Disadvantages:

- Extensive soft tissue dissection.
- Devascularizing effect on the osseous fragments frequently leads to delayed or non union. (22)
- Higher infection rate. (21)
- Delayed weight bearing.

Closed method

Anatomical realignment with correction of the deformities in length and rotation are the principles of closed method of treatment of these fractures.

Advantages:

- Fracture hematoma is not disturbed.
- Minimal soft tissue dissection.
- Load sharing device
- Reaming material serves as bone graft.

One goal of operative treatment is strong, stable fixation of the fracture fragments.

Kaufer, Matthews, and Sonstegard listed the following variables as those that determine the strength of the fracture fragment-implant assembly.

- Bone quality
- Fragment geometry
- Reduction
- Fixation device
- Device placement

Of these five elements of stable fixation, the surgeon can control only the quality of reduction and the choice of implant and its placement.

1. **Bone quality:**

Pertrochanteric and subtrochanteric fractures occuring in elderly people are relatively low energy trauma injuries occuring in atrophic, osteoporotic or osteomalacic bone.

Singh et al's roentgenographic method for determining bone strength is based on the trabecular pattern of the proximal femur and is sufficiently sensitive and prognostically useful.

Clinical studies confirm that regardless of other variables internal fixation failed in 80% of fracture of the bone of grade III or less.

In 1838, Ward described the internal trabecular system of the femoral head. It is important that the internal fixation device be placed in that part of the head and neck where the quality of the bone is best.

2. **Fragment geometry:**

Much clinical attention has been focused on the number, size, shape, location, and displacement of subtrochanteric fracture fragments.

Stable subtrochanteric fractures are those in which it is possible to re-establish the medial and posterior femoral cortical continuity and in these cases, an internal fixation device will act as a tension band on the lateral femoral cortex, and impaction and weight bearing can occur directly through the medial cortex.

In unstable fractures, medial cortical opposition is not attainable and the bending stress and the loads will concentrate in on the internal fixation device which greatly increases the risk of implant failure.

3. **Fixation device:**

High incidence of complications reported after surgical treatment has lead to series of internal fixation devices. Various commonly employed internal fixation devices are:

- **EXTRAMEDULLARY DEVICES:**
  - A.O. 95 degree blade plate
  - DCS
  - DHS

AO BLADE PLATE:

The AO/ASIF 95 deg fixed angle condylar blade plate gained popularity in the 1970s. The 95 deg design allows two or more cortical screws to be inserted through the plate into the Calcar region, providing additional fixation of the proximal fracture fragment. An additional benefit of this device is that it can be inserted into a small proximal fragment before fracture reduction; when correctly used, the device restores femoral alignment and provides stable fixation.

Initially, highest success rates with use of a condylar blade plate were reported in subtrochanteric fractures with a transverse fracture pattern.

Asher and associates also recommended the use of AO blade plate and stressed the importance of restoring medial cortical stability by the use of interfragmentary compression of medial cortical fragments. (2)

Kinast et al described the importance of an indirect reduction technique and osseous compression for a successful outcome using a 95 deg condylar blade plate. (24)

Placement of the 95 deg condylar blade plate, however, is a technically demanding procedure requiring exact three plane insertion (14) and cause extensive soft tissue devitalisation and lost popularity because of high failure rate.

DYNAMIC CONDYLAR SCREWS:

Condylar screw with 95° side plate was developed primarily for the treatment of distal femur fractures. This device has been adopted for use in the proximal femoral fractures.

The 95 deg dynamic condylar screw has a same basic design as the 95 deg condylar blade plate but with the blade plate replaced by a large diameter cannulated lag screw that is inserted over a guide pin after its channel is reamed and tapped.

In 1994 Blatter performed the first dynamic condylar screw fixation for pertrochanteric and subtrochanteric fractures.

Roy Sanders and Piettro from Switzerland, stated that since it required alignment only in two planes they were hopeful that the DCS (25,26,27) would prove easier to insert and mechanically as effective as 95° condylar plate. After a study of 22 fractures treated with DCS, they concluded that the DCS was an excellent alternative to the 95°condylar plate and its bending rigidity is twice that of condylar blade plate.

Regazzoni *et al*. (1985) and Tenbiner *et al*. (1983) have showed that relatively bulkier DCS has a higher yield strength (+63%) and superior fatigue strength (+56%) compared with angled plate.

In the proximal femur, 95° implant is stronger biomechanically than the 130° implants as it allows additional screw fixation into the proximal fragment and the lag screw has large threads for better and stronger purchase in the proximal fragment.

For transverse, short oblique or long oblique subtrochanteric fracture, with the lesser trochanter avulsed, DCS device is optimal (Sanders and Regazzoni (1989).

Redford and Howell in 1992 reported the use of DCS in either pertrochanteric fractures with subtrochanteric extension or subtrochanteric fracture too high for the interlocking nail, with acceptable results.

Sanders and Regazzoni reported a union rate of 77%, with functional results rated as good or excellent in 68% in a consecutive series of subtrochanteric fractures.

Vaidya et al examined the outcomes of patients with closed communited subtrochanteric fractures fixed with DCS and using biological reduction techniques over 3 years where union was achieved in all cases and concluded that use of biological (indirect) reduction techniques instead of anatomic, open reduction has proven to be successful, especially in comminuted subtrochanteric fractures and avoids the need for primary cancellous bone grafting, emphasizing the importance of preserving biology of the fracture fragments.

Advantages:

- Technically less demanding
- Malalignment can be corrected to some extent
- Better purchase in an osteopenic bone.
- Better hold over the proximal fragment.
- Can be used in revision surgeries.

- Provides higher stability, firm fixation and has increased strength and resistance to stress failure.
- Can be used even if perfect anatomical reduction may not be achieved
- Can be introduced with less vascular damage when done biologically using indirect reduction techniques.

DYNAMIC HIP SCREWS:

The popularity of the sliding hip screw in the early 1970s led to use of this device for stabilization of subtrochanteric fractures. (14) The sliding mechanism allows controlled collapse at the fracture site, which serves to reduce the bending moment on the implant and thus decrease the possibility of varus displacement or device failure. (28, 29, 30)

For impaction to occur, however the sliding mechanism must cross the fracture site and the plate must not be fixed to the proximal fragment. Hence it can be used only in proximal subtrochanteric fractures specifically, those with both subtrochanteric and Intertrochanteric involvement.

In practice, the sliding hip screw is used to stabilize a variety of subtrochanteric fracture patterns, reflecting, atleast in part, surgeon's desire to use a familiar device.

When the sliding hip screw is used to reduce more distal fractures or comminuted fractures, it is essential to reconstruct the posteromedial cortical buttress to minimize the risk of varus displacement and device failure.

Disadvantage:

It requires extensive exposure and cannot be done by minimally invasive technique in comparison to DCS.

Intramedullary fixation:

During the past century a better understanding of the biomechanics of pertrochanteric and subtrochanteric fracture has led to the development of better implants and radical changes in treatment modalities.

Biomechanically, these devices offer several advantages over plate and screw fixation.

1. Intramedullary nail is closer to the central axis of the femur than an extramedullary device and hence are subjected to smaller bending loads than plates and are less vulnerable to fatigue failure.

2. Intramedullary nails act as load sharing devices in fractures that have cortical contact of the major fragments. If the nail is not locked at both the proximal and distal ends, it will act as a gliding splint and allow continued compression as the fracture is loaded.

3. Stress shielding with resultant cortical osteopenia, commonly seen with plates and screws, is avoided with intramedullary devices; and refracture after implant removal is rare with the use of intramedullary devices, secondary to lack of cortical osteopenia and the minimum number of stress risers created in the cortical bone

Intramedullary devices also offer significant biological advantage over the other fixation methods. Although the insertion can be technically demanding, intramedullary implants do not usually require the extensile exposures required for plate application. With use of image intensification, these devices can be implanted in a closed manner, without exposing the fracture site. These closed techniques result in low infection and high union rates, with a minimum of soft tissue scarring.

Disadvantages:

- ✓ Hold on proximal fragment is not adequate and could lead to loss of fixation.
- ✓ Perfect control of rotation and shortening is not possible as in fractures fixed with first generation nails. (31,32,33)
- ✓ Not ideal for revision surgeries where fracture site is to be opened.

II) INTRAMEDULLARY DEVICES:

Condylocephalic nails described for subtrochanteric fractures are no longer used due to high failure rate.

Cephalomedullary Nails:

I) Zickel nail

II) Gamma locking nail

III) Reconstruction nail

IV) Proximal femoral nail

I) ZICKEL NAIL:

The Zickel nail, introduced in early 1970s, is pre bent to accommodate the anterior bow of the femur. Fixation of the proximal fragment with the nail is supplemented by a modified triflanged nail passed through the proximal portion of the nail into the femoral neck. It provides improved proximal fixation in subtrochanteric fracture. Its use is technically difficult. The development of first and second generation interlocked nails has supplanted the Zickel nail for stabilization of subtrochanteric fractures.

INTERLOCKING NAILS: (GROSSE KEMPF, AO)

AO nail allow both proximal and distal locking, and provide rotational stability of the fracture and prevents shortening and varus angulation. These devices are useful only in subtrochanteric fractures below the level of lesser trochanter and without involvement of greater trochanter. The ability to insert these devices without opening the fracture site and preventing further devascularization of fracture fragments has improved union in these fractures.

II) GAMMA LOCKING NAIL

Halder introduced this new intramedullary device for the treatment of unstable pertrochanteric and subtrochanteric fractures.

Leung and Colleagues compared the use of gamma nail and DHS for pertrochanteric and subtrochanteric fractures and concluded the gamma nail was associated with shorter operating time, smaller incision, less blood loss and quicker return to full weight bearing. (36)

Lei-sheng jiang in his study suggested the long gamma nail is reliable implant for subtrochanteric fractures, leading to high rate of bone union and minimal soft tissue damage. (37)

III) RECONSTRUCTION NAIL:

Modern reconstruction nails have greatly improved the outcome and ease of treatment of subtrochanteric fractures. Reconstruction nails are useful in more proximal fractures, where there is increase incidence of implant and proximal screw failures when first generation nails are used.

These nails provide better proximal fixation by directing screws into the head of the femur. It has additional 8°of anteversion to facilitate screw into head hence it necessitates separate nail for right and left.

Two screws are inserted in the proximal part of the nail.

1. 8 mm screw low in the femoral neck.

2. 2nd 6.4 mm screw in upper aspect.

Slater et al. reported the results of 64 consecutive unstable subtrochanteric fractures treated with Russell-Taylor reconstruction nail. Sixty one cases were available for follow up at an average of 11 months; all fractures united without revision surgery, bone grafting, or dynamisation. (34)

Taylor et al reported their experience using the reconstruction nail in five high energy communited subtrochanteric fractures in young paratroopers. Follow up averaged 22 months, and clinical results were good in all the patients. (35)

PROXIMAL FEMORAL NAIL

In 1997, the proximal femoral nail was introduced for treatment of pertrochanteric femoral fractures. It was designed to overcome implant related complications and to facilitate the operative treatment of unstable pertrochanteric fractures.

Biomechanical analyses of the proximal femoral nail show a significant reduction of distal stress and an increase in overall stability compared to Gamma nail. Evaluation of the treatment results of the proximal femoral nail shows a relatively low percent of complications and a low incidence of implant failure.

Reconstruction nail

Figure 7

Proximal femoral nail

Figure 8

Zickel nail DHS DCS

Figure 9

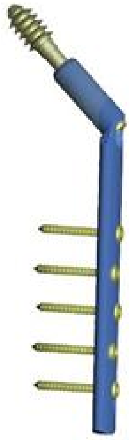


Figure 10

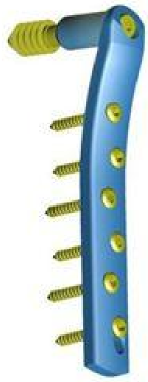


Figure 11

95 degree condylar plate

Figure 12

MATERIALS & METHODS

MATERIALS & METHODS

The present study consists of 28 adult patients with subtrochanteric fractures of the femur who were treated surgically in PSG IMS & R from Sep 2007- Sep 2011.

The fractures were classified according to Seinsheimer's classification and the cases were followed up at regular intervals postoperatively. This study was conducted with due emphasis for clinical observation and radiological evaluation after surgical management of subtrochanteric fractures fixed with DCS, DHS, Reconstruction nail.

INCLUSION CRITERIA:

1) Subtrochanteric fractures in adults

EXCLUSION CRITERIA:

1) Pediatric subtrochanteric fractures
2) Patients having segmental fractures of the same bone.
3) Pathological fractures
4) Old neglected fractures, fractures with implant failures and compound fractures since the functional outcome cannot be compared to that of fresh closed subtrochanteric fractures

DATA COLLECTION

After the patient with subtrochanteric fracture was admitted to the hospital all the necessary clinical details were recorded in the proforma prepared for this study. After the completion of the hospital treatment patients were discharged and called for follow up at outpatient level, at regular intervals for serial clinical and radiological evaluation and the data regarding the previously treated patients is collected from the medical records.

Table 1

Name	Age	Sex	Mode of injury	Assoc injuries	Type of #	Time of Sx from admn	Implant used	Sx time	Blood loss	Evidence of complete union	Complications

MANAGEMENT OF PATIENT

As soon as the patient with suspected subtrochanteric fracture was seen, clinical and radiological evaluation was done and admitted to ward after resuscitation and splintage with skeletal traction.

Patient is worked up for surgery with necessary blood and radiological investigations.

All the patients were evaluated for associated medical problems and were referred to respective department and treated accordingly.

Associated injuries were evaluated and treated simultaneously. The patients were operated on elective basis after overcoming the avoidable anaesthetic risks.

PRE OPERATIVE PLANNING:

The choice of implant for each case is based on:

1. The type of subtrochanteric fracture is classified by Scheinsheimer classification.
2. Achievement of closed reduction.
3. Surgeon's skills and familiarity with the procedure.

In type I, II, III – Intramedullary fixation was adopted if closed reduction of the fracture is achieved. If closed reduction was not achieved on traction table indirect reduction and biological DCS fixation is done.

In type IV, V –Biological DCS fixation is done.

Primary bone grafting was done in all type IV and type V cases where there is devitalization at the fracture site during the surgical procedure when open reduction of the fracture is done.

OPERATIVE TECHNIQUE:

BIOLOGICAL DCS FIXATION:

PROCEDURE:

- Under anaesthesia with patient on traction table fracture reduction was done using the fracture table utilizing skeletal traction. The focus was on obtaining the length, mechanical and rotational alignments.
- Correct alignment and rotation were checked intraoperatively using X-ray guidance.
- The length, axial alignment and rotation, were checked again using clinical assessment.

Figure: 13

- Two separate incisions were made. The DCS screw was placed as per the standard recommended DCS fixation from the proximal incision.
- From the proximal incision the plate was slid across the fracture extraperiosteally with the barrel facing laterally.
- Once the plate reached the proper length it was rotated 180 deg and the barrel slid over the condylar screw.
- The distal end of the plate was exposed by a second incision and after proper position fixed to the bone by cortical screws. During the whole procedure the fracture was not exposed. The incision was closed over a suction drain.
- If bone grafting was felt necessary access to the fracture got through the proximal incision without much disturbance to the biology of the fracture site.

-

Figure: 14

DHS and RECONSTRUCTION nailing is done as per the standard recommended procedure.

FOLLOW UP:

All patients were followed up at 4 weeks, 12 weeks, and every 6 weeks thereafter till the fracture union is noted, then at 6 months.

Clinical assessment is done in every follow up and analysis of results is based on the assessment as per Radford et al criteria (38) at the last follow up.

Table: 2

S.No	Implant used	Pain	Flexion loss	Varus, Valgus, Rotatory deformity	Limb length discrepancy	Perfect joint congruency	Results

Excellent	Flexion loss of less than 10 degrees
	No varus, valgus or rotatory deformity
	No pain
	Perfect joint congruity
Good	Not more than one of the following
	Loss of length not more than 1–2 cm
	Less than 10 degrees varus or valgus deformity
	Flexion loss not more than 20 degrees
	Minimal pain
Fair	Any of the two criteria in the good category
Failure	Flexion less than 90 degrees
	Varus or valgus exceeding 15 degrees
	Joint incongruency
	Disabling pain

X ray pelvis was taken in the regular follow up visits to assess fracture union and implant bone interaction Radiological union was said to be achieved on the evidence of obliteration of fracture lines and trabecular continuity between the two fragments on anteroposterior and lateral x rays in three cortices.

OBSERVATION AND RESULTS

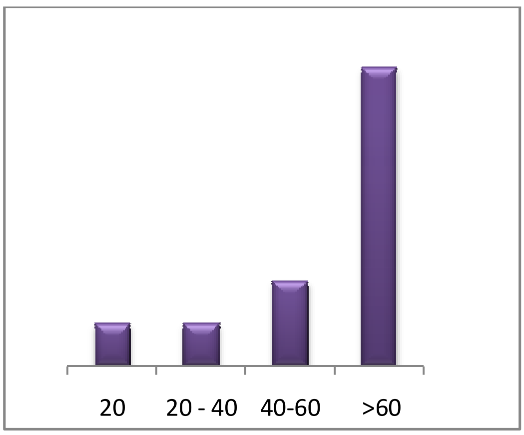
The following observations were made from the data collected during the study.

Total of 31 cases of subtrochanteric fractures are treated in the department of Orthopaedics, PSGIMS &R from Sep 2007 - Sep 2011.Three patients were diagnosed to have pathological fractures as a result of secondaries and were excluded from the study. 15 patients were treated with DCS, 8 patients were treated with DHS and 5 patients with reconstruction nail. Primary bone grafting was done in 4 patients and secondary bone grafting in 1 patient for delayed union.

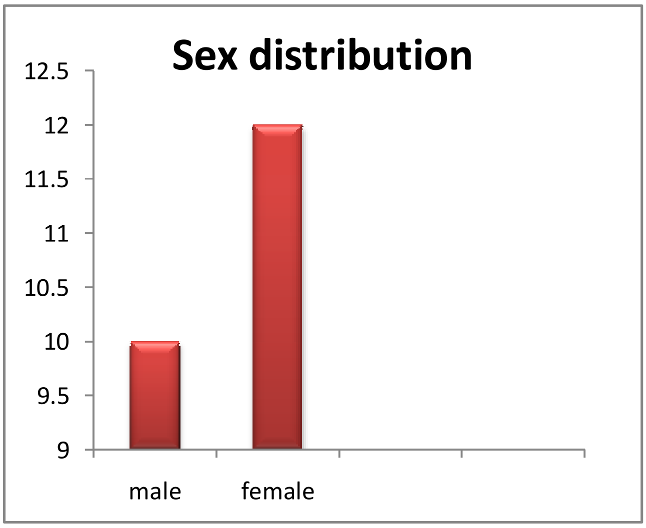
AGE & SEX DISTRIBUTION:

Incidence of subtrochanteric fractures was found to be more common in elderly females especially in >60 years age group pts with a mean age of 60.67 years

GRAPH 1: AGE DISTRIBUTION



GRAPH 2: SEX DISTRIBUTION



MODE OF INJURY:

Majority of the fractures were secondary to a low velocity injury.

Table3: MODE OF INJURY

Mode of injury	No of cases
High velocity	6
Low velocity	22

ASSOCIATED INJURIES:

In 4 patients subtrochanteric fracture was a part of polytrauma having other injuries elsewhere in the body and in one patient secondary to a trivial fall.

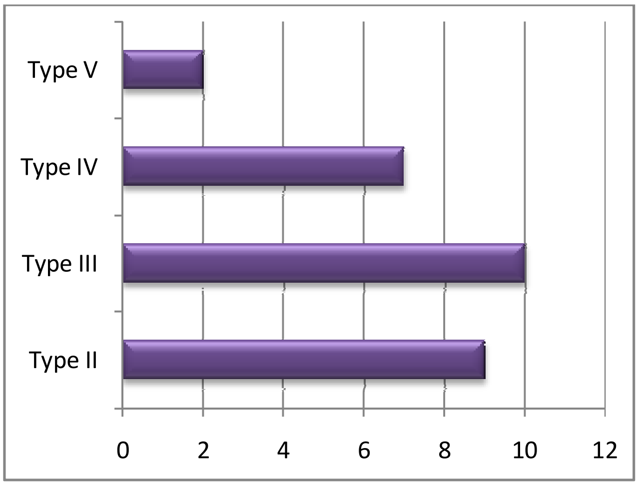
CLASSIFICATION:

The 28 fractures in our study were classified according to Seinsheimer's classification. In our study we had 9 cases of type II, 10 cases of type III, &7 cases of type IV and 2 cases of type V as per Seinsheimer classification.

Table 4: Classification of Subtrochanteric fractures

Seinsheimer's type	No of cases
Type II	9
Type III	10
Type IV	7
Type V	2

GRAPH 3: CLASSIFICATION OF FRACTURES



MODE OF FIXATION:

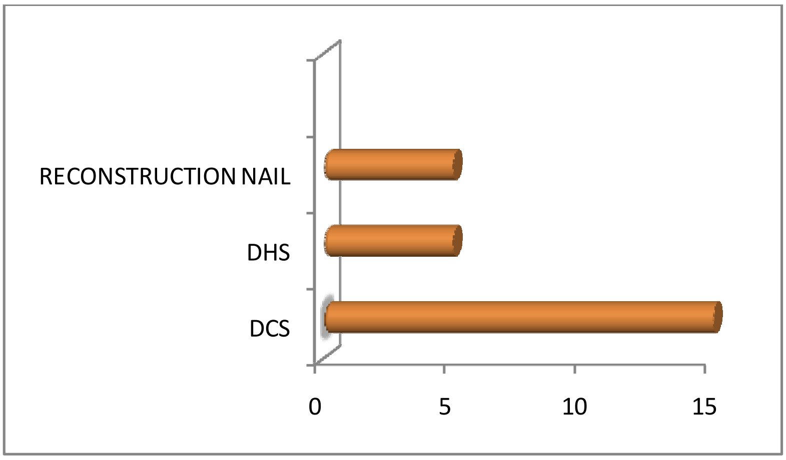
In 8 of 28 cases, DHS fixation was done, in 15 cases DCS fixation was done and Reconstruction nailing was done in 5 cases. The choice of implant was done based on the type of fracture and ability to achieve closed reduction on the fracture table.

DHS was the choice of implant for extramedullary fixation in the initial study period. Since the proximal fragment fixation is inadequate and DHS could not be done in a biological manner, DCS became the choice of implant for extramedullary fixation subsequently.

Table 5: MODE OF FIXATION

Mode of fixation	No of cases
DCS	15
DHS	8
Reconstruction nail	5

GRAPH 4: MODE OF FIXATION



STATISTICS OF SURGERY:

TIMING OF SURGERY:

< 7 days – 27 cases

> 7 days – 1 case

INTRAOPERATIVE DETAILS:

All the patients' intraoperative details were noted in terms of duration of surgery, complications and amount of blood loss.

Duration of the surgery was longer in the fractures fixed with reconstruction nail than those fixed with DCS and DHS.

TABLE 6: AVERAGE SURGICAL TIME

Mode of fixation	Average surgical time
Reconstruction nail	2 hrs 45 min
DCS	2 hrs 05 min
DHS	1 hr 38 min

TABLE 7: AVERAGE BLOOD LOSS

Mode of fixation	Average blood loss
DCS	302 ml
DHS	193.75 ml
RECONSTRUCTION NAIL	170 ml

Amount of blood loss was less in the cases where DHS fixation or Reconstruction nailing was done compared to the cases where DCS fixation was done. Blood loss was measured in terms of mop count and suction collection.

INTRA OPERATIVE OBSERVATIONS:

In 2 of the 5 cases where reconstruction nailing was performed, there was a difficulty in inserting the antirotation screw as it could not be accommodated in the neck.

In case 1 of the study, antirotation screw was not inserted as it was penetrating the superior cortex of the neck and in case 24 a shorter antirotation screw was inserted.

In 2 cases (6 and 17) reconstruction nailing was planned pre operatively. Since closed reduction was not able to be achieved biological DCS fixation was chosen.

In 2 cases (8 and 20), biological DCS fixation was planned. Since proper reduction was not achieved, open reduction of the fracture was done.

POST OPERATIVE COMPLICATIONS:

Open DCS fixation:

Implant failure secondary to delayed union - 1

Biological DCS fixation:

Wound infection - 1

Unicortical break in the neck of femur- 1

Delayed union - 1

DHS fixation:

Wound infection - 1

Reconstruction nail fixation:

Wound infection - 1

Delayed union- 1

Condition at discharge:

All the patients were mobilized non weight bearing using walker. However in 4 patients mobilisation was delayed due to associated injuries.

Mortality:

One patient (Case 19) died due to acute coronary syndrome one month post operatively which was not related to the surgical event.

Follow up:

All patients were followed up at 4 weeks, 12 weeks and every 6 weeks thereafter till fracture union is noted and at 6 months.

Two patients (Case 14, 22) failed to attend the first follow up and were lost for further follow up and one patient (Case 19) expired one month post operatively due to acute coronary syndrome.

One patient (Case 8) had implant failure secondary to delayed union.

One patient (case 24) patient had hip pain in the post operative period due to fracture site instability as the proximal fragment was inadequately fixed with the cephalomedullary screws.

One patient (case 16) developed hip pain in the immediate post operative period and was diagnosed to have Unicortical break in the neck of femur which went on to unite without any intervention and the mobilisation was delayed in view of unicortical break in the neck of femur.

TABLE 8 : CLINICAL OUTCOME USING RADFORD et al CRITERIA: (38)

Case no	Implant used	Pain	Flexion loss	Varus/Valgus/ Rot deformity	L.L discrepancy	Joint congruency	Results
1	Recon nail	A	A	A	A	P	Excellent
2	DHS	A	A	A	1 cm	P	Good
3	Biological DCS	A	A	A	A	P	Excellent
4	Biological DCS	A	A	10 deg	2cm	P	Fair
5	Recon nail	A	A	A	A	P	Excellent
6	Biological DCS	A	A	A	A	P	Excellent
7	DHS	Minimal pain	A	A	A	P	Good
8	DCS	Disabling pain	Painful restriction	A	2cm	P	Failure
9	DHS	Minimal pain	A	10 deg	A	P	Fair
10	Biological DCS	A	A	20 deg	A	P	Good

11	**Biological DCS**	A	A	A	A	P	Excellent
12	DHS with bone grafting	A	A	30 deg	1cm	P	Fair
13	Biological DCS	A	A	A	A	P	Excellent
14	Biological DCS	A	A	A	A	P	LIF
15	Biological DCS	A	A	A	A	P	Excellent
16	Biological DCS with bone grafting	Minimal pain	30 deg	20 deg	1cm	P	Failure
17	Biological DCS	A	A	A	A	P	Excellent
18	Biological DCS	Minimal pain	30 deg	A	A	P	Fair
19	DHS with bone grafting	A	A	A	A	P	LIF
20	DCS	A	20 deg	A	A	P	Good
21	Biological DCS	A	A	A	A	P	Excellent
22	DHS locking plate with bone grafting	A	A	A	A	P	LIF
23	DHS	A	30 deg	10 deg	A	P	Fair
24	recon nailing	Minimal pain	20 deg	A	A	P	Fair
25	DHS	Minimal pain	A	A	A	P	Good
26	Recon nail	Minimal pain	A	A	A	P	Good
27	Biological DCS	A	A	A	A	P	Excellent
28	Recon nail	Minimal pain	A	A	1cm	P	Fair

Table 9: BIOLOGICAL DCS FIXATION

Functional Outcome	No of cases
Excellent	8
Good	1
Fair	2
Failure	1
Lost for follow up	1

Table 10: OPEN REDUCTION & DCS FIXATION

Functional Outcome	No of cases
Good	1
Failure	1

Table 11: RECONSTRUCTION NAILING

Functional Outcome	No of cases
Excellent	2
Good	1
Fair	2

Table 12: DHS FIXATION

Functional Outcome	No of cases
Good	3
Fair	3
Lost for follow up & Death	2

UNION IN WEEKS:

Biological DCS fixation- 15.4 weeks (10-32 weeks)

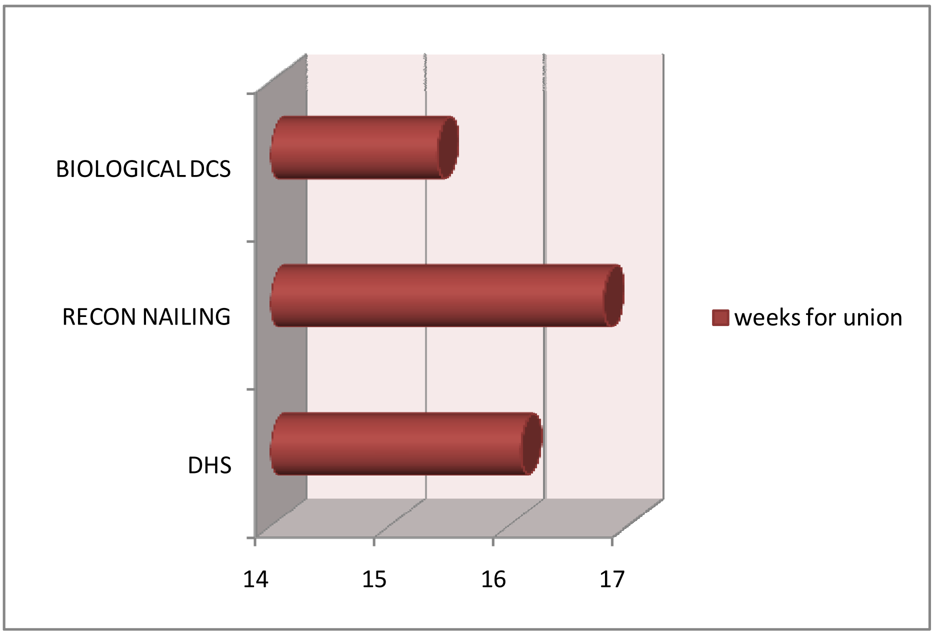
DHS fixation- 16.1 weeks (14-20 weeks)

Reconstruction nail fixation- 16.8 weeks (12-30 weeks)

One patient (Case 28) in reconstruction nail fixation group went for delayed union (30 weeks).By eliminating this case from the group there is a significant improvement in the standard deviation (7.56 to 1.91) and the average time for union in the remaining cases is **13.5 weeks**.

One patient (Case 27) in the DCS fixation group went for delayed union (32 weeks). By eliminating this case from the group the average time for union in the remaining patients is **15 weeks.**

GRAPH 5: UNION IN WEEKS



DISCUSSION

DISCUSSION

Subtrochanteric fractures of the femur demand a special consideration in orthopedic traumatology, given the high rate of complications associated with their management due to the high loading forces and immense stresses in this area.

Even though better reduction techniques and biomechanically improved implants and improved fracture fixation techniques have improved the functional outcome of these fractures ideal implant for these fractures is still not defined.

No single implant is ideal for all types of subtrochanteric fractures. An ideal implant should achieve stable fixation with no interference with the vascularity and hold the fracture till it unites.

Fixation is a race between fracture healing and implant failure.

Irrespective of the mode of fixation emphasis is laid on the medial cortex reconstitution as described in the study by Senter B et al. (56) but in many of these fractures, reconstruction of solid medial wall is not possible, due to comminution or bone loss where autogenous bone grafting is suggested.

This study analyses various aspects needed to be addressed while treating subtrochanteric fractures and determine the choice of implant in different subtrochanteric fractures.

RECONSTRUCTION NAIL FIXATION:

Intramedullary devices require less surgical exposure, enable early weight bearing and exert less biomechanical stresses (as the lever arm is moved medially) (39-41)

However technical difficulties are observed in upto 63% of the cases. (42,43) Lavell David G et al described Reconstruction nailing as a technically demanding procedure and suggested plate and screw fixation as the best option. (1)

We had difficulty in putting the derotation screw in 2 out of 5 cases (40%) compared to that of a study by Fogagnolo et al where 23.4% of intraoperative technical and mechanical complications were noted. When intramedullary devices cannot be used for technical reasons dynamic condylar screw provides a reasonable option.

In 2 cases where we had planned intramedullary nailing, procedure was abandoned as we were unable to achieve a perfect closed reduction and hence converted to DCS fixation.

Average time for union was 16.8 weeks compared to 15.1 weeks in a study by Lee et al. (44) with 60% excellent to good functional outcome.

We had achieved 100% union rate with one case of delayed union simulating the results of a study by Gibson et al. (45)

Reconstruction nail is recommended in:

- Type I, II & III subtrochanteric fractures when closed reduction is achieved.

Recon nail is not preferred in severe communited fractures and fractures with trochanteric extension as we feel that the hold of the implant on the proximal fragment is not adequate and also it is an observation that the head screws do not lock onto the nail and hence compromising the stability of the fixation.

DHS FIXATION:

Some decades ago, a sliding-screw plate system came into wider use even in sub-trochanteric fractures because of the successful treatment of stable trochanteric fractures. (48) In unstable per- and sub-trochanteric fractures, however, the system has been reported to involve high failure rates (46,47,48) as it may not be possible to supplement the sliding screw with additional cortical screws in the proximal fragment of a subtrochanteric fracture. (50)

Biologically, extensive comminution and fragment devitalisation compromises bone healing (49) Extensive dissection at the fracture site is required to place the DHS implant.

Even though we had achieved 100% union rate with average time for fracture healing of 16.1 weeks with no complications and 50% good functional outcome, the implant has its limitations of inadequate proximal fixation and it could not be done in a biological manner.

DCS FIXATION:

Comminuted subtrochanteric femoral fractures are often caused by high-energy trauma. (51, 52) Fractures may extend into the greater and the inter-trochanteric regions. (49) Open reduction further devitalizes fragments, damages the vascular supply or soft tissues, and increases the risks of non-union, infection, and implant failure [51] whereas indirect reduction does not. (49)

One case of implant failure (12.5%) is observed in fractures fixed with DCS by open reduction compared to failure rates of 20 to 23% in different studies. (53, 54) The likely cause for delayed union and implant failure was not doing a primary bone grafting in an extensively communited fracture.

In one case patient was found to have a Unicortical break in the neck of femur secondary to fixation with a short head screw which united without any intervention and mobilisation was delayed in this patient.

Vaidya et al. (55) evaluated the use of DCS and biological reduction techniques for subtrochanteric fractures and concluded the use of indirect reduction techniques instead of anatomic open reduction has proven to be successful, especially in comminuted fractures.

DCS fixation when done biologically have shown better results compared to those fractures fixed with Reconstruction nail. (44)

100% union rate is observed in cases where biological DCS fixation with 9 out of 13 patients had excellent to good results compared to the results obtained in the study by Vaidya et al. (55)

Average time for radiological union in cases where biological fixation is done was 110 days compared to 91 days in the study by Neher et al.

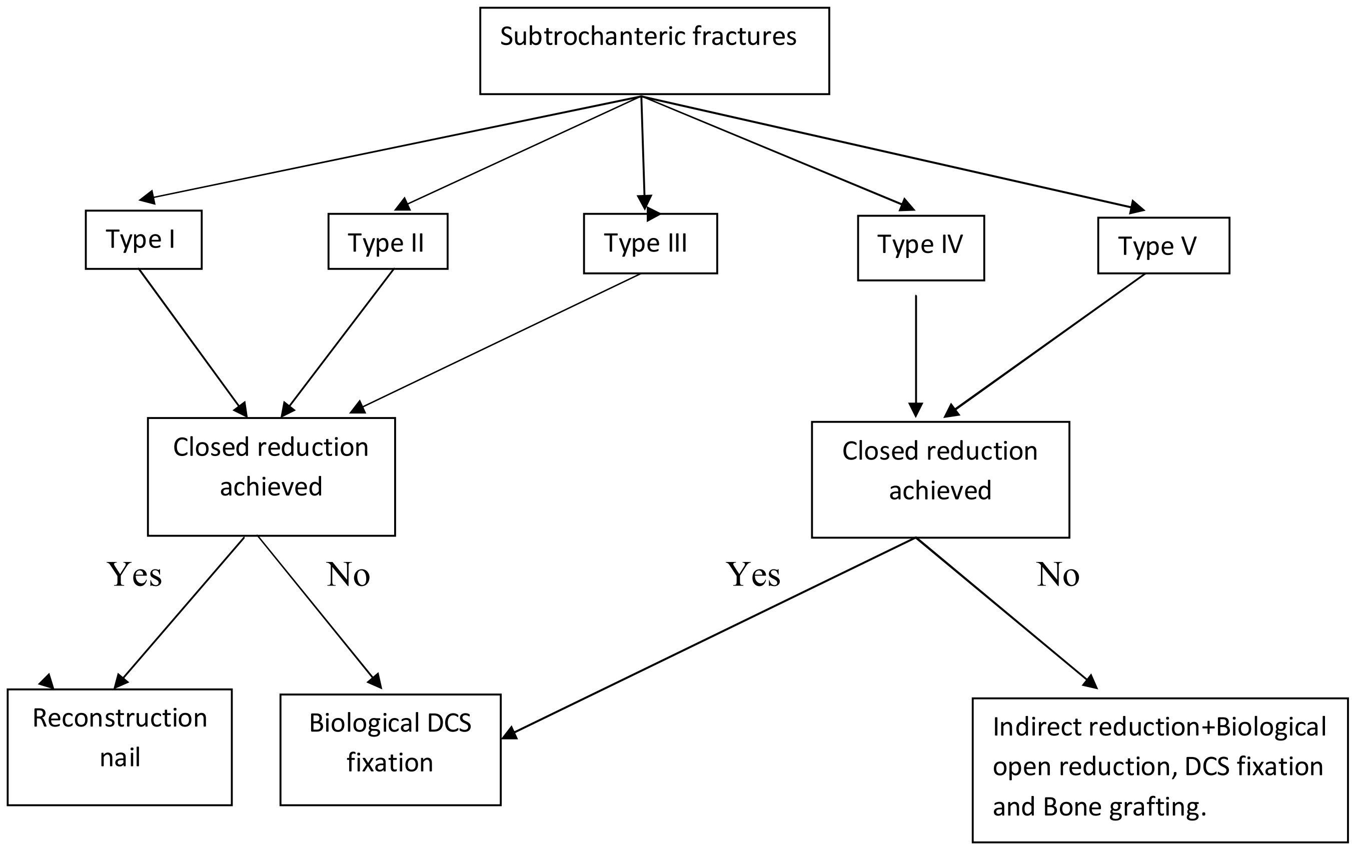
It could be a preferred implant of choice in:

- Type IV and type V subtrochanteric fractures.
- Revision surgeries.

DCS fixation should be done in a biological manner without opening the fracture site whenever reduction is achieved by indirect means to avoid the need for bone grafting and devitalisation of the fracture fragments.

In the management of subtrochanteric fractures ideal implant selection is important for a better functional outcome.

We propose the following algorithm for management of subtrochanteric fractures:



Limitations:

- Numbers are small to make a scientific comparison.
- Large no of cases are required to assess the reliability of the proposed algorithm.

CONCLUSION

CONCLUSION

- No single implant is ideal for all subtrochanteric fractures
- Intramedullary implant can be used in type I, II & III fractures if closed reduction is achieved.
- Biological DCS fixation is superior to other modes of fixation in type IV & V subtrochanteric fractures.
- Biological DCS fixation reduces the need for bone grafting in communited subtrochanteric fractures.
- Stable internal fixation using indirect reduction techniques rather than anatomic reduction enhances healing potential.

RADIOGRAPHS

Case 11 (Type II)

Pre op

Immediate post op

11 weeks post op

Case 5 (Type IV)

Pre op

Immediate Post op

3 months Post op

Case 2 (Type III)

Immediate Post op

3 Months Follow up

Case 8 (Type IV subtrochanteric fracture showing no evidence of callus at fracture site with implant failure 2 ½ months post op)

Immediate post op

2 ½ months post op

Case 24 (Type III fracture with a short derotation screw in the post op x ray)

Pre op

Immediate post op

Case 16 (Type IV fracture with a unicortical break in the neck of femur)

Pre op

Immediate Post op

1 month Post op

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MASTER SHEET

SL.NO	NAME	AGE in yrs	SEX	MODE OF INJURY	ASSOCIATED INJURIES	Time of sx after admission	TYPE OF FRACTURE	IMPLANT USED	Blood loss	surgical time	EVIDENCE OF COMPLETE UNOIN	COMPLICATIONS
1	Jothimani	65 yrs	F	High velocity	Fracture shaft of humerus,multiple rib fractures and head injury	2 days	Type IV	Recon nail	150 ml	2 hrs 15 min	12 weeks	Nil
2	Aruchamy	72 yrs	M	Low velocity	Nil	1 day	Type IIIA	DHS	150 ml	2 hrs	14 weeks	Nil
3	Umadevi	18yrs	F	High velocity	Fracture pelvis with right sacroiliac joint disruption	3 days	Type V	Biological DCS	200 ml	2 hrs 30min	10 weeks	Nil
4	navin	21	M	High velocity	Fracture pelvis with blunt injury abdomen	4 days	Type IV	Biological DCS	180 ml	2 hrs 30 min	16weeks	Nil
5	Naveen kumar	19	M	High velocity	Nil	1 day	Type IV	Recon nail	200 ml	3 hrs	12 weeks	Nil
6	Kandhasamy	77	M	Low velocity	Nil	5 days	Type IIIA	Biological DCS	1000ml	2hrs 30 min	12 weeks	Nil
7	Ranganayaki.N	80	F	Low velocity	Nil	3 days	Type IIIA	DHS	200ml	1 hr 15 min	16 weeks	Nil
8	Palanisamy.M	65	M	Low velocity	Nil	1 day	Type IV	DCS	600ml	2hrs15 min	lost for follow up	implant failure and delayed union
9	Paavaye	70	F	Low velocity	Nil	4 days	Type IIIB	DHS	250ml	2hrs	15 weeks	Nil
10	Karuppusamy.K	57	M	Low velocity	Nil	2 days	Type IIC	Biological DCS	250 ml	2hrs	14 weeks	Nil
11	Ramesh.P	36	M	High velocity	Iliac wing fracture	1 day	Type II b	**Biological DCS**	250ml	3hrs	11 weeks	Nil
12	Jebamalai mary.B	73	F	Low velocity	Nil	3 days	Type V	DHS with bone grafting	200 ml	2hrs 15 min	16 weeks	Nil
13	Ganeshan.N	47	M	Low velocity	Nil	8 days	Type IIIB	Biological DCS	200ml	2 hrs 15 min	18 weeks	wound infection
14	Kaveriammal	79	F	Low velocity	Nil	1 day	Type IIIA	Biological DCS	300ml	1 hr 15 min	lost for follow up	Nil
15	Chinnammal	75	F	Low velocity	Nil	3 days	Type II B	Biological DCS	200ml	1 hr 15 min	14 weeks	Nil
16	Ponnusamy.M	75	M	Low velocity	Nil	2 days	Type IV	Biological DCS with bone grafting	250 ml	2 hrs	16 weeks	Fracture neck of femur
17	Ponnammal.K	54	F	Low velocity	Nil	1 day	TypeIIB	Biological DCS	250 ml	2 hrs	14 weeks	Nil
18	Alice.P	70	F	Low velocity	Nil	5 days	Type IIC	Biological DCS	200 ml	2 hrs 30 min	16 weeks	Nil
19	Deivanaiachi	68	F	Low velocity	Nil	4 days	Type IIA	DHS with bone grafting	150 ml	1 hr 15 min	nil	patient died 1 month post op due to cardiac failure
20	visalatchi	56	f	Low velocity	Fracture proximal humerus	3 days	Type IIC	DCS	200 ml	1 hr 30 min	14 weeks	Nil
21	indirani	24	f	high velocity	nil	1 day	Type IV	Biological DCS	200 ml	1 hr 45 min	12 weeks	nil
22	dhanabagyam	56	f	low velocity	nil	4 days	Type IV	DHS locking plate with bone grafting	150 ml	1 hr 30 min	lost for follow up	superficial wound infection treated with antibiotics
23	mylswamy	76	m	low velocity	NIL	7 days	type III b	DHS	250 ml	1 hr 30 min	16 weeks	nil
24	thulasiammal	70	f	low velocity	nil	2 days	type III b	recon nailing	150 ml	2 hrs 30 min	16 weeks	pt developed AF and treated appropriately
25	Mariammal	60	F	low velocity	NIl	3 days	type III A	DHS	200 ml	1 hr 15 min	20 weeks	NO complications
26	Govindammal	87	f	Low velocity	NIl	2 days	Type II b	Recon nail	150 ml	3 hrs	14 weeks	Nil
27	palaniammal	85	F	Low velocity	NIl	5 days	Type IIC	Biological DCS	250 ml	2 hrs 15 min	32 weeks	6 months post op delayed union bone grafting done
28	Govindammal	64	F	low velocity	NIl	4 days	Type III A	Recon nail	200 ml	3 hrs	30 weeks	persistent fever spikes and wound infection debridement done