REVIEW OF LITERATURE
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Ambrose Pare, the famous French surgeon, recognized the existence of hip fracture more than four hundred years ago, however, Sir Astley Cooper (1827) appears to have been the first to attempt to delineate clearly between intracapsular fracture and other fracture and dislocation about the hip.

Phillip (1867) introduced a technique for longitudinal and lateral traction to be used in femoral neck fractures to eliminate shortening or other deformity.

With the advent of X-ray, Whitman (1902) advocated careful reduction and holding of reduced fractures in spica cast.

Cotton (1911) recommended artificial impaction of fractures fragment by blows from a heavy mallet applied to the padded trochanter before cast application.

Ruth (1921) advocated closed reduction and maintenance of reduction in a “Phillip Splint” for eight weeks and avoidance of weight bearing for six to twelve months after traction.

Wilkie (1927) modified the Whitman method by using bilateral short-leg cast connected by a transverse bar instead of spica cast for fracture immobilization.

Anderson and Childress (1932) described well-leg traction in treatment of intertrochantric fractures of the femur.

Murray (1949) claimed that trochanteric fractures treated conservatively by skin traction or Steinmann pin skeletal traction with Hamilton Russel traction has better results than any operation and that mortality is lower.

Clawson (1957) used longitudinal skeletal traction in certain unstable fractures. He stressed need to adjust rotation of
the limb, to use serial x-ray to evaluate fracture reduction and to encourage a daily programme of exercises.

Horowitz (1960) reported a mortality rate of 34.6% for trochanteric fractures treated by traction and 17.5% for those treated by internal fixation.

Shaftan (1967) suggested early mobilization to treat intertrochanteric fractures. The patient is mobilized immediately, just as if they had been treated operatively. They are not treated in traction but are given analgesics and placed in chair daily and fracture itself is essentially ignored.

Aufranc and associates (1967) recommended skeletal traction in balanced suspension for ten to twelve weeks. The leg is kept in slight abduction which allows easier reduction and maintenance of normal neck-shaft angle. The patient is then mobilized and allowed partial weight bearing until fracture healing is solid. They noted that partial weight bearing may be required for six months before good fracture stability is obtained, and that varus displacement could occur as late as three to four months after fracture.

Freidenberg and colleagues (1972) suggested that patients with terminal illness, patients with old fracture and non ambulatory patients who are comfortable with the fracture should receive conservative treatment.

Lyon and Nevins (1977) reported that non-surgical treatment in nursing home is safer and far less expensive for intertrochanteric fractures in patients who have little or no chance to walk. They recommended frequent turning, avoidance of catheterization and traction, plus nursing attention and chair transfer when pain subsides, usually in four to six weeks. These
authors believe that only indication for surgical repair of a hip fracture in an institutionalized patient is a reasonable chance to regain ambulatory status.

Hornby and associates (1989) compared operative and conservative treatment for intertrochanteric fractures of the femur in elderly patients. Operative treatment produced better anatomical results and shorter hospital stays than did conservative treatment.

INTERNAL FIXATION IN HIP FRACTURES

The first to have nailed a hip fracture appears to have been Von Langenbeck in 1850.

König (1875) and Nicolaysen (1897) advocated the use of nails in serious cases. Davis (1908) reported the use of ordinary wood screws for fixation of the femoral neck fractures. Similar wood screws for internal fixation were used by Da Costa in 1907, Delbet in 1919 and Martin and King in 1920.

Hey Groves (1916), designed a quadriflange nail to obtain better fixation, but it was made of unsatisfactory material.

Smith-Peterson (1931), using a triflange nail, reported a series of open nailing in which he advocated reduction, impaction and internal fixation.

Johansson (1932) simplified Smith-Peterson technique by cannulating the SP nail. Thornton (1937), added side plate to the triflange nail. This ultimately led to the development of solid nail plate by Jewett in 1941 and Holt in 1963.
DYNAMIC HIP SCREW

A screw that provided dynamic compression at the fracture site was introduced by Virgin and MacAusland in 1945.

Schumpelick and Jantzen (1955), Pugh (1955), Badgley (1960), Massie (1962), Clawson (1964), introduced telescoping nails or screws which allows gradual impaction at the fracture site.

Clawson (1964), pointed out that to ensure impaction, the barrel of the dynamic hip screw device must not cross the fracture site. There also must be enough room for the implant to collapse before screw impinges on the barrel because, when such impingement occurs, the device acts as a fixed-angle plate. Failure of hip screw to slide, also results in the implant functioning as a fixed-angle plate.

The low incidence of complications found after anatomical nailing of unstable fractures by Friedenberg and colleagues (1972), Sahistrand T (1974), and Mulholland and Gunn (1972) emphasizes the value of Sliding Compression hip screw in the treatment of intertrochantric fractures.

Laros and Moore (1974) emphasized that although dynamic hip screw devices being more technically demanding but had fewer complications of fracture and non union than with fixed-angle devices.

Clawson and Ecker (1975), noted that the unstable intertrochantric fractures treated with dynamic hip screw underwent shortening and medial displacement, but the fracture went onto prompt union. Although shortening of upto 1 cm occurred, the head did not fall into varus displacement and the
fixation device did not cut through the head to damage the acetabulum.

Jacobs and coworkers (1976) demonstrated an increased incidence of joint penetration with fixed nail plate devices as compared with sliding compression screw.

Kyle and colleagues (1980) suggested that the potential of jamming or failure of hip screw to slide is decreased by maximum engagement (more than 25 cm) of the screw in the barrel and by the use of a 150°, screw plate instead of 130° implant. In devices with angles lower than 155°, greater forces perpendicular to the axis of the sliding screw are present which act to jam or bend the device, which prevents impaction.

Jensen and colleagues (1980) demonstrated that in stable intertrochanteric fractures, choice of implant did not affect results, but in unstable fractures, the sliding hip screw was the most suitable implant.

Jacobs and colleagues (1980) demonstrated that dynamic hip screw allows an unstable intertrochanteric fracture to impact and thereby seek its own stability. Due to sliding of dynamic hip screw with settling of unstable fractures, the lever arm acting on nail plate junction shortens, thereby reduced force on the implant.

Jensen (1981) suggested that controlled collapse of sliding compression hip screw improves the weight bearing capacity of implant through reduction of moment arm.

Wolfgang and coworkers (1982), noted that unstable intertrochanteric fracture treated with dynamic hip screw without obtaining bony stability has a 21% rate of mechanical failure. This rate was reduced to 10% when bony stability was
obtained before the dynamic hip screw was used. They emphasized that failure of lag screw to telescope also can occur as the result of impingement of the sleeve of the side plate on the base of the proximal fragment. These authors also reported metal failure by side plate or lag screw fracture in patients in whom the fracture reduction was considered unsatisfactory. Hence, they concluded that a dynamic compression screw device must be sufficiently strong to withstand physiologic loading, or results will be no better than those of a rigid device.

Rao and coworkers (1983) reported that fixation with dynamic hip screw in unstable fractures resulted in 90% of their fractures moving into a medially displaced position after surgery, indicating that there was no advantage to a primary medial displacement osteotomy.

Heyse-Moore and associates (1983) concluded that sliding compression hip screw is superior to the Jewett nail in the treatment of intertrochanteric fractures of the femur.

Hopkins and coworkers (1989) suggested that there was no advantage to medial displacement osteotomy over anatomical nailing when a dynamic hip screw was used in unstable intertrochanteric fractures.

Chang and coworkers (1987) also compared the stability of anatomical reduction versus medial displacement osteotomy in unstable intertrochanteric fractures. They reported that an anatomical reduction of a four part intertrochanteric fractures internally fixed with a dynamic hip screw provided significantly higher compression across the calcar region and lower tensile strength on the plate than is obtained by medial displacement osteotomy.
Larsson and coworkers (1988), report that bending of a dynamic hip screw obstructs telescoping so that dynamic device is converted to a rigid system that does not allow impaction.

Kyle (1988) recommended using the highest-angle nail plate device that allows center head placement of the screw.

Des Jardines and coworkers (1993) found that postoperative complications and early mortality rates to be the same in unstable intertrochanteric fractures treated by anatomical fixation with DHS & those treated by medial displacement osteotomy. In addition, operating time and blood loss were greater in the osteotomy group. These authors concluded that there is no need for medial displacement osteotomy in unstable intertrochanteric fractures treated with a dynamic hip screw.

Yoshimi and coworkers (1993), report that high nail plate angle and longer screw barrel engagement have no correlation with ease of sliding, even in unstable fractures. These authors found quality of reduction and fracture stability to be the main factors related to screw sliding.

Spivak and associates (1993) discussed four modes of failure of the sliding screw in hip fracture fixation:

1. Cutting out of the compression screw from the femoral head
2. Pulling off the side plate from the femoral shaft
3. Disengagement of the sliding compression hip screw from the barrel
4. Failure of the hip screw.
They reported that all screw failures are related to non-union of the original fractures or the development of a second fracture in the region spanned by the sliding screw.

Gundle R, Gargan M F, Simpson A H (1995) concluded for the fixation of unstable inter-trochanteric fractures that the most important factor affecting the load borne by the fracture fragment was the amount of slide available within the device, and that affecting the load carried by device was the position of the screw in the femoral head. For the fracture fixed with device allowing less than 10 mm of slide and those with superior screw position, the risk of failure was increased by factor of 3.2 and 5.9 respectively.


Mohan R, Karthikeyan R, Sonanis S.V, (2000) concluded that rotational torque in the sagittal plane imparted during screw insertion can lead to a potentially unstable construct in left-sided D.H.S. fixations when compared to the right-sided ones. This unstable fixation constructs manifests as an anterior spike of the proximal fragment in left-sided fixations due to clockwise torque.

Dujardin F H & others (2001) compared between dynamic hip screw and mini-invasive static nail in fractures of the
trochanteric area and found the advantages of mini-invasive technique over D H S.

**INTRAMEDULLARY DEVICES**

**ENDER’S NAIL**

Ender (1970), reported use of multiple flexible condylocephalic nails that were introduced through the distal femur for the stabilization of the intertrochanteric fractures without opening the fracture site.

Chapman and associates (1981) reported complications of Ender nailing:

1. Nail backing out of the medullary canal.
2. Perforation of the nails through the femoral head.
3. Rotation deformity at the fracture site.

Sherk and Foster (1985), reported high incidence of varus deformity and knee pain caused by distal migration of the Ender pins in intertrochanteric fractures.

Nungu and colleagues (1991), reported complications and reoperation rates after treatment of intertrochanteric fractures with the Ender nails twice as high as those in patients treated with sliding compression hip screws.

Comparing Ender nails and a sliding compression hip screw for intertrochanteric fractures, Barrios and associates (1992), reported that quality of reduction, not the type of device or the stability of fracture, are the most important factor in determining results in these patients.
HARRIS NAIL

Harris (1980) designed a intramedullary device to prevent external rotation deformity and distal nail migration noted with Ender’s nail.

Sherk and Foster (1985), compared use of Harris condylocephalic nail with that of a sliding compression hip screw in the treatment of intertrochanteric fractures. There was a 51% loss of rigid fixation in patients with the condylocephalic nail, and in these patients deformity developed. In contrast there was no failure of fixation in patients treated with sliding compression hip screw. The authors concluded that sliding compression hip screw is better implant for these fractures.

GAMMA NAIL

Bridle and coworkers (1991) compared the dynamic hip compression screw with the Gamma nail in hundred intertrochanteric fractures of the proximal femur.

They reported the occurrence of four fractures close to the Gamma nail during the post operative period.

They recommended the use of the Gamma nails for intertrochanteric fractures with the sub trochanteric extension and for intertrochanteric fractures with reverse obliquity.

Lindsey and colleagues (1991) concluded that the distal screw holes in the Gamma nail were stress riser. They recommended using the Gamma nail only to increase stability in unstable fractures.

Leung and colleagues (1992) compared the use of the Gamma nail and dynamic hip screw for treatment of intertrochanteric fractures. They found that the Gamma nail was
associated with shorter operative time, smaller incision, less blood loss and a quicker return to full weight bearing. Although there was no difference in mortality at 6 months, there were more intraoperative complications with the Gamma nail. Two patients of the one hundred thirteen patients in the study suffered a fracture below the tip of the nail. No such fracture was reported with the use of the dynamic hip screw.

Radford and coworkers (1993) compared the Gamma nail and dynamic hip screw. They reported high incidence of femoral shaft fractures with use of the Gamma nail. According to the authors, the femoral shaft fractures resulted from a consistent mismatch between shape of nail and the proximal femur.

Because of high rate of femoral shaft fractures, they did not recommend the use of the Gamma nail in the treatment of intertrochanteric fractures.

Goldhagen and associates (1994), in a comparative study of compression hip screw and the Gamma nail, demonstrated similar clinical results in two treatment groups.

Intramedullary methods of therapy for intertrochanteric fractures require extensive operative experience with the techniques and expensive operative equipment, including image intensification. The high incidence of complications reported with their use has resulted in loss of popularity of these devices.

**PROSTHETIC HEMIARTHROPLASTY**

Rosenfeld and colleagues (1973) reported the use of prosthetic replacement for intertrochanteric fractures of the femur in debilitated patients.
Stern and Goldstein (1977) also reported successful use of Lienbach prosthesis in selected group of intertrochanteric fractures.

Pinder and associates (1981) and Heiman (1982), described the use of a Lienbach type femoral head-neck prosthesis in complex intertrochanteric fractures with excellent clinical results and a prompt return to preoperative status.

Stern and Angerman (1987) reported quicker restoration of function and shorter hospitalization for patients with comminuted intertrochanteric fractures treated with Lienbach prosthesis as compared with those treated by open reduction and internal fixation.

Green and coworker (1987) reported the use of bipolar prosthetic replacement for unstable intertrochanteric fractures in elderly patients.

Haentjens and associates (1989), reported primary bipolar arthroplasty in patients more than seventy five years of age with unstable intertrochanteric fractures.

Broos and colleagues (1991) suggested that complex multifragment intertrochanteric fractures might be better treated with endoprosthesis primarily.
CLASSIFICATION

According to Jensen, classification system of fractures must serve two functions. First, it must relate the possibility of obtaining a primary stable reduction. Second, it must allow surgeon to predict the risk of secondary loss of this fracture reduction after internal fixation.

Boyd and Griffin (1949), presented a classification system based on the ease of obtaining and maintaining fracture reduction. They divided intertrochanteric fractures into four types.

Tronzo (1974) modified Boyd and Griffin classification by dividing their type III fracture into two separate groups thereby creating five fracture types.

Kyle and colleagues (1979) modified Boyd's classification. Evans (1949) presented a simpler classification by dividing fractures into stable and unstable groups.

He further divided unstable fracture into those in which stability could be restored by anatomical or near anatomical reduction and in those in which anatomical reduction would not create stability.

Jensen found Evans classification to be most accurate system in predicting the possibility of both anatomical reduction and secondary fracture displacement after nailing.

**Evans Classification**: The main types depending upon direction of fracture line.

Type I: Fracture line extends upward and outward from the lesser trochanter.
Type II Fracture line is one of reversed obliquity

Stability in type I fracture is obtained by anatomical medial cortical reduction
Type II fracture have tendency towards medial displacement of the femoral haft and, hence retain a degree of instability

Boyd and Griffin classification

Type I Fracture are non-displaced, stable, intertrochanteric fractures without comminution. These account for 21% intertrochanteric fractures.
Type II Fractures are stable, minimally comminuted, but displaced fractures. These fractures represent 36% of intertrochanteric fractures and, once they are reduced, allow a stable construct.
Type III Fractures have a large posteromedial comminuted area and are unstable. They constitute 28% of intertrochanteric fractures.
Type IV Fractures consist of intertrochanteric fracture with subtrochanteric component. These make up 15% of intertrochanteric fractures.

A.O. Classification

Group A1 – Simple two-part fracture.
Group A2 – fracture extends over two or more levels of medial cortex
Group A3 – fracture extends through lateral cortex of femur.
Evan's Classification

Type I
- Undisplaced
- Displaced reduced
- Displaced not reduced
- Comminuted

Stable
- Stable medial cortical apposition
- Unstable no apposition
- Unstable no apposition

Type II
- Reversed obliquity
  - Adductors
- Unstable

Initial roentgenogram  Reduction roentgenogram
Boyd and Griffin Classification