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Research Article

**MANAGEMENT OF PROXIMAL FEMORAL FRACTURE IN
SAUDI ARABIA**Rakan Fraih Almuazzi^{1*}, Abdulmajeed Mohammed Alshammari¹¹ Hail Univeristy, Hail, Saudi Arabia**Abstract:**

Purpose: The purpose of this study was to review the principles involved in the management of proximal femoral fractures as reported in the literature.

Methods: A medical literature search in the MEDLINE (PubMed) and Cochrane database was undertaken to review strategies and principles in proximal femoral fracture treatment. Randomized control trials and meta analysis were given preference while case reports/small series were rejected.

Results and conclusions: Early anatomical reduction and surgical fixation remains the best option to reduce the risk of complications like non-union and avascular necrosis in treating fracture neck femurs. Cancellous screws continue to be the preferred treatment for fixation of neck femur fractures in younger population until the benefit of using sliding hip screws is validated by large multicentric studies. In the geriatric age group, early prosthetic replacement brings down the mortality and morbidity associated with neck femur fractures. Sliding hip screw (DHS) is the best available option for stable inter trochanteric fractures. The use of intramedullary nails e.g. PFN is beneficial in treating inter trochanteric fractures with comminution and loss of lateral buttress. Intramedullary implants have been proven to have increased success rates in subtrochanteric fractures and should be preferred over extramedullary plate fixation systems.

Keywords: Proximal femoral fractures, Surgical fixation, Management, Hemiarthroplasty, Intramedullary devices

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INTRODUCTION:

Proximal femoral Fractures account for a large proportion of hospitalization among trauma cases [1]. An overwhelming majority of these patients (>90%) are aged above 50 years [2]. The incidence of these fractures is 2-3 times more in females as compared to male population [2]. They are classified on basis of anatomical location of fracture into: neck of femur fracture, inter trochanteric fracture and subtrochanteric fracture. Each of these fracture types require special methods of treatment and have their own set of complications and controversies regarding the optimal method of management. We undertook a literature review to try and understand the various issues involved in management of proximal femoral fractures and search for answers to the existing contentions in the numerous treatment options available.

Fracture neck of femur

These fractures occur in the region between the head of femur and inter trochanteric region [3]. These fractures are prone to non-union because of three reasons:

- A) Being intracapsular, hip synovial fluid impedes the healing process [4].
- B) Loss of blood supply to femoral head and neck due to disruption of lateral ascending cervical branches of the medial femoral circumflex artery.

This also increases the risk for avascular necrosis of femoral head [5].

C) Absence of cambium layer of periosteum in this region.

Treatment: It generally requires operative intervention. The exact modality of treatment depends upon age of patient, fracture characteristics and duration following injury [1].

Neck of femur fracture in young adult

Fracture neck of femur in a young adult is a rare occurrence and signifies a high energy trauma. The principle of treatment is anatomic reduction and fixation, as early as possible, to reduce the chances of avascular necrosis and non-union [4]. We reviewed 3 studies comparing the outcome of fracture neck femur fixed early v/s those having delayed fixation Table 1.

Though the results of the above mentioned studies showed no increase in rate of non-union and avascular necrosis in patients who had delayed fixation of fracture neck femur. However these studies defined early surgery as within 12 h (in 2 studies) and 48 h (in 1 study) and had small cohorts. Until large multicentric trials comparing the rate of avascular necrosis following neck femur fracture are available, it is recommended to perform earliest possible reduction and fixation of fracture neck femur.

Table 1: Outcome of fracture neck femur treated early v/s delayed fixation.

Investigator	Total patients (at last follow-up)	Average age	Treatment groups		Nonunion		Avascular necrosis	
			Earl y	Delayed	Earl y	Delay ed	Earl y	Delayed
Jain (2002) ⁶	38	45.9	15	23	0	0	0	6
Damany (2004) ⁷	36	39.9	14	22	0	2	2	2
Upadhayay (2005) ⁸	92	37.7	50	42	9	8	7	8

FRACTURE CLASSIFICATION:

A number of classification systems are in place to categorize and help in choosing the best possible method of treatment viz. Garden's, Pauwel's and AO classification. Garden's classification categorises femoral neck fractures into 4 groups based on the alignment of bony trabeculae:

Type I: incomplete fracture (impacted valgus fracture)

Type II: complete fracture without displacement

Type III: complete fracture with partial displacement

Type IV: complete fracture with complete

displacement

Garden's classification is the most widely used system, although there is much inter observer variation with regard to fracture grading [4]. Pauwel's classification: Based on the obliquity of the fracture line, Pauwel classified femoral neck fractures into three types:

Type 1: with obliquity of 0-30°.

Type 2: with obliquity of 30-50°.

Type 3: with obliquity of 70° or more.

Pauwel's classification has good inter observer reproducibility but has been found to be of limited

use in predicting the clinical outcome or the rate of complications in the various fracture sub types [9]. AO classification: it's a comprehensive classification which groups femoral neck fractures in the 31. B group and further subdivides it into three types based on location of the fracture line and displacement.

31B1: subcapital fractures with minimal displacement.

31B2: transcervical fractures.

31B3: displaced subcapital fractures.

This classification has been reviewed and found to have a very poor inter and intra observer reliability. Its very complicated and doesn't have significant prognostic significance [10]. In essence none of the fracture classifications available have an edge over the other in predicting the outcome or the complications with a given fracture type. Hence today for decision making most surgeons classify fractures of femoral neck as undisplaced or displaced.

METHOD OF FIXATION:

The most widely used treatment modality for fixation of isolated fracture neck of femur in young adults is multiple cannulated screws although there is some evidence advocating the use of sliding hip screw. In an international survey Bhandari et al [11] found that

92% of surgeons preferred using multiple cannulated screws for fixation of undisplaced fracture neck femur. In displaced fractures 68% of surgeons using internal fixation favored multiple screws [11]. The rationale behind using multiple screws is manifold. They are less invasive, preserve more cancellous bone as compared to larger hip screws, and provide enhanced rotational stability [12-16]. The proponents of sliding hip screw argue that it provides better mechanical strength under physiological loading and is better in cases with osteoporosis and significant displacement [15]. In a meta analysis Bhandari et al reviewed 4 randomized control trials comparing outcome of femoral neck fractures fixed with either cannulated screws or sliding screw found that revision rates were marginally better with DHS although not conclusively significant [17]. In another meta analysis Parker and Blundell reviewed 28 trials and found no conclusive advantage of any implant over another although there was a trend for decreased revision rates and risk of avascular necrosis in patients treated with a sliding screw [18]. Hence, at this point of time it can't be conclusively said which implant choice is better, although DHS might be marginally better especially in vertical (type III Pauwel) fractures. Larger multicentric trials are needed to confirm this trend Table 2.

Table 2: Comparison of multiple screws v/s sliding hip screw in management of femoral neck fractures.17

Author	Sample size	Multiple screws		Sliding hip screw	
		No. of cases	Success rate (%)	No. of cases	Success rate (%)
Paus	131	65	73.8	66	74.2
Madsen	103	52	78.8	51	86.3
Sorens on	73	38	52.6	35	74.3
Harper	209	107	86.9	102	91.2

Screw configuration

Screw configuration has long been known to affect the stability of fracture neck femur fixation. In a study Huang et al [19] compared various screw configurations and found that 3 screws in inverted triangle configuration with parallel placed screws was associated with least rate of complications. Vertical screws and separated screw configuration were associated with the highest rate of non-union. Lindequist and Tornkvist [20] studied the relation between position of screw and its effect on outcome in fracture neck femur and found that 2 screws inserted close to the cortex (one placed 3 mm from inferior and the other within 3 mm from posterior cortex) had the best results. Guruswamy et al [21] in

his study found that closely spaced screws on lateral view in a radiograph were more prone to failure.

Nonunion neck of femur

Its one of the commonest complications following fixation of fracture neck of femur. Its reported incidence in displaced femoral neck fractures ranges from 10 to 30% [7]. Treatment in geriatric patients is usually prosthetic replacement. In young patients (<60 yrs of age) various procedures have been described. These include open reduction and internal fixation with muscle pedicle grafting, screw with fibular grafting either free fibula or vascularised fibula and valgus inter trochanteric osteotomy Table 3. Literature review indicates that all the procedures

have a high success rate of which vascularised bone grafting has the highest rate of union followed by

valgus osteotomy and fixation.

Table 3: Results with various methods of treating non-union neck femur.

Author	Sample size	Intervention	Nonunion (%)	AVN (%)
Meyer's et al ²²	32	ORIF + muscle pedicle grafting	28	0
Baksi et al ²³	56	CRIF + muscle pedicle grafting	18	4
Hou et al ²⁴	5	ORIF + pinning + vascularized iliac bone grafting	0	0
Nagi et al ²⁵	40	ORIF + CC screw + fibular strut	5	20
Sandhu et al ²⁶	168	CRIF + CC screw + fibular strut	12	4
Magu et al ²⁷	48	Valgus osteotomy	8	6

Fracture neck of femur in geriatric age group

These patients account for majority of the cases. Fracture neck of femur is associated with high mortality in geriatric age group (20-35% within the first year of injury) [28]. In view of the comorbidities, it was a practice to manage these patients on traction and delaying surgery. There seems to be no evidence suggesting any benefit of this protocol. Traction itself leads to more complications (skin necrosis, increased risk of DVT) and has been found to be not much of help in reducing pain or maintaining alignment for later surgery [29]. We also searched the literature regarding the optimal timing of surgery in geriatric patients. The reports suggested that although there is no difference in the rate of post operative complications and mortality following delayed surgery it lead to increased hospital stay, increased pain and decreased functionality. It can be concluded that early surgery (within 48 h in cases without comorbidities) and within 4 days in patients with coexisting medical conditions is beneficial [30-34]. It is generally agreed that prosthetic replacement of neck femur fractures is the preferred modality of treatment in geriatric patients [17]. Various meta analysis and randomized control trials have shown decreased reoperation rate (9%) after arthroplasty as compared to (35%) after internal fixation [35]. The current controversy is to determine which type of arthroplasty is best suited for treatment of neck femur fractures in the elderly population.

Hemiarthroplasty for neck of femur fractures

It is a well established treatment modality in geriatric patients and has yielded universally good results. However a few issues exist regarding the nature of implant (unipolar v/s bipolar) & method of fixation

(cemented v/s uncemented). We did a literature search to review studies comparing unipolar to bipolar arthroplasty for femoral neck fractures. We searched the Cochrane database and found 5 randomized control trials relevant to our review. The parameters compared were functional outcome, dislocation rates and mortality. All the studies reported no significant difference in all the parameters compared [36-40] Table 4. In view of these equally good results and the high initial cost of bipolar hemiarthroplasty (HRA), preferring bipolar over unipolar hemiarthroplasty can be questioned [41]. Another topic of debate for the past 2 decades has been the use of cemented or uncemented prosthesis. Use of bone cement for femoral stem fixation has been thought to increase cardio-pulmonary complications and increase peri-operative mortality [42]. Literature review suggests that both cemented and uncemented hemiarthroplasty have comparable results in term of revision rates, post-operative complications, perioperative mortality, and functional outcome [43]. The uncemented prosthesis being compared is not the Austin-Moore prosthesis. It is the porous coated modern femoral stem. The results of Austin-Moore prosthesis are not as good as cemented Thompson prosthesis and generally poor over long term. Lou et al in a meta-analysis found that residual pain at 1 year was significantly less with cemented prosthesis as compared to uncemented HRA, they also postulate that this should lead to increased mobility [44]. Costain et al in a study based on the Australian Orthopaedic Association National Joint Replacement Registry found decrease mortality at 1 year following cemented procedure, they also reported an increased implant survival following a cemented procedure and advocate the use of cemented HRA [45]. Total hip replacement (THA)

for Neck of femur fractures:

THA in intracapsular neck femur fractures is gaining popularity due to reduced rate of acetabular wear and better functional outcome. We analysed 5 studies comparing results following THA and HRA for fracture neck femur [46-50]. We found that while the mortality rate, pain and mobility following both type of procedures showed no statistical difference, dislocation rates were higher following total hip replacement while revision rates due to acetabular wear were higher in the HA group [46-50].

Dislocation following total hip replacement can be reduced by using a 32 mm diameter head, anterior approach or proper posterior capsulorrhaphy following posterior approach Table 5. Keeping above studies in mind it may be inferred that THA is preferred in mentally alert, more mobile patients with less comorbidities while HA may be suited for less mentally alert, less physically active and patients with comorbidities precluding a lengthy and more invasive procedure [50].

Table 4: Comparison of unipolar v/s bipolar hemiarthroplasty for managing femoral neck fractures.

Author	Unipolar group			Bipolar group		
	No. of cases	Harris hip score	No. of dislocations	No. of cases	Harris hip score	No. of dislocations
Calder ³⁶	74	70	2	67	72	1
Cornell ³⁷	14	-	1	31	-	1
Davison ³⁸	90	70.7	1	97	77.6	2
Jeffcoat ³⁹	27	65	-	24	75	-
Raia ⁴⁰	40	-	1	38	-	1

Table 5: THA compared with HRA for treatment of femoral neck fractures.

Author	Follow up (years)	THA group			HA group		
		No. of cases	Dislocation rate (%)	Revision rate (%)	No. of cases	Dislocation rate (%)	Revision rate
Bekero m ⁴⁶	1	115	7	1.7	137	0	4.4
Baker ⁴⁷	3	40	7.5	2.5	41	0	14.6
Keating ⁴⁸	2	69	4.4	-	69	2.9	-
Skinner ⁴⁹	1	80	12.5	3.8	100	11	13
Dorr ⁵⁰	2	39	18	5.1	37	4	8

Inter trochanteric fracture femur

These fractures occur in the area between the greater and lesser trochanter and may involve these two structures. Inter trochanteric fractures make up 45% of all hip fractures [51]. This region consists of weight bearing trabeculae and has a good amount of cancellous bone and vascularity thus minimizing the risk of avascular necrosis and non-union [52]. Inter trochanteric (I/T) fractures can be classified in many ways viz. Evan's classification, AO classification, Jensen's classification all of them divide this fracture into stable fractures and unstable fractures (reverse oblique and coronal split fractures).

TREATMENT:

Inter trochanteric fractures are usually managed by surgical fixation. The choice of implants depends upon the fracture pattern, age of patient and existing comorbidities. For treatment of stable Inter trochanteric fractures, the implant choices are extramedullary sliding screw systems (DHS), intramedullary nails with screws/flanges in the femoral head (PFN, Gamma nail) and prosthesis. The question arises as to which implant works best for a given patient?

DHS has been, for long, the standard implant of choice for stable Inter trochanteric fractures. However recent intramedullary implants specifically designed for the purpose (PFNa) are being propagated as the next best thing for inter trochanteric fracture fixation. A number of studies have reported decreased blood loss and operating time with the use of intramedullary systems [52-55], but none of them report an improved functional outcome with these implants. One of the major criticisms of intramedullary systems has been the risk of femoral shaft fractures distal to the implant. However in a meta analysis, Bhandari et al [56] found that the risk of femoral shaft fracture following insertion of newer intramedullary devices was comparable to DHS. We also analysed the Cochrane database and found that current evidence supports the continued use of the sliding hip screw for fixing the more common types of stable extra-capsular hip fractures [57]. We also evaluated various factors that influence outcome following management of inter trochanteric fractures. The most important factor is the position of lag screw and the tipapex distance[58]. Traditionally it was advocated that the lag screw be placed slightly inferiorly and posteriorly but this leads to an increased tip-apex distance. The new recommendation [59] is to place the lag screw in the middle of neck in both planes going just 10 mm short of subchondral bone, to achieve a tip-apex distance of <25 mm. This tip-apex distance holds good for PFN as well [59]. The concept of stable inter trochanteric fracture too has under gone a radical change. Earlier it was defined according to the orientation of fracture line (Evan's classification). Nowadays, its only after internal fixation that a fracture is labeled as stable, if the posteromedial cortex is intact and the valgus angulation is maintained. Unstable inter trochanteric fractures are notorious for their complications and high failure rates following treatment with conventional DHS. The trick is to identify unstable fracture patterns and use specific design implants for their management. Unstable fracture patterns include:

- Reverse oblique
- Transtrochanteric

- With subtrochanteric extension
- With 'large' posteromedial fragment e although the "large" is not well defined.

The use of DHS in fracture configurations that have comminution/loss of lateral wall are fraught with increased risk of failure. The use of trochanteric stabilizing plate and proximal femoral locking plate has been studied in these situations. They do help in preventing medial migration of distal fragment but are technically demanding. The available literature supports the use of intramedullary nails in the treatment of unstable fractures due to its bio mechanical superiority [59,60]. These implants are load bearing, have a shorter lever arm and prevent medialization of distal fragment. The fracture should be reduced properly before reaming the canal and it is advisable to avoid distracting the fracture.

Hip replacement following inter trochanteric fractures

In elderly population unstable inter trochanteric fractures present a special challenge as they have a high rate of mortality and morbidity. This sub group of patients usually has comminuted fractures and the underlying bone stock is weak due to osteoporosis, which compound fracture fixation and subsequent weight bearing. To circumvent this problem many surgeons prefer arthroplasty over internal fixation in treatment of unstable inter trochanteric fractures in such patients. On literature review we found that indication for primary arthroplasty in these patients was unstable fracture configuration with comminution, osteoporosis, advanced age (>75 years) [61]. Table 6 Geiger et al [65] in a study compared the outcome of unstable inter trochanteric fractures treated with either internal fixation (PFN, DHS) or arthroplasty, they reported similar functional outcome in both group of patients although blood loss, transfusion need, and operating time was higher in arthroplasty group. Reoperation rate was reduced in arthroplasty group. They also preferred hemiarthroplasty to total hip replacement as primary treatment modality in view of decreased dislocation risk.

Table 6: Results of hip replacement for inter trochanteric fracture femur.

Investigator	Indication	Average age	Treatment offered	Sample size	Functional outcome (harris hip score)	No. of revisions
Choy et al ⁶²	Unstable i/t fracture with osteoporosis	78.8	Cementless bipolar hemiarthroplasty	40	80.6	0
Sancheti et al ⁶³	Unstable i/t fracture with osteoporosis	77.1	Cemented bipolar hemiarthroplasty	35	84.8	0
Sidhu et al ⁶⁴	Unstable i/t fracture	77	Cemented total hip replacement	53	76	0

Subtrochanteric fractures

These are fractures occurring between the lesser trochanter and isthmus of the shaft of femur. The frequency of these fractures is less than that of neck femur and inters trochanteric fractures [3]. Subtrochanteric fractures constitute 10-30% of all hip fractures [66]. These fractures usually unite by primary cortical healing. These fractures are notorious for intra operative difficulty in reduction and post-operative complications like non-union and malunion. The reason for this being the muscular forces from around the hip acting on the fracture fragments which cause distraction and malrotation at the fracture site. The proximal fragment is abducted due to the pull of gluteus medius and minimus. In addition this fragment is forced in flexion and external rotation by iliopsoas. The adductors, on the other hand pull the distal fragment medially into adduction thus increasing the fracture deformity [66].

Treatment

Subtrochanteric fractures require operative intervention for favourable results. A number of procedures and implant designs have been utilized for this purpose. Apart from choosing the right implant, the other important factor is the reduction of fracture. As mentioned earlier the muscular forces acting on the fracture make it difficult to reduce the fracture fragments and consequently hold the fracture fragments in reduction during fixation.

Reduction of fracture

A variety of techniques and devices have been described to aid in reduction of subtrochanteric fractures. When using closed intramedullary nailing, the nail itself can be used for reduction. Percutaneous

devices such as schanz pins and clamps have also been used for aiding reduction. Bone clamps have the advantage of preserving soft tissue attachments and keeping the medullary canal free, while aligning fracture fragments making it easier to put in the definitive implant. Schanz screw needs removal during reaming and insertion of implant. Any eccentric reaming of canal can cause malalignment of the fracture fragments. Some fractures are only amenable to open reduction. As with inter trochanteric fractures two major categories of implants are widely used for fixation of subtrochanteric fractures. These are the intramedullary nailing systems and extramedullary fixed angle plate systems (condylar blade plates, proximal femoral locking plates, percutaneous compression plates, less invasive stabilizing systems, dynamic condylar screws). Russell and Taylor while describing subtrochanteric fractures grouped them based on two characteristics: extension of fracture line to pyriformis fossa and involvement of lesser trochanter. These have an important bearing on implant selection. In presence of an intact posteromedial buttress and no extension of fracture to pyriformis fossa intramedullary nails which have entry point in pyriformis fossa are beneficial. If the pyriformis fossa is fractured a nail with entry through greater trochanter is preferred. A comminution of posteromedial buttress is a relative indication for use of plate fixation systems [3]. In a meta analysis, Kuzyk et al [67] compared intramedullary implants to extramedullary fixation devices for treatment of subtrochanteric fractures and reported that intramedullary implants compared favourably to extramedullary plate systems in terms of operating time and lesser rate of implant failure.

Bisphosphonates and subtrochanteric fractures

In view of the increased awareness of osteoporosis and the significant risk of fracture associated with it, drugs for treatment and prevention of osteoporosis are in vogue. Bisphosphonates are the major class of drugs used for this purpose. They have anti resorptive properties thereby decreasing bone turnover and increasing BMD [68]. Although relatively safe, these drugs have been found to be associated with atypical subtrochanteric fractures which are precipitated by trivial trauma. The fractures usually present either as frank fractures or transverse lucency in subtrochanteric bone with an overlying cortical thickening [69]. These fractures have a very low incidence and are usually associated with long term continuous use of bisphosphonates. It is postulated that long term use of bisphosphonates leads to over suppression of bone turnover leading to deficiency in micro fracture remodeling and consequently weakening of bone [68]. Management of these insufficiency fractures involves a multi pronged approach. Medical interventions include calcium and vitamin-D supplementation. There is a need to consider discontinuation of bisphosphonates in such case. Recalcitrant lesions may require the use of rPTH (recombinant parathormone) preparations. Surgical management of these cases usually depends upon the clinico-radiological presentation. Incomplete fractures may be managed conservatively, but if they are painful or show signs of persistence should be managed operatively. In a retrospective study Ha et al [70] observed that complete insufficiency fractures have a tendency to go into non-union/ delayed union and should be managed with intramedullary nailing.

CONCLUSIONS:

Optimal management of proximal femoral fractures remains a challenge for the orthopedic surgeon. We in our literature review found a number of controversies and possible solutions to these problems. Early anatomical reduction and surgical fixation remains the best bet to reduce the risk of complications like non-union and avascular necrosis in treating fracture neck femurs. At present no classification system for fracture neck of femur is helpful in identifying fracture patterns at risk for poor outcome and there are no radiological pointers to diagnose the same. Almost all the classification systems suffer from poor inter observer reproducibility. Cancellous screws continue to be the preferred treatment for fixation of neck femur fractures in younger population until the benefit of using sliding hip screws is validated by large multicentric studies. Screws placed in an inverted triangle configuration, parallel to each other and

inserted in up to 3 mm from the cortex are strongly recommended. In the geriatric age group, early prosthetic replacement brings down the mortality and morbidity associated with neck femur fractures. Total hip arthroplasty with a cemented prosthesis is advocated for active, mentally alert individuals while for the more elderly, less active and patients with more comorbidities hemi replacement should be the treatment of choice. Inter trochanteric fractures are the commonest hip fractures and need to be managed successfully. Sliding hip screw (DHS) is the best available option for stable inter trochanteric fractures. The use of intramedullary nails e.g. PFN is beneficial in treating inter trochanteric fractures with comminution and loss of lateral buttress. Primary hemiarthroplasty for these fractures should be reserved for elderly patients (>75 years of age), with unstable/comminuted fractures and concomitant poor bone stock. Subtrochanteric fractures are prone to non-union and malunion and require proper reduction before and during fixation to ensure good results. Intramedullary implants have been proven to have increased success rates in these fractures and should be preferred over extramedullary plate fixation systems. Insufficiency fractures in subtrochanteric region caused by long term bisphosphonate use are rare but the treating physician should be aware of the possibility. They need surgical fixation with intramedullary devices and medical management of the cause. Many questions still remain to be adequately resolved regarding management of proximal femoral fractures. The need for further investigative studies and evidence-based approach can never be over emphasized in the quest for upgrading our knowledge of the subject and consequent improvement in clinical outcomes.

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