Management of Femoral Neck Fractures In Young / Middle Aged Adults

Gupta A, Choudhari P, Nagla A

Department of Orthopaedics, Bombay Hospital, Indore

Abstract
Femoral neck fractures account for nearly half of all hip fractures with the vast majority occurring in elderly patients after simple falls. Currently there is sufficient evidence to support the routine use of hip replacement surgery for low demand elderly patients in all except non-displaced and valgus impacted femoral neck fractures. However, for the physiologically young / middle aged patients (40 to 65 years) preservation of the natural hip anatomy and mechanics is a priority in management because of their high functional demands especially in Indian population. The biomechanical challenges of femoral neck fixation and the vulnerability of the femoral head blood supply lead to a high incidence of non-union and osteonecrosis of the femoral head after internal fixation of displaced femoral neck fractures. Anatomic reduction and stable internal fixation are essentials in achieving the goals of treatment in this relatively young patient population. Furthermore, other management variables such as surgical timing, the role of capsulotomy and the choice of implant for fixation remain controversial. This review will focus both on the demographics and injury profile of middle aged patients with femoral neck fractures and the current methodology and evidence behind the surgical management of these injuries.
Keywords: Femoral neck fracture, Middle aged patient, Capsulotomy, Osteonecrosis.

Address of correspondence:
Dr. Pradeep Choudhari,
Professor, Department of Orthopaedics,
Aurobindo Medical College, Indore
Email – pchoudhari@rediffmail.com

How to cite this article:
Gupta A, Choudhari P, Nagla A. Management Of Femoral Neck Fractures In Young / Middle Aged Adults Orthop JPMC 2018;24(2):48-60.
Available from:
https://ojmpc.com/index.php/ojmpc/article/view/92

Introduction

Femoral neck fractures account for nearly half of all hip fractures with the vast majority occurring in elderly patients after simple falls [1]. Currently there may be sufficient evidence to support the routine use of hip replacement surgery for low demand elderly patients in all but non-displaced and valgus impacted femoral neck fractures. This is based on a multitude of randomized controlled trials documenting improved short and long-term hip function and lower re-operation rates with primary hip arthroplasty as compared to internal fixation in elderly adults [2]. Furthermore, early weight bearing protocols post-arthroplasty minimizes complications of prolonged inactivity [3].

For the non-elderly patient with good bone quality, preservation of the natural hip anatomy and mechanics is a priority as their high functional demands and young age preclude their candidacy for replacement procedures [4]. While only 3%-10% of these fractures occur in younger adults, the major differences in physiology, injury characteristics and activity level necessitate a dedicated treatment pathway [5]. However, the biomechanical challenges of femoral neck fixation and the vulnerability of the femoral head blood supply lead to a high incidence of non-union and osteonecrosis of the femoral head (ONFH) after internal fixation of displaced femoral neck fractures [6]. These complications are highly symptomatic in active patients leading to salvage procedures with significant failure rates.

Undisputedly, anatomic reduction and stable internal fixation are essentials for achieving the goals of treatment in this relatively young population allowing preservation of the femoral head while minimizing rates of non-union and osteonecrosis [7]. Other management variables such as surgical timing, the role of capsulotomy and the choice of implant remain controversial. This review will focus both on the demographics and injury profile of the young / middle aged patients with femoral neck fractures and the current evidence behind the management of these injuries and their secondary complications.

Consideration of physiological age

The age range describing a young patient is most often between skeletal maturity and the age of fifty [5,6]. More recently, patients up to 65 years have been considered within this definition [3,8]. The majority of surgeons prefer to treat young patients (< 40 years) with internal fixation and elderly patients (>65 years) with arthroplasty / hemiarthroplasty. However, patients between 40 to 65 years constitute a grey area, where the treatment approach is variable. For this "relatively young" population, chronologic age becomes less important and establishing a patient's physiologic age becomes the first step in management [9]. Several variables have been used to characterize the physiologic age of a patient; pre-injury activity level, medical co-morbidities and bone quality. In addition to chronological age these variables dictate the goals of management for this population and have an impact on the outcome of surgical treatments. Bone quality and comminution at fracture site influences the success of internal fixation of femoral neck fractures. Cadaveric studies of femoral neck fixation have shown a positive correlation between bone density and achieved fixation stability [10]. In a review of over one thousand patients with femoral neck fractures, Parker et al. found the incidence of non-union to be age dependent with a rate of 5.9% in patients younger than 40 years compared to 24.9% for patients in their 70s. In addition to non-union, failure of osteoporotic bone around multiple screw fixation leads to increased screw sliding and shortening of the femoral neck. Femoral neck shortening of more than 5 mm has been correlated with decreased functional outcomes and an increased incidence of requiring walking assistance [11].

Although risks of non-union and osteonecrosis are significant in this patient population (40 to 65 years age), arthroplasty is avoided as first line treatment. Highly active patients have increased failure rates of hip prosthetics and less favorable functional outcomes compared to their elderly counterparts [4,12].

Demographics of the middle aged femoral neck fracture patient

The literature suggests that femoral neck fractures in middle aged adults are most often a result of high-energy trauma such as motor vehicle collisions. Patients often present with poly-traumatic injuries such as other fractures or head, chest and abdominal trauma [13]. While this is true for patients with dense bone, more recent work demonstrates that femoral neck fractures in chronologically young patients occur from low energy trauma with a higher than expected frequency [14]. A study conducted by Robinson et al [15] examined ninety-five patients with both intra and extra-capsular hip fractures under the age of 50 years over a five-year period. They identified two demographics within this population; a male predominant group between the ages of 20 and 40 years who sustained high-energy injuries, and a larger group between the ages of 40 and 50 years who sustained fractures after falls. The majority of patients within the latter group had long standing medical conditions and a high prevalence of alcoholism. This demonstrates that there are two main reasons for femoral neck fractures in chronologically young adults, significant trauma in healthy patients or comparatively low energy trauma in patients with predisposing diseases, alcoholism or early age related bone fragility.

Anatomy

Blood supply to the femoral head comes from three main sources, the medial femoral circumflex artery (MFCA), the lateral femoral circumflex artery (LFCA) and the obturator artery. The majority of the blood supply to the femoral head, more specifically to the vital superior-lateral weight-bearing portion, comes from the lateral epiphyseal artery, a branch of the MFCA. This artery courses up the posterior-superior aspect of the femoral neck where it is prone to damage during femoral neck fracture fragment displacement. The second largest contributor to femoral head blood supply is the LFCA whose ascending branch gives rise to the inferior metaphyseal artery supplying the anterior-inferior aspect of the femoral head. Finally, the smallest and most variable contributor to blood supply in the adult femoral head is via the obturator artery which enters the femoral head via the ligamentum teres [16].

Femoral head vascularity is at risk after femoral neck fractures because the vascular supply is intra-capsular. The most common hypotheses of causes for femoral head ischemia after femoral neck fracture are direct disruption or distortion of the intra-capsular arteries during the initial femoral neck fracture, compression secondary to elevated intra-capsular pressure due to fracture hematoma, pre-operative traction and quality of the surgical reduction and its ability to restore blood flow [17].

Initial Evaluation

The mechanism of injury is important. A large majority of relatively young patients with femoral neck fractures present after high-energy trauma. If a relatively young patient with femoral neck fracture presents after a low-energy trauma or no clear history of trauma, a more in depth history should be carried out. One should inquire specifically about risk factors for osteoporosis, previous pain about the hip both at rest or with activity and constitutional symptoms including fever, weight loss and night sweats. Low-energy fracture can be due to underlying osteoporosis, stress fracture or pathologic bone [14].

In a poly-trauma presentation, Advance Trauma Life Support (ATLS) protocol should be promptly initiated; fixation of the femoral neck fracture be dealt with following the appropriate treatment algorithm based on priority of the injuries. Nevertheless, in isolated or in poly-trauma situations, the patient needs to be medically optimized prior to surgery and evaluated by an anesthesiologist.

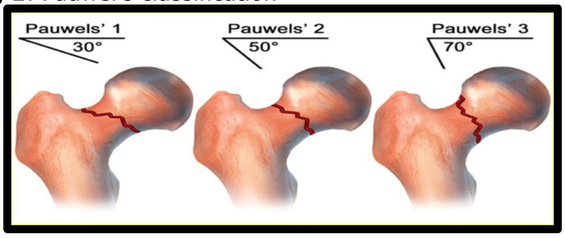
Physical examination findings in patients of all ages with femoral neck fractures are similar. Classically, the affected limb is painful, especially with movement, shortened, flexed and externally rotated. However, the diagnosis of femoral neck fracture in young patients can be more elusive. With a significant proportion of patients presenting after high-energy injuries and often in poly-traumatized patients, these fractures can easily be overlooked [13]. In the presence of a femoral shaft fracture, an ipsilateral femoral neck fracture will occur up to 9% of the time [18]. In this clinical setting, the diagnosis is missed approximately 30% of the time [19]. Most of these fractures (between 25% and 60%) are non-displaced at initial presentation [20]. Because of the morbidity associated with osteonecrosis, a high index of suspicion should be entertained when evaluating the poly-traumatized patient. Prompt recognition of femoral neck injuries cannot be underemphasized at timing to surgical intervention which may affect outcomes [3].

Imaging and classification

Regardless of the mechanism of injury, antero-posterior (AP) pelvis, radiograph of the affected hip and entire femur should be obtained. In addition, traction-internal rotation radiographs may allow for a better interpretation of fracture pattern [21]. Lateral view radiograph is practically difficult to take in ward / ICU setups. Up to 2%-10% of femoral neck fractures may not be clearly visible on standard radiographs and computed tomography (CT) can aid in the diagnosis [22]. In cases of significant trauma where an abdomino-pelvic CT scan is required, it is recommended to extend imaging to the level of the lesser trochanter in order to fully evaluate the femoral neck. Recent studies have found MRI to be as effective as CT scan in detecting these fractures and reducing the chance of a missed injury [22].

Several characteristics identified on imaging have been shown to influence the biomechanical stability of the fracture. First, the verticality of the fracture line in the coronal plane should be assessed. Pauwels first recognized the significance of high angle fractures in the 1930s. He established a descriptive classification scheme that helps determine fracture stability based on the "Pauwels angle". A femoral neck fracture line < 300 from the horizontal plane is Pauwels Type I, fractures with an angle between 300 and 500 is Pauwels Type II and an angle of > 500 categorizes a Pauwels Type III fracture (fig 1). Increased verticality of the fracture decreases the load shared through the fracture fragments resulting in a biomechanically unstable pattern, susceptible to the development of mal-unions, non-unions and osteonecrosis [3,21].

Fig 1. Pauwel's classification



Another well-known and widely used classification system is that of Garden, originally published in 1961[23] Low inter and intra-rater reliability has led to it being mostly used for femoral neck fractures in the elderly population where the classification can be simplified to non-displaced (Garden I or II) vs displaced (Garden III or IV) in order to dictate appropriate management (fig 2) [24]. Secondly, special consideration should also be given to fractures with posterior neck comminution. Several studies have indicated this to be a poor prognostic factor after internal fixation and correlate the comminution with fracture severity and instability [25].

Fig 2. Garden's classification

Principles of Management

Non-operative treatment of femoral neck fractures in relatively young / middle aged patients has a very limited role and is only reserved for the sickest of patients whose surgical risks negate any benefit of fixation. Moreover, operative management is recommended for non-displaced impacted fractures. In a prospective study of three hundred and twelve patients with impacted femoral neck fractures (Garden I-II), Raaymakers et al [26] found that 5% of healthy patient below age 70 had secondary displacement and 87% of patients in this age group achieved union. Considering the pre-injury activity level of most of these patients, surgical management is recommended, as union rates are higher with operative treatment [25]. Goals of the surgical management of femoral neck fractures in young adult patients are three-fold: (1) Achieve an anatomic reduction of the fracture and preserve the blood supply and effectively prevent ONFH; (2) Provide a stable fixation while preserving bone stock to achieve union; (3) Return to pre-injury level of function.

Preoperative Considerations - Surgical timing of displaced and non-displaced fracture

The consensus for time to surgery following femoral neck fracture in this patient population is still a matter of debate. These fractures are classically treated on an urgent basis with the aim to regain and preserve blood flow to the femoral head but should not be operated in the middle of the night by a junior / less experienced surgeon. Studies have shown that early fixation decreases osteonecrosis and increases functional outcome [27]. In a retrospective study, Jain et al [28] looked at thirty-six young patients with femoral neck fractures. Patients treated within twelve hours of injury had a decreased rate of osteonecrosis as compared to the delayed fixation group. However, there was no difference in functional outcome between the early and delayed fixation group. In contrast, other studies have found no difference in osteonecrosis rates between early and delayed time to fixation [29]. Razik et al [30] retrospectively analyzed ninety-two patients with femoral neck fractures and found no difference in rates of osteonecrosis when comparing treatment within 6 h post-injury, and delayed treatment 48 h post-injury. They found that the rate of osteonecrosis was related to the type of fixation, which may be indicative of surgeon treatment bias. The conflicting results in the literature are indicative of the wide amount of variance in the studies, which did not uniformly control for cofounding variables such as the quality or the type of reduction and fixation [31]. Given the controversial evidence and considering the impetus to prevent osteonecrosis and improve functional outcome, we recommend treating displaced femoral neck fractures on an urgent basis by an experienced surgeon.

Surgical management

Open vs Closed reduction: The decision between attempting an open or closed approach for fracture reduction is the first step when attempting primary fixation. There is no dispute as far as the management of non-displaced femoral neck fractures (Garden I-II) is concerned, as most of the authors agree on performing a closed reduction and internal fixation [32]. However there is considerable debate between the two strategies for reduction of displaced fractures (Garden III-IV). Obtaining an anatomic reduction is paramount, as a poorly reduced fracture is a major risk factor for non-union and ONFH [25]. Some authors argue that closed reduction can achieve anatomic reduction with intra-operative fluoroscopy; they suggest that this approach decreases cost, is less invasive and saves operating time. Care should be taken while performing the close reduction, as multiples attempts are associated with an increased risk of ONFH [33]. Others support the need for an open reduction to facilitate direct visualization for anatomic reduction, and with the same token, provide relief of a possible intra-capsular tamponade.

Approach: Traditionally, two different surgical approaches for open reduction of femoral neck fractures;

a. Watson-Jones (antero-lateral) [34]: the approach is in between the TFL and Vastus lateralis. With the same incision fracture is fixed and is best suited for basicervical fractures.
b. Smith-Peterson (anterior) [35]. Direct access to fracture between TFL and Sartorius. One needs to take a second incision laterally for fixation of fracture.

There is no gold standard as to proceed with closed or open reduction for displaced femoral neck fractures in this middle aged population as long as anatomic reduction is achieved.

Closed reduction can be attempted by adequate sedation and relaxation of muscle tone. Leadbetter first described in 1939 the maneuver to reduce of femoral neck fractures [36]. The affected leg is flexed to 45° with slight abduction and then extended with internal rotation while longitudinal traction is applied. The quality of reduction can be ascertained clinically by "**Heelpalm" test**: the patient's heel is placed in the palm of the surgeon's outstretched hand. If reduction is complete, the limb will not externally rotate (37). The reduction is verified with fluoroscopy in the AP and lateral view of the hip to verify the anatomic reduction. The quality of reduction can be ascertained using Garden's alignment index, which evaluates the angle of the compressive trabeculae as compared to the femoral shaft on both AP and lateral hip radiographs. Anatomic reduction is achieved with an angle of 160° on the AP, and 180° on the lateral view. Varus angulation of less than 160° on the AP view and posterior angulation of more than 5° on the lateral view indicate an unsatisfactory reduction [25].

Hematoma decompression

Another topic of controversy in treating femoral neck fractures in relatively young patients is the role of capsulotomy for hematoma decompression. The theoretical goal of capsulotomy is to relieve the tamponading effect of the developed intra-capsular hematoma and subsequently increase blood flow to the femoral head. There is good evidence in the literature correlating hemarthrosis following femoral neck fracture and increased intra-articular joint pressure.

In an interventional study, Beck et al [38] injected saline into intact intra-capsular space of eleven patients before having surgical dislocations and subsequently measured blood flow to the femoral head with laser Doppler flowmetry. The measurable blood flow to the femoral head disappeared with increased pressure (average 58 mmHg) and the blood flow returned once the saline was re-aspirated. In contrast, in a prospective study involving thirty-four patients with femoral neck fractures, Maruenda et al [39] found no correlation between increased intra-capsular pressure and femoral head perfusion. Interestingly they also showed no difference in intra-capsular pressure between non-displaced and displaced fractures. Others have suggested higher pressures are found in non-displaced fractures. Disruption of the hip capsule during facture fragment displacement is thought to be responsible for the decreasing intra-capsular pressures.

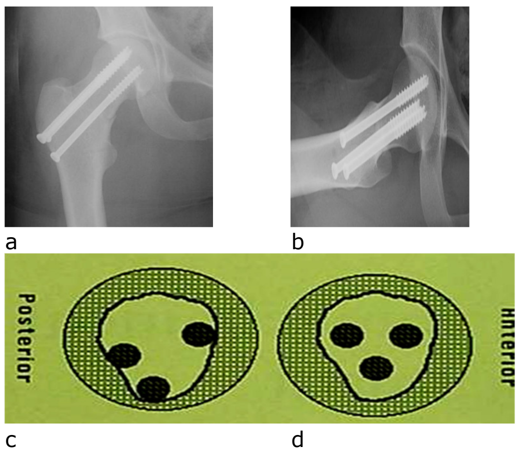
In the study by Maruenda et al [39] five out of the six patients that developed osteonecrosis had pre-operative intra-capsular pressures below diastolic pressure. They concluded what many presently think: high-energy trauma and the initial fracture displacement probably play a more significant role than intra-capsular tamponade in the development of osteonecrosis. Nevertheless, given the current evidence, we do not recommend the routine use of capsulotomy for femoral neck fractures.

Choice of construct

There are several biomechanical constructs available for the fixation of femoral neck fractures and knowing when and how to position the implant is paramount to attain a stable fixation. Compression screws (CS) and fixed-angle dynamic implants, or a combination of both, promote union during weight bearing by allowing the fracture fragments to slide along the implant while being axially loaded [31]. Fixed-angle and length stable implants, such as blade plates, maintain intraoperative reduction by providing a rigid construct [31]. Currently, hemiarthroplasty or total hip arthroplasty are not used as the primary surgery in middle aged patients. Total hip arthroplasty and valgus osteotomy are used as salvage operations in case of failure of fixation. There is still a debate on the optimal method of fixation for promoting union and preventing ONFH in this age group [30]. This is mainly because most opinions on fixation in this population are extrapolated from studies in elderly osteoporotic patients.

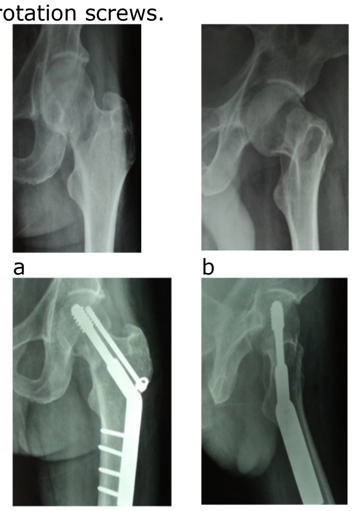
Multiples compressive screws: The use of the multiple compressive screws has been advocated for Garden type I-II in attaining union [40]. In a prospective randomized controlled trial of patients allocated to CS or dynamic hip screw (DHS) with non-displaced or minimally displaced femoral neck fracture, Watson et al found no difference in union rate, ONFH or functional outcome between the groups. Numerous studies have looked at biomechanical variations of this construct including the number and placement of the screws or variability in the proprieties of the screws themselves such as the length of the threads [41]. For instance, parallel screws have been shown to be superior construct than convergent screws in maintaining stability reduction [42]. Some authors advocate the use of a fourth screw in cases of fractures with posterior comminution [3]. However, optimal stiffness can be achieved with a three-screw configuration [7]. Three parallel screws placed perpendicular to the fracture line in a inverted triangle with the most inferior screw placed on the medial aspect of the distal femoral neck provides the ideal stability and compression at the fracture site (fig 3) [3].

Fig 3. Placement of cancellous screws in reverse triangle pattern in both AP (a) and lateral (b) views, along with showing screw orientation good (c) and bad (d) in cross section of neck of femur.



Fixed angle implants: The dynamic hip screw (DHS) has been advocated as a more stable construct than compressive screws for high shear angle neck fractures (Pauwels type III) [42] . Addition of a derotational screw placed in the cranial part of the femoral neck superior to the dynamic hip screw can improve the rotational stability of the construct (fig 4). In a biomechanical study comparing four commonly used constructs for Pauwels type III fractures, Bonnaire et al [42] found the DHS with derotational screw to be more load stable than compressive screws, a fixed-angle plate or a simple DHS construct. However, for more stable fracture patterns this screw may be of little benefit. Furthermore, in their retrospective study of ninety-two young patients with femoral neck fractures, Razik et al [30] found that DHS alone or DHS supplemented with a derotational screw had significantly less osteonecrosis for Garden III-IV fractures.

Fig 4. Preoperative (a & b) and postoperative (c & d) AP and lateral views of Pauwels' type 3 fracture fixed with DHS and derotation screws.



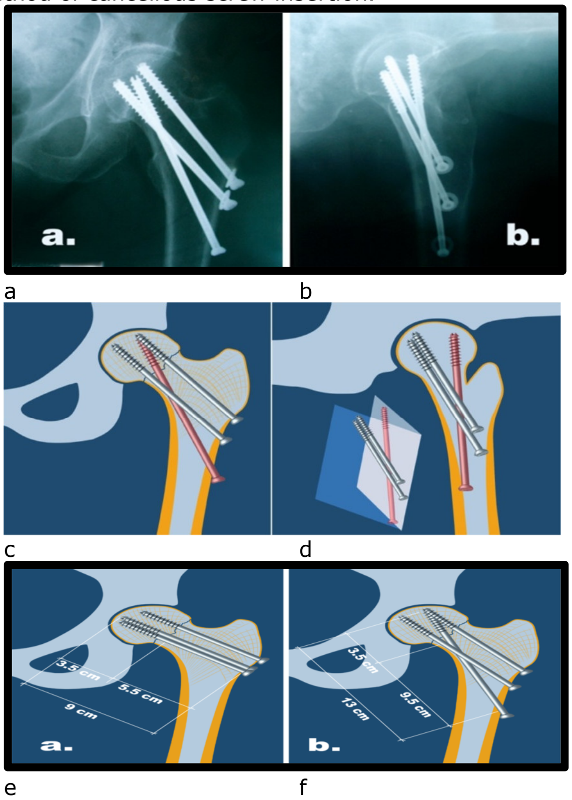
Siavashi et al [43] in their study of 58 cases concluded that fixation of femoral neck fracture in young adults with the DHS is a better option compared with osteosynthesis with multiple cannulated screws with no fixation failures with DHS; however rate of AVN is same as cannulated screw fixation. In a cadaveric study, Aminian et al [44] compared the stability of DHS, CS, dynamic condylar screw and a proximal femoral locking plate (PFLP) for Pauwels type III femoral neck fractures. PFLP was the most stable for this fracture pattern, followed by the dynamic condylar screw, the DHS and CS. Currently, no clinical studies directly compare proximal femoral locking plate with DHS and/or DHS with derotational screw. We recommend the treatment of Garden I-II fracture with CS and Garden III-IV with a DHS and the addition of a derotational screw for Pauwels type III fractures.

Newer methods of fixation:

Biplane double-supported screw fixation (BDSF): It is method of screw fixation at osteoporotic fractures of the femoral neck. First series published in 2011. BDSF is a new method of internal fixation, designed to improve the internal fixation strength at intracapsular femoral neck fractures in the presence of osteoporosis, according to an original concept of the establishment of two supporting points for the implants and their biplane positioning in the femoral neck and head. The provision of two steady supporting points for the implants and the highly increased (obtuse) angle at which they are positioned, allow the body weight to be transferred successfully from the head fragment onto the diaphysis. The position of the screws allows them to slide under stress with a minimal risk of displacement. This method can be used for Garden types from I to IV and the implant used is 7.3-mm self-tapping cannulated screws.

The BDSF-method has two calcar-buttressed implants. The distal screw (red color) touches on the calcar in the lateral part of the femoral neck, and also in the middle part of the femoral neck this screw has a cortical support on the posterior cortex of the neck. The middle screw (white color) touches on the calcar in the middle part of the neck (Fig. 5). At the method of BDSF, the innovative position of the three screws, laid in two planes (in lateral view), makes it possible for the entry points of two of the implants to be placed much more distally, in the solid cortex of the proximal diaphysis, and also to lean onto the femoral neck distal cortex. Thus it establishes two supporting points. The solid cortex of the calcar acts as a medial supporting point for the screws. This supporting point works under pressure.

Fig 5. AP (a) & lateral (b) view & illustrations (c & d) of hip showing the configuration of BDSF. Illustrations showing comparison of conventional (e) & BDSF (f) method of cancellous screw insertion.



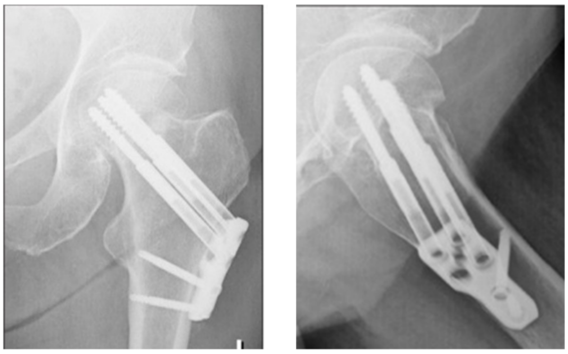
The entry points of the distal and the middle screws in the solid cortex of the proximal diaphysis, acts as a lateral supporting point for the two screws. This supporting point works under pressure in proximal direction. The position of the distal screw as well as the middle screw thus achieved by the method, in terms of statics, turns them into a simple beam with an overhanging end, loaded with a vertical force. This beam with an overhanging end, bridging the fracture, successfully supports the head fragment, bearing the body weight and transferring it to the diaphysis, resisting to the shearing forces (in a standing position). In the sagittal plane (in lateral view) the distal screw is touched on the posterior cortex of the femoral neck, thus ensuring a posterior supporting point, which works under pressure in posterior direction, in the process of antero-posterior bending of the neck (when rising from a chair). Other advantages of the method are:

1. Due to the biplane placement, enough space for a third screw is provided, unlike the classical methods, where just one or a maximum of two implants are placed at an obtuse angle (Burns 1944 [46], Küntscher 1953 [47], Garden 1961 [23], Von Bahr 1974 [48]).
2. Due to the increase in the distance between the two supporting points, the weight borne by the bone is reduced.
3. The entry points of the screws are positioned wide apart from each other, which ensure that when weight bearing, the tensile forces spread over a greater surface of the lateral cortex and thus the risk of a subtrochanter fracturing decreases significantly.
4. The screw, placed at a highly increased angle, works in a direction close to the direction of the loading force, which guarantees better results for the screw in its role of a beam because of the influence of its sagging decreases.
5. Very important advantage for BDSF is that the distal screw is touched on the posterior cortex, which together with the highly increased angle of this screw, provides improved strength of fixation at antero-posterior bending of the neck. (Walker 2007 [49]).

The popular conventional methods of femoral neck fixation by three cancellous screws, placed parallel to each other and parallel to the femoral neck axis, are associated with poor results in 20–42% [50,51]. The position of the screws with BDSF technique allows them to slide under stress at a minimal risk of displacement. The achieved results with the BDSF method in terms of fracture consolidation are far more successful than the results with conventional fixation methods. The BDSF method ensures reliable fixation, early rehabilitation and excellent long-term outcomes, even in non-cooperative patients. The author stressed the fact that BDSF is mainly addressed to patients, who have contraindications for arthroplasty, as well as for conventional screw fixation [45]. Orlin F et al [45] studied 88 patients with BDSF method and fracture union was registered in 87 patients (98.86%) and failure in 1 patient (1.13%).

Tragon fracture neck femoral system: This is a fixed angle device, combines the dynamic compression of DHS and the anti-rotation advantages of the cannulated screws. It consists of a short 6-hole plate that incorporates 4 proximal dynamic locking cancellous screws with associated sleeves and 2 distal standard locking screws. This allows controlled fracture collapse in line with the axis of the femoral neck, while the fixed angle implant design resists varus displacement (fig 6). This system is developed by Aesculap B-Braun (Germany) and results of large multicenter trials are still awaited although early results are encouraging [52].

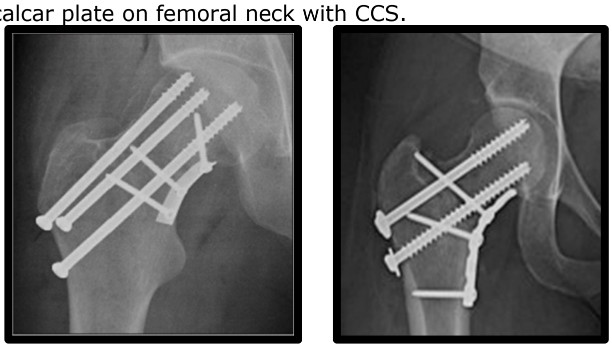
Fig 6. Fracture fixed with Tragon system AP (a) & lateral (b) view.



a b

Medial plate on femoral neck: This is a concept by which application of a medial buttress plate which may prevent many treatment failures and varus collapse, particular seen after fixation of vertical femoral neck fractures in relatively young adults (fig 7). Mir H et al [53] has shown in his series that the application of a medial buttress plate may prevent many treatment failures seen after fixation of vertical femoral neck fractures in young adults.

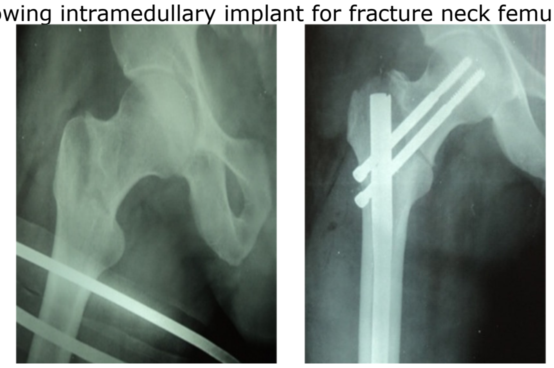
Fig 7. X-rays AP (a) & lateral (b) view showing medial calcar plate on femoral neck with CCS.



a B

Intramedullay implant for fixation of fracture neck femur: Cephallomedullary fixation is usually indicated in ipsilateral fracture shaft femur with neck femur. Mir HR et al [54] in their study of 18 patients with displaced intracapsular femoral neck fractures with a cephalomedullary nail concluded that cephalomedullary nail fixation of displaced intracapsular femoral neck fractures demonstrated mixed results (fig 8). For younger patients with midcervical fractures that were well reduced, the fixation performed well. Displaced subcapital fractures in patients older than 60 years demonstrated a 100% failure rate. As a result, they did not advocate cephalomedullary fixation for displaced intracapsular femoral neck fractures in patients older than 60 years, although in younger patients, these implants may provide an alternative to side-plate based fixation devices.

Fig 8. Preoperative (a) & postoperative (b) AP view showing intramedullary implant for fracture neck femur.



a b

Valgus osteotomy: It is a well-established procedure for nonunion and neglected fracture neck femur. This is a kind of intertrochanteric osteotomy which converts the shearing forces into compressive forces to enhance the healing at fracture site, which is usually performed in cases with high Pauwel's angle (fig 9). Both, the fracture neck femur and the osteotomy can be fixed with DHS, fixed angle blade plate or condylar blade plate depending on surgeon's choice. With better understanding of patho-anatomy of fracture neck femur, low threshold for open reduction and availability of good quality implants, the incidence of valgus osteotomy for a fresh fracture has reduced drastically in the recent past.

Fig 9. Intraoperative floroscopic view (a & b) of fracture neck femur fixed with condylar blade plate following a valgus osteotomy. Post-operative x rays (c) showing good union


a


b


c

Replacement arthroplasty: Replacement arthroplasty is not considered a first line treatment in relatively young patients as bone stock should be preserved and the potential complications of replacement arthroplasty avoided. The major early complications are dislocations for total hip arthroplasty and acetabular erosion for hemiarthroplasty [55]. In the elderly patients, short-term follow up has shown better functional outcome for total hip arthroplasty over hemiarthroplasty [56,57]. Studies have shown that internal fixation has higher re-operation rates and that both hemiarthroplasty and internal fixation have comparable functional outcomes [58]. To this date, there are no levels-I studies comparing arthroplasty to internal fixation in the relatively young adult.

Post-operative considerations

The postoperative recommendations are geared to lower the incidence of wound infection, deep vein thrombosis (DVT), and pulmonary embolism as well as to encourage mobilization. An antibiotic regimen with a first generation cephalosporin is indicated for 24 h [59]. The patients should be placed on DVT prophylaxis for thirty days with a pharmacologic agent such as low molecular weight heparin [60]. Physiotherapy should not be delayed and patients should be encouraged to mobilize with no restriction on range of motion of the hip. The patients are usually subject to toe-touch weight bearing with a walker or crutches for 12 week until the fracture is healed. They are then progressed to full weight bearing as tolerated. The patient should follow-up in 10-14 d post-operatively to assess the wound for infection and to assess the stability of the fixation construct. Follow up visits are indicated at six weeks and three months to assess for clinical and radiologic signs of non-union, osteonecrosis and hardware failure.

Conclusion

The role of conservative management in relatively young patients with femoral neck fracture is limited to patients who are medically unfit; we recommend treating displaced femoral neck fracture on an urgent basis; we do not recommend the routine use of capsulotomy for femoral neck fractures given the lack of evidence to support the development of osteonecrosis from intracapsular hematoma; we recommend the treatment of Garden I-II fracture with compressive screws and Garden III-IV with a dynamic hip screw and the addition of a derotational screw for Pauwels type III fractures.

References

1. Karagas MR, Lu-Yao GL, Barrett JA, Beach ML, Baron JA. Heterogeneity of hip fracture: age, race, sex, and geographic patterns of femoral neck and trochanteric fractures among the US elderly. Am J Epidemiol. 1996;143:677–82.
2. Chammout GK, Mukka SS, Carlsson T, Neander GF, Stark AW, Skoldenberg OG. Total hip replacement versus open reduction and internal fixation of displaced femoral neck fractures: a randomized long-term follow-up study. J Bone Joint Surg Am. 2012;94:1921–8.
3. Ly TV, Swiontkowski MF. Treatment of femoral neck fractures in young adults. J Bone Joint Surg Am. 2008;90:2254–66.

4. Girard J, Glorion C, Bonnomet F, Fron D, Migaud H. Risk factors for revision of hip arthroplasties in patients younger than 30 years. Clin Orthop Relat Res. 2011;469:1141–7.
5. Gerber C, Strehle J, Ganz R. The treatment of fractures of the femoral neck. Clin Orthop Relat Res. 1993; 292:77–86.
6. Askin SR, Bryan RS. Femoral neck fractures in young adults. Clin Orthop Relat Res. 1976;(114):259–64.
7. Yang JJ, Lin LC, Chao KH, Chuang SY, Wu CC, Yeh TT, Lian YT. Risk factors for nonunion in patients with intracapsular femoral neck fractures treated with three cannulated screws placed in either a triangle or an inverted triangle configuration. J Bone Joint Surg Am. 2013;95:61–9.
8. Karantana A, Boulton C, Bouliotis G, Shu KS, Scammell BE, Moran CG. Epidemiology & outcome of fracture of the hip in women aged 65 years & under: a cohort study. J Bone Joint Surg Br. 2011;93:658–64.
9. Talboys R, Pickup L, Chojnowski A. The management of intracapsular hip fractures in the 'young elderly' internal fixation or total hip replacement? Acta Orthop Belg. 2012;78:41–8.
10. Hedstrom M. Are patients with a nonunion after a femoral neck fracture more osteoporotic than others? BMD measurement before the choice of treatment? A pilot study of hip BMD and biochemical bone markers in patients with femoral neck fractures. Acta Orthop Scand. 2004;75:50–2.
11. Zlowodzki M, Brink O, Switzer J, Wingerter S, Woodall J, Petrisor BA, Kregor PJ, Bruinsma DR, Bhandari M. The effect of shortening and varus collapse of the femoral neck on function after fixation of intracapsular fracture of the hip: a multi-centre cohort study. J Bone Joint Surg Br. 2008;90:1487–94.
12. Adelani MA, Keeney JA, Palisch A, Fowler SA, Clohisy JC. Has total hip arthroplasty in patients 30 years or younger improved? A systematic review. Clin Orthop Relat Res. 2013;471:2595–601.
13. Davidovitch RI, Jordan CJ, Egol KA, Vrahas MS. Challenges in the treatment of femoral neck fractures in the nonelderly adult. J Trauma. 2010;68:236–42.
14. Al-Ani AN, Neander G, Samuelsson B, Blomfeldt R, Ekström W, Hedström M. Risk factors for osteoporosis are common in young and middle-aged patients with femoral neck fractures regardless of trauma mechanism. Acta Orthop. 2013;84:54–9.
15. Robinson CM, Court-Brown CM, McQueen MM, Christie J. Hip fractures in adults younger than 50 years of age. Epidemiology and results. Clin Orthop Relat Res. 1995;(312):238–46.
16. Xiao J, Yang XJ, Xiao XS. DSA observation of hemodynamic response of femoral head with femoral neck fracture during traction: a pilot study. J Orthop Trauma. 2012;26:407–13.
17. Sevitt S, Thompson RG. The distribution and anastomoses of arteries supplying the head and neck of the femur. J Bone Joint Surg Br. 1965;47:560–73.
18. Tornetta P, Kain MS, Creevy WR. Diagnosis of femoral neck fractures in patients with a femoral shaft fracture. Improvement with a standard protocol. J Bone Joint Surg Am. 2007;89:39–43.
19. Riemer BL, Butterfield SL, Ray RL, Daffner RH. Clandestine femoral neck fractures with ipsilateral diaphyseal fractures. J Orthop Trauma. 1993;7:443–9.
20. Wolinsky PR, Johnson KD. Ipsilateral femoral neck & shaft fractures. Clin Orthop Relat Res. 1995;(318):81–90.
21. Collinge CA, Mir H, Reddix R. Fracture morphology of high shear angle "vertical" femoral neck fractures in young adult patients. J Orthop Trauma. 2014;28:270–5.
22. Gill SK, Smith J, Fox R, Chesser TJ. Investigation of occult hip fractures: the use of CT and MRI. Scientific World J. 2013;8:303-19.
23. Garden RS. Low-angle fixation in fractures of the femoral neck. J Bone Joint Surg Br. 1961;43:647–63.
24. Van Embden D, Rhemrev SJ, Genelin F, Meylaerts SA, Roukema GR. The reliability of a simplified Garden classification for intracapsular hip fractures. Orthop Traumatol Surg Res. 2012;98:405–8.

25. Upadhyay A, Jain P, Mishra P, Maini L, Gautum VK, Dhaon BK. Delayed internal fixation of fractures of the neck of the femur in young adults. A prospective, randomised study comparing closed and open reduction. J Bone Joint Surg Br. 2004;86:1035–40.
26. Raaymakers EL. The non-operative treatment of impacted femoral neck fractures. Injury. 2002;33 Suppl 3:8–14.
27. Kuner EH, Lorz W, Bonnaire F. Femoral neck fractures in adults: joint sparing operations. I. Results of an AO collective study with 328 patients. Unfallchirurg. 1995;98:251–8.
28. Jain R, Koo M, Kreder HJ, Schemitsch EH, Davey JR, Mahomed NN. Comparison of early & delayed fixation of subcapital hip fractures in 60 years of age or less. J Bone Joint Surg Am. 2002;84:1605–12.
29. Karaeminogullari O, Demirors H, Atabek M, Tuncay C, Tandogan R, Ozalay M. Avascular necrosis and nonunion after osteosynthesis of femoral neck fractures: effect of fracture displacement and time to surgery. Adv Ther. 2004;21:335–42.
30. Razik F, Alexopoulos AS, El-Osta B, Connolly MJ, Brown A, Hassan S, Ravikumar K. Time to internal fixation of femoral neck fractures in patients under sixty years--does this matter in the development of osteonecrosis of femoral head? Int Orthop. 2012;36:2127–32.
31. Lowe JA, Crist BD, Bhandari M, Ferguson TA. Optimal treatment of femoral neck fractures according to patient’s physiologic age: an evidence-based review. Orthop Clin North Am. 2010;41:157–66.
32. Petrie J, Sassoon A, Haidukewych GJ. When femoral fracture fixation fails: salvage options. Bone Joint J. 2013;95-B:7–10.
33. Garden RS. Malreduction and avascular necrosis in subcapital fractures of the femur. J Bone Joint Surg Br. 1971;53:183–97.
34. Watson JR. Fracture of the neck of the femur. British J Surg.1936;23:787.
35. Molnar RB, Routt ML. Open reduction of intracapsular hip fractures using a modified Smith-Petersen surgical exposure. J Orthop Trauma. 2007;21:490–4.
36. Leadbetter GW. A treatment for fracture of the neck of the femur. J Bone Joint Surg. 1938;20:108-13.
37. Whittle P. Fractures of lower extremity. In:Cannale T, Beaty JH. Campbell’s operative orthopaedics.11th ed. Philadelphia: Mosby Elsevier. 2008. pp 2214.
38. Beck M, Siebenrock KA, Affolter B, Nötzli H, Parvizi J, Ganz R. Increased intraarticular pressure reduces blood flow to the femoral head. Clin Orthop Relat Res. 2004;(424):149–52.
39. Maruenda JI, Barrios C, Gomar-Sancho F. Intracapsular hip pressure after femoral neck fracture. Clin Orthop Relat Res. 1997;(340):172–80.
40. Zhou L, Tan J, Xu B. Treatment of femoral neck fracture with cannulated screw fixation in young adults. Zhongguo Xiufu Chongjian Waike Zazhi. 2007;21:275–7.
41. Watson A, Zhang Y, Beattie S, Page RS. Prospective randomized controlled trial comparing dynamic hip screw & screw fixation for undisplaced subcapital hip fractures. ANZ J Surg. 2013;83:679–83.
42. Bonnaire FA, Weber AT. Analysis of fracture gap changes, dynamic and static stability of different osteosynthetic procedures in the femoral neck. Injury. 2002;33 Suppl 3:C24–32.
43. Babak S, Arash A. A comparative study between multiple cannulated screws and dynamic hip screw for fixation of femoral neck in adults. Intern orthop. 2015;39:2069-71.
44. Aminian A, Gao F, Fedoriw WW, Zhang LQ, Kalainov DM, Merk BR. Vertically oriented femoral neck fractures: mechanical analysis of four fixation techniques. J Orthop Trauma. 2007;21:544–8.
45. Filipov O. Biplane double-supported screw fixation (F-technique): a method of screw fixation at osteoporotic fractures of the femoral neck. Eur J Orthop Surg Traumatol. 2011;21(7):539543.
46. Burns BH, Young RH. Early movement in the treatment of closed fractures. Lancet. 1944;243(6301):723-5.
47. Kuntscher G. Fully automatic nailing of the femoral neck. Z Orthop Ihre Grenzgeb. 1953;84(1):17- 28.

48. Von Bahr V, Syk B, Walheim G. Osteosynthesis of femoral neck fracture using screws. Acta Chir Scand. 1974;140(4):277-82.
49. Walker E, Mukherjee DP, OgdenAL, Sadasivan KK, Albright JA. A biomechanical study of simulated femoral neck fracture fixation by cannulated screws: effects of placement angle and number of screws. Am J Orthop (Belle Mead NJ). 2007;36(12): 680-4.
50. Aisns SE, Wanek-Sgaglione L. Intracapsular fractures of the femoral neck. Results of cannulated screw fixation. J Bone Joint Surg. 1994;76(12):1793–803.
51. Gjertsen JE, Vinje T, Engesaeter LB, Lie SA, Havelin LI, Furnes O, Fevang JM. Internal screw fixation compared with bipolar hemiarthroplasty for treatment of displaced femoral neck fractures in elderly patients. J Bone Joint Surg Am. 2010;92:619–28.
52. Martyn P, Hans WS: Aesculap Orthopaedics Targon® FN September, 2007.
53. Mir H, Collinge C. Application of a medial buttress plate may prevent many treatment failures seen after fixation of vertical femoral neck fractures in young adults. Med Hypotheses. 2015;84(5):429-33.
54. Mir HR, Edwards P, Sanders R, Haidukewych G. Results of cephallomedullary nail fixation for displaced intracapsular femoral neck fractures. J Orthop Trauma. 2011;25(12):714-20.
55. Avery PP, Baker RP, Walton MJ, Rooker JC, Squires B, Gargan MF, Bannister GC. Total hip replacement and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck: a seven- to ten-year follow-up report of a prospective randomised controlled trial. J Bone Joint Surg Br. 2011;93:1045–8.
56. Baker RP, Squires B, Gargan MF, Bannister GC. Total hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. J Bone Joint Surg Am. 2006;88:2583–9.
57. Keating JF, Grant A, Masson M, Scott NW, Forbes JF. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. J Bone Joint Surg Am. 2006;88:249–60.
58. Parker MJ, Pryor G, Gurusamy K. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures: a long-term follow-up of a randomised trial. Injury. 2010;41:370–3.
59. Gillespie WJ, Walenkamp GH. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. Cochrane Database Syst Rev. 2010;(3):CD000244.
60. Barrera LM, Perel P, Ker K, Cirocchi R, Farinella E, Morales Uribe CH. Thromboprophylaxis for trauma patients. Cochrane Database Syst Rev. 2013;3:CD008303.