https://doi.org/10.48047/AFJBS.6.2.2024.3391-3398

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Management of Unstable Pertrochanteric Femoral Fractures in Elderly: An Article Review

Rami Hashem Abdou Ragheb, El-Sayed El-Etewy Soudy, Ahmed Elsayed Ahmed El-Malt, Islam Sameeh Abdel-Fattah Othman

Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt

Corresponding Author: Rami Hashem Abdou Ragheb

Email: Dr.rami93@gmail.com

Article History

Volume 6, Issue 2, Apr-Aug 2024

Received: 1 August 2024

Accepted: 15 August 2024

Published: 20 August 2024

doi: 10.48047/AFJBS.6.2.2024.3391-3398

Abstract: Aim: Pertrochanteric fractures comprise approximately 50 % of all proximal femur fractures and occur in an older patient population than do femoral neck fractures. A direct relationship between age and the severity of pertrochanteric fractures has also been identified. As patients age, their risk of sustaining unstable and comminuted pertrochanteric fractures increases. Injuries associated with low-energy pertrochanteric fractures include distal radius, proximal humerus, and other fragility fractures. Injuries associated with high-energy pertrochanteric fractures often included acetabular and ipsilateral extremity fractures. The goal of treatment of pertrochanteric fractures is to restore, within the shortest possible time, the pre-injury level of independence and function with no treatment-related complications.

Keywords: *Pertrochanteric Femoral Fractures ; Elderly; Surgical Management.*

Introduction

Fractures occurring in the region of the hip are divided into intracapsular (the region from the femoral head to the attachment of the hip joint capsule at the base of the femoral neck) and extracapsular fractures (distal to the joint capsule). Extracapsular fractures are further subdivided into pertrochanteric (intertrochanteric) fractures, involving the region extending from the extracapsular basilar neck region distally to the lesser trochanter before the development of the medullary canal, and subtrochanteric fractures that occur in the region extending from the lesser trochanter to 5 cm distally in the femoral diaphysis [(1)].

Pertrochanteric fractures have been categorized by many including Evans, Ramadier, Ender, Boyd and Griffin, and the AO/OTA. The two most commonly used classification systems are those of Evans and AO/OTA [(2)]. Compared with other pertrochanteric fracture classification systems, the commonly utilized AO/OTA classification system is both reliable and reproducible [(3)].

The risk factors predisposing patients to these injuries. In general, age, gender, race, medical comorbidities, and bone density have all been consistently shown to be risk factors for fracture [(4)]. Medical comorbidities, such as syncope, secondary to cardiovascular or neurologic disease, have also been noted to be a common underlying etiology of low-energy falls resulting in hip fractures [(5)].

Operative success may be defined by obtaining these and many other benchmarks goals of treatment. With every case, the treating surgeon is provided the responsibility to formulate and execute an effective treatment plan in a timely and comprehensive fashion. All of this is
done to maximize the clinical outcomes of pertrochanteric fracture patients both at the time of injury and throughout their lifetime [2].

1. **Non-operative Treatment:**

Non-operative treatment of pertrochanteric fractures can be considered in non- ambulatory, demented, and terminally ill patients as well as in those with recalcitrant complex medical comorbidities. Successful non-operative treatment requires an effective multidisciplinary team with particular attention paid to scheduled patient repositioning to avoid decubitus ulcers, nutrition and fluid balance, as well as pain control. Despite careful management, non-operative treatment often results in serious morbidity. Parker et al. noted that conservative treatment of extracapsular hip fractures is associated with femoral shortening, prolonged hospital stay, and loss of functional independence [6].

2. **Operative Treatment of Pertrochanteric Fractures:**

The goal of any treatment plan is to eliminate pain and to return the patient to his or her pre-injury level of function. As such, operative treatment is indicated for all patients with pertrochanteric fractures that were previously ambulatory, without dementia, and do not have significant medical comorbidities precluding operative treatment [7].
Operative options can be categorized into two main groups: internal fixation and arthroplasty [7]. The internal fixations are usually considered as prior options for treatments that can enable the patient to have postoperative early mobilization, good functional recovery and less complications [8].
Evidence from numerous studies has demonstrated that surgery should be performed as soon as possible after judicious medical optimization within a reasonable timeframe (i.e., within 36–48 hours). Surgical delays for extensive medical workup are associated with increased 30day and 1year mortalities, prolonged hospitalization, and complications from immobilization (e.g., venous thromboembolism, atelectasis, pneumonia, pressure sores, and urinary tract infections) [9]. However, timing of definitive fixation in the polytraumatized patient requires special consideration [7].

- ***Fixation***

Extramedullary fixation includes dynamic hip screw (DHS), compression hip screw (CHS), percutaneous compression plate (PCCP), Medoff sliding plate, and less invasive stabilization system (LISS) and intramedullary fixation includes (Gamma nail, proximal femoral nail (PFN), and proximal femoral nail anti-rotating (PFNA)). Generally, intramedullary fixation is a valuable alternative method for patients with intertrochanteric fractures, which could be associated with lower levels of operation time, blood loss, and tissue damage [5]. Extra-medullary fixation is the oldest and includes blade plate, fixed angle nail plate, sliding nail plate, sliding hip screw, and locking plate fixation constructs [11].

- ***Sliding Hip Screw***

Originally developed in 1950, the sliding hip screw is indicated for intertrochanteric hip fractures and was largely thought to be the gold standard for treatment of these injuries **(Fig. 1)**. These devices allow dynamic interfragmentary compression at the fracture site.

Available plate angles range from 130 to 150 degrees. The steeper angle allows for better sliding characteristics, while lower angles are more anatomic. Thus, most surgeons tend to choose 130 or 135 degree side plates [12].

More recent literature shows equivocal outcomes when treating stable fractures with these implants compared to cephalomedullary nails. While they require an open technique and are associated with a higher estimated blood loss, the surgical approach spares the hip abductors, and they are the lowest cost implants available for treatment of stable intertrochanteric hip fractures. Today, these implants are reserved for the most stable fracture patterns as a cost saving measure [13].

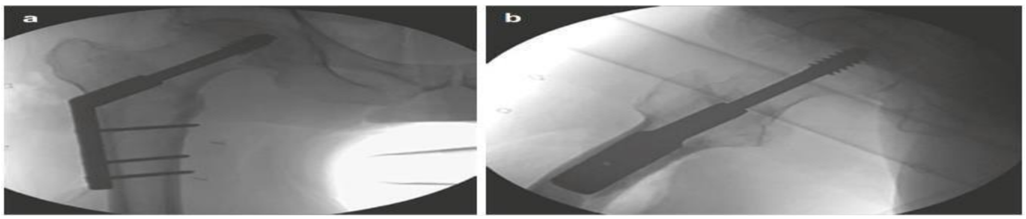

Figure (1): An 80 year old male sustained a stable right intertrochanteric hip fracture. AP (**a**) and lateral (**b**) radiographs of a left hip demonstrate treatment with a sliding hip screw. The lag screw is placed central and deep [13].

- ***Medoff Sliding Plate:***

The Medoff sliding plate serves as a modification of the sliding hip screw and is composed of two interdigitating femoral plates and a lag screw. These implants can be used for the management of unstable fractures. In addition to allowing dynamic compression along the axis of the femoral neck, these devices also provide dynamic compression along the axis of the femoral shaft. This implant has been replaced by the use of intramedullary nails in the case of an unstable fracture pattern [14].

- ***Lateral Trochanteric Stabilizing Plate:***

The lateral trochanteric stabilizing plate is another modification of the sliding hip screw which provides additional support for the disrupted lateral femoral wall. It is composed of a lateral (side) plate that clips to a standard sliding hip screw to buttress an incompetent lateral wall and greater trochanter **(Fig. 2)**.It helps diminish excessive slide seen in unstable patterns by providing a "metal lateral wall." This device can also be used as a reconstructive adjunct for fractures of the greater trochanter [14].

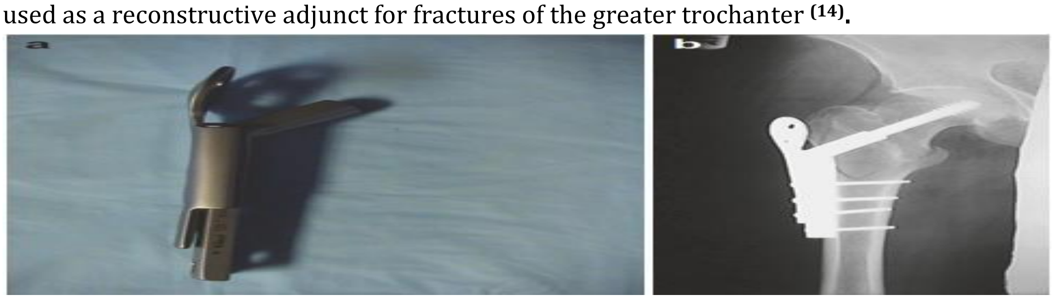

Figure (2): (**a**) Side profile of a lateral trochanteric stabilizing plate (TSP) attached to a standard barrel hip screw side plate. (**b**) AP radiograph of a right hip demonstrating treatment of a pertrochanteric hip fracture with lateral wall incompetence with a TSP [14].

Intramedullary Nails:

Intramedullary fixation is newer and has become more popular for the treatment of pertrochanteric fractures. Theoretically, intramedullary devices have the advantage of more efficient load transfer due to its proximity to the medial calcar compared to extramedullary implants as well as less implant strain because of its closer positioning to the mechanical axis of the femur resulting in a shorter lever arm. Several studies have noted a clinical advantage of intramedullary fixation over extramedullary fixation for the treatment of pertrochanteric fractures [15].

- ***Cephalomedullary Nail***

Cephalomedullary nails became widely available in the 1980s and have undergone extensive design modifications since that time. Earlier implant designs were associated with femur fractures around the tip of the nail or distal interlocking screw insertion point, extrusion of the head screw (i.e., screw-cutout), and breakage of the implant **(Fig. 3)**. There has been a significant increase in the use of cephalomedullary nails in the last decade and a half. With the modern cephalomedullary nail designs, equivalent outcomes have been demonstrated when compared to sliding hip screws for treating stable fracture patterns [16].

These devices come in several options, varying in nail length and diameter, static or dynamic distal locking, or uniaxial versus biaxial proximal fixation. Compared to sliding hip screws, these implants can be placed percutaneously and as such have a lower estimated intraoperative blood loss. However, they are more costly, and the surgical approach violates the hip abductors [16].

In general, the indications for a short cephalomedullary nail are intertrochanteric hip fractures and basicervical femoral neck fractures. A long cephalomedullary nail is indicated in pathologic fractures, metabolic bone disease, and fracture extension >3 cm below the lesser trochanter [14].

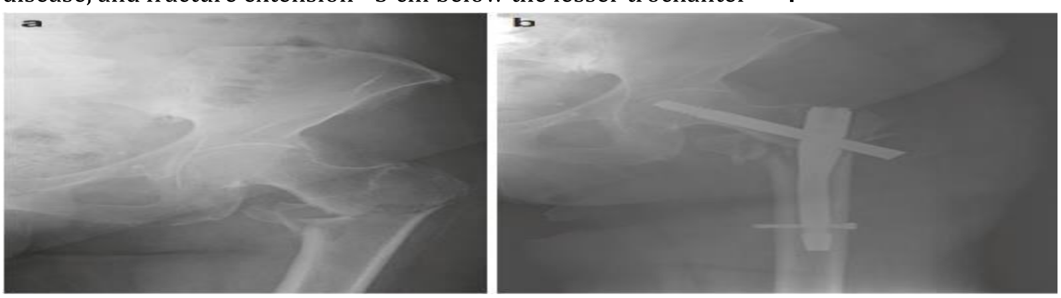

Figure (3): (**a**) AP radiograph of a left hip demonstrating an unstable intertrochanteric hip fracture. The posteromedial cortex is comminuted. (**b**) AP radiograph after treatment with a short cephalomedullary nail. Note the amount of fracture impaction or "slide" with this unstable pattern [14].

It was previously thought that short nails provided inadequate fixation of the diaphysis compared to long nails (e.g., in the case of subtrochanteric fracture extensions); additionally, stress risers present at the tip of the short nails may pose a risk of developing future stress fractures, especially in osteoporotic bone. Long cephalomedullary nails are more expensive devices and require a longer operation (secondary to distal intramedullary reaming that is not necessary when inserting short nails). There have been extensive studies comparing short and long cephalomedullary nails and the consensus is that there is no significant difference in the development of complications (i.e., periprosthetic fractures about the nail tip) or functional outcome [17].

Intramedullary fixation is generally indicated for operative treatment of unstable pertrochanteric fractures (AO/OTA 31-A2.2, 31-A2.3, and 31-A3 fractures). Intramedullary fixation may also be utilized in stable fractures (AO/OTA 31-A1 and 31-A2.1 fractures) though there does not seem to be an advantage when compared with extramedullary fixation. There are many factors to evaluate when selecting the optimum intramedullary fixation construct. These include, but are not limited to proximal nail diameter, lateral bend, distal nail diameter, neck-shaft angle, length, and the nail's radius of curvature as well as the proximal sliding screw and distal locking screw design [18].

Haidukewych [19] advised surgeons to be wary of the radius of curvature when performing fixation with intramedullary nails as iatrogenic anterior femoral impingement or fracture can occur with mismatched femoral and intramedullary nail radii of curvature.

De Landevoisin Soucanye et al. [20] concluded that intramedullary nailing with a helical blade may confer additional benefit in treatment of pertrochanteric fractures, particularly amongst osteoporotic patients as the design of the helical blade prevents rotation and results in compaction of cancellous bone. **Gallagher et al.** [21] found that distal locking of intramedullary nail constructs increased rotational load to failure, indicating a stronger construct.

Complications:

1- ***Lag Screw Cut-Out:***

Lag screw cut-out is the most common complication after surgical treatment of intertrochanteric hip fractures and usually occurs within the first 3 months postoperatively. The incidence is 1–3%. Lag screw cut-out may occur as one of two forms: superior screw cut- out or medial screw migration **(Fig. 4)**. Superior screw cut-out is attributed to inadequate reduction of the fracture resulting in poor (eccentric) placement of the lag screw (e.g., superiorly within the femoral head) as well as a TAD >25 mm [22].

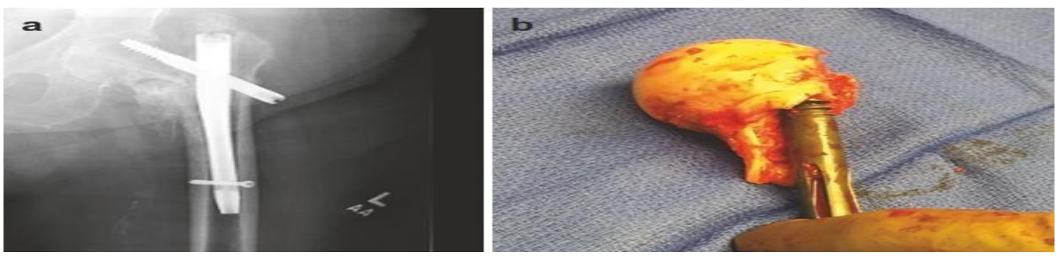

Figure (4): (**a**) AP radiograph of a left hip demonstrating superior lag screw cut-out following treatment of a pertrochanteric hip fracture with a short cephalomedullary nail. (**b**) Clinical demonstration of the superior lag screw cut-out in this patient [14].

2- ***Nonunion:***

Fracture nonunion after pertrochanteric hip fractures occurs less commonly compared to femoral shaft or subtrochanteric fractures, at a rate of ~2%. Persistence of hip pain and lucency about the fracture site 4–7 months after surgical fixation should rise concern for nonunion. Removal of the distal locking screw and nail dynamization to facilitate fracture union may be employed for initial treatment **(Fig. 5)**. A persistent nonunion should be addressed by revision fixation with bone grafting (in younger patients with adequate bone stock) or conversion to arthroplasty (in elderly patients with osteoporotic bone) [23].

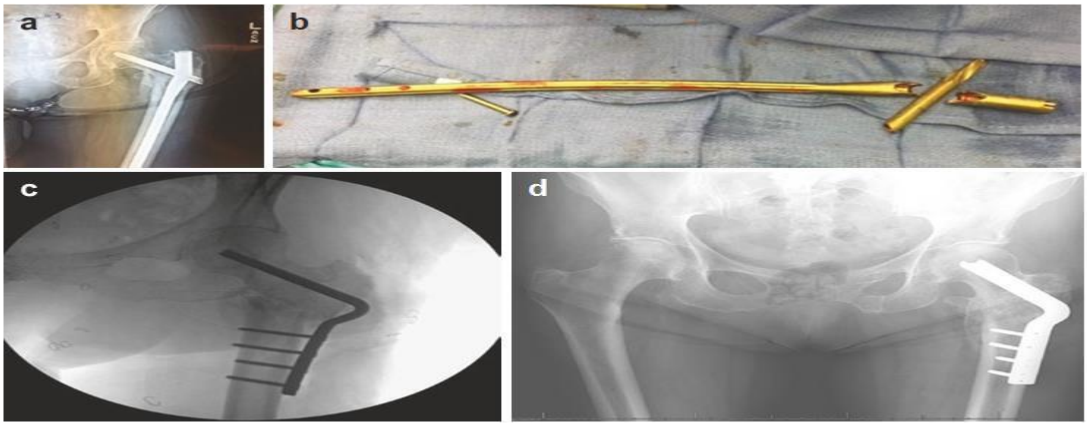

Figure (5): An 80-year-old female who is one year status post treatment of a pertrochanteric hip fracture with a long IM Nail. (**a**) AP radiograph demonstrating fracture nonunion with hardware failure. (**b**) Intraoperative photo demonstrating nail failure at the lag screw hole. (**c**) AP intraopera- tive radiograph following osteotomy and nonunion repair with a blade plate. (**d**) AP pelvis radio- graph at 1 year following nonunion repair. There is complete union and an excellent clinical result [14].

3- *Fracture-Related Infection*

The incidence of a wound infection after treatment of a pertrochanteric hip fracture is about 1% [14]. The incidence of delayed peri-implant fracture is ~0.1% for sliding hip screws and 0.5–1% for cephalomedullary nails. Earlier nail designs were associated with much higher rates (up to 10%) of fractures at the tip of the nail; however, advancements in nail designs have significantly reduced the incidence to rates comparable to that of sliding hip screws. A peri-implant fracture may be addressed with exchange to a long nail (i.e., if it occurs around a short nail) or with overlapping plate fixation [23].

Anterior perforation of the distal femur, particularly with long cephalomedullary nails, is another form of peri-implant fracture. Historically, impingement or perforation of the anterior femoral cortex was of particular concern due to a mismatch between the radius of curvature of the femur (shorter radius of curvature) and the implant (longer radius of curvature). Modern implant designs have mitigated this potential complication by reducing the radius of curvature such that it closely matches that of the femur [23].

4- *Avascular Necrosis of the Femoral Head*

Femoral head avascular necrosis following pertrochanteric hip fractures is much lower than after a femoral neck fracture given the extracapsular location of the intertrochanteric region. The incidence is 1–2%. This complication may be observed if the patient is asymptomatic, otherwise arthroplasty is the definitive treatment [14].

Arthroplasty

Arthroplasty is typically reserved as a salvage procedure for unsuccessful primary fixation of pertrochanteric fractures. However, arthroplasty as the primary treatment for pertrochanteric

fractures has been shown to have satisfactory results in selected patients with osteoporosis and comminuted fracture patterns. **Kim et al.** found no differences in functional outcomes, hospital stay, complications, and time to weight-bearing in their comparison study of hemiarthroplasty versus intramedullary fixation for the treatment of AO/OTA 31-A2 fractures [24].

Primary bipolar hemiarthroplasty (BPH) has been advocated as an alternative to osteosynthesis for IFF in the elderly, as it provides the advantages of permitting early full- weight bearing, avoiding the failures of osteosynthesis and good functional outcomes. However, subsidence and failure rates are significant, especially in cases that have postero- medial comminution. Use of cement may be associated with increased intra-operative or post- operative morbidity and mortality [25].

Because these fractures tend to involve the greater and lesser trochanters, replacement arthroplasty for pertrochanteric (i.e., extracapsular) hip fractures is generally only indicated when there is severe, preexisting symptomatic hip arthritis in the setting of a hip fracture, as a salvage for failed internal fixation, or in the setting of severely osteoporotic bone [26].

Historically, a long stem cemented hemiarthroplasty was most commonly used (in conjunction with cerclage wires about the proximal femur) and a calcar replacing prosthesis was often necessary due to the level of these fractures. With the advent of modern arthroplasty implant designs, pertrochanteric fractures are more commonly managed today with long, tapered stems with distal flutes that allow for improved diaphyseal fixation. Replacement arthroplasty is associated with increased blood loss and the need for blood transfusion. This procedure also carries the added risk of postoperative prosthetic hip dislocation [27].

Primary arthroplasty can be technically demanding; primarily due to the need for a calcar replacing prosthesis, secondarily due to potential complications in greater trochanter fragment reattachment and any resulting hip abductor weakness [28].

Conclusion:

Unstable trochanteric fractures are challenging with a high rate of implant failure and re- operation. Cephalomedullary nails proved to be a rational management choice for these injuries, yet other management options have not been well assessed.

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