FRACTURES ABOUT THE HIP

When femoral fracture fixation fails

SALVAGE OPTIONS

Most hip fractures treated with modern internal fixation techniques will heal. However, failures occasionally occur and require revision procedures. Salvage strategies employed during revision are based on whether the fixation failure occurs in the femoral neck, or in the intertrochanteric region. Patient age and remaining bone stock also influence decision making. For fractures in young patients, efforts are generally focused on preserving the native femoral head via osteotomies and repeat internal fixation. For failures in older patients, some kind of hip replacement is usually selected. Disuse osteopenia, deformity, bone loss, and stress-risers from previous internal fixation devices all pose technical challenges to successful reconstruction. Attention to detail is important in order to minimise complications. In the majority of cases, good outcomes have been reported for the various salvage strategies.

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The number of hip fractures continues to increase, and although the vast majority will heal, failures occasionally occur and require revision. This review will address both the avoidance of failure and the options for treatment when failure occurs, including revision, open reduction and internal fixation (ORIF), osteotomy, and joint replacement. The selection of a particular salvage procedure in these circumstances depends primarily on patient activity and fracture location. Any discussion of salvage options depends on the age of patients, and whether the fracture occurs in the femoral neck or intertrochanteric region.

Failure prevention

Outcomes of treating fractures of the femoral neck are related to fracture displacement, patient age, and quality of reduction. For the older patient with a displaced fracture of the femoral neck, choosing the most appropriate initial operation can minimise the need for revision surgery. It is believed a high proportion of displaced fractures of the femoral neck in older individuals treated with ORIF will fail. These fractures are better addressed by some form of hip replacement, which have lower rates of re-operation when compared with ORIF. Ten-year data on cemented hemiarthroplasty describes a rate of survivorship of 94% free of re-operation for any reason, whereas the rate of failure would have been nearly ten times higher if internal fixation was performed in this cohort. Recent data suggests a lower re-operation rate and fewer implant-related complications for cemented versus uncemented hemiarthroplasty, with similar rates of mortality at up to 19 years’ follow-up.

When deciding between total hip replacement (THR) and hemiarthroplasty, the condition of the acetabular articular cartilage and patient age are the main factors considered by the senior author (GJH). In patients aged > 80 years with normal appearance of their acetabular articular cartilage, a cemented hemiarthroplasty is preferred. In most other instances the senior author uses a THR. In an active, elderly population, despite a higher dislocation rate, THR patients score significantly higher on patient outcomes when compared with patients with a hemiarthroplasty. A national database study has shown that, over time, the in-hospital dislocation rates after THR relating to a fracture of the femoral neck have approached those following elective THR. Other factors to consider include the functional and cognitive abilities of the patient and the presence of antecedent hip pain prior to fracture.

Younger patients with displaced fractures of the femoral neck present several challenges. If the fracture is reduced anatomically and stable fixation is obtained, the outcomes are predominantly good. In a recent study evaluating the survivorship of the hip in young patients with...
Fractures of the femoral neck, avascular necrosis (AVN) and nonunion rates were low for well-reduced fractures.14 The selection of the type of fixation is important in younger patients, because many if not most of the fracture patterns have a relatively vertical configuration. The Pauwels’ classification14 can help guide treatment and implant selection. The higher the shear angle, the more likely the fixation will fail if the load is not shared with the bone and the device is not in some way cantilevered to share loads.15 With a vertical fracture line, the calcar does not offer enough support to prevent the femoral head from shearing and displacing into varus. The authors prefer a sliding hip screw in the management of these fractures, as the barrel and side plate help to neutralise shear across the femoral neck. Additionally, a supplementary anti-rotational screw is often used to help prevent torque and hence rotational malalignment during lag screw insertion.

Intertrochanteric fracture fixation has a potential for failure as well, and as with femoral neck fractures, reduction and implant selection are important. If a fracture is returned to an anatomical position and supported with appropriate hardware, it is very unlikely that the fixation will fail. Sliding hip screw devices are still used, however, there has been a huge increase in the popularity of cephalomedullary nails. Intramedullary fixation performs better than plate-based devices in situations where the lateral femoral wall is fractured, or in fractures with reverse obliquity, subtrochanteric extension, or large posteromedial fragments (Fig. 1).4,16 Understanding these radiological features of unstable fractures is essential in implant selection. Fixation into the femoral head, whether associated with a side plate or a nail, should be centred in both planes. The ‘tip to apex’ distance has been described as a method to quantify a deep and central position of the lag screw in the femoral head, and should be used as a guideline in these instances.3

Salvage of fixation failure
Following failure of fixation in young patients with fractures of the femoral neck, efforts should be focused on saving the native femoral head. Valgus intertrochanteric osteotomies are useful in retrieving failures associated with vertical femoral neck fractures (Fig. 2). This technique converts a high shear-angle fracture into a more horizontal configuration, which encourages compression forces across the ununited fracture site, facilitating healing with impressive rates of union reported.17 Pedicle grafts of various types are generally used in developing countries where it is thought delayed presentations of fractures of the femoral neck in young patients are common.

Failed fixation of fractures of the femoral neck in older patients is best treated with either THR or hemiarthroplasty, both of which have been shown to be effective.18,19 A key technical point for either procedure is to be aware of severe osteopenia. Some patients present following an extended period of time during which they were not walking. In these circumstances an uncemented acetabular component should be supported with supplementary screw fixation. On the femoral side the authors prefer collared, extensively coated uncemented stems, because they can be effective even in cases with compromised, osteopenic proximal bone stock. Occasionally, a cemented femoral stem is chosen. A high-speed burr can be useful in removing sclerotic tracks from prior screws that can otherwise deflect a broach and cause fractures in weak bone.

Failure of fixation of intertrochanteric fractures in young patients is exceedingly rare. Revision through ORIF preserves the native femoral head. Plates with 95° blades are very useful because they target bone in the inferior portion of the femoral head, which typically has not been violated by prior fixation devices. It is important to avoid a varus malreduction and obtain stable fixation of the proximal fragment.

Radiographs of a 66-year-old woman who was struck by a car while riding a scooter a) at presentation, showing an unstable intertrochanteric fracture of the right hip with subtrochanteric extension of the fracture and involvement of the lesser trochanter, b) intra-operatively, showing the fracture anatomically reduced with the aid of a bone clamp, and c) immediately following surgery, showing implantation of a long cephalomedullary nail that was locked distally.
Failure of fixation of intertrochanteric fractures in older patients is usually salvaged with some form of hip replacement. Lag screw cut-out has usually occurred and little proximal bone remains. Hemiarthroplasty and THR can both be effective, depending on the status of the acetabular articular surface. Hip replacement after intertrochanteric fixation failure presents several unique challenges. Typically, the calcar bone deficiency will be lower than the standard resection level for a primary THR, therefore, having ‘calcar replacing’ or modular stems may be necessary.

Additionally, one must bypass the most distal shaft stress riser by two diaphyseal diameters (about 6 cm), which necessitates longer femoral components (Fig. 3). The status of the greater trochanter is important; it can be malunited and occluding the intramedullary canal, or completely ununited. In cases where malunion prevents adequate preparation of the femur, a trochanteric slide technique, which maintains the continuity of the abductors and the vastus lateralis, can be useful. This facilitates removal of the overhanging trochanter as an obstacle during femoral preparation, which with its subsequent reattachment at the end of the case without compromising soft-tissue attachments, is important in maintaining hip stability. It is wise to dislocate the hip before removing any...
hardware to minimise the risk of iatrogenic fracture of the femoral shaft.

It can be difficult to determine the correct level of the femoral reconstruction, but restoring the relationship of the tip of the greater trochanter and the centre of femoral head rotation can provide a reasonable reference point. Careful intra-operative trialing and intra-operative radiographs are recommended. The authors generally favour uncemented fixation, either with extensively coated monobloc stems or with fluted, modular tapered titanium stems. The use of modular titanium, diaphyseal-engaging stems has facilitated management of several difficulties. By employing the diaphysis for fixation, the previously violated metaphysis is bypassed. Additionally, proximal malunions can be osteotomised without compromising fixation, even in capacious osteopenic canals. Finally, modularity allows fine-tuning of length and version, which can be difficult to assess initially during complex revisions. Published outcomes have demonstrated good survivorship with these techniques.

**Conclusion**

In summary, minimise failures and re-operations when treating patients with hip fractures by choosing the most appropriate operation for the right patient. If the fracture is anatomically reduced and the fixation device is implanted accurately, the rate of fixation failures will be low. For older patients with displaced fractures of the femoral neck, a hip replacement of some sort is a better choice than internal fixation.

When fixation failure occurs one must have effective, proven strategies for salvage. Young patients presenting with femoral neck failures usually have vertical nonunions, and repeat ORIF is probably a good tactic. Typically a valgus osteotomy is chosen to convert shear forces into compression and promote fracture healing. For older patients with femoral neck failures, THR is preferred. These patients often suffer from disuse osteopenia, which is an important consideration when selecting components.

For young patients with intertrochanteric failures, repeat ORIF is preferred. One might suggest supporting the inferior femoral head bone with a fixed angle device, such as a blade-plate. Finally, in older patients with intertrochanteric failures, hip replacement remains the best option. Femoral reconstruction in this setting presents many challenges, including stress risers, bone loss, and greater trochanteric malunion. Careful attention to indications, techniques, and avoiding common pitfalls is important for a logical, effective salvage strategy.

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**References**