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Educational Corner

Choosing Device in Intertrochanteric Fracture Based on AO/OTA Classification: Educational Corner

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Background

With the rising number of older adults suffering from osteoporosis, trochanteric fractures are on the rise. The hip fracture is perhaps the most prevalent problem orthopedic surgeons deal with. The goal of treating a spinal cord injury is to minimize surgical and medical complications in order to restore function. The key to these goals is achieving a stable reduction and fixation of the fracture, allowing immediate mobilization. Many methods are available for reduction and internal fixation. Despite this, complications remain common. In order to begin mobilization as early as possible after a trochanteric fracture, a stable internal fixation is generally accepted as being necessary.

In the past 25 years, intramedullary devices have become popular as an alternative to sliding hip screws (SHS) for treating intertrochanteric fractures. The key to a successful outcome is stabilization until fracture union. Preoperative planning before reconstruction of these fractures has been found to be essential, including i) Fracture geometry, ii) Bone quality, iii) Amount of comminution, and iv) Fracture extensions in nearby areas like neck femur or subtrochanteric extension.

For these fractures, there are a number of classification systems, but they all rely on the concept of stability. In unstable fractures, either due to comminution or because of oblique orientation (Reverse Oblique), or both, axial loading is associated with collapse. One of the most important modifiable factors in the treatment of intertrochanteric fractures is the quality of the reduction, regardless of the pattern of the fracture. Fractures with the patterns 31-A1.1 to 31-A2.1 tend to have stable reductions, but fractures with the patterns 31-A2.2 to 31-A3.3, which are characterized by mixed fragment patterns, have an unstable reduction (Figure 1).

Lateral involvement of the cortex is only a specific criterion for fractures in the 31-A3 group, and can have an impact in low-reduction cases when using an extramedullary SHS method (1).

Comparison of Devices

With respect to short nails, the costs of long nails and SHSs both are higher. The cost of intramedullary implants is 20-40 percent more expensive than that of SHSs; therefore, if both are appropriate, the less costly one should be chosen. Studies have suggested that extramedullary implants would be more cost-effective for A2 fractures, but they assumed that the failure rates of SHSs and nails were equivalent.

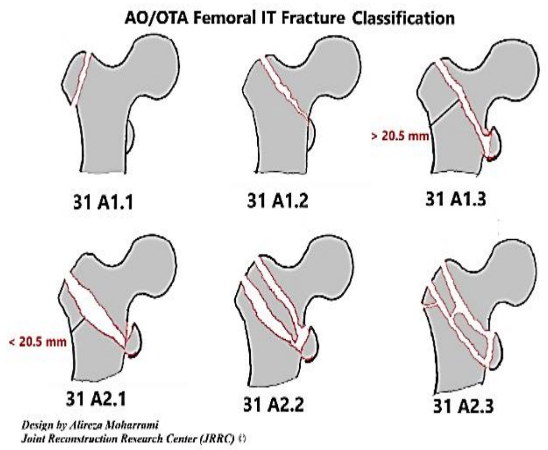

Figure 1. AO Classification for intertrochanteric fractures (1)

The periprosthetic fracture rate of first-generation intramedullary implants was higher, causing their cost to increase even further. There was a 4.5-fold increase in periprosthetic fracture risk in 1997 and a 1.87-fold increase in 2005, but now there is none.

The first-generation intramedullary implants were associated with an increased risk of periprosthetic fractures, increasing their already high costs. In 1997, periprosthetic fractures were 4.5 times more likely, which increased to 1.87 in 2005, and it does not exist anymore. As reported by Pajarinen et al. (2), intramedullary fixation improved mobility and reduced the shortening of the femoral neck, a finding that was in accordance with research results reported by Hardy et al. (3), who reported better early mobility, less sliding, and less discrepancy in leg lengths. A better early functional recovery can be achieved in those whose SHS slides less, suggesting that changes in the hip biomechanics can negatively affect mobility.

In a recent randomized controlled trial by Reindl et al. (4), the intramedullary group showed less shortening of the femoral neck, but the timed up and go (TUG) scores did not change significantly. The ability of a patient to tolerate malunion may be related to pre-injury function, but there is currently no reliable evidence to indicate this since studies tend to pool all patients. In one, two, or five years postoperatively, there is no significant difference between short and long nails in the rates of periprosthetic fracture (5, 6).

In a prospective randomized clinical trial by Kouvidis et al. (7), a SHS group (60 patients) and a biaxial intramedullary nail group (62 patients) showed no difference in outcomes (activities of daily living or mobility) at 1-year follow-up. There is only one study that suggests that biaxial fixation reduces the risk of periprosthetic fracture postoperatively compared to uniaxial fixation. While this review focused exclusively on periprosthetic fractures, no other outcome or complications were recorded, including those associated with biaxial fixation (8).

Stable Intertrochanteric Fractures (A1 to A2.1)

Current research on the management of these fractures shows little evidence of one device being superior to another. Following accurate reduction, stable fractures have direct contact with the cortex. SHS fixation after careful reduction is preferred at our institution.

Subtrochanteric and Reverse Oblique Fractures (A3)

Subtrochanteric and reverse oblique fractures are strongly supported by evidence for intramedullary fixation. Biomechanically, these fractures cannot be fixed with an SHS since the line of collapse is not parallel to the fracture line, and the lateral cortical buttress cannot resist collapse. Although trochanteric sliding plates (TSPs) provide improved stability, they are less reliable than intramedullary devices, which offer better functional outcomes. Proximal femoral locking plates are also associated with poorer results. An intramedullary nail's intramedullary position and an enlarged proximal end offer internal support against collapsing. The minimally invasive nature of the surgery preserves the vastus soft tissue envelope, ensuring stability and vascularity.

Unstable Intertrochanteric Fractures (A2.2 to A2.3)

For the treatment of these fractures, current guidelines recommend intramedullary devices (9). In unstable fractures lacking posteromedial or lateral cortical buttresses, where a SHS is used, a TSP may prevent excessive collapse. The results of a randomized prospective study comparing the impact of using a SHS (343 patients) to that of using an intramedullary nail (341 patients) to fix all intertrochanteric and subtrochanteric fractures showed no long-term differences at three and 12-month follow-up, but the intramedullary group improved mobility scores (10). TSPs were most frequently used for A3 fractures and optional for osteoporotic A1, A2 fractures whose lateral cortical buttress could not be determined. As a consequence of the equivalence of outcomes between these constructs, it is evident that maintaining good reduction and preventing collapse is vital to optimum performance. The SHS/TSP group showed more medialization of the femoral shaft, which was associated with greater postoperative pain. The evidence suggests that an intramedullary device would offer more benefit than a SHS with TSP.

Basicervical Fracture

Basicervical fractures are uncommon, and although extracapsular, the rotational instability is similar to that of the femoral neck, which is more medial in location. Compression fixation should be used whenever possible to reduce and stabilize two basicervical fractures. It may be advantageous to use a derotation screw to prevent rotational loss of reduction. Comminuted fractures with anterior cervical extension are treated with an intramedullary device as comminuted, unstable intertrochanteric fractures.

There are unique anatomical and biomechanical characteristics of AO/OTA 31-A3 intertrochanteric femoral fractures, with the major fracture line running from distal-lateral to proximal-medial. Whenever a SHS is used to fix a fracture, the fracture line is almost perpendicular to the screw orientation, and sliding compression can, in effect, lead to the proximal fracture being displaced laterally, causing the neck screw to protrude away from the fracture. In the meantime, a proximal fracture can easily split during drilling since the lateral wall of the femur is destroyed, and the entrance point of the neck screw is located where the fracture splits at the fracture line. According to Haidukewych et al. (11), the failure rate was up to 56%. With intramedullary nails, internal fixation of these fractures can provide better biomechanical stability because central fixation is involved. The osteoporotic fractures of AO31-A3 were considered to be more appropriate for intramedullary devices by Kokoroghiannis et al. (12).

A nail inserted into the intramedullary canal may not be sufficient to treat all unstable proximal femoral fractures. Moreover, intramedullary fixation is associated with a high rate of blood loss, but is not equal to extramedullary fixation when it comes to damage to soft tissues. Therefore, intramedullary nails are not considered to be a minimally invasive treatment. However, advances in the technology of intramedullary nails have improved the rate of a second fracture following internal fixation. Based on a systematic review by Norris et al., hip fractures must be treated individually and in correlation with the fragility of the bone as well as the fragility of the patient (13). Gotfried argued that the percutaneous compression plating (PCCP) can be beneficial toward this objective (14). As part of the PCCP, two neck screws and three cortical bone screws are used along with closed reduction during the surgery. Two neck screws provide rotational stability for the proximal fracture, while parallel screws are used to restrict lateral displacement of the fragments, providing a much better biomechanical solution than SHS. There are two neck screws in the PCCP (7.2 mm) that are smaller than those in the SHS. The use of a small drill bit and gradual drilling can protect the lateral wall of the fracture and reduce the likelihood of trauma-related fracture collapse.

The biomechanical advantage of cephalomedullary implants in the treatment of unstable intertrochanteric fractures has been documented by Lorich et al. (15).

After one or three months following surgery, patients can move freely with cephalomedullary implants. According to Babhulkar's study, stable trochanteric fractures are usually treated with dynamic hip screw (DHS), while unstable fractures usually require cephalomedullary implants to prevent rotational instability (16). According to Kulkarni et al., a cephalomedullary implant is the preferred treatment for unstable trochanteric fractures, but a DHS is still considered the gold standard for stable trochanteric fractures (17).

Haidukewych et al. summarized 10 simple tips to help patients with hip fractures avoid failure and improve their outcomes (11). They are measurement of the tip-apex distance (TAD); no lateral wall: no use of hip screw; knowing the unstable intertrochanteric fracture patterns and nail theming; being aware of the anterior bow of the femoral shaft; when using a trochanteric entry nail, starting slightly medial to exact tip of greater trochanter; not reaming an unreduced fracture; being cautious about the nail insertion trajectory and not using a hammer to seat the nail; avoiding varus angulation of the proximal fragment-using the relationship between the tip of trochanter and center of the femoral head; when nailing, locking the nail distally if the fracture is axially or rotationally unstable; and avoiding fracture distraction when nailing. Even stable or nondisplaced fractures have become more popular for intramedullary nail fixation. They conducted a prospective study that involved 80 consecutive patients of any age with a trochanteric fracture using DHS and TSP in their article entitled, "The Role of Lateral Wall Restoration.". Several studies have demonstrated that combining TSP and DHS was effective for treating femoral fractures with burst lateral walls (18).

To maintain adequate lever arm and abductor strength, a biomechanically stable construction is created during reconstruction of the lateral wall. In addition, it allows the passage of an anti-rotation screw, thereby providing two-point fixation with additional rotational stability. Patients with unstable trochanteric fractures show a better overall functional and radiological outcome with DHS and modular TSP when compared with DHS alone. In a surgeon-allocated study between November 2005 and November 2008, Knobe et al. examined 108 patients with unstable pertrochanteric fractures. It was concluded based on their data that pertrochanteric fractures could be repaired either with small-diameter screw systems locked to prevent lateral wall fractures or with the new intramedullary systems to avoid possible mechanical complications (19).

In order to prevent reoperation, preserving the preoperative femoral neck-shaft angle and calculating the TAD are key technical factors. Knobe et al. conducted a national survey of chairpersons of German institutions in order to investigate their perspectives and perceptions regarding their experience with unstable intertrochanteric fractures, the diagnosis and management of these fractures, and surgical treatment of these fractures. A broken medial wall and a detached greater trochanter were considered to be major indicators of fracture instability by 4 and 5% of respondents, respectively. Extramedullary devices are routinely used to fix unstable intertrochanteric fractures (20). According to reports, 98% of German hospitals perform surgery within 24 hours of admission. The time to surgery varied with hospital level, with more direct surgeries taking place in Level I hospitals. Hsu et al. conducted a retrospective study on 208 patients treated with DHS and barrel plates in their study on the lateral femoral wall thickness (21).

On the basis of the results, 42 (20%) patients experienced lateral wall fractures. A threshold value of 20.5 mm was found to be a reliable predictor for secondary lateral wall fractures based on lateral wall thickness. Hence, they suggested that for patients with a lateral wall thickness of 20.5 mm, the use of a DHS is not recommended; for patients with a fracture of the intertrochanteric joint with a lateral wall thickness of 20.5 mm, no DHS is advised; as well as for patients with a fracture of the intertrochanteric joint with a lateral wall thickness of 20.5 mm (Table 1).

- **Summary table for choosing the right device**

	A	B	C
A1-A2.1	DHS/INTRAMEDULLARY NAIL	DHS/INTRAMEDULLARY NAIL	DHS/INTRAMEDULLARY NAIL
A2.2	DHS + TSP/INTRAMEDULLARY NAIL	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP
A2.3	DHS + TSP/INTRAMEDULLARY NAIL	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP
A3.1	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP
A3.2	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP
A3.3	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP	INTRAMEDULLARY NAILING + LOOP

Table 1. A summary of the device choosing in intertrochanteric fracture based on OTA/AO classification

Conclusion

Trochanteric fractures are on the rise due to the increasing number of senior citizens with osteoporosis. Because of osteoporosis of the hip and low energy mechanism of injury, the intertrochanteric fracture is called a fragile fracture. The best device and fixation for these fractures should be chosen in order to achieve early motion and weight bearing. As outlined in the AO/OTA classification, there are many options for fixation including DHS and cephalomedullary fixation [proximal femoral nail antirotation (PFNA)]. Many factors should be considered when fixing the intertrochanteric fracture, such as lateral wall thickness, osteoporosis, and fracture stability.

Conflict of Interest

The authors declare no conflict of interest in this study.

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None.

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