Outcomes of Sliding Hip Screw Fixation in Stable versus Unstable Intertrochanteric Hip Fractures

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Research Article

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Abstract

Background: Unstable intertrochanteric (IT) fractures are common orthopedic injuries in elderly with high morbidity. The treatment of unstable IT fractures with Sliding Hip Screw (SHS) is still controversial. The purpose of our study is to assess the outcomes of conventional SHS in unstable IT fractures in comparison to stable ones.

Methods: Thirty-five stable and 23 unstable IT fractures retrospective cases treated with SHS between January 2017 and December 2018. Patients were evaluated for infection, revision rate, screw cut-out, the development of post-traumatic arthritis or heterotopic ossification and mortality.

Results: Mean age of the patients at the time of surgery was 69.8 and 73.9 years for stable and unstable IT fractures, retrospectively, with 38 males and 20 females. The mean follow-up of 45.9 weeks. We found significant association between occurrence of SHS screw cutout and unstable fractures compared to stable ones (0% *versus* 17.4%, respectively, $p = 0.01$). There was an obvious trend for non-union and higher revision rate in unstable IT fractures (17.4% vs. 2.9%, $p = 0.056$). Logistic regression analysis didn't reveal any statistically significant confounder that might affect the rates of fracture union or revision rates. Post-traumatic arthritis and heterotopic ossification occurred in one case of unstable IT fracture. There were no reported cases of infection.

Conclusion: There is high risk of screw cutout, nonunion and revision using the SHS in unstable intertrochanteric fractures (AO type A2.2 and A2.3) compared to stable ones (AO type A2.1). Therefore, other modalities are preferred for the fixation of unstable IT fractures.

Level of Evidence: III

Introduction

Intertrochanteric (IT) fractures are among the most common orthopedic injuries in the elderly, and one-third of these intertrochanteric fractures are unstable with high morbidity[1, 2]. They usually occur because of low-energy trauma, and they carry considerable morbidity and mortality. They also occur in younger patients secondary to high-energy mechanisms such as motor vehicle accidents and falls from heights[3–5].

Surgical treatment of IT femur fractures aims to achieve early mobility and restore the ability to walk to pre-injury levels. Failure rates have been reported at < 2% in stable IT femur fractures that were treated with standard Sliding hip screw (SHS) fixation techniques[6–8]. By contrast, SHS fixation does not perform as well in unstable fractures; implant-related complications have been reported in 4–19% of these repairs[9–11]. Despite the higher failure rate reported in the literature, the SHS is still used as a fixation device for unstable IT fractures[12, 13].

One of the most common complications of a conventional SHS is excessive sliding of the lag screw, which contributes to femoral shortening and other functional impairments[14, 15]. Other severe complications include perforation of the femoral head and subsequent arthritis and pain[16, 17].

In contrast to what has been observed for the treatment of stable fractures, the failure rate of SHS fixation has been reported at 10–16% for unstable IT femur fractures[18–20]. Therefore, the use of SHS in the treatment of unstable IT fracture is still controversial[9, 21].

SHS fixation is generally perceived to be a cost-effective treatment for IT femoral fractures because a biomechanically stable construct can typically be achieved in patients with good bone stock. However, SHS fixation might not be as effective for the treatment of unstable IT fractures. There is a gap between best practice and actual practice concerning repair of unstable IT femur fractures. Therefore, this study was conducted to help steer colleagues away from use of the SHS in repair of unstable fractures. The objective of this study was to compare the outcomes and failure rates among patients with stable or unstable IT femur fractures who underwent this SHS fixation. We Hypothesized that the failure rate of SHS in unstable IT femur fractures is higher than that in stable ones.

Materials And Methods

This study was a retrospective review of adults with IT fractures who underwent SHS fixation during a 2-year period (January 2017 to December 2018) at a single level I trauma center. According to the admission and surgery logs, 372 patients were treated for hip fracture. Of these patients, 135 were treated for intertrochanteric or sub-trochanteric fracture. Clinical records and radiographs that had been made at the time of the injury or immediately post-operatively for these patients were reviewed, and fifty-eight consecutive patients with intertrochanteric fracture treated with SHS were identified. The rest were treated with either intramedullary nailing or primary prosthetic replacement. Patients were followed until union occurred or a revision operation was performed. The mean duration of clinical follow-up was 45.9 ± 4.1 weeks.

Approval for this retrospective study was obtained from our institutional review board. All patients were interviewed and examined by us personally. An assessment of function was based upon pain, living situation, need for walking aids, need for analgesics, and walking capacity. Fractures were judged to be clinically healed when pain-free walking and range of motion of the hip were possible. All patients had a complete set of radiographs, including initial diagnostic radiographs, immediate postoperative radiographs, and final radiographs.

Radiographs were reviewed for fracture translation in the anterior-posterior and medial-lateral planes. Fractures were judged to be healed radiographically if bridging callus was evident on three of four cortices as seen on two views. All patients were followed until radiographic signs of union were present.

Medical records were reviewed. Demographic details, as well as fracture stability, side of the fracture, mechanism of injury, comorbidities, and smoking status were extracted from the patient records. The inclusion criteria included: intertrochanteric femur fractures in patients with age above eighteen years.

Fractures were divided into two groups; stable IT fractures (group I) and unstable IT fractures (group II). Stable IT fractures were identified as those in the posteromedial cortex (i.e., AO/OTA type 31-A1) in which the fracture line runs obliquely between the lesser and greater trochanter of the femur with intact lateral hinges. Unstable IT fractures again have an oblique fracture line running between the trochanters but in addition there is involvement of the calcar femorale or comminution of the lateral cortex and reverse obliquity fractures (i.e., AO/OTA types 31-A2 and 31-A3) (Figs. 1 and 2)[22].

The SHS consists of a lag screw passed up the femoral neck to the femoral head. This lag screw is then attached to a plate on the side of the femur. These are considered ’dynamic’ implants as they have the capacity for sliding at the plate/screw junction to allow for collapse at the fracture site.

The primary outcome measure was the fracture union rate. Secondary outcome measures included the rates of infection, revision rate, screw cut-out, the development of post-traumatic arthritis, heterotopic ossification and mortality.

Operative Technique

After spinal anesthesia, the patients were placed in the supine position on a fracture table. The surgical technique employed a direct lateral approach to the hip. A Lateral incision was made 5 cm below the trochanteric ridge. The fracture was reduced by traction and internal rotation. Guide wires for SHS were inserted in the center of the femoral neck and the position was confirmed on fluoroscopic images. A derotation guide wire was passed parallel and superior to the SHS guide wire and derotation screw of appropriate length were inserted. Triple reaming and tapping were performed and a lag screw of appropriate length was inserted. Four or five-hole side plates were used in all of the cases. We didn’t use any additional augmented wiring. Derotational screws and lateral greater trochanter plate were used according to the surgeon judgement. No drains were utilized.

Static exercises in bed for glutei, hamstrings and quadriceps were started if pain permitted. Weight bearing on the operated side was started on day 1 in case of stable IT fractures. In group II unstable IT fractures, walker assisted non-weight bearing on the operated side was started after 2 days. Active ranges of motion hip exercises were started after 5 days. Postoperative dressings were done on days 2, 5 and 8. Suture removal was undertaken on or after 14 days. Weight bearing in group II was started only after radiological evidence of healing

Statistical Analysis

Data were analyzed using SPSS statistical software (IBM SPSS version 20; SPSS Inc, Chicago, IL, USA). Fisher’s exact test was used for comparisons of categorical data, and the Mann–Whitney test was used to compare continuous data between the groups. Logistic regression analyses were performed to identify significant predictors of union complications and to adjust for possible confounders between outcomes. P-values < 0.05 were considered to be significant.

Results

Of the 58 patients included in the study, 35 patients were diagnosed with stable IT fractures (group 1), accounting for 60.3% of IT fractures, and 23 with unstable IT fractures (39.7%) (group 2). There were thirty-eight male patients and twenty female patients. The mean age at the time of fracture was 69.8 years in the group 1 and 73.9 years in group 2. There were twenty-nine right and twenty-nine left fractures. Fifty-five fractures (94.8%) were caused by a fall, and three fractures were caused by a motor-vehicle accident. Five patients had an associated injury and 79.3% of the patients had at least one major medical comorbidity.

All patients underwent a SHS fixation procedure that was carried out within two days of admission. We identified no statistically significant differences in demographics between the two patient groups. However, the values of Tip-to-Apex Distance (TAD) had a trend toward statistical significance; as they tended to be less in the unstable IT group, (Table 1).

Table 1
Demographic characteristics of Intertochanteric hip fracture patients

	Stable		**Unstable**		
	n = 35		n = 23		*P*-value
Age (y ± SD)	69.8 ± 17.2		73.9 ± 15.2		0.347
BMI (kg/m^2 ± SD)	23.3 ± 5.1		21.7 ± 4.3		0.200
TAD (mm ± SD)	21.7 ± 6.3		18.2 ± 7.0		**0.061**
Follow-up (wk ± SD)	42.2 ± 4.7		49.4 ± 3.5		0.499
Gender					
- Female	10	28.6%	10	43.5%	0.247
- Male	25	71.4%	13	56.5%	
Side					
- Left	18	51.4%	11	47.8%	0.873
- Right	17	48.6%	12	52.2%	
Mechanism					
- Fall	33	94.3%	22	95.7%	0.820
- MVA	2	5.7%	1	4.3%	
Smokers	3	8.6%	0	0.0%	0.153
Comorbidities	27	77.1%	19	82.6%	0.618
- DM	19	54.3%	16	69.6%	0.249
- HTN	23	65.7%	14	60.9%	0.710
- CAD	8	22.9%	6	26.1%	0.780
- CKD	3	8.6%	5	21.7%	0.158
- Stroke	6	17.10%	1	4.30%	0.147
- Respiratory	4	11.4%	4	17.4%	0.523
- Others	6	17.1%	4	17.4%	0.981

BMI: Body Mass Index; TAD: Tip-to-Apex Distance; MVA: Motor Vehicle Accident; DM: Diabetes Mellitus; HTN: Hypertension; CAD: Coronary Artery Disease; CKD: Chronic Kidney Disease

Thirty-four (97.1%) of the group 1 fractures compared to nineteen (82.6%) of the group 2 healed and did not require another operation (p = 0.056). The mean time to union for the group 1 fractures that healed primarily was 4.1 months and 5.1 months for group 2 fractures. The incidence of screw cut-out was significantly higher in unstable compared to stable IT fractures (0% *versus* 17.4%, respectively, $p = 0.01$). The revision rate was also higher after unstable IT fractures (2.9% for stable fractures *versus* 17.4% for unstable fractures) although it did not reach statistical significance ($p = 0.056$). The failure mode of the SHS in group 1 was non-union. The failure mode of the SHS in group 2 was medial translation of the distal fragment and loss of proximal fixation resulting in either nonunion or screw cutout (Fig. 3). There was no statistically significant difference in the incidence of post-traumatic arthritis or heterotopic ossification and no reported cases of infection or death among the two groups (Table 2).

Table 2
Outcomes Dynamic Hip Screw in stable and unstable Intertrochanteric hip fractures

	Stable		**Unstable**		**P-value**
Union	34	97.1%	19	82.6%	**0.056**
Time to union (wk ± SD)	17.6	± 3.1	21.9	± 4.1	0.187
Screw Cut-Out	0	0.0%	4	17.4%	**0.011**
Infection	0	0.0%	0	0.0%	1.000
Revision	1	2.9%	4	17.4%	**0.056**
Post-Traumatic Arthritis	0	0.0%	1	4.3%	0.217
Heterotopic Ossification	0	0.0%	1	4.3%	0.217
Death	0	0.0%	0	0.0%	1.000

Radiographic review of medial-lateral fracture translation for the group 1 showed no measurable translation of the proximal fracture fragment in 24 patients (68.6%) compared to 10 (43.5%) in group 2. There was no noticeable translation in the anterior-posterior plane in any hip. Fracture reduction in group 1 was graded as anatomic in twenty-three hips (65.7%) and nonanatomic in twelve. In group 2, Four fractures were anatomically reduced (17.4%) and nineteen nonanatomically reduced fractures. One of the anatomically reduced fractures and 3 of the nonanatomically reduced fractures (15%) had a failure of treatment ($p = 0.060$).

Two patients were diagnosed with a nonunion but did not undergo a reoperation because they had major medical comorbidities and low functional demands. Three failures with loss of fixation and cutout through the femoral head were revised to a hemiarthroplasty with internal fixation of the greater trochanter. one patient had revision of the internal fixation with bone grafting. One patient had a revision to a blade-plate (Fig. 4). All revisions with internal fixation healed without additional surgery.

Logistic regression analysis revealed no statistically significant confounders that might affect the rates of fracture union, screw cut-out, or revision, or the development of post-traumatic arthritis or heterotopic ossification.

Functional outcome

Before the hip fracture, forty-two patients (78%) walked without support, 4% required a cane, and 18% required a walker. At the time of the last clinical review, 57 of patients (98.2%) had little or no pain, one (1.8%) had moderate pain, and none had severe pain. Forty-six patients (79.3%) used no analgesics, and twelve (20.7%) used non-narcotic analgesics for occasional discomfort. Ten patients (17.2%) were unable to walk, twenty-four (41.4%) could walk indoors only, seven (12.1%) could walk one to six blocks, one (1.7%) could walk greater than six blocks, and sixteen (27.5%) could walk an unlimited distance.

Twelve patients (20.6%) needed no walking aids, three (5.2%) used a cane occasionally, four (6.9%) needed a cane full-time, and thirty-nine (67.2%) needed a walker.

Medical Complications and Mortality

The mortality rate was 0%. There was one intraoperative complication; marked hypotension developed in one patient, necessitating rapid completion of the procedure. Twenty-one patients (36.2%) had one or more postoperative medical complications. These included congestive heart failure in six, cardiac arrhythmia in three, deep venous thrombosis in three, pneumonia in three, myocardial infarction in two, pulmonary emboli in two, hematoma in two, and severe inappropriate antidiuretic hormone secretion syndrome in one. There were no infections.

Discussion

Proximal femoral fractures with or without instability of fragments remain a topic of vivid discussion amongst orthopedic trauma surgeons[23]. Operative treatment of IT hip fractures was introduced in the 1950s using a variety of different implants. Implants may be either extramedullary or intramedullary in nature. The most commonly used extramedullary implant is the sliding hip screw. In this study we sought to investigate the association between the construct failure rates and the stability of the fracture among patients with IT femur fractures who underwent this SHS fixation.

While we found no significant differences in union or revision surgery rates between the two patient cohorts, the incidence of screw cut-out was significantly higher in the group presenting with unstable IT fractures. Rates of infection and/or other complications were similar between the groups regardless of potential confounding factors.

Because revision surgeries are complex and technically demanding, various fixation techniques have been developed to improve anchorage of the lag screw in the femoral head and to maintain the bone fragments in position until the fracture has healed[24–26]. Many authors have reported excellent results when treating IT femur fractures with a SHS[27, 28].

Although the use of this sliding screw device presents many advantages, including controlled impaction at the fracture site and short operation time with no need for osteotomy, unstable fractures that are comminuted at the posteromedial cortex often become displaced because of excessive sliding and extrusion of the lag screw[14]. For example, Steinberg and colleagues reported that the failure rate increased with screw sliding > 15 mm[14]. Common causes of failure of fixation are instability of the fracture (most important), osteoporosis[29, 30], lack of anatomic reduction, failure of the fixation device[31], and the location of the screw within the femoral head[9, 16, 17]. However, we believe that poor reduction and implant position result in a poor prognosis in hip fracture treatment. In the present study, implant cutout and other surgical complications were associated with a higher TAD, poor reduction, or reduction more into varus but were independent of the type of implant. Therefore, an increased focus on surgical perfection, rather than implant selection, is probably the best way to address this problem. The increased medialization in the sliding hip screw in the unstable IT fractures could not be prevented by the trochanteric stabilizing plate, and our data do not allow us to quantify the extent to which a trochanteric stabilizing plate may have helped.

Other treatment modalities for unstable IT fractures include intramedullary devices, angle blade plates, and hemiarthroplasty, although these approaches may be more technically demanding. The current literature discusses the use of other devices for unstable IT fractures, including proximal femoral nails and Gamma nails[32, 33]. However, recent high-quality evidence does not support the use of intramedullary nailing devices over procedures using SHSs for the fixation of unstable IT femur fractures[34–36]. In their Cochrane review, Parker et al showed that the incidence of operative fracture of the femoral diaphysis is significantly increased when the Gamma nail is used (RR 3.02, 95% CI 1.51 to 6.03). Pooled data for cut-out of the implant from the femoral head showed no difference between implants (RR 1.15, 95% CI 0.76 to 1.72). Data for varus deformity (expressed as angulation greater than 10 degrees, malunion or deformity) showed no statistically significant difference between the two groups[34]. In a prospective, randomized multicenter study of 684 elderly patients were treated with the INTERTAN nail or with a sliding hip screw, Matre et al found that Regardless of the fracture and implant type, functional mobility, hip function, patient satisfaction, and quality-of-life assessments were comparable between the groups at three and twelve months. The numbers of patients with surgical complications were similar for the two groups[35].

Treating unstable reverse oblique with a sliding hip screw is controversial, and is not recommended by many authors[20, 37–39]. Although it is clear that SHS yields superior results for stable fractures, our findings revealed no specific confounders that might be taken into consideration. SHS remains the gold standard for such injuries[40]. In addition, the sliding hip screw is a less expensive implant. We have continued to favor the use of the sliding hip screw for IT fractures, but we are using an additional trochanteric stabilizing plate to prevent excessive medialization of the femoral shaft.

One of the strengths of this study is that our analysis included both simple and complex fracture patterns and that the procedures were performed by several surgeons. This design increases the generalizability of our results, closely resembling a real-life setting. However, a post-hoc analysis revealed that the study was underpowered due to limited sample sizes in both groups. Therefore, the results should be interpreted as exploratory in nature.

Conclusion

The use of the SHS was associated with a trend for lower union rates and higher revision rates in cases of unstable compared to stable fractures. The Failure rates of SHS are too high in unstable IT fractures to recommend its use. Further prospective randomized controlled trials should be performed to determine which procedures and devices are ideal for these patients. True patient "functional outcomes" should be included in these trials.

Declarations

Funding:

No funding was received.

Research involving human participants:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to Participate:

Not applicable

Consent to Publish:

Not Applicable

Disclosure of potential conflicts of interest:

The authors have no relevant financial or non-financial interests to disclose.

Author's Contribution:

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Waleed Assad, Yousef Abuodeh and Salman Shiraz. The first draft of the manuscript was written by Manaf Younis and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability:

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

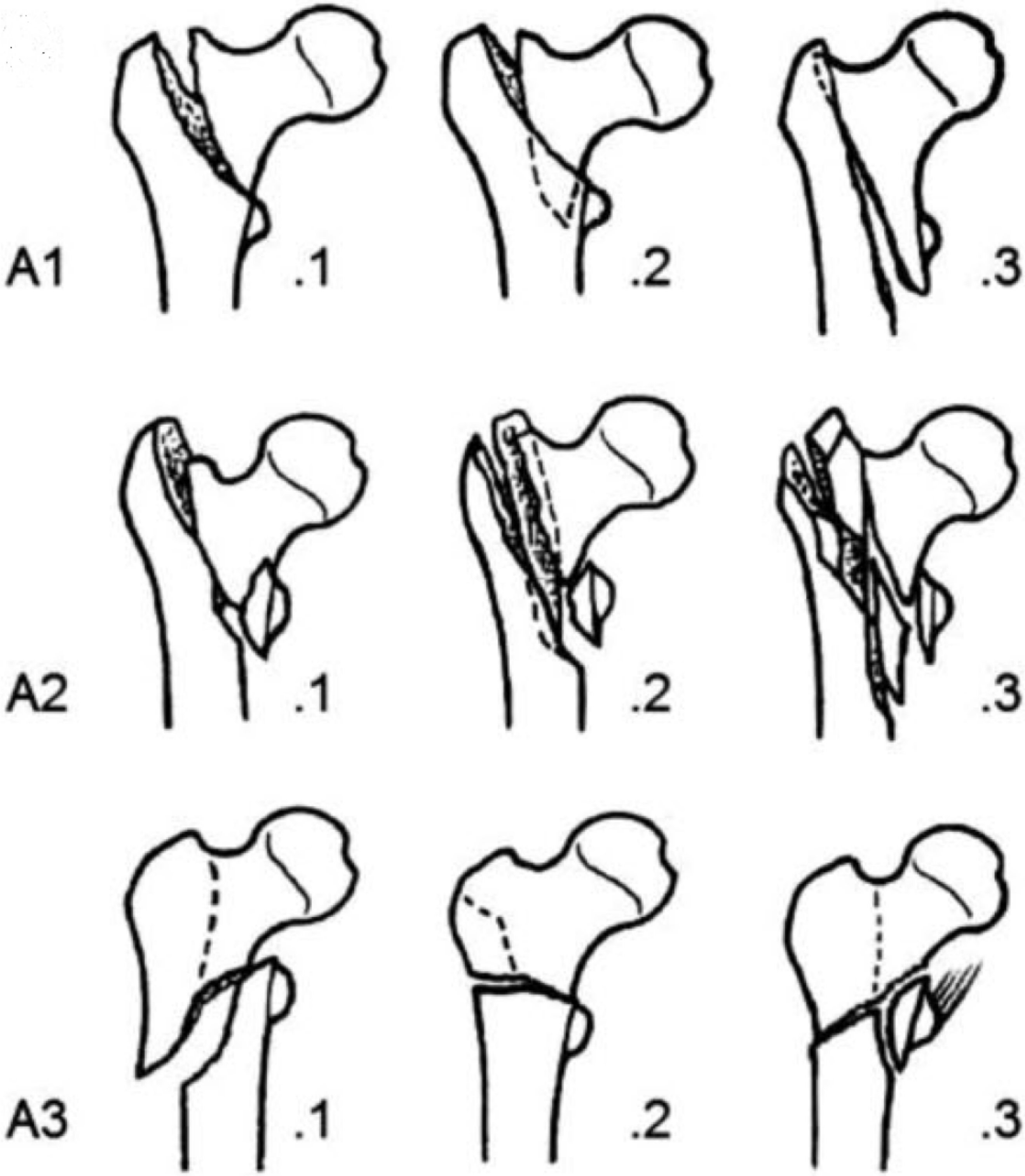

Figure 1

Hip fracture classification according to AO/OTA.

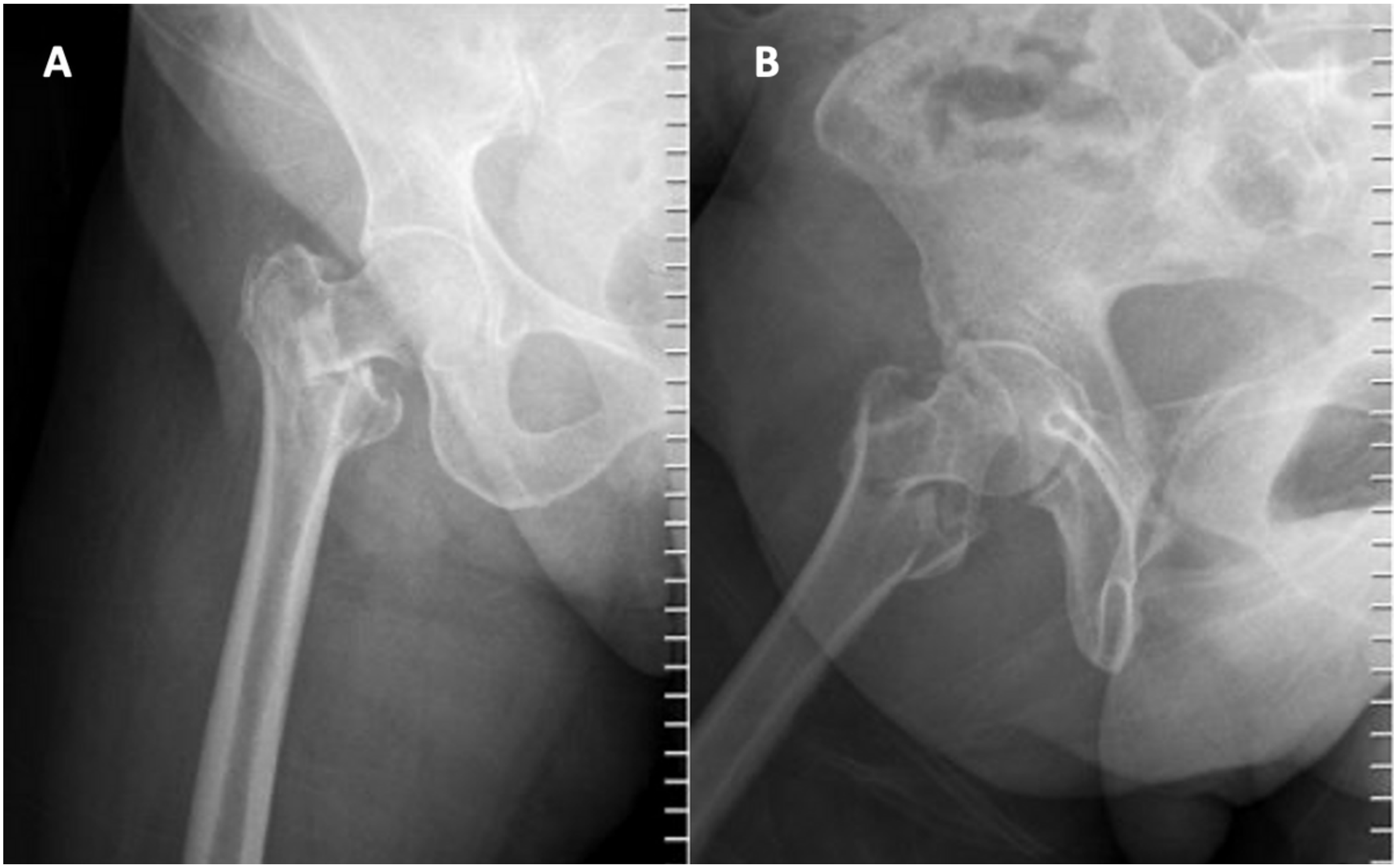

Figure 2

A and B show a typical unstable fracture with the major fracture line with comminution of the lateral wall and involvement of calcar foramenale.

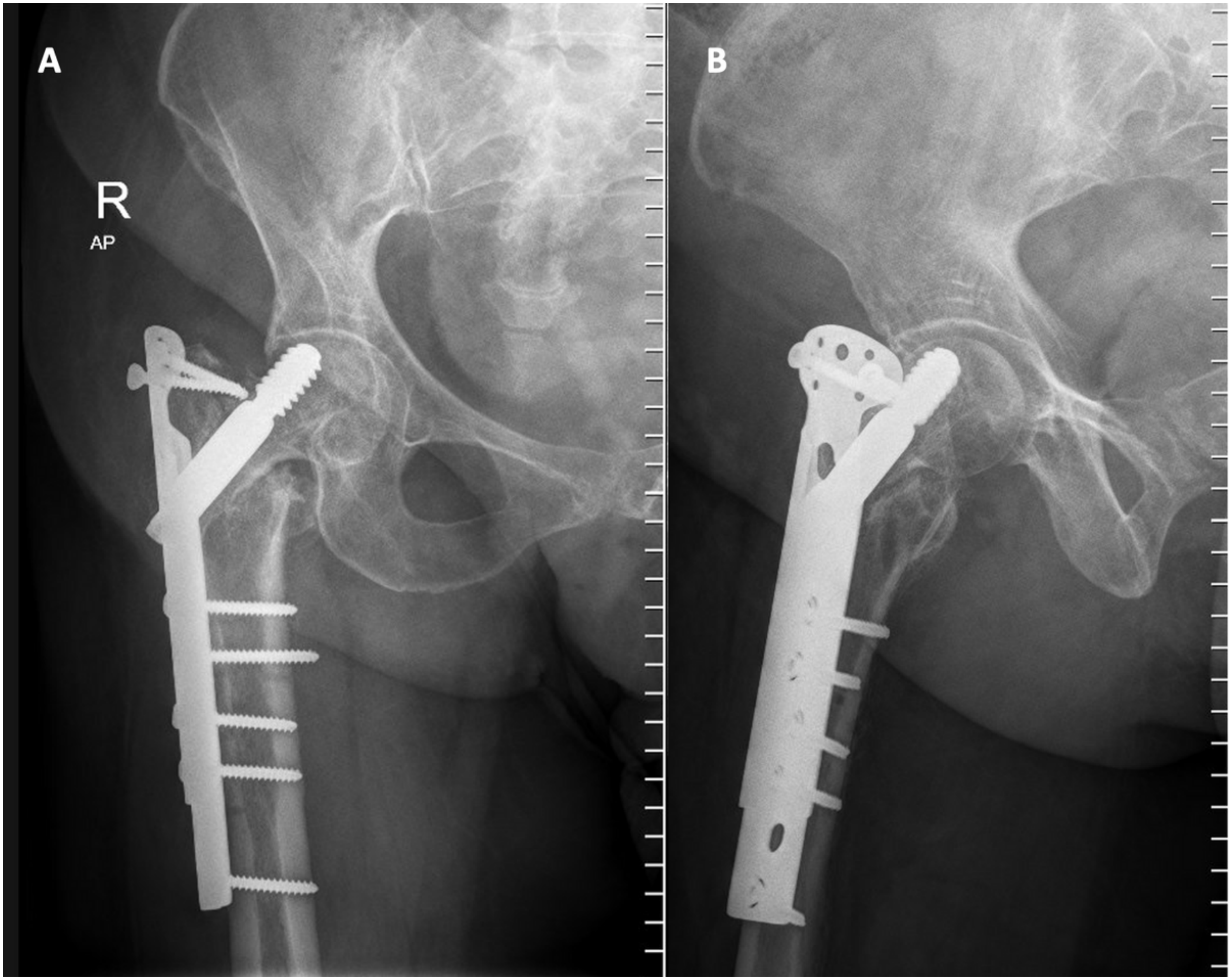

Figure 3

A and B show failed fixation with medialization of the distal fragment, varus deformity and lag screw cut-out.

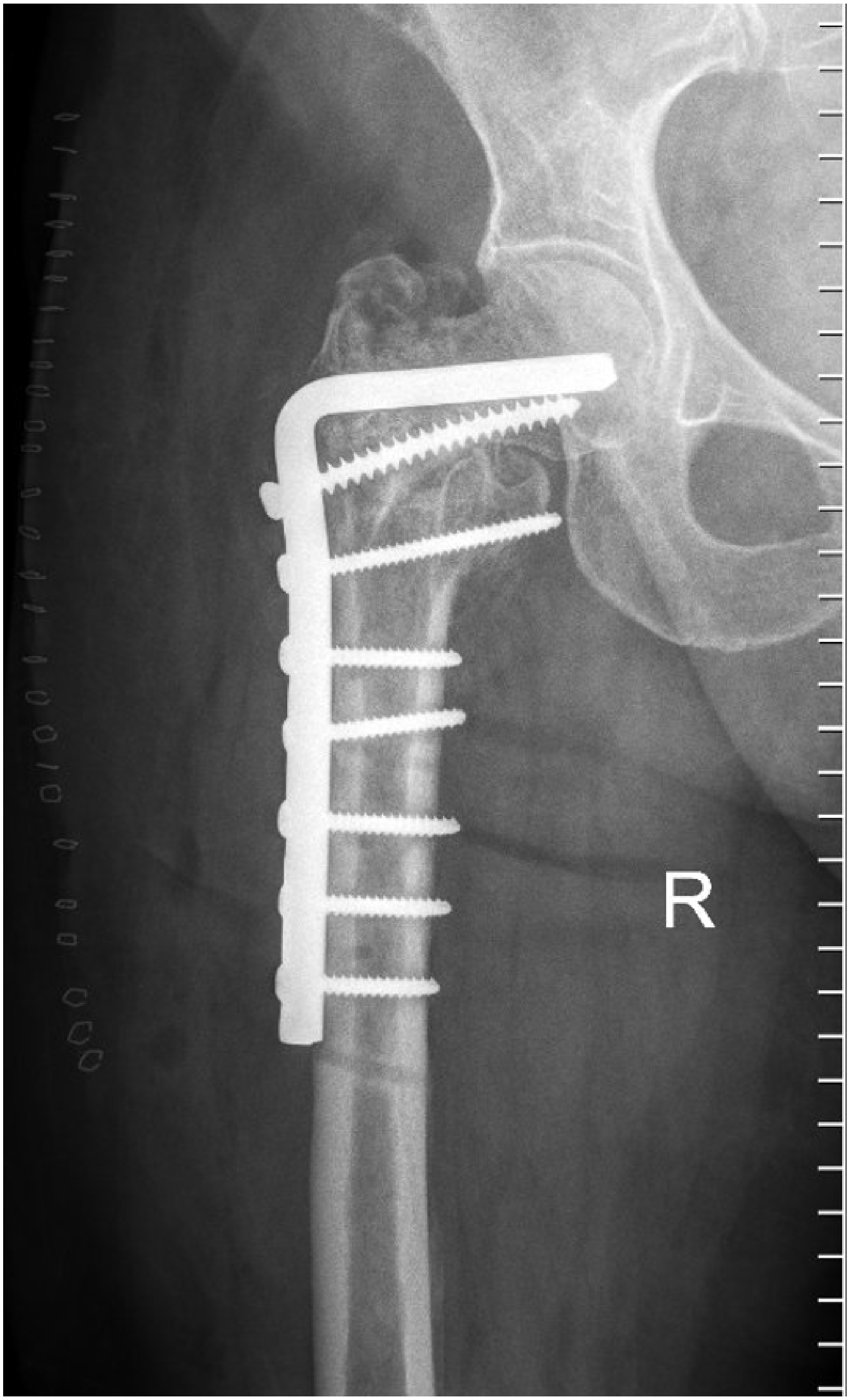

Figure 4

A salvage procedure using a blade-plate device with residual varus deformity