



Cohort Study

Intertrochanteric fractures treated by diaphyseal support arthroplasty with hook plate vs cerclage wires only: A retrospective cohort study

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ABSTRACT

Background: The treatment of unstable fractures of the intertrochanteric region of the hip in the elderly is controversial. Conventionally, internal fixation with intramedullary nail or a dynamic hip screw is the treatment of choice in intertrochanteric fractures. Nowadays, some authors encouraged the use hip arthroplasty for management of these fractures with good outcome. The aim of this study is to compare total hip arthroplasty with hook plate against total hip arthroplasty with cerclage cables in the management of unstable intertrochanteric fractures.

Materials and methods: Out of 100 admitted patients to a central university hospital in Beirut between 2013 and 2019 with a diagnosis of unstable intertrochanteric fracture of the hip, only 64 (36 hook plate vs 28 cerclage) patients were selected. This is a retrospective study, patients were excluded if lost to follow up, or if follow up less than one year is available. The data were retrieved from inpatient and outpatient hospital files. Functional outcomes were assessed according to ambulatory capacity. The main clinical measures were early postoperative full weight bearing, postoperative complications, functional outcome and radiologic assessment done by a radiologist in addition to measuring the dysfunction via the Harris Hip Score.

Results: The time to full weight bearing, the rate of postoperative complications, radiologic outcome and the functional outcomes were more satisfactory in the hook - plate group than in the cerclage - cable group.

Conclusion: According to the results, total hip arthroplasty with hook plate is considered the preferred modality of treatment in mobile elderly patients above sixty-five years of age with an unstable intertrochanteric femoral fracture, despite being a bulky foreign material that can lead to trochanteric bursitis.

1. Introduction

Intertrochanteric fractures among the elderly population are becoming a common pathology encountered in the orthopedic field, especially with the increasing number of elderly patients as the general population is aging [1]. These unstable fractures in the elderly patients are linked to a high rate of mortality during the first postoperative year [2]. The management of such fractures is still debated, despite of the numerous related publications in the literature [3,4].

Excessive collapse, loss of fixation, malalignment, femoral head necrosis and cut-out of the lag screw resulting in poor function remain

problems associated with internal fixation of unstable intertrochanteric fracture in the elderly patient with osteoporotic bone [5]. Many surgeons have suggested arthroplasty as the initial operative management of unstable intertrochanteric fractures to avoid the need of a second surgery in these frail patients and for the purpose of restoring pre-fracture ambulatory capacity, which is achieved by allowing earlier postoperative weight-bearing and reducing collapse at the fracture site [5,6]. Many of these patients are unable to tolerate non-weight or partial weight bearing protocols due to the increased risk of developing complications such as thrombosis, pressure ulcers and cardiopulmonary problems; thus, achieving early full weight bearing ambulation and

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proper mobilization is essential [7]. However, partial or total hip arthroplasty for the management of intertrochanteric fractures remain controversial as some studies have shown clear benefit of total hip arthroplasty in terms of mortality, function, and costs while other studies reported no difference in these parameters [8–12]. Traditionally, hip arthroplasty in intertrochanteric fractures has been reserved for cases associated with either arthritis, femoral head necrosis or severely osteoporotic bone [13].

The purpose of this retrospective study is to assess the functional, clinical, and radiologic outcomes of modular total hip arthroplasty with greater trochanteric plate fixation as a primary treatment for unstable intertrochanteric fracture in the elderly patient.

2. Materials and Methods

This is a retrospective study done at a central university hospital in Beirut, Lebanon. Between 2013 and 2019, 100 patients admitted with unstable intertrochanteric hip fracture according to AO classification (Arbeitsgemeinschaft für Osteosynthesefragen) and 64 patients were selected (A22, A23) [14]. These patients were all above 65 years of age and were independently mobile before sustaining the fracture. To note, a peak of cases was observed during Fall/early Winter with 40% of the cases presented during this time with the most reported mechanism of injury being related to handling carpets in preparation to the Winter season. Exclusion criteria included patients unable to walk before the fracture, patients less than 65 years old, patients with pathological fractures, patients on anticoagulation therapy, and patients with stable fractures and intact lesser trochanter. Data was collected from in-patient hospital files and out-patient department upon follow up. After taking into consideration the inclusion and exclusion criteria, patients were divided at random into two groups, the hook plate group (Fig. 1) and cerclage only group (Fig. 2).

Pre-operative data included: age, sex, fracture type, and preoperative comorbidities. Postoperative data included time to full weight bearing, postoperative complications such as urinary tract infection, trochanter fixation failure, prosthetic dislocation, deep vein thrombosis, infection (superficial and deep), pressure ulcers, and mortality. The preoperative templating for total hip arthroplasty in the cases included in this study was done by hand.

All surgical procedures were performed by the two senior surgeons as soon as the condition of the patient was stabilized, usually within a time frame of 48 h after admission. The hip prosthesis used was imported by groupe Lepine, the acetabulum (Quattro cup), femoral diaphyseal support with metaphyseal modular calcar replacing component (integra stem) and trochanteric hook plate fixation (integra plate) with cerclage wires for fixation of the trochanters (or only cerclage wires). Preoperative templating of radiographs of the contra-lateral side and the fractured side was done to determine the approximate position and size of the stem and the approximate femoral neck offset.

The surgeries were performed using the posterolateral approach with the patient in a lateral decubitus position. The definitive femoral stem was hammered into the femoral canal after holding the femur with bone holding forceps and at least one cerclage cable to prevent fracture extension during component placement. The large calcar bone fragments as well as the greater trochanter were reduced with cerclage wires through the prosthesis and over the trochanteric hook plate. Fascia Lata was tightly closed and 1g of tranexamic acid was used intra-articularly and 1g IV perioperatively. No drains were used, and a soft spica was applied to the patients to reduce bleeding. The prophylactic antibiotic regimen used was first generation cephalosporin (Cefazolin) and it was given at the induction of anesthesia and continued for 3 doses postoperatively. Venous thromboprophylaxis consisted of low-molecular-weight heparin that was begun 12 h after the operation and sustained for 35 days postoperatively. Pain medications were given as needed. The arthroplasty patients ambulated either full or partial weight bearing on the first postoperative day with the aid of a physiotherapist.

After being discharged from the hospital, patients were observed at six weeks; at three months, and twelve months; and yearly thereafter for radiological control (anteroposterior pelvis and lateral hip x-rays) and functional evaluation at each visit. A stem is considered to be unstable when there is progressive subsidence exceeding 3 mm. A greater trochanter was assumed to be avulsed if it was displaced more than 5 mm. The radiographic evaluation was done by a radiologist who did not participate in the surgery. The patients included in this study were not on anti-osteoporosis treatment. A multidisciplinary team assessed the patients 6 months postoperatively and started them on anti-catabolic drugs for their osteoporosis. However, these drugs would not show significant effect in a short period of time such as 6 months [15].

This paper's registry number is researchregistry7180 and IRB approval number 03152. Moreover, the work has been reported in line with the STROCSS criteria [16].

3. Statistical analysis

Data were reported as mean, standard deviation (SD), median (range) or number (percentage). Multivariate analysis was done for variables such as gender, age, stem subsidence, trochanter healing vs avulsion. P-values < 0.05 were considered statistically significant.

4. Results

Out of 100 patients, 64 were enrolled in this study. All patients had intertrochanteric fracture of the hip after falling from an upright position to ground level. The average age at operation was 82.36 years with no statistical difference (Table 1) (range 62–98 years).

There were 23 men and 41 women divided depending on the use of hook plate (Table 2).

Postoperatively, half of the patients were walker-dependent while

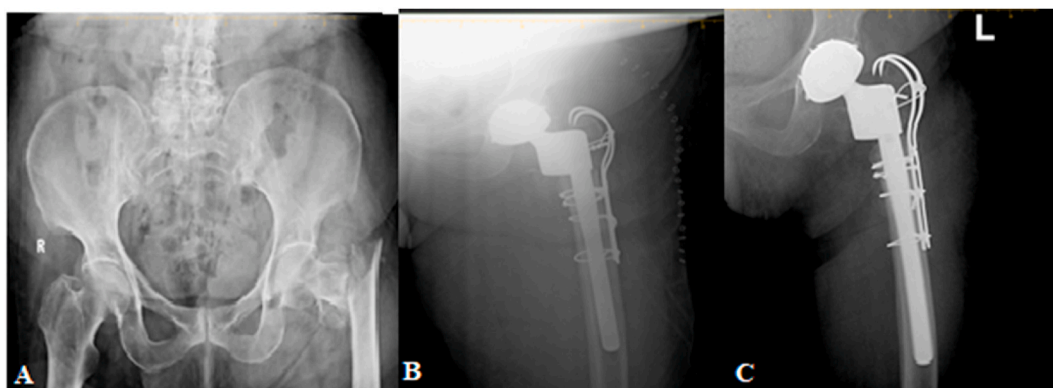


Fig. 1. (A) X-ray of the pelvis showing an unstable intertrochanteric fracture in a 90-year-old patient. (B) day 0 post-op X-ray. (C) at one year follow up.

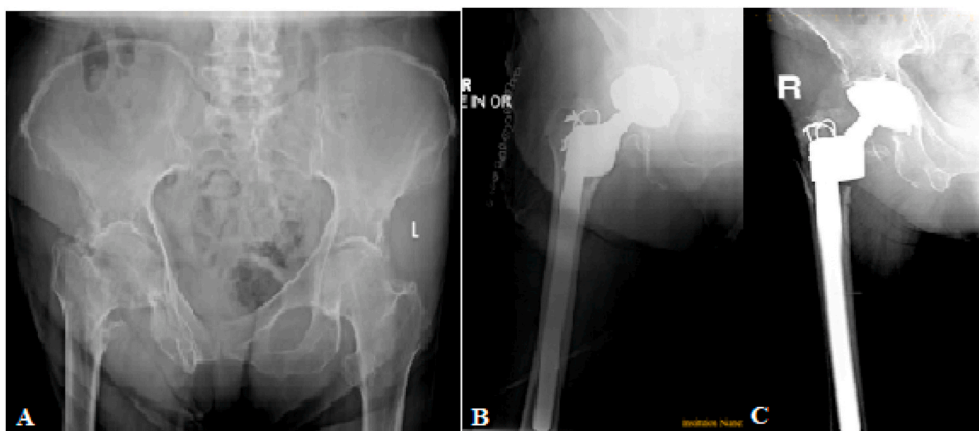


Fig. 2. (A) 84-year-old female patient with right intertrochanteric fracture. (B) Total hip arthroplasty with cerclage. (C) Avulsion of greater trochanter.

Table 1
Age demographics.

| Age demographics | | | |
|------------------|---------|-------|--|
| Age | | | |
| N | Valid | 64 | |
| | Missing | 0 | |
| Mean | | 82.36 | |
| Std. Deviation | | 7.745 | |
| Minimum | | 62 | |
| Maximum | | 98 | |

Table 2
The use of hook plate and gender demographics.

| Hook plate and gender demographics | | | |
|------------------------------------|---------|-----------|---------|
| | | Frequency | Percent |
| Hook plate | Absent | 28 | 43.8 |
| | Present | 36 | 56.3 |
| | Total | 64 | 100.0 |
| Gender | Female | 41 | 64.1 |
| | Male | 23 | 35.9 |

the other half were divided between free ambulators and cane dependent ambulators (Table 3).

The patients had the A22, A23 fracture type. Multivariate analysis (Table 4) showed statistically significant difference ($p < 0.05$) favorable outcome when hook plate is used.

When the hook plate is used, it is associated with a significant decreased risk of trochanter avulsion and non-union (Fig. 3).

Furthermore, when the hook plate is present it is associated with decreased subsidence risk (Fig. 4).

The rationale behind the good outcomes with hook plate use, is likely due to anatomic reconstruction of the greater trochanter and the abductor mechanism with greater biomechanical stability which in turn allows favorable outcomes radiologically and clinically. This is demonstrated in Table 5 with the improved Harris hip score.

Furthermore, blood loss and duration of surgery were statistically

Table 3
Post-operative ambulatory capacity.

| Ambulation | | | | |
|------------|-----------|---------|---------------|--------------------|
| | Frequency | Percent | Valid Percent | Cumulative Percent |
| Cane | 18 | 28.1 | 28.1 | 28.1 |
| Free | 17 | 26.6 | 26.6 | 54.7 |
| Walker | 29 | 45.3 | 45.3 | 100.0 |
| Total | 64 | 100.0 | 100.0 | |

Table 4
Multivariate analysis showing statistically significant difference ($P < 0.05$) favorable outcome with the use of hook plate.

| Multivariate Tests | | | | | | |
|------------------------|----------------|-------|---------------------|---------------|----------|------|
| Effect | | Value | F | Hypothesis df | Error df | Sig. |
| Intercept | Pillai's Trace | .626 | 50.265 ^b | 2 | 60 | .000 |
| | Wilks' Lambda | .374 | 50.265 ^b | 2 | 60 | .000 |
| | | | | | | |
| Leg Length Discrepancy | Pillai's Trace | .048 | 1.516 ^b | 2 | 60 | .228 |
| | Wilks' Lambda | .952 | 1.516 ^b | 2 | 60 | .228 |
| | | | | | | |
| Hook plate | Pillai's Trace | .188 | 6.958 ^b | 2 | 60 | .002 |
| | Wilks' Lambda | .812 | 6.958 ^b | 2 | 60 | .002 |
| | | | | | | |

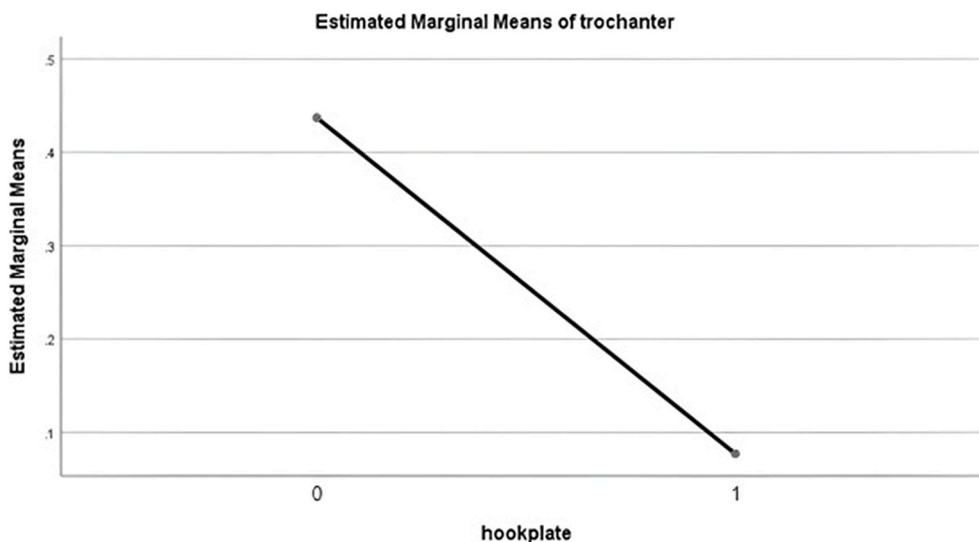
a. Design: Intercept + Leg Length Discrepancy + hook plate.
b. Exact statistic.

similar. Some patients suffered from postoperative complications such as pressure sores, superficial wound infection, occurrence of urinary tract infection and symptomatic deep vein thrombosis documented by ultrasound (Table 6). The patients had different post-op complications related to the surgery; one patient had leg length discrepancy (more than 1 cm), three patients had moderate pain and limping associated with non-union of the greater trochanter with avulsion (Fig. 2), three patients had stem subsidence more than 5 mm, and one patient suffered from prosthetic dislocation. There was no acetabular erosion with cup migration.

5. Discussion

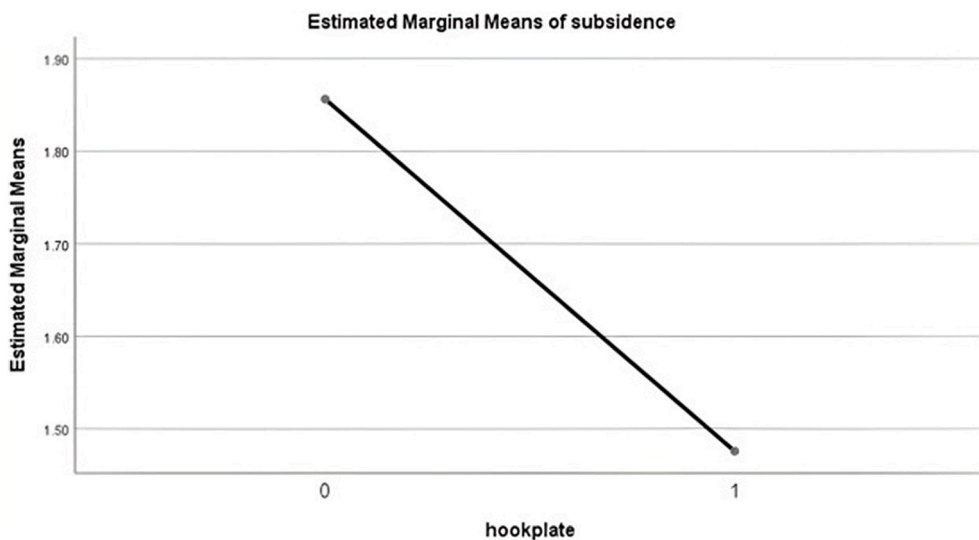
Most intertrochanteric hip fractures can be successfully managed with internal fixation [17]. Dynamic devices, nail, and dynamic hip screw are widely used as reliable methods of internal fixation even though the operative technique is more challenging, and the post-operative rehabilitation regimens cannot be standardized. Although union rates of 100% have been reported in association with well-reduced, stable fractures treated with ideal implant placement, failure rates of as high as 50% have been noted in association with unstable fractures, comminution, suboptimal fracture fixation, or poor quality of bone in elderly patients.

The mechanical properties of the bone in these elderly patients are weak and porotic, and thus do not usually provide a firm purchase for screws thereby leading to biomechanical failure [17]. This subsequently leads to the collapse of the femoral head into varus with migration and



Covariates appearing in the model are evaluated at the following values: LegLengthDiscrepancy = 1.2906

Fig. 3. Greater trochanter avulsion occurrence as a function of hook plate presence or absence.



Covariates appearing in the model are evaluated at the following values: LegLengthDiscrepancy = 1.2906

Fig. 4. Stem subsidence occurrence as a function of hook plate presence or absence.

Table 5
Harris hip score in both groups.

| Harris hip score in the hook plate group and the group without hook plate | | | |
|---|------------|-------|--------------------|
| | Hook plate | value | Standard deviation |
| Harris hip score | present | 89.2 | 7.4 |
| | absent | 83.5 | 9.8 |

retroversion resulting in limping due to shortening of lower limb and decreased abductor muscle lever arm [13,18]. Additionally, screw cut-out from the femoral head is a dreaded complication of internal fixation leading to profound functional disability and pain [19]. Even though the use of internal fixation has led to a decrease in mortality rate, the rate of postoperative complications still ranges from 3% to 50%. Moreover, full weight-bearing ambulation before the complete healing of the fracture is often impossible [20]. Whenever internal fixation fails in an elderly patient, conversion to total hip arthroplasty is the most common subsequent approach [21]. Whenever revising these patients,

one must remember the challenges to be faced such as retained hardware and its removal, proximal femoral malunion, and soft tissue damage either by initial trauma or by the performed surgery which often leads to scarring and sometimes heterotopic bone formation [21]. Multiple authors have reported increased incidence of periprosthetic fracture, dislocation and infection following revision of internal fixation of intertrochanteric fractures by arthroplasty [22–24].

However, in a study on 58 osteoporotic patients with an average age of 78 years suffering from a comminuted intertrochanteric femoral fracture treated with a bipolar prosthesis and followed for a period of 28 months, about 90% of these patients ambulated prior to being discharge [25]. The authors reported complications of greater trochanter nonunion in two patients; however, no reports of dislocations, deep infections, acetabular erosions, or cases of stem loosening. Furthermore, in two studies on 94 and 54 elderly patients respectively with intertrochanteric fractures treated with a bipolar hemiarthroplasty, the mortality rate was found to be lower, the average operating time was shorter, and the functional outcomes were better in the hemiarthroplasty group than in groups treated with internal fixation.

Table 6

Post operative complications in patients with and without the use of trochanteric hook plate showing that the use of a hook plate was associated with decreased stem subsidence and greater troch avulsion. "0" = hook plate not used, "1" = hook plate used.

| Complications postoperatively | Urinary infection | Pressure ulcer | Superficial wound infection | Deep vein thrombosis | Greater trochanter avulsion | Leg length discrepancy >1 cm | Stem subsidence >5 mm |
|-------------------------------|-------------------|----------------|-----------------------------|----------------------|-----------------------------|------------------------------|-----------------------|
| Hook plate present | 1 | 1 | 1 | 0 | 4 | 0 | 1 |
| Hook plate absent | 3 | 3 | 0 | 0 | 10 | 1 | 2 |

There were no reports of dislocations or stem loosening [26,27]. Early postoperative full weight bearing ambulation was the main reason for decrease in postoperative complications such as pressure sores and pulmonary complications [28,29].

The most severe complication in patients who underwent a prosthetic operation of the hip is deep infection accounting for an incidence of 0%–3%. The large wound surfaces and the extensive dissection that is needed are factors facilitating bacterial contamination [30]. However, the deep infection rate in the presented study is zero.

The dislocation rate post-total hip arthroplasty in previously treated patients for hip fractures may be due to many factors [31]. In one study, the authors attribute the high rate of hip dislocation was likely due to abductor weakness with or without concomitant trochanteric non-union [31]. The dislocation rate in our total hip arthroplasty group was 1.5% (one patient). The surgical technique may reduce the risk of dislocation whenever the soft tissue balancing is done properly around the hip joint. Also, care must be taken to restore adequate leg length, to reinsert the external rotators and the capsule, as well as proper selection of the offset, neck length, and version.

The finding of an unattached lesser trochanter may impede accurate adjustment of limb length. Therefore, this finding increases the technical difficulty of the operation. To establish a proper limb length, the prosthetic head center is fixed in a way to be in line with the tip of the anatomically placed greater trochanter [32].

In one study where the authors compared the outcomes between the greater trochanter reconstruction against a non-reconstructed group of hemiarthroplasty for the treatment of intertrochanteric fracture in the elderly, better functional results according to Harris hip score was noted in the reconstructed greater trochanter group and no abductor lurch gait was reported [33].

In a meta-analysis, comparing hemiarthroplasty to intramedullary fixation, it was found that hemiarthroplasty group had less post-operative complication, shorter duration to mobilization, fewer complications related to implants. However, they had greater intraoperative blood loss [33]. It also showed no difference regarding surgery time or need for blood transfusions [34].

In a study conducted by Chang et al. comparing cementless hemiarthroplasty in displaced femoral neck fracture to unstable intertrochanteric fracture in the same age group, no difference was found in terms of clinical outcomes and 1-year survival. The authors concluded that arthroplasty may be a treatment option in the intertrochanteric fractures [35].

Most studies in the literature have relied on cerclage cables for fixation of the greater trochanter; however, one study described trochanteric plate fixation of the greater trochanter with excellent clinical and radiological results including greater trochanter healing in all their patients [36].

In this study, intertrochanteric fractures were treated with total hip arthroplasty and diaphyseal support stems with better results in the hook plate group functionally and clinically. Clear benefits of this management are early full weight-bearing ambulation and early return to activity of daily life which likely reduced the incidence of pressure sores, pulmonary infection, and atelectasis. There was no symptomatic postoperative deep vein thrombosis. While the hook plate is a better

option for anatomic reconstruction and functionality, it is a bulky foreign material which may lead to trochanteric bursitis.

This study has several limitations, such as: (1) this is a retrospective study with a limited number of patients spanning over 10 years, (2) there was no control group of patients treated by osteosynthesis technique to make an appropriate comparison. (3) This study focused on unstable intertrochanteric fractures only, (4) Uneven number of patients in the 2 groups that are being compared. The strengths of this study include (1) an experienced orthopedic surgery team, (2) same surgeons performed the hip reconstructive operations in all of the patients included in the study, (3) the radiologic evaluation was conducted by an independent radiologist, who had not been present in the OR.

6. Conclusion

As the aging population wellbeing increases with medical advances, new challenges arise in the management of intertrochanteric hip fractures. Numerous studies have shown the benefit of hip arthroplasty in the elderly in terms of early ambulation leading to subsequent decrease in postoperative complications, decreased revision rates secondary to implant failure in the osteoporotic patients. Furthermore, studies have shown the superiority of total hip arthroplasty to hemiarthroplasty in functional and economic aspects which is important in the increasingly active elderly patients. According to the results in this article and the literature, it can be an option to operate on these unstable intertrochanteric fractures with a total hip arthroplasty while reconstructing the trochanters with a hook plate and cerclage cables.

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Ethical approval

IRB.
03152.

Research registration Unique Identifying number (UIN)

1. Name of the registry: www.researchregistry.com
2. Unique Identifying number or registration ID: researchregistry7180
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/register-now#user-researchregistry/registerresearchdetails/614f9e7ed22669001f843e59/>

Author contribution

Ghadi Abboud: Data curation, Methodology, Writing- Original draft preparation, analysis and interpretation of data. Joseph Maalouly: Conceptualization, Methodology, Writing- Original draft preparation, analysis and interpretation of data. Antonios Tawk: Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing. Dany Aouad: Data curation, Methodology. Rami Ayoubi:

Conceptualization, Data curation, Methodology. Talal Najm: Data curation, Methodology. Gerard Hajj: Data curation, Methodology. George El Rassi: Conceptualization, Methodology, Supervision. Alexandre Nehme: Conceptualization, Methodology, Supervision.

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Declaration of competing interest

The authors declare no conflict of interest.

List of abbreviations

| | |
|----|---|
| IV | intravenous |
| AO | Arbeitsgemeinschaft für Osteosynthesefragen |
| SD | standard deviation |

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.103075>.

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