



High comorbidity index is not associated with high morbidity and mortality when employing constrained arthroplasty as a primary treatment for intertrochanteric fractures in elderly patients

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Abstract

Aim The aim of our study is to investigate the results of constrained total hip arthroplasty as a primary treatment of intertrochanteric fractures (ITF) in elderly patients with high comorbidities.

Materials and methods Total hip replacement (THR) with a retentive cup was performed on 73 patients with ITF over the age of 54 years who had high comorbidities and a Charlson score above five. Short- and long-term complications were determined by follow-up. Bivariate analysis was conducted in order to determine the possible determinants of mortality and factors associated with comorbidity as measured by the Charlson comorbidities index.

Results Patient demographics that consisted of females (58.9%) ($p < 0.04$) with the mean age of both males and females demonstrated no statistical significance. The mean hospitalization time and weight bearing time were 11 and 2.67 days, respectively. Only 4.1% needed re-intervention due to re-fracture and none due to prosthesis failure. There was a statistical significance between the comorbidity index and the mortality rate. However, no statistical significance was identified between the comorbidity index and the functional status after constrained THR.

Conclusion High comorbidity index is not associated with high morbidity and mortality when employing constrained arthroplasty as a primary treatment for ITF in elderly patients.

Keywords Total hip replacement · Metallic implant · X-ray · Intertrochanteric fractures

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Introduction

Hip fractures are a leading cause of mortality and morbidity among the elderly [1]. The risk of hip fractures increases with age [2]. Management and treatment of elderly patients aims to reduce morbidity by early rehabilitation, restoration of the anatomic alignment and reduction of the rate of re-operation [3]. There is a wide array of management that have been proposed for intertrochanteric fractures (ITF), such as dynamic compression sliding plate, fixed angle blade plate, intramedullary sliding hip screw and external fixator [4]. There has been for many years consensus regarding the treatment for femoral neck fractures for elderly patients by total hip replacement, and the optimal treatment for intertrochanteric fractures is still under debate [3]. However, comparative studies between internal fixation (IF) and total hip replacement with the alter previous studies have also found THR following failed internal fixation after intertrochanteric fracture led to increased risk of early complication, inferior hip function and higher revision rate [5]. Nevertheless,

restrained arthroplasty has not been widely used as a primary treatment.

The overall failure rate in patients after IF in ITF was reported to be between 3 and 49% [6, 7], and the rate is higher in elderly patients due to the coexistence of osteoporosis and various comorbidity conditions. For a group with high Charlson comorbidity index (CCI), elderly patients recovered faster with THR compared to IF [6]. Nevertheless, recent studies [8–12] have demonstrated that elderly patients with osteoporosis had high rate of complications after IF in the treatment of ITF which resulted in excessive collapse, loss of fixation and cutout of the lag screw resulting in poor function. The rate of complication due to osteoporosis ranges from 4 to 56% due to the bone fragility and the unstable nature of the bone construct [13], and the reoperation rate is estimated between 8 and 16% [8].

Reoperation in these categories of patients carries high incidence of medical complications estimated between 22 and 50% [12]. Additionally, secondary replacement after a failed internal fixation is technically more complex and the results are unpredictable [11], with particular emphasis on the long periods of bed rest between 4 and 6 weeks [8], and patients are unable to tolerate partial weight bearing due to their cognitive impairment, and this increases the risk of complications and the mortality rate [14]. Due to high rate of failure and complications after IF, THR has been suggested by some authors [12] as primary treatment for intertrochanteric fractures in elderly comorbid patients. The aim of our study is to investigate the results of constrained total hip arthroplasty as a primary treatment for intertrochanteric fractures in elderly patients with high comorbidities.

Materials and methods

This study was approved by our local institutional review board. Multicenter study involved 73 patients that were retrospectively reviewed between January 2010 and October 31 2014 who underwent total hip replacement for ITF by the same orthopaedic surgeon. Inclusion criteria for the study were patients aged greater than 52 years, Charlson score above 5 and patients with ITF treated by THR with retentive cup. The exclusion criteria were determined by patients that had pathological, subtrochanteric, femoral head or isolated (greater or lesser trochanteric) fractures that were not treated by THR and all other fractures that employed internal fixation plate and screws.

Surgical approach

All patients were operated through a lateral approach under general or spinal anesthesia, and a lateral incision is made and centered over the tip of the greater trochanter. For femoral neck fracture, the length of the incision is approximately 12 cm, and

for intertrochanteric fractures, the incision is extended distally, as necessary, to enhance the exposure of the femur. In obese patients, the fat plane is gently undermined to facilitate fascia closure.

The fascia Latakie is opened longitudinally. The posterior aspect of the greater trochanter and of the gluteus medius is identified. The dissection is then carried out till the insertion of the piriformis. The latter is released close to the bone and mounted on a stay suture than the capsule is opened and mounted on stay suture. The femoral neck is exposed and the resection line marked according to the preoperative planning. The femur is prepared first. More often this will allow a better exposure of the acetabulum.

Next, the acetabulum is prepared according to the preoperative planning. The final cup is inserted at 45° inclination and 25° anteversion aiming at a total version of 40°. On top of the use of the guides, the transverse ligament is typically used as a major landmark. A constrained retentive polyethylene cup is inserted next. The trial femoral implant is inserted. Trial reduction is made. The final femoral implant is inserted. A femoral head with the proper neck length is adapted to the femoral implant. The hip is reduced. The capsule and the piriformis are reinserted without tension. If indicated, i.e., for intertrochanteric fractures, the greater trochanter is fixed either by a tension band or simple wiring. Hence, the reinsertion of the gluteus medius is carefully secured. A drain is used in 70% of patients without any suction, and the soft tissues are closed in layers.

Patient medical record files were reviewed, and patient comorbidities, radiology reports and imaging, laboratory results, physical examinations and postoperative treatment and outcomes were analyzed. Long-term complications were also determined by follow-up employing the Katz and Akpom, and Charnley pain score.

Data were analyzed using SPSS 18 (Statistical Package for Social Sciences, Chicago, Illinois). Descriptive analysis was performed in order to obtain a descriptive account of the baseline characteristics as well as variables such as mortality status, functional status and postsurgical complications. At a later stage, and after recoding variables when needed, bivariate analysis was conducted in order to determine the possible determinants of mortality and factors associated with comorbidity as measured by the CCI. *p* values were computed using independent samples *t* test, ANOVA and Chi-square. *p* values were compared against a significance level greater than 0.05.

Results

Patient demographics, Charlson score and comorbidities

The study retrospectively reviewed 73 patients, who underwent THR for an ITF. All surgeries were performed by the

same orthopedic surgeon. The majority of patients were females (58.9%) ($p < 0.04$). Mean age of both males and females demonstrated no statistical significance.

The CCI that was less than 7 demonstrated significance in females being double ($n = 20$) than that of males ($n = 10$) ($p < 0.03$). This would indicate that a large proportion of female patients undergoing THR have a higher comorbidity. There was no statistical difference between males and females in the range above 7 and 10 of the CCI index (Table 1).

Medical comorbidities that patients endured were components of the CCI. Cardiovascular, neurological and endocrinological problems were the three most frequent medical comorbidities (59, 24 and 31 patients, respectively) (Table 1).

Surgery, hospitalization and functional status

The mean operative time was 99.18 min with times ranging between 55 and 180 min (time taken from anesthesia sheet). Mean drop in hemoglobin (pre-op hemoglobin minus the first post-op hemoglobin) was 1.56 and ranged from -2.2 to 4.60. The negative values in this range were observed in patients who needed blood transfusion. On average, 2.11 units of packed red blood cells (PRBC) was required per patient in the range of 0–14 units. For patients who had a blood drain, the mean blood loss was 39.00 mL in the range of 5–120 mL.

Mean hospitalization time was 11 days in the range of 2–45 days. The time for total weight bearing was 2.67 days on average (range = 1–24 days) (Table 2).

The distribution of patients by their score on the Katz and Akpom scale relies on the basic activities of daily living to

measure the functional status in the patients. This score was computed for the 68 patients only excluding the five patients who passed at the hospital, the two patients who were lost to follow-up and the seven patients that were completely dependent before the fracture. Of these 68 patients, 5.9% were completely dependent on others, 10% were dependent on others for most activities, 10% were independent except for some activities and 74.1% were completely independent (Table 2).

The time required for sitting and standing was 55.12 days on average (range = 2–150 days), knowing that data on this question were obtained for 68 patients (93.1%) while five (6.9%) were suffering from incapacity. The time required for walking through use of walking aid was 51.08 days on average (range = 7–365 days). The functional status score computed following the Katz and Akpom method averaged 3.28 in the range of 1 (min)–4 (max) (Table 2).

Association between Charlson and functional status variables

There was no demonstrable significant statistical association between patients' Charlson score and their functional status variables. This finding suggests that even for highly comorbid patients, total hip replacement provides the opportunity for early mobilization and a better functional outcome (Table 3).

Short- and long-term complications

Inhospital complications (short term) occurred in 26 patients (35.6%) who had suffered from postsurgical complications. The highest proportion of patients suffered from postsurgical

Table 1 Distribution of patients according to their baseline characteristics and comorbidities

| | Male | Female | Sig. |
|---------------------------|--------------|---------------|------|
| Number | 30 | 43 | 0.04 |
| Age | 82.78 ± 9.37 | 82.61 ± 12.12 | ns |
| Charlson score | | | |
| < 7 | 10 | 20 | 0.03 |
| 7–10 | 20 | 17 | ns |
| > 10 | 3 | 3 | ns |
| Disease/disorders | | | |
| Connective tissue | 2 | 1 | ns |
| Gastroenterological | 4 | 3 | ns |
| Hematological–oncological | 4 | 3 | ns |
| Nephrological | 3 | 6 | ns |
| Pulmonary | 6 | 6 | ns |
| Endocrinological | 15 | 16 | ns |
| Neurological | 11 | 13 | ns |
| Cardiovascular | 30 | 29 | ns |

Table 2 Distribution of patients by surgical time, hospitalization, time for weight bearing and patient functional status postsurgery

| | Frequency | % |
|--|-----------|-------|
| Surgery time (min) | 99.18 | 31.85 |
| Hospitalization (days) | 11.02 | 6.88 |
| Time for weight bearing (days) | 2.67 | 3.56 |
| Functional status (Katz and Akpom Scale) | | |
| Complete dependence (score = 1) | 4 | 5.9 |
| Dependence on others in most activities (score = 2) | 7 | 10.0 |
| Independence except for some activities (score = 3) | 7 | 10.0 |
| Complete independence (score = 4) | 50 | 74.1 |
| Functional status variables | | |
| Time required for sitting and standing alone (in days) | 55.12 | |
| Time required for use of walking aid (in days) | 51.08 | |
| Functional status (Katz and Akpom scale) | 3.28 | |

Table 3 Distribution of the patients by their Charlson score and functional status variables \pm = standard deviation

| | <7 | 7–10 | > 10 | <i>p</i> |
|--|-----------------|-----------------|-----------------|----------|
| Time for weight bearing in days | 3.2 \pm 5.0 | 2.3 \pm 1.6 | 1.8 \pm 0.8 | 0.401 |
| Time required for sitting and standing in days | 53.6 \pm 21.4 | 56.0 \pm 29.7 | 60.0 \pm 21.2 | 0.833 |
| Time required for use of walking aid in days | 45.2 \pm 28.5 | 57.9 \pm 60.6 | 44.8 \pm 18.8 | 0.467 |
| Functional status (Katz and Akpom scale) | 1.8 \pm 0.3 | 1.7 \pm 0.4 | 1.8 \pm 0.4 | 0.338 |

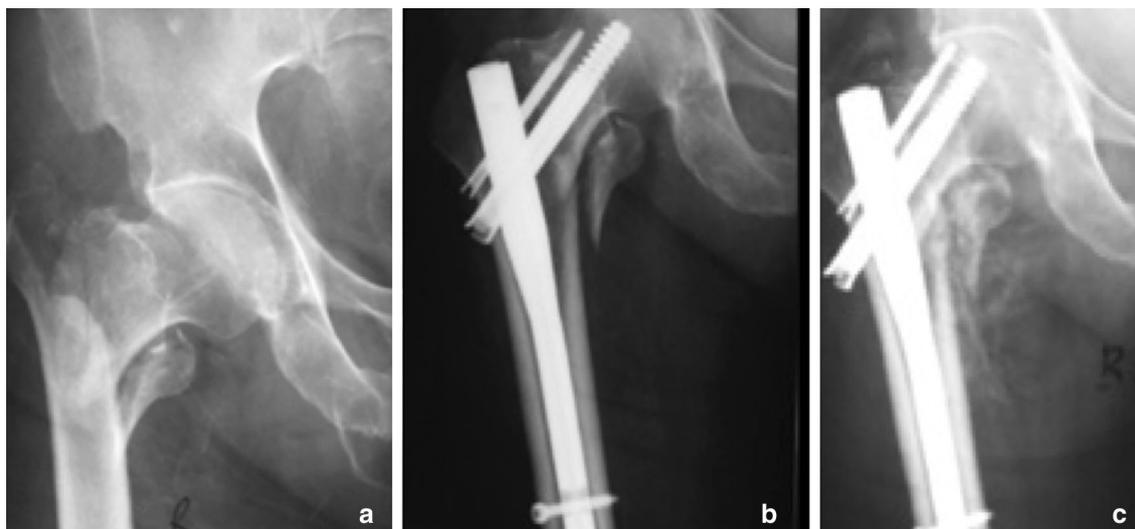


Fig. 1 Eighty-nine-year-old patient with multiple comorbidities including Alzheimer's disease, CAD, PVD, DM and hypertension presented after a fall with right intratrochanteric fracture (a), b and c

demonstration of implant failure after surgery of the same patient; the screws are out of the femoral neck. Because of osteoporosis, a weak interface between screws and the bone results in fixation failure

complications including urinary tract infection (15.4%) and postsurgery pneumonias (3.8%) while the remaining suffered from other postsurgical complications. Surgical site infections ($n=3$) were superficial and treated by removal of alternate stitches, daily wound dressing and antibiotics therapy according to sensitivity pattern, and the other ($n=1$) sustained a deep wound infection treated by drainage.

Long-term complications were determined by death after discharge: need for re-intervention and dependence on others for daily living. Out of the 73 patients, 16 (21.9%) passed after discharge. Concerning the need for a re-intervention, 57 (78.1%) did not require re-interventions, three (4.1%) needed a revision and one (1.0%) needed drainage for surgical site infection (Fig. 1). As for their functional status based on the Katz and Akpom score, 18 (24.6%) were completely dependent on others or dependent on others in most activities (Table 4).

Pain management

The majority of the patients (93.1%) responded well to pain medication. As for the Charnley score, 58.8% of the patients scored 1, 35.3% had a score of 2 and a minority of 5.9% had a score between 3 and 5 (Table 5).

Table 4 Distribution of patients by their long-term complications

| | Frequency | Percentage |
|---|-----------|------------|
| Death after discharge | 16 | 21.9 |
| Needed re-intervention | | |
| Peri-prosthetic fracture | 3 | 4.1 |
| Needed drainage | 1 | 1.0 |
| Dislocation | 0 | 0 |
| Dependence based on Katz and Akpom score | | |
| Complete dependence/dependence on others in most activities (score = 1–2) | 18 | 24.6 |

Mortality and survival rates

The distribution of the study patients by mortality and possible determinants including age, time since surgery, operative delay (time between hospital admission and surgery), Charlson score and gender. Out of these potential determinants, three: age, Charlson score and gender, demonstrated significant statistical association with mortality at a 0.05 significance level. The mean age for deceased patients was

Table 5 Distribution of patients by pain-related variables

| | Frequency | Percentage |
|---|-----------|------------|
| Pain well controlled on pain medication | | |
| Yes | 69 | 94.5 |
| No | 4 | 5.5 |
| Charnley pain score | | |
| 1 | 44 | 60.4 |
| 2 | 27 | 36.9 |
| 3 | – | – |
| 4 | – | – |
| 5 | 2 | 2.7 |

Table 6 Distribution of patients by mortality and possible determinants

| | Patient deceased at the end of the study | | <i>p</i> value |
|-----------------------------|--|---------------|----------------|
| | Yes | No | |
| Age (years) | 86.35 ± 6.85 | 81.51 ± 8.65 | <i>0.011</i> |
| CCI | 8.19 ± 1.57 | 6.84 ± 1.85 | <i>0.001</i> |
| Operative delay (days) | 2.08 ± 1.85 | 2.54 ± 3.58 | 0.531 |
| Time since surgery (months) | 35.92 ± 15.00 | 30.74 ± 15.25 | 0.136 |

Statistically significant values are in italic

86.35 while that of the non-deceased patients was 81.51 (*p* value = 0.011) (Table 6).

The mean Charlson score for deceased patients was 8.19 while that of non-deceased patients was 6.84 (*p* < 0.001). Among males, 37.5% were deceased at the end of the study compared to only 18.6% among the females (*p* < 0.053). Mortality and time since surgery were not statistically associated indicating that mortality rate was independent of time since surgery.

The mean operative delay of 2 days there was difference in mortality. Nevertheless, all patients underwent surgical intervention after optimization of medical comorbidities and the duration of optimization was between 2 h and 20 days with an average of 2.4 days. Only 11.5% of the patients waited for more than 3 days before surgery, while 3.8% were operated on the same day and 39.4% were operated the next day. Finally, the average follow-up period was 3.6 years (range 1–6.3 years).

Discussion

Employing internal fixation in stable IF in young patients is considered since they can tolerate immobilization and reoperation. However, in elderly debilitated patients, prolonged immobilization or reoperation carries a high

incidence of medical complications and comorbidities. Our study demonstrated that there were no dislocation in the postoperative period and no need for re-intervention due to prosthesis failure. But, when compared to the literature, the need for re-intervention after IF in elderly patients is high [13].

Patient mobility is key to patient outcomes after THR, especially with patients that have cognitive impairment. In our study, the mean time of weight bearing was 2.67 days post-op and most of the patients regained the previous walking abilities and became independent compared to patients treated with IF who had weight bearing time that ranged from 4 to 6 weeks [8]. Early assisted ambulation accelerates the functional recovery and reduces the rate of complications related to prolonged bed rest such as pulmonary embolism, deep venous thrombosis, pneumonia and bed sores. Nevertheless, pain can be a limiting factor for successful rehabilitation, so relieving pain is an equally important goal in the treatment for hip fracture as enabling patients to move as soon as possible. All patients in our study that had a Charnley score of 1 and 2 demonstrated well-controlled pain without or with pain medications.

One of the major technical issues is postoperative stability of the hip. It has a major bearing on patient mobilization and rate of re-intervention, hence on the vital prognosis. Both mechanical stability and dynamic stability have to be considered. The former should be tackled by proper preoperative planning and accurate surgical technique.

The surgeon should not rely only on the implant constraint, hence on the intrinsic stability of the construct. Instead, one should achieve adequate positioning of the acetabular and femoral implants. Since we invariably use the posterior approach, we aim at a total version of 40°–45°. The cup is implanted at an inclination of 45° and at 25°–30° of anteversion.

The femoral implant is fitted at 15° of anteversion. If the press fitting and the quality of the bone allow proper primary fixation, the components are implanted without cement. If the primary fixation is deemed inadequate, cemented implants should be used without hesitation. Hybrid fixation is the most common scenario in this subgroup of patients.

With the proper version being achieved, the implant constraint will help compensate for lack of inadequacy of dynamic hip stabilizers.

In case the fracture is a pertrochanteric or intertrochanteric, the greater trochanter should be properly fixed using either aubanage, cerclage wiring or trochanter ice plate as deemed necessary. Gluteus medius reconstruction is hence a major part of hip reconstruction. Failing to do so entails failure of the arthroplasty. This muscle is the major dynamic stabilizer of the hip. Before closure, the capsule and the piriformis tendon are reinserted to the posterior

aspect of the greater trochanter. This will also consistently increase hip stability.

Measuring the CCI relative to the mortality rate and functional status is a key indicator in patients with IF that are treated with THR. In our study, there is a significant relationship between CCI and mortality rate and these findings are not surprising, as one would expect increased mortality with increasing age and comorbidities. Patients in our series had a mean CCI of 7.19 (age combined with comorbidities), and all of them had a CCI of 5 or greater, which suggest that they have multiple medical comorbidities and are presumed to have a higher mortality rate 1 year after the surgery. Most of the previous studies [1, 3, 8] do not take into account the relationship between post-op functional status and CCI after hip fracture, and this is one of the strengths of our study. Despite this, our study demonstrated the overall 1-year mortality rate which was 17.6%. Additionally, when comparing the relationship between CCI and functional status after THR, there was no statistical significance. This could elude to achieving the same functional status after the operation regardless of the age and the comorbidities of these patients. Finally, for patients that underwent THR with comorbidities, it provides a greater opportunity for better functional outcome when compared to IF.

The predictors of mortality in patients with IF undergoing THR are seen to occur 1-year post-operation fracture with mortality rate ranging from 14 to 36% [15, 16]. The results obtained by Koval et al. [15] suggest that increased age, male gender, poorly controlled systemic disease, psychiatric illness (components of Charlson score) and postoperative complications are associated with increased risk of death after hip fracture. In comparison, Sebestyén et al. [17] studied the relationship between the operative delay and the mortality rate in elderly patients with femoral neck fracture operated by THR and showed that there is no statistically significant relationship between mortality rate and operation interval at 12–24 h, 24–48 h and over 48 h. However, he showed that age, sex and accompanying diseases significantly influence mortality. In our study, increased incidence of mortality was seen in patients with high CCI and age. It was independent from a mean operative delay of 2 days and from time since surgery.

The limitations include the retrospective design and lack of control group (elderly patients with PFF treated by IF) which have been compared to results from the literature. In addition, patients joined the study at different times and the follow-up time is different.

Conclusion

High comorbidity index is not associated with high morbidity and mortality when employing constrained arthroplasty as a primary treatment for intertrochanteric fractures in elderly patients.

Compliance with ethical standards

Conflict of interest All authors declare that there is no financial, family or any other person related to them that have had any form of involvement in the study other than the authors stated. There are no financial, academic or clinical conflicts when this study was being developed, executed, reviewed, written and submitted to this journal.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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