Bipolar prosthesis in elderly patients with unstable intertrochanteric hip fractures. Functional outcomes and reoperation rate after the first 100 cases

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ABSTRACT

Introduction: The purpose of this retrospective study was to evaluate the functional outcomes, complications, and reoperations for the treatment of unstable intertrochanteric hip fractures by bipolar hip arthroplasty in elderly patients. **Materials and Methods:** We analyzed >70-year-old patients with unstable intertrochanteric hip fractures undergoing surgery between 2002 and 2013. Fractures were classified according to the OTA/AO classification. The analysis included length of hospital stay (LOS), Charlson comorbidity index (CCI), time to weight-bearing, need for weight-bearing assistance, all complications related to the procedure, and the reoperations rate. **Results:** Study population consisted of 100 patients (84 females, 16 males), with 101 fractures. Average age was 82.4 years (range, 72-102 years). Fractures were categorized as A2.2 in 59 cases and A2.3 in 42 cases. The average CCI was 6.23 (range, 4-9). The average LOS was 6.95 days (range, 5-18). Weight-bearing ambulation started on postoperative day 2 in 87,12% of cases. The average Harris hip score (HHS) was 84.7 (range, 69-92). The average follow-up period was 28.4 months (range, 12-40). There were 7 (6.93%) complications: 2 (1.98%) deep venous thrombosis, 1 (0.99%) pulmonary thromboembolism, 3 (2.97%) periprosthetic infections and 1 (0.99%) dislocation. The reoperation rate was 2.97%. Complications were significantly related to age (P=0.005) and to ICC (odds ratio [OR]: 2.8071; 95% confidence interval [CI]: 1.4105-5.58669). **Conclusions:** Bipolar prostheses allowed for early rehabilitation with acceptable functional outcomes, associated with a low complication rate (6,93%) and a low reoperation rate (2,97%).
Key words: Elderly patients, intertrochanteric hip fracture, bipolar prosthesis, hemiarthroplasty, functional outcomes, reoperation.
Level of Evidence: IV

Prótesis bipolares en pacientes añosos con fractura lateral inestable de cadera. Resultados funcionales y tasa de reoperación luego de los primeros 100 casos

RESUMEN

Introducción: Se realizó un estudio retrospectivo para evaluar los resultados funcionales, las complicaciones y las reoperaciones del tratamiento con prótesis bipolar en adultos mayores con fracturas intertrocantéricas inestables de cadera. **Materiales y Métodos:** Se evaluó a pacientes >70 años con fracturas laterales inestables de cadera operados entre 2002 y 2013. Las fracturas se clasificaron según la OTA/AO. Se analizaron los días de internación, el índice de Charlson, el día que comenzaron la marcha, la necesidad de asistencia para deambular, toda complicación relacionada con el procedimiento y la tasa de reoperaciones. **Resultados:** Se incluyeron 100 pacientes (84 mujeres y 16 hombres) con 101 fracturas. La edad promedio era de 82.4 años (rango 72-102). Cincuenta y nueve fracturas eran del subtipo A2.2 y 42, del A2.3. El índice de Charlson promedio fue de 6,23 (rango 4-9) y el tiempo promedio de internación, de 6.95 días (rango 5-18). El 87% comenzó la marcha al segundo día poscirugía. El HHS promedio fue de 84,7 (rango 69-92) y el seguimiento promedio, de 28.4 meses (rango 12-40). Hubo 7 (6,93%) complicaciones: 2 (1,98%) trombosis venosas profundas, 1 (0,99%) tromboembolismo pulmonar, 3 infecciones (2,97%) y 1 (0,99%) luxación. La tasa de reoperaciones fue del 2,97%. Las complicaciones se relacionaron significativamente con la edad (p = 0,005) y el índice de Charlson (*odds ratio* 2,8071; IC95% 1,4105-5,58669). **Conclusiones:** El tratamiento con prótesis bipolar permitió una rápida rehabilitación con puntajes funcionales buenos o excelentes en el 93% de la serie, asociados a una baja tasa de complicaciones y de reoperaciones.
Palabras clave: Pacientes añosos; fractura lateral de cadera; prótesis bipolar; resultados funcionales, reoperación.
Nivel de Evidencia: IV

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INTRODUCTION

Unstable intertrochanteric hip fractures have a high incidence rate in the elderly.[1] Gait alterations result in more falls from standing height, which represent the main cause of these fractures in osteoporotic bones.[1,2]

Comorbidities and the high one-year mortality rate (reaching 25%) require these "fragile" patients to undergo a treatment that allows for early rehabilitation without weight-bearing restrictions.[1,3]

Owing to the anatomical characteristics of the intertrochanteric region, internal fixation using cephalomedullary nails obtain satisfactory bone union in these fractures, resulting in this method being the first treatment option.[2-4] However, in elderly patients, osteoporosis, partial weight-bearing difficulties, and fixation failure in comminuted fractures have led to the use of prosthesis in *selected* patients to be reported as a treatment option for several years.[3-6]

In 2000, Broos and Fourneau[6] reported that the prosthetic treatment failure and reoperation rates were lower in >80-year-old patients with poor bone quality and unstable comminuted fractures.

In 2018, Rottela *et al*.[7] published a comparative study between cephalomedullary nail and bipolar prosthesis outcomes in >70-year-old patients with intertrochanteric fracture, where they reported similar functional scores between both groups and highlighted the early rehabilitation and resumption of full weight-bearing in the patients with bipolar prostheses, with lower complication and reoperation rates, which they associated with the patients' early mobilization.

The purpose of this study was to evaluate the functional outcomes, complications, and reoperations for the treatment of unstable intertrochanteric hip fractures by bipolar hip arthroplasty in elderly patients.

MATERIALS AND METHODS

Between 2002 and 2013, at our center, a total of 165 unstable intertrochanteric hip fractures were treated with hip arthroplasty. The inclusion criteria were: unstable intertrochanteric hip fractures, bipolar hip arthroplasty, age over 70, and a 12-month minimum follow-up.

Patients with total hip arthroplasty, surgical history on the affected hip, pathologic fractures, or less than a 12-month follow-up were excluded.

Fractures were classified according to the OTA/AO classification. Unstable fracture was defined as showing comminution or involvement of the posteromedial cortex or comminution of the lateral cortex.

Patient selection criteria for the bipolar hip arthroplasty were: elderly patients (>70 years), poor bone quality (radiography established), ability to walk indoors or within a block's radius from their homes, and no signs or symptoms of hip osteoarthritis.

All prostheses were of Argentine origin (Implantes Fico, Ortopedia Alemana, Argentina), consisting of Charnley cemented stems and, when available, modular necks. According to the level of the intertrochanteric fracture line, standard neck prostheses or 10-20mm extra length prostheses were used.

All surgeries were performed by the same surgical team, at a laminar flow operating room, via a Bauer direct anterolateral transgluteal approach, with the patient in the supine position and under hypotensive spinal anesthesia, unless anesthetic or cardiological expressed contraindication where the general anesthesia was administered due to comorbidities.

No case involved trochanteric cerclage; in all cases, an uninterrupted suture of the abductor mechanism was performed. In all cases, antibiotic-impregnated cement (1g vancomycin/40g cement) was used. A distal plug was placed to pressurize cement, and cement application was performed with a digital method. Low-molecular-weight heparin and lower limb compression bandage were administered to prevent thromboembolic complications, and doses (1g) of IV cefazolin (1 before and 2 after surgery) were administered to prevent infectious complications.

Rehabilitation therapy was instituted the first day after surgery with isometric exercises and sitting on the bed; on postoperative day 2, patients began standing and weight-bearing walking with a walker, according to tolerance.

Postoperative controls were performed at 3 and 6 weeks, 3 and 6 months, 1 year, and annually thereof. Patients who had failed to attend the last annual control or who had had the surgery within a year of this study were contacted for a control visit, asked whether they walked, and, if so, whether they needed weight-bearing assistance, and asked to perform a radiographic control.

The study analysis included the days from admission to surgery due to the presence of comorbidities that resulted in patients requiring clinical stabilization before surgery. Other study variables were comorbidities (using the CCI), LOS, time to weight-bearing, need for transfusions, all complications related to the procedure, and the reoperation rate.

For the objective analysis of outcomes, we used the HHS,[8] with outcomes graded into excellent, good, fair, and poor. In addition, although considered under the HHS, we performed an independent analysis on the need for weight-bearing assistance and the patient's ability to walk indoors and outdoors.

Radiographic evaluation

Lower limb length was measured manually inter-teardrop and bi-ischial lines as pelvic landmarks and a fixed reference point on the femur. The acceptable length difference was established as being equal or within ±5 mm.

Prosthesis loosening was studied by the detection of demarcation lines and any change they showed over time, between the first and last radiographic study.

The presence of greater trochanter pseudarthrosis (>25mm intertrochanteric ridge separation) was also considered.

Statistical analysis was performed with Graph Pad PRISM-7.4. Continuous variables are presented with mean and standard deviation, and categorical variables are presented with absolute values and percentages. Results were compared using the Student's t-test, the Fisher's Exact Test, and the Mann Whitney test to establish significant associations. Values were considered to be statistically significant at $P<0.05$.

RESULTS

Sixty-four patients were excluded: 31 had undergone total hip replacement, 14 had pathologic fractures, 10 had previous surgeries, and 9 were lost to follow-up and unable to be contacted by telephone.

Based on the inclusion and exclusion criteria, the final study population consisted of 100 patients with 101 bipolar prostheses. The case of bilateral replacement had a 27-month gap between fractures. The study population was conformed by 84 females (84%), and 16 males (16%), averaging 82.4 years (range, 72-102).

Fractures were categorized according to the OTA/AO classification as A2.2 in 59 cases and A2.3 in 42 cases.

Preoperative comorbidities

Regarding pathological history and comorbidities, 78% of patients had at least 3 prior conditions, 45% more than 4, and 25% more than 5. The most common conditions were: high-blood pressure, dyslipidemia, diabetes, hypothyroidism, and heart conditions (intravascular stents, pacemakers, valve surgery). Ten patients (10%) had history of contralateral hip fracture, in 4 cases treated with internal fixation, and in 6 cases with arthroplasty. The average CCI was 6.23 (range, 4-9), with a median score of 6.

Ability to walk before surgery

Forty-two patients were able to walk outdoors (within a block's radius from their homes), 54 walked indoors, and 4 did not walk. Before surgery, 65% used a cane or a walker.

Inpatient variables

The average delay from admission to surgery was 2.8 days (range, 1-18). Seventy-two patients underwent surgery within 72 hours from admission, and a subgroup of 28 patients (29 cases) required clinical stabilization before surgery. The average delay from admission to surgery for this subgroup was 5.5 days (range, 4-18).

The most common reason for surgical delay (13/28; 46.2%) was anticoagulant medication for different conditions. The average LOS was 6.95 days (range, 5-18).

Standard neck prostheses were used in 14 cases, 10mm-extra length neck prostheses in 58, and 20mm-extra length neck prostheses in 29 (Figure 1).

After surgery, 28 patients (28%) received at least 1 unit of blood transfusion and, during surgery, 5 received at least 1 unit of blood transfusion while 6 patients received platelets.

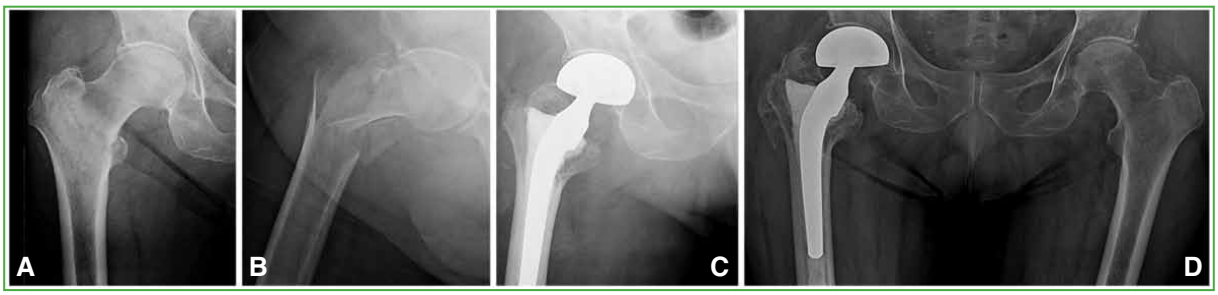

Figure 1. Woman of 73 years of age. **A and B.** Preoperative lateral and anteroposterior traction radiographs evidencing greater trochanter comminution and lesser trochanter involvement. **C.** Radiograph from the immediate postoperative showing a bipolar prosthesis with a 20mm-extra length neck. **D.** Radiograph from the 14-month postoperative control showing bone union, adequate cement distribution, and acceptable length.

Walking and need for weight-bearing assistance after surgery

Eighty-eight patients (87.12%) started walking on postoperative day 2, 10 (9.9%) during the following days, and 3 did not walk (they did not walk before surgery either).

At last follow-up, 69% needed assistance to walk. Thirty-eight patients (37.62%) walked outdoors, 59 (58.41%) only walked indoors, and 3 were only able to stand.

Average HHS at final follow-up was 84.7 (range, 64-92), with 62 cases graded as excellent, 32 as good, 5 as fair, and 2 as poor.

Radiographic results

The lower limb measurement showed that 91 hips (90.1%) had a length difference within ±5 mm and 10 (9.9%) without ±5 mm. Six patients had an average shortening of 7.3mm (range, 6-8) and 4 an average lengthening of 6.8mm (range 6-9) (Figure 2).

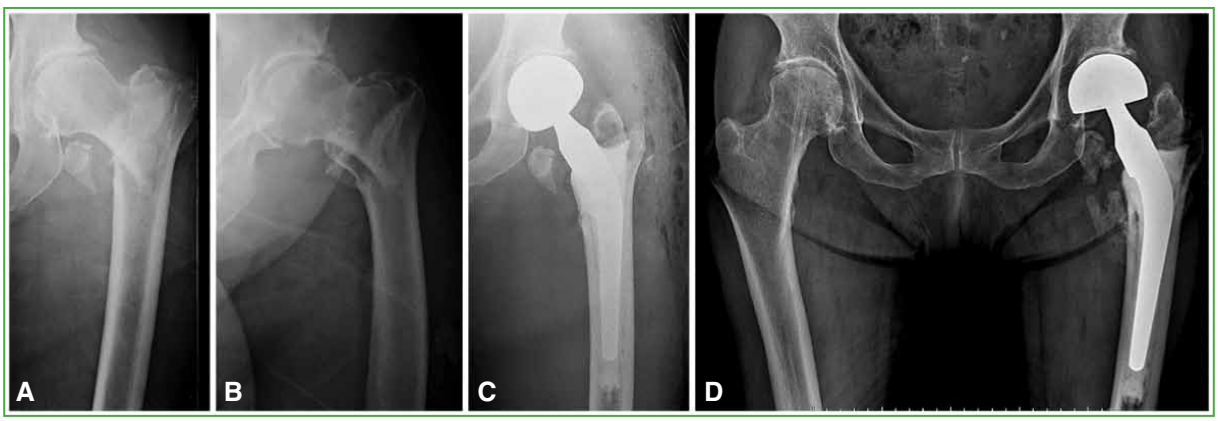

Figure 2. A and B. Fracture radiographs evidencing greater trochanter comminution and lesser trochanter avulsion. **C.** Radiograph from the 3-month postoperative control. **D.** Radiograph from the 17-month postoperative control showing no signs of cement delimitation that would suggest loosening, and acceptable limb length.

Greater trochanter pseudarthrosis was detected in 28 cases, 11 of them in Trendelenburg position. No signs of loosening were radiographically detected at final follow-up.

Complications, reoperation rate, mortality rate

Recorded complications were: 2 cases of deep venous thrombosis (1.98%) that had a favorable course with medical treatment; 1 case of pulmonary thromboembolism (0.99%) that required an ICU stay of 3 days, venous filter implantation, and antiaggregant treatment, and had a favorable course.

Three patients (2.97%) had acute infections. Two were successfully treated with surgical debridement while the third, a morbidly obese patient with uncontrolled type 1 diabetes mellitus and a history of multiple heart conditions, required two surgical debridements and died a month after surgery.

One patient (0.99%) had a posterior dislocation of the prosthesis, 16 months after surgery, after suffering a standing-height fall. The patient underwent a closed reduction and experienced no recurrence.

Reoperation rate was 2.97%, with all surgeries being surgical debridements. No prosthesis revision surgeries were required.

The 12-month mortality rate was 12.94% with 2 patients who died in the early postoperative period (within 4 weeks), and the mortality rate at last follow-up was 15.84%. The mean follow-up period was of 28.4 months (range, 12-40).

The variable analysis between the group of patients who suffered from at least one complication and those who did not suffer from any complications yielded a significant association between complications and age (P=0.005). Patients who suffered from complications were 5.68 years older (89.42 vs 83.74).

The analysis of the patients' history showed that for each additional CCI point the likelihood to suffer a complication almost tripled (OR: 2.8071; 95% CI: 1.4105-5.58669).

The remaining study variables showed no significant differences: LOS, P=0.053; transfusions, P=0.512; fracture subtype, P=0.063.

DISCUSSION

The main findings of the study were that the prosthetic arthroplasty for unstable intertrochanteric hip fractures allows for 87% of the patients to start weight-bearing walking with a walker 48h after surgery, since progressive weight-bearing until fracture healing is no longer necessary, and 93% of the patients to achieve excellent or good functional outcomes.

Additionally, we found that the complication rate (6.93%) and the reoperation rate (2.98%) were relatively low, especially when compared to the international literature on the use of internal fixation for this type of fractures in the age group considered by this study.[3,5-7,9]

The study of this study complications showed a significant relation both with age and the CCI. Age is a well-known risk factor for postoperative complications following a hip fracture.[9,10] In this series, on average, the patients who suffered from complications were almost 6 years older than those who had no complications. With respect to the CCI, we found that for each additional CCI point the likelihood to suffer a complication increased by a factor of 2.8.

Although no case required prosthesis revision surgery, the need for reoperation was associated with infectious complications. Reoperation rate was 3%, which is higher than our Department's infection rate for primary arthroplasties (1%). However, as previously stated, the only significant risk factors associated with complications were age and the CCI.

Dynamic hip screw and cephalomedullary nail internal fixation methods are considered the first-choice treatments for stable intertrochanteric hip fractures; however, the treatment for unstable intertrochanteric hip fractures in patients over 70-80 remains controversial.[2,4,11]

We consider bipolar prosthesis to be a valid initial treatment option for *selected* patients, over 70, osteoporotic, with some degree of impaired walking ability and who, due to their comorbidities, require early mobilization to avoid prolonged bed rest.[4,5,11-17]

In their meta-analysis on postoperative rehabilitation, Yoo *et al*.[5] reported that time to walking and time to full weight-bearing were shorter in patients undergoing hemiarthroplasty (6-9 days) than in patients undergoing internal fixation (6 weeks).

In their comparative study between bipolar hemiarthroplasty and cephalomedullary nailing for the treatment of intertrochanteric fractures in >80-year-old patients, Fichman *et al.*[16] failed to find any significant differences in terms of LOS, rehabilitation, functional outcomes and requirement of blood transfusions but reported that cases associated with complications that required reoperation were six-fold higher in the cephalomedullary-nailing patients than in the bipolar-hemiarthroplasty patients, with a statistically significant difference.

In their study on >75-year-old patients, Ozkayin *et al.*[17] compared cephalomedullary nailing and bipolar hemiarthroplasty and reported better functional outcomes during the first three months in hemiarthroplasty patients, but better functional outcomes at last follow-up in cephalomedullary-nailing patients, with similar complication and reoperation rates between both groups.

Jolly *et al.*[18] conducted a comparative study on the complications associated with cephalomedullary nailing and bipolar hemiarthroplasty, and reported that cephalomedullary-nailing patients had higher rates of complications, including thrombosis, pulmonary thromboembolism and urinary tract infections, and of reoperations within the first postoperative year, and that bipolar-hemiarthroplasty patients had a higher infection rate, with both groups having a similar mortality rate (22%), which was associated with the patient's clinical history and not with the treatment.

Our functional outcomes in terms of the HHS were similar to those reported by Mukherjee and Ganguli[14] (84 points) and lower to those of Naik *et al.*[13] (92 points). Our 48-hour time-to-weight-bearing results were similar to those reported by Yoo *et al.*,[5] and the requirement of blood transfusion (28%) to those of Mukherjee and Ganguli[14] (30%) y Fichman *et al.*[16] (31%).

Our results for the need for weight-bearing assistance after surgery were higher than those of Mukherjee and Ganguli[14] (45%); however, we failed to compare this parameter with the rest of the studies as it is not specified, probably because it is considered by the HHS.

In our series, the incidence of deep venous thrombosis incidence was similar to the one reported by Jolly *et al.*[18] (4%). Our rate of cases associated with complications that required reoperation was 3%, which is similar to Fichman *et al.*[16] rate (3.4%) and inferior to Jolly *et al.*[18] rate (20%). Fichman *et al.*[16] reoperations were due to dislocations, and Jolly *et al.*[18] reoperation causes included infections (8%), dislocations (10%), and periprosthetic fractures (2%). The difference between their and our dislocation incidence may be associated with the surgical approach; however, dislocation is a multi-etiological complication and should be thoroughly addressed in future studies.

With respect to the approach performed in this series, we consider it favors fracture access and neck-head fragment removal since the intertrochanteric ridge in line with the abductor mechanism has a posterior displacement. Furthermore, the supine position favors both lower-limb measurement and anesthesia in this group of fragile patients.

The limitations of this study are those inherent to a retrospective study, including patients with numerous prior conditions, which combined or as a whole could lead to bias in terms of the observed complications.

The strengths of this study include the number of patients undergoing surgery at the same center, by the same surgical team, with identical preoperative and postoperative assessments, the same surgical technique, and the same prosthesis.

CONCLUSIONS

Although there seems to be no consensus in the English-language literature regarding the treatment of unstable intertrochanteric hip fractures by bipolar arthroplasty in elderly patients, with poor bone quality and significant pathological history, bipolar arthroplasty allows for early weight-bearing walking in the immediate postoperative period, and thus the decrease of potential complications associated to prolonged bed rest (however, it does not eliminate them).

Asepsis measures should be strictly followed to prevent infectious complications, considering the high infection rate of this series. Likewise, this study shows that the more elderly patients (around 90 years) should undergo a more thorough evaluation since this subgroup of patients had a significant relation with postoperative complications in our study.

Further properly designed studies with larger study populations are warranted to establish the best treatment option for this group of patients.

Conflict of interests: Authors claim they do not have any conflict of interests.

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REFERENCES

1. Peeters Ch MM, Visser E, Van de Ree C, Gosens T, Den Oudsten BL, Vries J. Quality of life after hip fracture in the elderly: A systematic literature review. *Injury* 2016;47(7):1369-82. https://doi.org/ https://doi.org/10.1016/j.injury.2016.04.018
2. Sidhu AS, Singh AP, Singh Ap, Singh S. Total hip replacement as primary treatment of unstable intertrochanteric fractures in elderly patients. *Int Orthop* 2010;34:789-92. https://doi.org/10.1007/s00264-009-0826-x
3. Kim WY, Han CH, Park JI, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. *Int Orthop* 2001;25(6):360-2. https://doi.org/10.1007/s002640100287
4. Kaplan K, Miyamoto R, Levine BR, Egol KA, Zuckerman JD. Surgical management of hip fractures: An evidence-based review of the literature. II: Intertrochanteric fractures. *J Am Acad Orthop Surg* 2008;16:665-73. https://doi.org/10.5435/00124635-200810000-00005
5. Yoo Jun-II, Ha Yong-Chan, Lim Jae-young, Kang Hyun, Yoon Byung-Ho, Kim Hyunho. Early rehabilitation in elderly after arthroplasty versus internal fixation for unstable intertrochanteric fractures of femur: a systematic review and meta-analysis. *J Korean Med Sci* 2017;32:858-67. https://doi.org/10.3346/jkms.2017.32.5.858
6. Broos PLO, Fourneau I. Intertrochanteric fractures: internal fixation or prosthetic replacement. *Acta Orthop Belgica* 2000;66(1):34-40. http://www.actaorthopaedica.be/archive/volume-66/issue-1/article/intertrochanteric-fractures-internal-fixation-or-prosthetic-replacement/
7. Rottela SK, Guru PS, K Harsha V, Harshavardhan R. Comparative study between proximal femoral nail and bipolar prosthesis in intertrochanteric fractures of the femur. *Int J Orthop Sci* 2018;4(1):708-13. https://doi.org/10.22271/ortho.2018.v4.i1k.102
8. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fracture: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am* 1969;51:737-40. PMID: 5783851
9. Jameson SS, Khan SK, Baker P, James A, Gray A, Reed MR, Deehan DJ. A national analysis of complications following hemiarthropasty for hip fracture in older patients. *Ann Int J Med* 2012;105(5):455-60. https://doi.org/10.1093/qjmed/hcs004
10. Iglesias SL, Gentile L, Vanoli F, Mangupli MM, Pioli I, Riikka EK, et al. Femoral neck fractures in the elderly: from risk factors to prognostic features for survival. *J Trauma Crit Care* 2017;1(1):16-21. https://www.alliedacademies.org/articles/femoral-neck-fractures-in-the-elderly-from-risk-factors-to-pronostic-features-for-survival.html
11. Elmorsy A, Saied M, Allah AA, Zaied M, Hafez M. Primary bipolar arthroplasty in unstable intertrochanteric fractures in elderly. *J Orthop* 2012;2:13-7. https://doi.org/10.4236/ojo.2012.21003
12. Butler M, Forte M, Joglekar SB, Swiontkowski MF, Kane RL. Evidence Summary: Systematic review of surgical treatments for geriatric hip fractures. *J Bone Joint Surg Am* 2011;93:1104-15. https://doi.org/10.2106/JBJS.J.00296
13. Naik LG, Badgire KS, Sharma GM, Qureshi F. Treatment of unstable intertrochanteric fractures with cemented bipolar prosthesis. A prospective study. *Indian J Orthop Surg* 2017;3(1):27-30. https://doi.org/10.18231/2395-1362.2017.0006
14. Mukherjee J, Ganguli R. Clinical outcome of primary cemented hemiarthroplasty in unstable trochanteric fractures in elderly patients. *Int J Res Orthop* 2018;4(4):543-6. https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20182032
15. Engin ED, Yunus I, Murat E, Ozlem A. Quality of life following treatment of trochanteric fractures with proximal femoral nail versus cementless bipolar hemiarthroplasty in elderly. *Clin Invest Med* 2015;38(2):E63-E72. https://doi.org/10.25011/cim.v38i1.22577

16. Fichman SG, Makinen TJ, Safir O, Vincent A, Lozano B, Kashigar A, et al. Arthroplasty for unstable pertrochanteric hip fractures may offer a lower re-operation rates as compared to cephalomedullary nailing. *Int Orthop* 2016;40(1):15-20. https://doi.org/10.1007/s00264-015-2794-7
17. Ozkayin N, Okcu G, Aktuglu K. Intertrochanteric femur fractures in the elderly treated with either proximal femur nailing or hemiarthroplasty: A prospective randomised clinical study. *Injury* 2015;46(Suppl 2):s3-8. https://doi.org/10.1016/j.injury.2015.05.024
18. Jolly A, Bansal R, More AR, Pagadala MB. Comparison of complications and functional results of unstable intertrochanteric fractures of femur treated with proximal femur nails and cemented hemiarthroplasty. *J Clin Orthop Trauma* 2019;10(2):296-301. https://doi.org/10.1016/j.jcot.2017.09.015