Comparison of Three Methods of Greater Trochanter Fixation in Intertrochanteric Femur Fractures (AO Type 31/A2) Treated with Cementless Bipolar Hemiarthroplasty

Mehmet Yiğit Gökmen[1], Mesut Uluöz[1], Hasan Orkun Varmış[1], Hakan Çiçek[1]

1 Department of Orthopedics and Traumatology, Adana City Training and Research Hospital, Adana, Türkiye

Abstract

Aim: The aim of this study was to compare the three most commonly used fixation methods for the fractured trochanter major fragment in patients undergoing uncemented bipolar hemiarthroplasty for unstable intertrochanteric fractures.

Methods: The medical records of 231 acute hip fracture cases aged 65 years and older with AO classification 31/A2.2 and 31/A2.3 who underwent unilateral primary cementless bipolar hemiarthroplasty at Adana Şehir Training and Research Hospital between January 2021 and January 2023 were retrospectively analyzed. The files were classified into three groups based on the fixation technique used in the operation.

Results: There were 231 files, with a mean age of 82.3±7.9. The majority (55.8%) were classified as ASA III. The analysis resulted in no significant differences between the groups in terms of age, number of days between the day of the injury and the day of the surgery, fixation failure, nonunion, number of revision surgeries, hospitalization duration, and HHS recorded at the third and sixth-month follow-up visits. Among the 73 males and 158 females, the ratio of the side in which the fracture occurred showed no difference (p=0.854). The female rate was significantly higher in group 3 compared to other groups (p=0.003). Regarding union success, cases in group 1 had significantly lower trochanter major union rates (p<0.001).

Conclusions: This study demonstrated that in patients treated with cementless bipolar hemiarthroplasty for unstable intertrochanteric fractures, union rates were significantly higher when fixated using trochanteric grip plates.

Keywords: *Hip, intertrochanteric fracture, hemiarthroplasty, cementless stem, greater trochanter, fracture fixation, bone plates, cable*

1. Introduction

In recent years, with the increase in life expectancy, the elderly population has increased, which has significantly elevated the occurance of intertrochanteric femoral fractures. Especially, patients with unstable fragmented hip fractures have high complication and mortality rates due to their high average age, multiple underlying comorbidities, osteoporosis, impaired muscle strength and proprioceptive function, and more difficulty in rehabilitation.[1] For these reasons, the most critical factor in fracture treatment is to ensure the stability of the bone to improve healing using the most appropriate surgical procedures. Unlike femoral neck fractures, intertrochanteric femoral fractures are located in the metaphyseal region and have higher union rates. Bone fusion using a dynamic hip screw (DHS) and proximal femoral intramedullary nail (PFN) is recommended as the routine fixation procedure for this particular class of fractures.[2] Nevertheless, in the aged population who have osteoporosis and thus present with poor bone strength, complications such as shifting of the varus and femoral head cut-out are not uncommon after osteosynthesis. These patients have difficulty in weight bearing in the early period, resulting in prolonged treatment duration, elevated number and types of systemic problems, leading to poor functional recovery and health-related findings. Moreover, prolonged immobilization with multiple underlying comorbidities may worsen medical and psychiatric problems.[3] Recently, bipolar hemiarthroplasty (BPHA) for early ambulation and rehabilitation in elderly patients has become an increasingly popular surgical alternative.[4]

Corresponding Author: Mehmet Yiğit Gökmen, mehmet_yigit_gokmen@hotmail.com,
Received: 15.08.2024, Accepted: 28.09.2024, Available Online Date: 29.09.2024 Cite this article as: Gokmen MY, Uluöz M, Varmis HO, Cicek H. Comparison of three methods of greater trochanter fixation in intertrochanteric femur fractures (AO type 31/A2) treated with cementless bipolar hemiarthroplasty. J Cukurova Anesth Surg. 2024; 7(3): 195-9. https://doi.org/10.36516/jocass.1534039

BPHA, when preferred for the treatment of intertrochanteric femoral fractures, involves a few technical challenges. Firstly, it may be technically difficult to adjust limb lengths due to fractures of the trochanter major and minus. Secondly, initial fixation may be difficult due to fragmented proximal femur fractures. Finally, the reduction and the fixation of trochanteric fragments, the surfaces allocated for the connection for the iliopsoas and abductor muscles, become difficult due to the scattered characteristics of the fracture. However, reduction and fixation of the afore-mentioned pieces require completion because stable fixation, especially of the greater trochanteric fragment, plays a very important role in complete union, functional recovery of the hip joint, and prevention of postoperative prosthetic dislocation.[5]

Various internal fixation materials are presented, and fixation procedures are described to provide stable fixation and bone healing of the fractured fragment in the trochanter major, including tension band wiring, short or long trochanteric grip/periprosthetic cable plates, titanium cables, multifilament polymer cables, and cerclage wires.[6–9] However, implant failure and nonunion rates of up to 50% have been reported.[6]

After the BPHA procedure performed for fragmented, unstable intertrochanteric fractures, nonunion of the fractured trochanter major fragment resulting in decreased hip abductor strength causes pain in the trochanteric region, gait disturbances, and prosthesis dislocation. Therefore, structural reduction and a firm fixation of the fractured trochanter major fragment is preferred by more surgeons, but the choice of fixation method is still controversial.[10]

In this study, we compared the three increasingly being preferred fixation procedures used for the fractured trochanter major fragment in patients undergoing uncemented BPHA for unstable intertrochanteric fractures.

2. Materials and methods

2.1. Study Design and Data Collection

The medical records of 683 acute hip fracture cases aged 65 and older who underwent unilateral primary cementless bipolar hemiarthroplasty surgery were analyzed between January 2021 and January 2023. The patients with 31/A2.2 and 31/A2.3 type fractures, based on the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification, were included for analysis (n=326). The number of patients lost in the six months of follow-up after the surgery was 95, and therefore, the analysis was conducted on the data of the remaining 231 files (73 males and 158 females). Age, gender, in which the hip fracture occurred, the duration between the occurrence of the hip fracture and the day of the surgery, the number of days of hospitalization, American Society of Anesthesiologists Classification (ASA) scores, the method of anesthesia, the method of fixation of the greater trochanter, the union rates of the fixated fragment, the existence of fixation failure, and Harris Hip scores (HHS) recorded at the follow-up visits conducted at the 3rd and 6th postoperative months were analyzed.

The radiological assessment included the AP and lateral X-ray images of the hip taken preoperatively and at the postoperative visits conducted at the end of the 3rd and 6th month.

The Harris Hip Scoring data collected at the postoperative 3rd and 6th month visits was used to assess pain, function, range of motion of the joint, and level of deformity. A maximum of 100 was used to define the best scores for functionality[11].

The files were classified into three groups based on the fixation technique used in the operation (Figure 1). Group 1 included patients who underwent fixation using only titanium or multifilament polymer cables, group 2 involved cases with short trochanteric grip plates, and finally, group 3 included cases with long trochanteric grip plates. Following grouping, the number of cases in the groups was 66, 100, and 65, respectively.

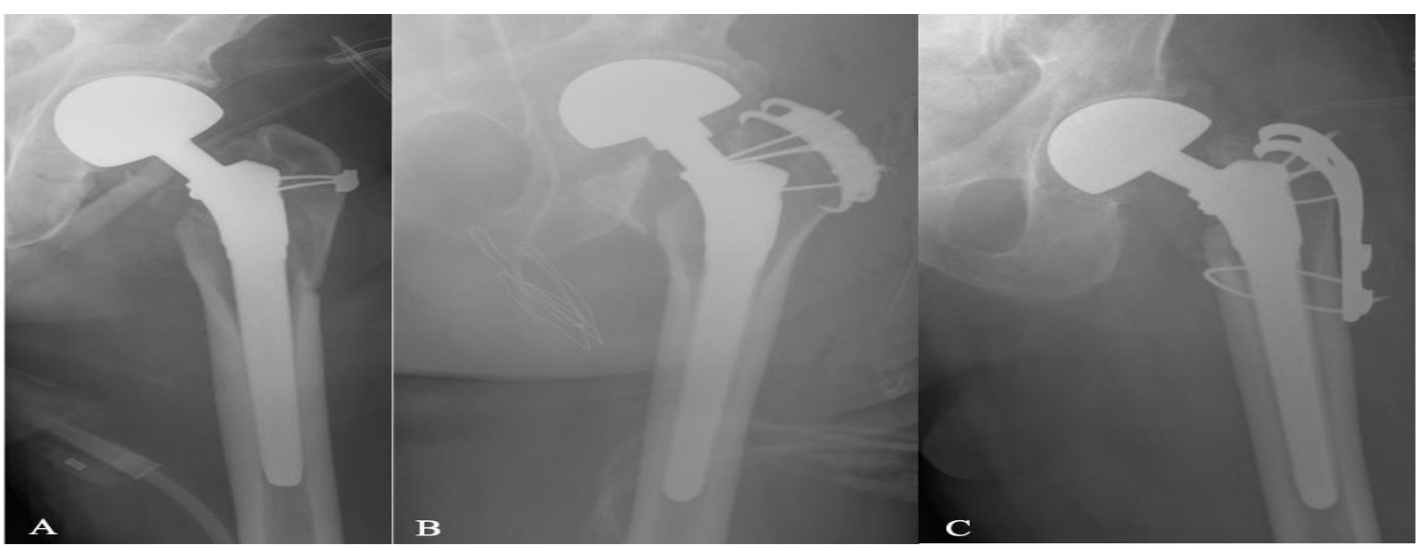
A comparative analysis of the groups was conducted, focusing on the union success of the greater trochanter fragment.

2.2 Statistical analysis

Statistical Package for the Social Sciences (SPSS) 25.0 software was used for statistical analysis of the data. Categorical assessments were abstracted as numbers and percentages, and continuous valuations were summarized as mean and standard deviation (median and minimum-maximum where necessary). The chi-square test was used to compare categorical expressions. Shapiro-Wilk test was used to assess the normality of the distribution of the collected data. The Kruskal-Wallis test was used in the analysis of more than two groups that did not show normal distribution. The statistical cut-off level for scientific meaning was considered as 0.05.

Figure 1

The methods used to fix the fractured trochanter major fragment in the study group. Group 1 (A), Group 2 (B), and Group 3 (C) are demonstrated with example radiographs



3. Results

There were 231 files, with a mean age of 82,3±7,9. The majority (55.8%) were classified as ASA III. The main features of the sampling universe are presented in Table 1.

Among the 73 males and 158 females, the ratio of the side in which the fracture occurred showed no difference (p=0.854). The female rate was considerably elevated in group 3 compared to the other two groups (p=0,003). Regarding union success, cases in group 1 had significantly lower trochanter major union rates (p<0,001) (Table 2).

The analysis resulted in no remarkable differences between the groups in the context of age, number of days between the day of the injury and the day of the surgery, fixation failure, nonunion, number of revision surgeries, hospitalization duration, and HHS recorded at the third and sixth-month follow-up visits.

Table 1

The main characteristics of the study population

		Mean	Median (Min-Max)
Age		82.3±7.9	82 (66-106)
		n	%
Gender	• Male	73	31.6
	• Female	158	68.6
The location of the fracture	• Right Hip	116	50.2
	• Left Hip	115	49.8
American Society of Anesthesiologists Classification (ASA)	• II	60	26
	• III	129	55.8
	• IV	42	18.2
Anesthesia method	• General	57	24.7
	• Spinal	174	75.3
Complications	• Trochanter major non-union	80	34.6
	• Fixation failure	27	11.7
	• Revision Surgery	14	6.1
Revision indication	Prosthesis dislocation	14	6.1
		Mean	Median (Min-Max)
Days between the injury and the surgery (day)		1.74±1.7	1 (0-10)
Hospitalization Duration (day)		5.59±4.6	4 (2-53)
Harris Hip Scores	Post-operative 3rd month	54.7±21.2	67.7 (21.2-75.85)
	Post-operative 6th month	66.8±16.7	71.65 (32.5-85.85)

Table 2

The main characteristics of the study population distributed according to groups

		Group 1 (n=66)	Group 2 (n=100)	Group 3 (n=65)	p
		Med (25-75th)			
Age		82.2 (75.8-88.3)	81 (78.3-88)	82 (76.5-87)	0.854
		n (%)	*n* (%)	n (%)	
Gender	• Male	27 (40.9)	36 (36)	10 (15.4)	0.003**
	• Female	39 (59.1)	64 (64)	55 (84.6)	
The location of the fracture	• Right hip	32 (48.5)	46 (46)	38 (58.5)	0.278
	• Left hip	34 (51.5)	54 (54)	27 (41.5)	
American Society of Anesthesiologists Classification (ASA)	• II	14 (21.2)	25 (25)	21 (32.3)	0.268
	• III	35 (53)	58 (58)	36 (55.4)	
	• IV	17 (25.8)	17 (17)	8 (12.3)	
Anesthesia method	• General	21 (31.8)	26 (26)	10 (15.4)	0.085
	• Spinal	45 (68.2)	74 (74)	55 (84.6)	
Trochanter major union	Achieved	26 (39.4)	79 (79)	46 (70.8)	<0.001**
Complications	• Fixation failure	10 (15.2)	8 (8)	9 (13.8)	0.305
	• Revision Surgery	1 (1.5)	9 (9)	4 (6.2)	0.141
Revision indication	Prosthesis dislocation	1	10	3	0.287
Days between the injury and the surgery (day)		2 (1-3)	1 (0.25-3)	1 (1-2)	0.506
Hospitalization duration (day)		4 (3-6)	4 (3-6)	5 (3.5-6)	0.512
Harris Hip Scores	• Post-operative 3rd month	67.7 (32.5-75.9)	67.7 (26.9-73.5)	67.7 (31.9-73.5)	0.353
	• Post-operative 6th month	71.7 (50.2-85.9)	50.5 (45.7-83.5)	73.5 (50.2-83.5)	0.068

** p<0,05, **p<0,01, †: Ki-kare, ‡: Kruskal Wallis test*

4. Discussion

In our study comparing three different fixation methods for fixation of the fractured trochanter major fragment in patients undergoing uncemented BPHA for unstable intertrochanteric fractures, we found that the union rates of the fractured trochanter major frag-

ment were significantly higher in fixation using long or short trochanteric plates.

Traditional titanium or polyethylene cables are widely used for fixation of the fractured trochanter major fragment due to the relatively simple procedure and low cost.[10] However, plates and cable systems require a larger surgical exposure than other techniques, are expensive, and trochanteric nonunion occurs more frequently.[12] Similarly, our study shows that the preference of wires and cables for fixation of the trochanter major in unstable intertrochanteric fractures undergoing cementless bipolar hemiarthroplasty results in union failure. We believe that one of the main reasons for union failure is the limited biomechanical resistance to vertical displacement and rotation. For a stable fixation, the cancellous surfaces of the fractured greater trochanteric fragment should be well compressed to resist displacing muscular forces.[13]

As emphasized by Zhu et al.[14] in their biomechanical study, the use of a trochanteric grip plate with a cable system helps to resist the multidirectional forces of the abductor's muscle in both vertical and anteroposterior planes by providing compression along the bony surface of the trochanteric fragment where the implant is placed. In parallel, we found that the union rates of the fractured trochanter major fragment were significantly higher in the groups where the fixation was provided using long and short trochanteric plates (p<0.001).

The analysis of the demographic data revealed that the mean age was 82.3±7.9 years and the number of females was significantly higher (p=0.003). The incidence of hip fracture is higher in men than in women among people under 60 years of age. Conversely, among people over 60 years of age, it is more common in women due to hormonal changes after menopause. In addition, the prevalence and incidence rates for hip fractures among women increase with age.[15]

A large study conducted by the Committee for Osteoporosis Treatment of The Japanese Orthopaedic Association, which evaluated 110,747 hip fracture cases, showed that left hips were fractured more than right hips; however, no significant difference was found between the left and right sides.[16] The analysis results did not demonstrate a substantial dissimilarity between the hip sides; the distribution was even.

In a cohort research carried out by Zaib et al.[17], which was similar in design the average age of the patients selected was 80.80±11.18 years, and 97.45% of the patients had ASA scores of 3 and above. In our study, 74.03% of the patients (n=171) had ASA scores of 3 and above, and we attributed the difference to the presence of comorbidities such as hypertensive conditions, diabetes mellitus, and ischemic heart disease, which increase with age. In our study, 74.03% of the patients (n=171) had ASA scores of 3 and above, and we attributed the difference to the presence of comorbidities such as hypertensive conditions, diabetes mellitus, and ischemic heart disease, which increase with age.

During surgery for hip fractures, spinal anesthesia is often preferred to reduce the prevalence and duration of intraoperative hypotensive episodes and potentially poor outcomes related to mortality and morbidity.[18] In our study, spinal anesthesia was preferred in the vast majority of patients (n=174, 75.3%).

Unfixed large trochanter fractures may cause impairment in the functionality of the abductor muscles of the hip joint subsequent to partial hip arthroplasty, which may generate an amplified risk of prosthesis disengagement and Trendelenburg gait pattern.[19] Zhang et al.[20], evaluated the efficacy of tension band fixation in geriatric unstable intertrochanteric fractures undergoing hip arthroplasty and reported that no cases of dislocation or fracture nonunion were observed. Besides, the HHS results were improved. In contrast, our total dislocation rate was 6.1%, the single indication for revision surgery.

Grimsrud et al.[21], in a series of 39 patients who were operated on for hip arthroplasty for unstable intertrochanteric hip fractures, one cerclage cable fixation technique was used, and the findings of the follow-up visits conducted after one year showed that all trochanters were healed and fixation failure was seen in 5 cases (12.8%). In our series, the highest rate of fixation failure among the groups occurred in group 1 (4.3%), where a similar method was used.

Ozan et al.[22] examined a total of 32 unstable trochanteric femoral fracture cases who underwent greater trochanteric fixation procedures, in which the cable method was preferred, following partial hip arthroplasty, and found nonunion in 18.7% of the cases. In our study, our total nonunion rate was 34.6%. The difference in rates might be attributed to the age of the cases; the average age of patients included in the former study was 20 years younger than ours.

In studies comparing BPHA with internal fixation for the treatment of unstable intertrochanteric fractures, it was reported that recuperation was easier and faster in the arthroplasty group due to early ambulation, adding that the frequency of pressure ulcers, pneumonia, and atelectasis was significantly lower.[23,24] The authors suggested that more favorable clinical results could be obtained with hip arthroplasty.[25] Our study assessed the mean HHS results recorded at the postoperative 6th-month follow-up visit as fair for all groups.

4.1. Limitations

Our study has several limitations. Firstly, the small sample size in the groups and the retrospective design of the study. In addition, the short follow-up period of this study is another important limitation; no long-term clinical follow-up was performed to evaluate subjective patient satisfaction.

5. Conclusion

This study demonstrated that in patients treated with cementless bipolar hemiarthroplasty for unstable intertrochanteric fractures, union rates were significantly higher when fixated using trochanteric grip plates. Despite the challenges and risks of surgery, including requiring a wider exposure and the difficulty of preserving and maintaining the hip abductor mechanism, the high union rates provide a much higher level of ambulation among the elderly population.

Statement of ethics

Ethical permission was obtained from the Adana City Training and Research Hospital Clinical / Human Research Ethics Committee for this study date on May 11, 2023, and decision number 2549 and Helsinki Declaration rules were followed to conduct this study.

Source of Finance

The authors declare that they have received no financial support for this study

Conflict of interest statement

The authors declare that they have no conflict of interest.

Authors' contributions

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by MYG. The first draft of the manuscript was written by MYG, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Availability of data and materials

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

References

1.Lorich DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures: management and current controversies. Instr Course Lect. 2004;53:441-54.
https://doi.org/10.2106/00004623-200402000-00028
2.Haentjens P, Casteleyn PP, De Boeck H, et al. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Primary bipolar arthroplasty compared with internal fixation. J Bone Joint Surg Am. 1989;71(8):1214-25.
https://doi.org/10.2106/00004623-198971080-00015
3.Green S, Moore T, Proano F. Bipolar prosthetic replacement for the management of unstable intertrochanteric hip fractures in the elderly. Clin Orthop Relat Res. 1987;(224):169-77.
https://doi.org/10.1097/00003086-198711000-00024
4.Kayali C, Agus H, Ozluk S, et al. Treatment for unstable intertrochanteric fractures in elderly patients: internal fixation versus cone hemiarthroplasty. J Orthop Surg (Hong Kong). 2006;14(3):240-4.
https://doi.org/10.1177/230949900601400302
5.Bourne RB, Rorabeck CH. Soft tissue balancing: the hip. J Arthroplasty. 2002;17(4 Suppl 1):17-22.
https://doi.org/10.1054/arth.2002.33263
6.Sun D, Park BS, Jang GI, et al. The Fixation Method according to the Fracture Type of the Greater Trochanter in Unstable Intertrochanteric Fractures Undergoing Arthroplasty. Hip Pelvis. 2017;29(1):62-7.
https://doi.org/10.5371/hp.2017.29.1.62
7.Nam HJ, Sun DH, Jang SW. Fixation of Greater Trochanteric Fracture Using Double Strands and Double Loops with Figure of 8 Wiring in Non-cement Total Hip Arthroplasty for Unstable Intertrochanteric Fracture. Hip Pelvis. 2012;24(4):316.
https://doi.org/10.5371/hp.2012.24.4.316
8.Cho HM, Lee SR, Park MS, et al. Standard Type Cemented Hemiarthroplasty with Double Loop and Tension Band Wiring for Unstable Intertrochanteric Fractures in the Elderly. J Korean Hip Soc. 2010;22(2):159.
https://doi.org/10.5371/jkhs.2010.22.2.159
9.Kim IS, Pansey N, Kansay RK, et al. Greater Trochanteric Reattachment Using the Third-Generation Cable Plate System in Revision Total Hip Arthroplasty. J Arthroplasty. 2017;32(6):1965-9.
https://doi.org/10.1016/j.arth.2017.01.017
10.Huang G, Zhang M, Qu Z, et al. Fixation options for reconstruction of the greater trochanter in unstable intertrochanteric fracture with arthroplasty. Medicine. 2021;100(26):e26395.
https://doi.org/10.1097/MD.0000000000026395
11.Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969;51(4):737-55.
https://doi.org/10.2106/00004623-196951040-00012
12.Tang J, Wu T, Shao H, et al. Greater trochanter fixed with a claw plate and cable system in complex primary and revision total hip arthroplasty: long-term follow-up. International Orthopaedics (SICOT). 2022;46(11):2553-60.
https://doi.org/10.1007/s00264-022-05538-3
13.Plausinis D, Speirs AD, Masri BA, et al. Fixation of trochanteric slide osteotomies: a biomechanical study. Clin Biomech (Bristol, Avon). 2003;18(9):856-63.
https://doi.org/10.1016/s0268-0033(03)00148-7
14.14. Zhu Z, Ding H, Shao H, Zhou Y, et al. An in-vitro biomechanical study of different fixation techniques for the extended trochanteric osteotomy in revision THA. J Orthop Surg Res. 2013;8(1):7.
https://doi.org/10.1186/1749-799X-8-7
15.Feng JN, Zhang CG, Li BH, et al. Global burden of hip fracture: The Global Burden of Disease Study. Osteoporos Int. 2024;35(1):41-52.
https://doi.org/10.1007/s00198-023-06907-3
16.Hagino H, Nakamura T, Sakamoto K, et al. Nationwide survey of hip fractures in Japan. Journal of Orthopaedic Science. 2004;9(1):1-5.
https://doi.org/10.1007/s00776-003-0741-8
17.Zaib J, Madni A, Saad Azhar M. Predictive Value of Comprehensive Geriatric Assessment Scores for Mortality in Patients with Hip Fracture: A Retrospective Cohort Study. Cureus. Published online September 11, 2023.
https://doi.org/10.7759/cureus.45070
18.White SM. A retrospective, observational, single-centre, cohort database analysis of the haemodynamic effects of low-dose spinal anaesthesia for hip fracture surgery. BJA Open. 2024;9:100261.
https://doi.org/10.1016/j.bjao.2024.100261
19.Patel S, Soler JA, El-Husseiny M, et al. Trochanteric Fixation Using a Third-Generation Cable Device—Minimum Follow-Up of 3 Years. The Journal of Arthroplasty. 2012;27(3):477-81.
https://doi.org/10.1016/j.arth.2011.06.032
20.Zhang H, Xu Z, Zhou A, et al. Efficacy of Kirschner-wires and tension band in hip arthroplasty for aged patients with unstable intertrochanteric osteoporotic fracture: A 2-to-11-year follow-up. Medicine (Baltimore). 2017;96(1):e5614.
https://doi.org/10.1097/MD.0000000000005614
21.Grimsrud C, Monzon RJ, Richman J, et al. Cemented hip arthroplasty with a novel cerclage cable technique for unstable intertrochanteric hip fractures. J Arthroplasty. 2005;20(3):337-43.
https://doi.org/10.1016/j.arth.2004.04.017
22.Ozan F, Koyuncu S, Pekedis M, et al. Greater trochanteric fixation using a cable system for partial hip arthroplasty: a clinical and finite element analysis. Biomed Res Int. 2014;2014:931537.
https://doi.org/10.1155/2014/931537
23.Chan KC, Gill GS. Cemented hemiarthroplasties for elderly patients with intertrochanteric fractures. Clin Orthop Relat Res. 2000;(371):206-15.
https://doi.org/10.1097/00003086-200002000-00025
24.Haentjens P, Casteleyn PP, Opdecam P. Primary bipolar arthroplasty or total hip arthroplasty for the treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Acta Orthop Belg. 1994;60 Suppl 1:124-8.
25.Stern MB, Angerman A. Comminuted intertrochanteric fractures treated with a Leinbach prosthesis. Clin Orthop Relat Res. 1987;(218):75-80.
https://doi.org/10.1097/00003086-198705000-00012