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World J Clin Cases 2024 February 26; 12(6): 1039-1195



EDITORIAL

- 1039 Lateral clavicle fracture-plating options and considerations
Muthu S, Annamalai S, Kandasamy V
- 1045 Tumor deposits in axillary adipose tissue in patients with breast cancer: Do they matter?
Mubarak M, Rashid R, Shakeel S

MINIREVIEWS

- 1050 New strategies in the diagnosis and treatment of immune-checkpoint inhibitor-mediated colitis
Velikova T, Krastev B, Gulinac M, Zashev M, Graklanov V, Peruhova M

ORIGINAL ARTICLE**Retrospective Cohort Study**

- 1063 Correlative factors of poor prognosis and abnormal cellular immune function in patients with Alzheimer's disease
Bai H, Zeng HM, Zhang QF, Hu YZ, Deng FF
- 1076 Bipolar hip arthroplasty using conjoined tendon preserving posterior lateral approach in treatment of displaced femoral neck fractures
Yan TX, Dong SJ, Ning B, Zhao YC

Retrospective Study

- 1084 Association of preschool children behavior and emotional problems with the parenting behavior of both parents
Wang SM, Yan SQ, Xie FF, Cai ZL, Gao GP, Weng TT, Tao FB
- 1094 Assessment of the triglyceride glucose index in adult patients with chronic diarrhea and constipation
Zhu JY, Liu MY, Sun C
- 1104 Acute pancreatitis as a complication of acute COVID-19 in kidney transplant recipients
Basic-Jukic N, Juric I, Katalinic L, Furic-Cunko V, Sesa V, Mrzljak A

Observational Study

- 1111 Clinical analysis of 12 cases of ovarian neuroendocrine carcinoma
Xing XY, Zhang W, Liu LY, Han LP

META-ANALYSIS

- 1120 Efficacy and safety of remimazolam in bronchoscopic sedation: A meta-analysis
Zhou Y, Zhao C, Tang YX, Liu JT

CASE REPORT

- 1130** Simple bone cysts of the proximal humerus presented with limb length discrepancy: A case report
Lin CS, Lin SM, Rwei SP, Chen CW, Lan TY
- 1138** Postoperative abdominal herpes zoster complicated by intestinal obstruction: A case report
Dong ZY, Shi RX, Song XB, Du MY, Wang JJ
- 1144** Clinical evolution of antisynthetase syndrome-associated interstitial lung disease after COVID-19 in a man with Klinefelter syndrome: A case report
Wu XX, Cui J, Wang SY, Zhao TT, Yuan YF, Yang L, Zuo W, Liao WJ
- 1150** Giant bile duct dilatation in newborn: A case report
Quan DW, Li PG, Xu XH, Liu SQ
- 1157** Left atrial appendage occluder detachment treated with transthoracic ultrasound combined with digital subtraction angiography guided catcher: A case report
Yu K, Mei YH
- 1163** Adult sigmoid intussusception resembling rectal prolapse: A case report
Tsai TJ, Liu YS
- 1169** Gigantic occipital epidermal cyst in a 56-year-old female: A case report
Wei Y, Chen P, Wu H
- 1174** Autoimmune hepatitis-primary biliary cholangitis overlap syndrome complicated by various autoimmune diseases: A case report
Qin YJ, Gao T, Zhou XN, Cheng ML, Li H
- 1182** Parotid metastasis of rare lung adenocarcinoma: A case report
Yan RX, Dou LB, Wang ZJ, Qiao X, Ji HH, Zhang YC
- 1190** Management of retroperitoneal high-grade serous carcinoma of unknown origin: A case report
Hsieh WL, Ding DC

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Retrospective Cohort Study

Bipolar hip arthroplasty using conjoined tendon preserving posterior lateral approach in treatment of displaced femoral neck fractures

Ting-Xin Yan, Sheng-Jie Dong, Bo Ning, Yu-Chi Zhao

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Hip fractures account for 23.8% of all fractures in patients over the age of 75 years. More than half of these patients are older than 80 years. Bipolar hemiarthroplasty (BHA) was established as an effective management option for these patients. Various approaches can be used for the BHA procedure. However, there is a high risk of postoperative dislocation. The conjoined tendon-preserving posterior (CPP) lateral approach was introduced to reduce postoperative dislocation rates.

AIM

To evaluate the effectiveness and safety of the CPP lateral approach for BHA in elderly patients.

METHODS

We retrospectively analyzed medical data from 80 patients with displaced femoral neck fractures who underwent BHA. The patients were followed up for at least 1 year. Among the 80 patients, 57 (71.3%) were female. The time to operation averaged 2.3 d (range: 1-5 d). The mean age was 80.5 years (range: 67-90 years), and the mean body mass index was 24.9 kg/m² (range: 17-36 kg/m²). According to the Garden classification, 42.5% of patients were type III and 57.5% of patients were type IV. Uncemented bipolar hip prostheses were used for all patients. Torn conjoined tendons, dislocations, and adverse complications during and after surgery were recorded.

RESULTS

The mean postoperative follow-up time was 15.3 months (range: 12-18 months). The average surgery time was 52 min (range: 40-70 min) with an average blood loss of 120 mL (range: 80-320 mL). The transfusion rate was 10% (8 of 80 patients).

The gemellus inferior was torn in 4 patients (5%), while it was difficult to identify in 2 patients (2.5%) during surgery. The posterior capsule was punctured by the fractured femoral neck in 3 patients, but the conjoined tendon and the piriformis tendon remained intact. No patients had stem varus greater than 3 degrees or femoral fracture. There were no patients with stem subsidence more than 5 mm at the last follow-up. No postoperative dislocations were observed throughout the follow-up period. No significance was found between preoperative and postoperative mean Health Service System scores (87.30 ± 2.98 vs 86.10 ± 6.10 , $t = 1.89$, $P = 0.063$).

CONCLUSION

The CPP lateral approach can effectively reduce the incidence of postoperative dislocation without increasing perioperative complications. For surgeons familiar with the posterior lateral approach, there is no need for additional surgical instruments, and it does not increase surgical difficulty.

Key Words: Conjoined tendon preserving; Bipolar hip arthroplasty; Femoral neck fractures; Postoperative dislocation; Posterolateral approach

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Core Tip: We evaluated the effectiveness and safety of the conjoined tendon-preserving posterior (CPP) approach for bipolar hemiarthroplasty (BHA) during a short-term follow-up. We retrospectively evaluated 80 patients who underwent CPP BHA implanted with cementless femoral prostheses. We protected the posterior structures of the hip joint. We made a partial incision in the quadratus femoris muscle to increase exposure, thus making the surgical procedure more feasible. There was no dislocation or other adverse events observed during the early follow-up period. The CPP approach can effectively reduce dislocation after BHA and improve postoperative hip joint stability.

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INTRODUCTION

Hip fractures account for 23.8% of all fractures in patients over the age of 75 years[1]. More than half of these patients are older than 80 years[2]. A substantial proportion of hip fractures are femoral neck fractures, which puts the femoral head at risk of osteonecrosis and nonunion due to the vulnerable blood supply[3]. Bipolar hemiarthroplasty (BHA) was established as an effective management option that results in excellent pain relief, early mobilization, a short operation time, similar revision rate to total hip replacement within 5 years, and good long-term return to function in inactive elderly patients[4,5].

Various approaches can be used for the BHA procedure. The conventional posterolateral approach is the most widely used technique because it provides easy exposure, a short operation time, and a low incidence of postoperative gait disturbances[6]. However, it also leads to a higher postoperative dislocation rate than the anterior and lateral approaches [7,8]. Surgeons modified the posterolateral approach and reduced the incidence of postoperative dislocation by retaining the piriformis tendon and short external rotators with varying degrees[9-11].

Tetsunaga *et al*[12] reported a BHA technique using the conjoined tendon-preserving posterior (CPP) approach. For this technique, only the external obturator muscle is dissected in geriatric patients. Good outcomes with no cases of postoperative dislocation have been reported. Our department started using the CPP approach for BHA for displaced femoral neck fractures in 2021. This retrospective study was conducted to evaluate the effectiveness and safety of the CPP approach for BHA in elderly patients with femoral neck fractures.

MATERIALS AND METHODS

Population

This retrospective cohort study was approved by the institutional review board of our hospital. A prospectively compiled database was used to recruit patients who underwent cementless BHA for a displaced femoral neck fracture at our hospital from February 2021 to May 2022. A total of 103 consecutive patients were identified. One year after the surgery, 23 patients were lost to follow-up or died due to causes unrelated to the BHA. A total of 80 patients were included in this study.

Surgical procedure and postoperative rehabilitation

All operations were performed by a single senior surgeon (Yu-Chi Zhao), who performs at least 200 hip arthroplasty surgeries annually. The patients underwent BHA in the lateral decubitus position, and the iliac crest and sacrum were fixed anteriorly and posteriorly, respectively, to obtain a stable pelvis. A 45° incision about 10 cm in length was made posteriorly with the apex of the greater trochanter as the center. The gluteus maximus was bluntly separated along its fibers. Then, self-retaining retractors were placed under the deep fascia layer of the gluteus maximus. The pericapsular fat was resected using electrocautery to expose the posterior margin of the gluteus medius and the short external rotator muscles. The sciatic nerve was identified and protected during the operation. The piriformis tendon was palpable in the superior aspect of the wound deep to the gluteus Medius muscle. The gemellus superior, internal obturator, gemellus inferior, external obturator muscles, and quadratus femoris were identified caudally (Figure 1A). The obturator externus and proximal quadratus femoris were sectioned at the bony insertion site along the posterior aspect of the greater trochanter (Figure 1B).

It is important to coagulate the deep medial circumflex femoral artery, which is almost always at the proximal margin of the quadratus femoris muscle. The inferior portion of the joint capsule was incised in an “L” shape that started from the caudal margin of the gemellus inferior muscle. The arthrotomy was extended distally along the posterior border of the femur while preserving the posterior labrum. Then, No. 1 Ethicon was used to mark and invert the dissected capsule (Figure 1C). After the femoral neck was cut along the planned osteotomy line, the femoral head was removed using a corkscrew (Figure 1D). The femoral head was measured to select the appropriate outer head. The hip joint was flexed, adducted, and internally rotated to manipulate the femur in a similar way to the classical approach. Next, femoral broaching and insertion of instruments and femoral components were performed while preserving the piriformis muscle and conjoined tendon. An inner head and outer head of appropriate lengths were put in place to perform reduction. Manual reduction was performed according to a previous report[12]. This often requires a greater hip flexion degree than the conventional posterolateral approach. Then, the reduction was completed by pushing the outer head to the acetabulum. At this time, the suture on the capsule was retracted to prevent the capsule from embedding into the acetabulum (Figure 1E). After testing the hip stability and determining that there was no discrepancy in leg length, the joint was irrigated by a pulse flusher. The capsule, obturator externus, and proximal quadratus femoris was repaired to the trochanter by two transosseous tunnels, and the proximal capsule incision was repaired side to side (Figure 1F). All patients began full weight-bearing exercises assisted by a walker on postoperative day 1. A pillow was recommended to avoid excessive adduction for 3 wk.

Statistical analysis

The primary outcome was postoperative dislocation and adverse event rates. We also collected demographic data, including age, sex, and body mass index, perioperative data, including time to operation, operation time, preservation of short external rotator muscles, bleeding volume, transfusion, and the type of the prosthesis used, and postoperative data, including prosthesis alignment and femoral stem subsidence during follow-up. The Health Service System (HSS) score [13] was used to evaluate the hip function.

SPSS software (IBM Corp., Armonk, NY, United States) was used for statistical analysis, and continuous variables were represented by mean ± SD. The paired *t* test was used to compare HSS scores before surgery and 1 year after surgery. *P* values < 0.05 were considered significant.

RESULTS

Among the 80 patients, 57 (71.3%) were female. The time to operation averaged 2.3 d (range: 1-5 d). The mean age was 80.5 years (range: 67-90 years), and the mean body mass index was 24.9 kg/m² (range: 17-36 kg/m²). According to the Garden classification, 42.5% of patients were type III and 57.5% of patients were type IV.

General data

The mean postoperative follow-up time was 12.3 months (range: 10-18 months). Uncemented bipolar hip prostheses were used for all patients: 31 hips with Self-Centering Bipolar and HA-coated Corail® stem (Depuy, Warsaw, IN, United States); and 49 hips with Cocr Ball Head & Bipolar Head and tapered HA-coated CL stem (AKMEDICAL, Beijing, China). The average surgery time was 52 min (range: 40-70 min) with an average blood loss of 120 mL (range: 80-320 mL).

Soft tissue damage during operation

The gemellus inferior was torn in 4 patients (5%), while it was difficult to identify in 2 patients (2.5%) during surgery. The posterior capsule was punctured by the fractured femoral neck in 3 patients, but the conjoined tendon and the piriformis tendon remained intact. The transfusion rate was 10% (8 of 80 patients). No patients had stem varus greater than 3 degrees or femoral fractures.

Adverse events and HSS score

There were no patients with stem subsidence more than 5 mm at the last follow-up. There were also no postoperative dislocations throughout the follow-up period. No significance was found between preoperative and postoperative mean HSS scores (87.30 ± 2.98 *vs* 86.10 ± 6.10, *t* = 1.89, *P* = 0.063).

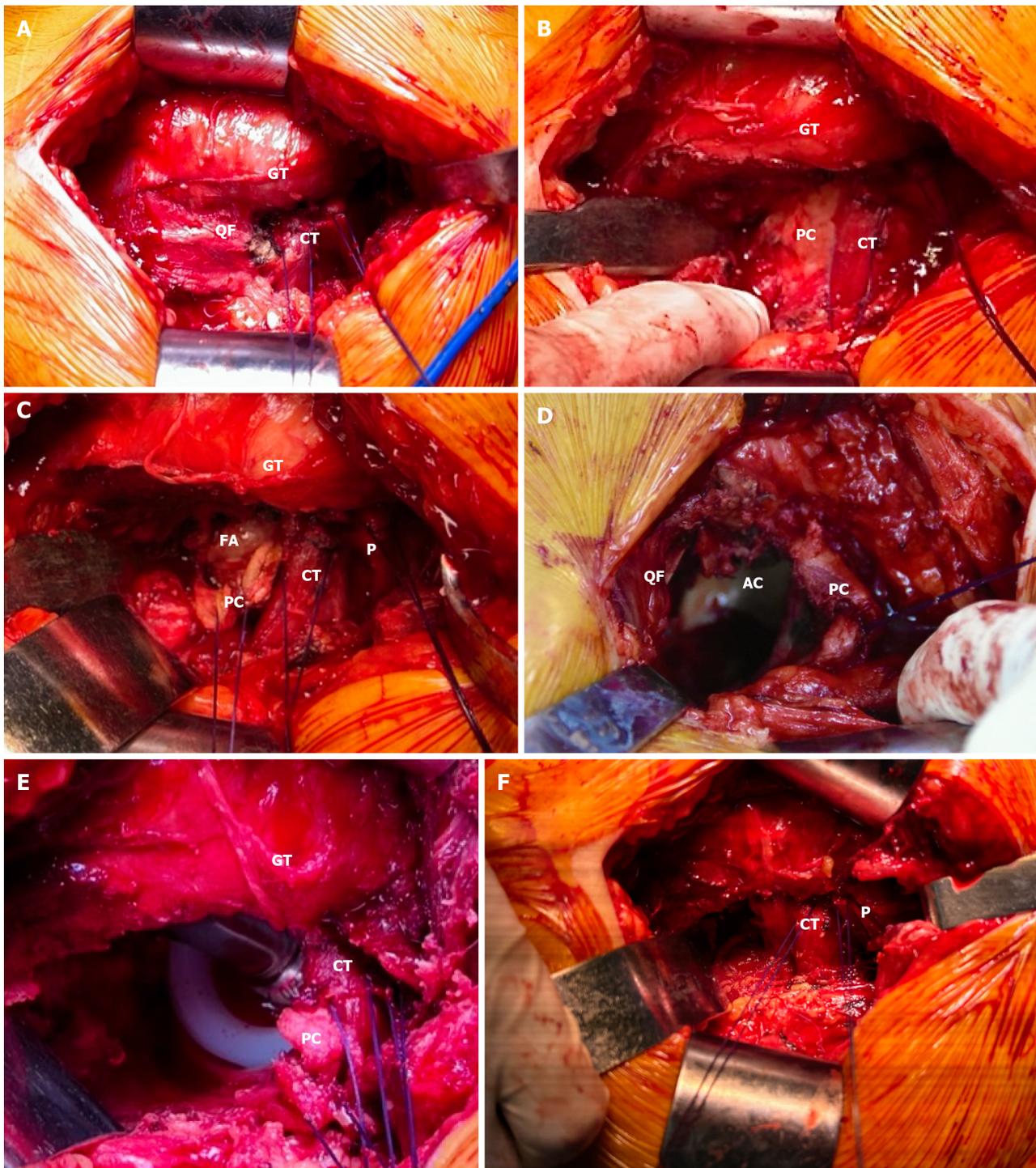


Figure 1 Shows the exposure of left hip joint, protection of the external external rotator muscles and piriformis tendon during bipolar hip arthroplasty using conjoined tendon preserving posterior lateral approach. A: After self-retaining retractors were placed under the deep fascia layer of the gluteus maximus, the piriformis and conjoined tendon were marked by two No. 1 Ethicon sutures. Expose the greater trochanter and quadratus femoris muscle; B: The partial quadratus femoris muscle was incised and retracted by a Hohmann retractor. The posterior capsule was exposed; C: The bottom half of the posterior capsule was incised and inverted by two sutures. Expose the femoral head D: After removing the femoral head, the acetabulum was exposed. A Hohmann retractor was placed behind the posterior-inferior wall to better observe the acetabulum; E: The prosthesis was implanted, and the marking sutures remained in place; F: The posterior capsule was reattached at the trochanteric insertion site. The conjoined tendon and piriformis marked by sutures remained intact. GT: Greater trochanter; CT: Conjoined tendon; PC: Posterior capsule; FA: Femoral head; QF: Quadratus femoris muscle; AC: Acetabulum; P: Piriformis.

DISCUSSION

Hemiarthroplasty has been widely used for the treatment of displaced intracapsular fractures of the femoral neck with favorable clinical outcomes[14,15]. However, postoperative dislocation in patients who underwent the conventional posterolateral approach remains a seemingly inevitable complication[8,16]. The lateral approach[6] and direct anterior approach (DAA)[17] were introduced for hemiarthroplasty in recent years. Compared to the posterolateral approach,

significantly lower dislocation rates and early functional mobility were observed[18].

Recently, Maratt *et al*[19] reported that there was no difference in the dislocation rate after total hip arthroplasty (THA) between patients undergoing a DAA (0.84%) and a modern posterior approach with repair of the capsule (0.79%). Christensen *et al*[20] conducted a retrospective review of 13335 primary THA procedures and found that patients in the posterior approach group had a slightly higher dislocation rate compared to the DAA and lateral groups (1.1% *vs* 0.7% *vs* 0.5%, respectively). Differences in dislocation rates for different approaches may be due to improved protocols and surgical techniques, larger bearing heads, and dual mobility constructs to avoid prosthetic impingement and dislocations that have occurred over the past decade. Furthermore, there is still a learning curve for the different approaches, even for surgeons who are already familiar with the posterolateral approach. In addition, perioperative complications such as femoral fracture, nerve palsy, and prosthesis malposition will still inevitably occur in the early stages of the learning curve[21,22].

The conventional posterolateral approach usually requires excision of the insertion point of the piriformis tendon, and short external rotators are released from their insertion on the posterior margin of the greater trochanter. The posterior capsule is incised as far superior and inferior as feasible for exposure of the acetabulum and intraoperative dislocation of the femoral head from acetabulum[23]. Due to instability after surgery, Pellicci *et al*[24] advocated that posterior soft tissue should be repaired to reduce the dislocation rate. However, Stähelin *et al*[25] reported that the repair failure rate of short external rotator muscles was as high as 70%. Stangl-Correa *et al*[26] reported that the incidence of failure of the reinsertion of short external rotators and the posterior capsule was 16.2% based on ultrasound findings conducted 6-8 wk after surgery.

Pellicci *et al*[27] used magnetic resonance imaging to evaluate the integrity of the posterior soft tissue repair after primary THA. They found that in 90% of patients the posterior capsule remained intact. They also observed that 43% of piriformis tendons and 57% of conjoined tendons had a gap > 25 mm between the hypointense tendon end and the greater trochanter. Additionally, they found atrophy of the piriformis muscle and the obturator internus muscle. The different results from these studies may be due to different assessment methods. However, they demonstrate that there is still a possibility of failure and compromised muscle function even after repair. Therefore, it is better to maintain continuity during surgery instead of repairing after cutting. Maintaining continuity can maintain a greater degree of integrity and physiological function of the soft tissues.

Several authors have reported that the modified posterior approach can preserve some of the short external rotators of the hip. Khan *et al*[28] reported lower mean blood loss, greater improvement in Western Ontario McMaster Osteo-Arthritis Index scores, and no dislocations for the less invasive approach compared to the standard posterior approach. They preserved the piriformis tendon and released the posterior capsule and tendons of the gemelli and obturator internus. Repair of the posterior capsule was suggested. Kim *et al*[9] reported excellent results in a series of 220 patients using external rotator preservation, in which they preserved the piriformis, superior gemelli, and obturator internus with complete posterior capsulectomy.

Roger and Hill[10] adopted a posterosuperior approach, which detaches and repairs the piriformis or conjoined tendon. Penenberg *et al*[29] introduced a percutaneously assisted THA, which is similar to the approach reported by Roger and Hill[10]. These two approaches need specialized instruments to complete the operation procedure. The CPP approach we adopted in this study uses traditional posterior lateral approach instruments without the need for specialized instruments, making it easy to implement in clinical practice. Moreover, surgical records show that the integrity of short external rotator muscles and piriformis tendon is well preserved during surgery, without increasing the exposure difficulty.

For BHA, it is not often necessary to expose the acetabulum like in a THA. In BHA, removing the femoral head, exposing the femoral medullary cavity, and completing the joint reduction after implanting the prosthesis are required. This allows the preservation of more of the joint capsule and external rotators. Tetsunaga *et al*[12] performed BHA in 40 geriatric patients aged ≥ 80 years using the CPP approach, which dissects only the external obturator muscle and preserves the gemellus inferior muscle. No cases of intraoperative fracture or postoperative dislocation were observed in the study. Nakamura *et al*[30] conducted a prospective multicenter clinical study of 322 patients who underwent BHA using the CPP approach. They also resected the proximal part of the quadratus femoris and external obturator muscles. No postoperative dislocations were detected throughout the 9.1 ± 1.5 months (range: 6-17 months) follow-up.

We have performed BHA using the CPP approach since 2021. Two different brands of prostheses have been implanted. Both have reduced shoulder design, which allows the prosthesis to be implanted in a neutral alignment while reducing the risk of injury to the conjoined tendons. In addition to preserving short external rotators and the piriformis tendon, we also focus on preserving the integrity of the posterior upper joint capsule (ischiofemoral ligament). This can form a soft tissue wall that blocks the posterior upper dislocation. Moreover, it can preserve the wrapping effect on the large outer head, which can reduce the abnormal increase in mobility after joint replacement surgery[31]. We do not emphasize the integrity of the quadratus femoris muscle. To avoid damaging the short external rotator muscles, caudal exposure is necessary to make the removal of the femoral head and the procedure of the medullary cavity easier. In addition, electrocoagulation reduces intraoperative blood loss compared to intraoperative blunt injury of the ascending branch of the medial circumflex femoral artery in the quadriceps femoris muscle caused by traction.

Although no cases of postoperative dislocation and femoral fracture were detected, 4 cases of gemellus inferior tears were detected during surgery, which mainly occurred in the early stage. No cases needed total posterior capsulotomy, but we observed puncture of the posterior capsule by the fractured femoral neck in 3 cases. This may be due to the lack of preoperative immobilization, such as transcuteaneous traction. Postoperative rehabilitation for these patients was the same as the other patients.

Our study had some limitations. First, our study was retrospective despite using prospectively compiled data. Second, there was no comparative group *via* conventional posterolateral approach during the same period. Because there is very little risk of posterior dislocation after utilizing the CPP approach, we have avoided performing BHA using the conventional posterolateral approach during the study period. However, the dislocation rate in this study was significantly lower than that at our institution from 2019-2020 [0% (0/80) *vs* 4.32% (6/139)]. Third, the follow-up time was short. Since dislocation after hip arthroplasty usually occurs within 3 months, the length of follow-up in our study also has some degree of clinical significance.

CONCLUSION

This retrospective study revealed that the CPP approach for BHA is a safe and effective approach for treatment of femoral neck fractures with fully coated cementless femoral stem. For surgeons who are familiar with the posterolateral approach, no special instrumentation is required and the learning curve is minimal. Compared with the traditional posterolateral approach, the CPP approach can preserve the conjoined tendon, piriformis tendon, and partial posterior joint capsule, providing greater hip stability and significantly reducing the postoperative dislocation rate without increasing perioperative complications.

ARTICLE HIGHLIGHTS

Research background

The traditional posterior lateral approach for hip replacement carries a high risk of hip dislocation. Surgeons have reduced the incidence of dislocation after hip replacement by modifying the surgical approach. Reducing the dislocation rate after bipolar hemiarthroplasty (BHA) surgery will greatly improve patient satisfaction and quality of life.

Research motivation

To improve the stability of the hip joint and reduce the postoperative dislocation rate through modifying the posterior lateral approach by preserving the conjoined tendon, piriformis tendon, and partial posterior joint capsule.

Research objectives

To explore the effectiveness and safety of the conjoined tendon-preserving posterior lateral (CPP) approach for BHA in patients with a fractured femoral neck.

Research methods

This retrospective study included adult inpatients from single hospital who underwent BHA with the CPP approach. Paired *t* test was used to compare the Health Service System scores before surgery and 1 year after surgery.

Research results

No dislocation was found during the follow-up period. No serious postoperative complications occurred.

Research conclusions

The CPP approach can significantly reduce postoperative dislocation after BHA in femoral neck fracture patients.

Research perspectives

This study provided evidence for how to reduce the dislocation rate after hip replacement surgery and emphasized the importance of the soft tissue integrity around the hip joint.

FOOTNOTES

Author contributions: Zhao YC designed the report; Yan TX collected the patients' clinical data; Dong SJ analyzed the data, Yan TX and Ning B wrote the paper; All authors read and approved the final manuscript.

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