

Cementless total hip arthroplasty for failed treatment of subtrochanteric fracture

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Research article

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Abstract

Background Failed treatment of subtrochanteric fractures commonly leads to pain, limping, and poor function. Cementless total hip arthroplasty (THA) could be an option as a salvage procedure in such cases. This study was to evaluate the clinical and radiological results and complications of this treatment in our hospital.

Method Eighteen cementless THAs for failed treatment of subtrochanteric fractures were performed at our institution between January 2001 to December 2017. There were eleven males and seven females, and the average age was 74 years (range 57.0-89.0). Eight patients were previously operated with an intramedullary nail, six patients were treated with a dynamic hip screw, two patients were treated with an angled blade plate, one patient was treated with a proximal femur locking plate, and one patient was treated with a dynamic compression plate.

Results The mean follow-up was 5.2 years (range 2.2-10.8). The mean duration of the operation was 98.0 minutes (standard deviation [SD],15.4; range 70-135). The mean total blood loss was 992.2 mL (SD,171.2; range 640-1260 mL), and the amount of transfusion was 2.2 units (SD, 0.8, range 1-4). The mean Harris hip score (HHS) was 38.2 (SD, 9.3; range, 24-56) preoperatively and 85.4 (SD, 4.9; range, 79-92) at the last follow-up. Compared to the patients treated with plate-screws, those treated with an intramedullary nail had significantly shorter surgical duration, fewer blood transfusions, and less intraoperative blood loss. Kaplan-Meier survivorship with an endpoint of revision was 94.4% (95% confidence interval 72.7-99.9) at five years.

Conclusion Cementless THA is one of the acceptable procedures for failed treatment of the subtrochanteric fracture with fewer complications.

Introduction

Subtrochanteric fractures occur in the proximal femur between an inferior aspect of the lesser trochanter and a distance that extends by approximately 5 cm distally. Subtrochanteric fractures are common in young males (severe comminuted and displaced fractures), caused by high energy impacts and in elderly females with osteoporosis, caused by low energy impacts (typically long spiral fractures).

Subtrochanteric fractures (so-called atypical femoral fractures) also occur in patients who take long-term bisphosphonates. Because of the high stress concentration of the subtrochanteric region and high tension across the subtrochanteric area, the treatment of such fractures is challenging [1]. Complex fractures associated with comminution of the posteromedial cortex show a high incidence of fixation failure and a high rate of nonunion [2].

Two main methods of treatment include intramedullary fixation and extramedullary plates [3-5]. The complications that can often result from failed surgery are fixation failure, malunion, nonunion, and infection [2]. These complications are associated with severe bone defects, articular damage, and even

avascular necrosis of the femoral head. Such situations present a considerable challenge to orthopedic surgeons.

When fixation failure occurs, certain salvage treatments can be performed, such as re-osteosynthesis[6] and prosthetic replacement [7]. For young patients, every effort the conservation of bone by revision fixation should be made a priority, whereas for elderly patients with poor bone quality, hip replacement is a promising option [8]. Total hip arthroplasty (THA) is accepted as a successful salvage procedure for failed fixation of the subtrochanteric fractures [9]. In cases of failure caused by cut-out screws, damage of the acetabular cartilage, and degenerative changes of articulation, THA can reduce the need for subsequent reoperation[10-15].

To the best of our knowledge, few reports have described the results and complications of cementless THA performed as a salvage therapy for failed subtrochanteric fracture fixation. The purpose of this study is to evaluate the clinical outcomes and complications of this treatment after failed subtrochanteric fracture fixation.

Materials And Methods

This retrospective study was approved by the institutional review board of our hospital. Eighteen hips in 18 patients with failed fixation of subtrochanteric fractures were treated at our institution between January 2001 and December 2017. There were 11 males and seven females, with an average age of 74 years (range 57 - 89 years). Eight patients were operated on using an intramedullary nail, six patients were treated using a dynamic hip screw, two using an angled blade plate, one using a proximal femur locking plate, and another using a dynamic compression plate. All fractures were classified as subtrochanteric fractures as per the Orthopaedic Trauma Association (OTA) system and Russell-Taylor criteria. Among the 18 (100%) patients, 13 (72.2%) were type A, three (16.7%) were type B and two (11.1%) were type C as per the OTA classification system. According to the Russell-Taylor classification, the subtrochanteric fracture was type 1A in eight (44.4%) patients, type 1B in three (16.7%), type 2A in four (22.2%), and type 2B in three (16.7%) patients. Infection was preoperatively dismissed in all patients based on complete blood white cell count, erythrocyte sedimentation rate, and C-reactive protein results. The mean interval between primary fixation and conversion THA was 19.8 months (range 4.7 - 53.8 months). At the time of performing internal fixation, the mean age of the patients was 72 years (range 57 - 86 years). All fractures remained unhealed after one to three surgical treatments. The mean follow-up duration after THA was 5.2 years (range 2.2 - 10.8 years). There were occurrences of fracture nonunion in all patients, which were unrelated to metal failure in nine patients. In the others, there were metal failures related to metal breakage in eight patients and a cut-off screw in one patient. Prophylactic antibiotics were used to treat all patients half an hour before the operation, and continued postoperatively for two days. Patient demographic details were shown in Table 1.

Table 1. The demographic details of the patients

Variable	Value
Male/Female	11/7
Age at time of fracture (years)	72 (range 57.0-86.0)
Age at THA (years)	74 (range 57.0-89.0)
ASA score	1.8 (range 1-2)
Body mass index (kg/m ²)	23.2 (range 14.6-30.6)
Average follow-up (years)	5.2 (range 2.2-10.8)
Average time to the salvage THA (months)	19.8 (range 4.7-53.8)
Indication	
Nonunion	18
Cutting out / Metal breakage	1 / 8
Fixation Used	
Intramedullary nail	8
Plate device	10
DHS	6
Angled blade plates	2
PF-LCP	1
DCP	1
Frequency of operation before THA	
1/2/3/4	16/1/0/1

Date in gender column, indication, fixation, and frequency of operation columns represent the total number of patients. Data in other columns show an average of the patients within that group. THA is total hip arthroplasty. ASA is the American Society of Anesthesiologists. DHS is dynamic hip screw. PF-LCP is proximal femur locking compression plates. DCP is dynamic compression plate.

All cases with fixation failure were treated using THA with cementless components by an experienced orthopedic surgeon. A lateral approach was used with either proximal or distal extension, depending on the need. An additional skin incision was used to remove the previously implanted fixation devices if necessary, which was required in all cases. The length of the femoral stem was selected such that at least two cortical diameters bypassed the distal screw hole, which is considered to effectively prevent subsequent fractures. After reduction, the greater trochanter was reattached to the proximal femur using

a trochanter grip or a trochanter grip plate or cables (Dall Miles, Stryker Orthopaedics, Mahwah, USA). Postoperatively, a range of motion exercises and walking with limited weight-bearing was encouraged after the second day. Weight-bearing was gradually increased before obtaining radiological confirmation of bone union. Exercises for range of hip motion and abductor strengthening were encouraged for all patients.

All cases were followed up after operation at one, three, six, and 12 months for the first year and every six months after that. During the follow-up, pain and ambulatory statuses were evaluated. The functional result and clinical status were evaluated using Harris hip scores (HHS), as were any resulting complications.

Postoperative radiographs were assessed for prosthesis position and fixation. Limb length discrepancy was measured from radiographs at the last follow-up, using the method described in Woolson et al. [16] Implant migration, a complete radiolucent line at the implant-bone interface, or fixation-screw breakage were considered to indicate loosening of the cementless socket. Heterotopic ossification was assessed using the Brooker system.

Statistical analysis

Statistical analyses were performed using independent samples t-test or Mann-Whitney U test by the Statistical Package for Social Science (SPSS) software (Base 25.0 SPSS Inc. Chicago, Ill); $P < 0.5$ was deemed significant. Survival of implants was analyzed using the Kaplan–Meier survival curve with 95% confidence intervals (CI). The starting point was the date of salvage THA and endpoint was the date of revision.

Results

The mean duration of the operation was 98 min (standard deviation [SD], 15.4; range, 70 - 135 min). The mean total blood loss was 992.2 mL (SD, 171.2; range, 640 - 1260 mL), and the amount of blood transfused was 2.2 units (SD, 0.8; range, 1 - 4 units). The mean HHS was 38.2 (SD, 9.3; range, 24 - 56) preoperatively and 85.4 (SD, 4.9; range, 79 - 92) at the last follow-up. In 4/18 (22.2%) cases, the postoperative HHS was between 90 and 100, in 9/18 (50.0%) cases, between 80 and 89, and 5/18 (27.8%) cases, between 70 and 79. The mean postoperative HHS of patients with subsidence of stem was lower than that in patients without postoperative subsidence of stem, but it was not significantly different.

A Delta-PF cup (Lima-Lto, Udine, Italy) was used in 11 cases. The Fitmore acetabular cup (Zimmer, Winterthur, Switzerland) was used in two cases. A G7 acetabular shell (Biomet, Indiana, USA) was used in two cases. A Maxera™ cup (Zimmer Biomet, Warsaw, USA), an MMC cup (Zimmer Biomet, Warsaw, USA) and an ACCIS cup (Implantcast, Buxtehude, Germany) was used in one case each. A trochanteric hook plate was used in four cases (22.2%), a Dall Miles cable-grip system in 10 cases (55.6%), and cables in

four other cases (22.2%). The Wagner cone stem was used in seven cases (38.9%) and the Wagner SL stem in 11 cases (61.1%).

In the plate fixation group, we had five cases with metal breakage of the device (Fig. 1). In the group who underwent fixation with intramedullary nails, we had three cases with metal breakage of the device (Fig. 2). When compared to patients treated with plate-screws, those treated with an intramedullary nail had shorter surgical time, fewer blood transfusions, and less intraoperative blood loss (Table 2).

Table 2. The subanalysis of clinical results on fixation types

Variable	Plate	Intramedullary nail	P-value
Number of hips	10	8	/
Operation time (minutes)	106.9±12.0	86.9±12.0	0.004
Estimated blood loss(mL)	1099.0±135.9	858.6±122.2	0.001
Transfusion (number of units)	2.6±0.7	1.8±0.7	0.021
Hospital stay (days)	26.2±19.7	26.0±10.2	0.981

Before the salvage operation, all cases (100%) had a walking disability; they had to use crutches because of hip pain. After the salvage THA, nine patients (50%) could walk without assistance; eight (44.4%) could use a cane to walk, and one (5.6%) walked using a walking aid. The Kaplan-Meier survivorship analysis, with revision of the implant for any reason as the endpoint, revealed a survival rate of 94.4% (95% CI: 72.7-99.9) at five years (Fig. 3).

Complications occurred in two of the 18 hips (11.1%). One patient had postoperative dislocation and was treated by closed reduction with no recurrence. Delayed union occurred in one patient. The mean postoperative limb length discrepancy was 6.4 mm (SD, 1.5; range, 4 - 9 mm). Subsidence of the stem occurred in nine cases (50.0%) at three months postoperative. The mean subsidence was 3.4 mm, and two cases (11.1%) subsided more than 5 mm. One stem showed bone in-growth failure caused by subsidence after THA, and this patient underwent revision with a cemented stem. For the cementless cups, no malposition or aseptic loosening was detected. There were two cases with class I heterotopic ossification and one patient with class II heterotopic ossification.

Discussion

THA in failed subtrochanteric fractures has rarely been reported. To our knowledge, there are only two other studies reporting more than 18 cases of failed THA for subtrochanteric fractures. Weiss et al. [17] reported 30 THAs using a modular uncemented stem for failed trochanteric and subtrochanteric fractures with a mean follow-up period of four years. Twenty patients from their study had subtrochanteric fractures. Revisions were conducted for one case of dislocation and six cases of infection, and the rate of

reoperation was 23% (7/30 cases). Enocson et al. [7] also reported a cohort study with a 5 to 11-year follow-up of 88 patients who underwent hip arthroplasty for failure of trochanteric or subtrochanteric fractures. Twenty-five of these patients suffered subtrochanteric fractures and all underwent cemented THA; the rate of revision was 16% (14/88 hips). In our study, cementless THA was performed in 18 cases as a salvage operation. In most patients, the pain was relieved and all the reattached proximal femur fragments were united. However, closed reduction was required for one patient because of dislocation after the THA, and only one patient received stem revision because of the bone in-growth failure. The rate of revision was 5.5%, with a mean follow-up of 5.2 years.

Elderly patients with metal failure of subtrochanteric fractures usually have poor bone quality in the proximal femur. In this case, refixation will prolong their bed-rest period and prevent the patient from early ambulation, often necessitating replacement surgery [8]. THA enables patients to achieve early mobilization and early weight-bearing. We also preferred THA over hemiarthroplasty patients often experience pain associated with acetabular cartilage destruction after hemiarthroplasty. THA for displaced femoral neck fractures in the elderly leads to better patient-based outcomes than hemiarthroplasty, again justifying our use of THA over hemiarthroplasty [18]. Cho et al. [19] compared the results of 18 consecutive cases of hip arthroplasties after failed fixation of intertrochanteric femur fracture. They found that THA achieved more favorable results than bipolar hemiarthroplasty in functional outcomes, including pain and functional scores [19]. A recent review of literature on hip arthroplasty after failed fixation of intertrochanteric fractures found that THA has a greater advantage in functional outcomes than hemiarthroplasty [9]. When compared with previous studies, we believe that THA can provide a higher level of function when used to salvage failed fixation of proximal femur fractures.

In this study, nine patients (50%) showed stem subsidence within three months of THA, but the amount of stem subsidence had no influence on clinical outcomes such as thigh pain, HHS, or patient satisfaction. The rate of subsidence observed in this cohort is comparable to reported rates of subsidence for cemented femoral stems. Siepen et al. [20] reported an 11.1% (11/100) subsidence rate during a two-year follow-up. Patel et al. [21] reported 10 occurrences of subsidence in a total of 100 hips; they found that subsidence was not associated with radiological changes and cementing quality. For a diaphyseal fixed conical femoral stem, such as the Wagner cone stem, subsidence is a common complication. We assume that subsidence occurred within three months due to the final position of the settled implant induced by early weight-bearing, design of the stem and poor bone stock of elderly patients. However, particular care should be taken for patients with subsidence of the stem to avoid reoperation.

Regarding THA for the failed subtrochanteric fracture, there are several factors to be considered, including removal of the failed nail or plate, abnormal soft tissue caused by previous operations, and poor bone quality. Structural bone defects, displacement of bony landmarks, and screw holes increase the risk of fractures and make it difficult to insert femoral components [10]. Surgeons will need to focus more attention and spend more time navigating these difficulties to avoid blood loss and other complications.

For elderly patients, weak bones lead to a higher risk of intraoperative femur fracture in the salvage THA than in primary arthroplasty.

There is some controversy regarding the usage of either cemented or cementless THA for failed subtrochanteric fractures. Some studies report that the cement could leak through holes of the prior fixation device and result in early aseptic stem loosening in the cement fixation. Cement extravasation due to previous screw holes leads to a weak cement mantle, which is visible from postoperative radiographs [22]. Besides, cement may also elevate cardiovascular risk in elderly patients [23]. For the femoral side, because the previously failed fixation device causes bone sclerosis and absence of the femoral metaphyseal, it is difficult to anchor in the cortex for the cemented femoral implant. Nevertheless, it is difficult to form a cement layer with a relatively uniform thickness around the femoral stem. Early weight-bearing may cause stress concentration in the interface or within the cement mantle near the implant, damaging the bone cement and causing early mechanical failure. Therefore, cementless prostheses may be a better choice that avoids the disadvantages of cement prostheses.

We believe that the Paprosky classification system can guide surgeons in choosing prostheses for conversion THA. The Paprosky classification system has been widely used to guide surgeons when making implant choices for revision THA. In our study, as per the Paprosky classification, the femoral defect was type I in 10 patients (55.6%), type II in seven patients (38.9%), and type III in one patient (5.5%). For these patients, the use of a proximally fixed femoral prosthesis would not be a good option, as excellent stability and bone ingrowth cannot be obtained using this method. This implies that a distal fixation femoral stem should be used in such cases. For our study, we selected the Wagner stem to cope with conditions such as bone sclerosis and defects to achieve better durability and longevity of the femoral stem. The stems were designed for uncemented fixation in cases of severe bone deformity at the proximal femur and for cases with severe dysplasia. The surface of the prosthesis is rough blasted, making it beneficial for initial fixation within the diaphysis. It can also promote bone in-growth to achieve biological fixation with the metaphysis and diaphysis. Sandiford et al. [24] reported 104 femoral revisions using the Wagner SL stem, with a follow-up of 24 - 46 months, and found that no femoral stems had failed from aseptic loosening. Only one patient with infection of the stem and cup required operation [24]. Previous studies have shown that the Wagner tapered femoral stems have excellent survival rates and favorable results in revision and primary THA [25,26], potentially making it a better choice. Subsidence of the femoral stem could be a common complication in cementless stems and can lead to failure of osseointegration, especially in complex primary THA. Of these cases in this study, only one stem was revised because of bone in-growth failure with severe subsidence one year after THA.

We analyzed our results to study the impact of different fracture fixations on the outcome. The patient group with intramedullary nails had lower surgical durations, less blood loss, and required less transfusion. We thought that intramedullary nails might be a better implant of choice for the treatment of subtrochanteric fractures, especially since, in case of failure, it is easier to convert to THA.

Most studies report intraoperative periprosthetic fracture as a common complication. Lee et al. [13] reported a 15.2% (5/33) incidence of intraoperative femoral crack for failed internal fixation of intertrochanteric fractures. The distal part of the stem should bypass the previous screw holes and bone defects by at least two cortical diameters to preventing subsequent fractures around the screw hole. In this study, no patients sustained intraoperative periprosthetic fractures. We believe that one of the reasons for this was the fact that we placed the cerclage wire in a manner that prevented intraoperative or postoperative fracture in cases with localized osteoporosis and screw holes.

Dislocation is another severe problem seen after the salvage procedure, often as a result of poor hip joint stability. Zhang et al. [22] reported that the overall dislocation rate of rescue hip replacement after the failure of proximal femoral internal fixation was 15.8%. Archibeck et al. [27] reported that dislocation occurred in five of 102 patients with previous proximal femur fracture, and reoperation was performed in one patient because of instability. In the arthroplasty setting, the abductor mechanism is a significant contributor to stability of an implanted prosthesis [28]. Thus, if component positioning is determined to be acceptable and the hip joint continues to be unstable, then trochanteric advancement may be a suitable choice [29]. For recurrent dislocation of hips, trochanteric advancement offers a surgical option for hip stability by re-tensioning the abductor muscles and increasing the lever arm [30]. In this study, the dislocation rate was lower than in other reports, and only one patient reported dislocation, which can be repaired by altering the position of the components or sufficient repair of the short external rotators and securing greater trochanteric reattachment. Reattachment of a proximal fragment with the greater trochanter plays an essential role in restoring hip abduction mechanism for cases of THA for failed fixation of the subtrochanteric fracture. During operation, the proximal fracture fragment can be fixed proximally and distally using a cable or cable-grip system to make it an extended bone contact, obtaining good tension of the abductors and increasing the healing potential. The cable grip system can provide strong fixation, but care should be taken to protect the peritrochanteric musculature to avoid damage to the abduction function. The surgeon should also avoid over-tightening to prevent failure events such as bone cutout, absorption around the cable, or cable breakage. Thus, for the secure fixation of the greater trochanter, we believe the cable grip system to be a good choice.

There are some limitations to this study. We did not set up a control group to compare the outcomes and the study was retrospective. There was a limited number of cases, and the follow-up duration also rather short. However, there have been very few reports of THA for failed subtrochanteric fracture and ours appears to be the first study evaluating the effect of a salvage cementless THA using the Wagner stem for failed subtrochanteric fracture.

Conclusion

Our study indicates that cementless THA and the selection of Wagner tapered stems could be beneficial for salvaging the failed treatment of subtrochanteric fractures. We think this report conveys valuable messages to the surgeons struggling from the failed subtrochanteric femur fracture.

Abbreviations

THA: total hip arthroplasty

SD: standard deviation

HHS: Harris hip score

OTA: Orthopaedic Trauma Association

CI: confidence intervals

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of our hospital . Written informed consent was obtained from all patients.

Consent for publication

Not applicable

Availability of data and materials

The data sets supporting the results of this article are included within the article and its additional files. The datasets are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interests.

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Authors' Contributions

KSP conceived and supervised the study. SYJ participated in the design of this study and wrote the manuscript. SYJ, JYJ, and WJK analyzed the data. TRY and KSP provided critical review and substantially revised the manuscript. All authors read and approved the final manuscript.

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Figures

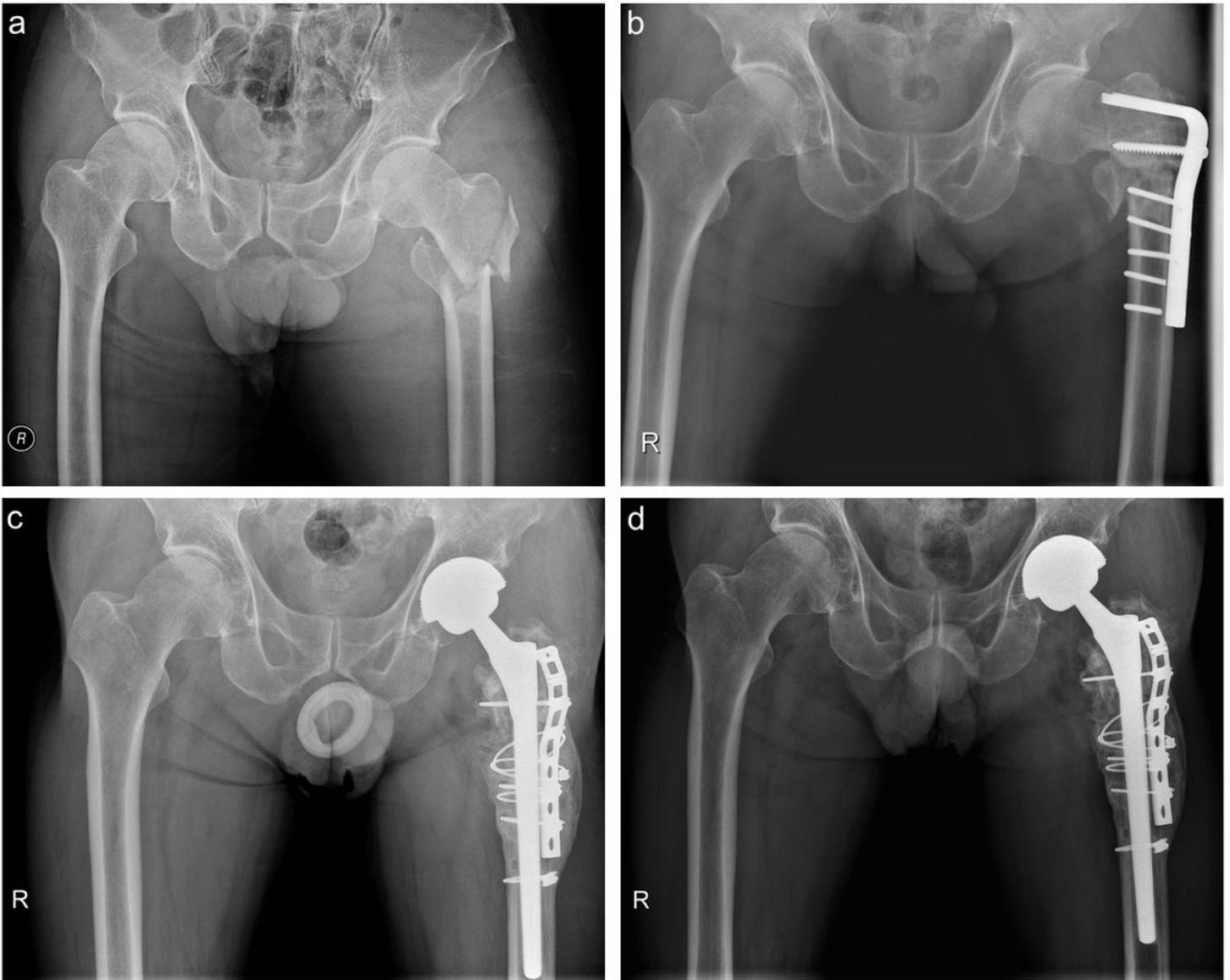


Figure 1

(a) A 69-year-old man sustained a subtrochanteric fracture of the left femur (b) Preoperative radiograph showing the failure of the angled blade plate with screw breakage and the nonunion of subtrochanteric fracture 15 months after internal fixation (c) The plate was removed and total hip arthroplasty was performed with long femoral stem and reconstruction of fragments with the cable grip system (d) Six years postoperatively: the patient returned to unassisted ambulation with a pain-free range of motion of the hip joint

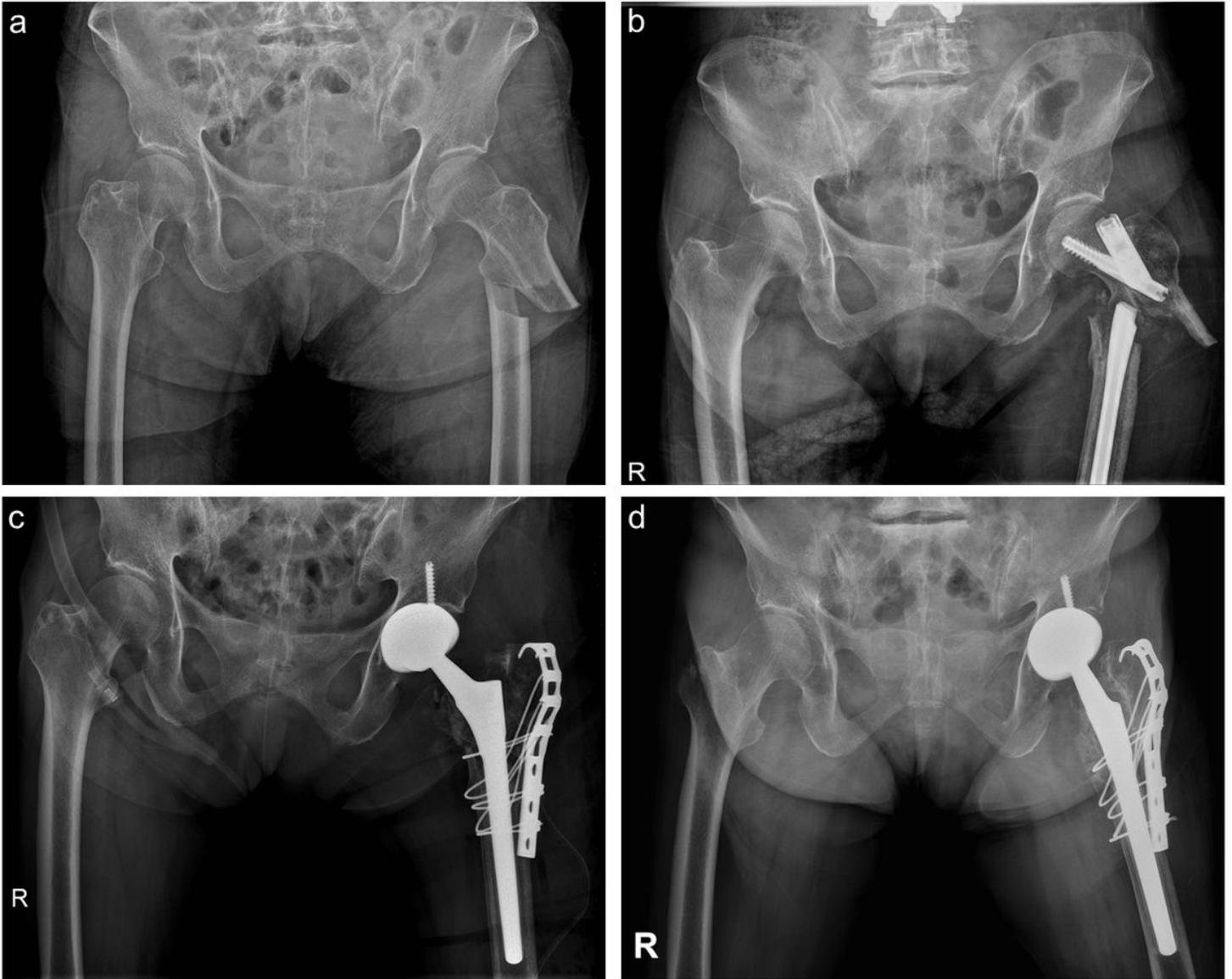


Figure 2

(a) A 72-year-old woman sustained an atypical femur subtrochanteric fracture (b) The nail breakage and the nonunion of subtrochanteric fracture 13 months after internal fixation (c) The device was removed and total hip arthroplasty was performed with long femoral stem and trochanteric reattachment using a cable grip system (d) Two years and eleven months postoperatively: the patient with remarkable pain relief and return to ambulation

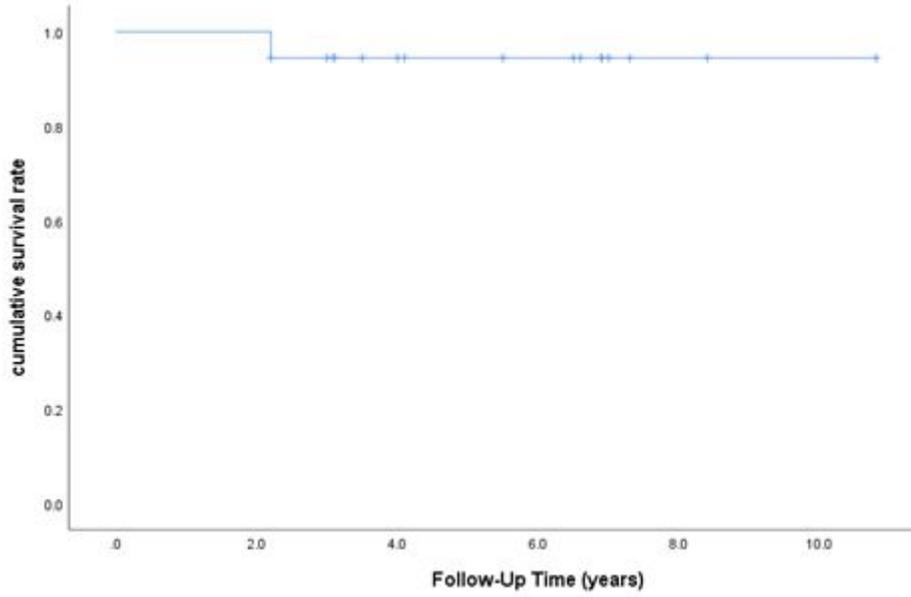


Figure 3

Kaplan–Meier curve, with 95% confidence interval for revision of the implant for any reason