Outcomes of Proximal Femoral Locking-plate Fixation for Pathological Fractures of the Proximal Femur

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ABSTRACT

Objective: To study the treatment outcomes of proximal femoral locking-plate fixation of pathological fractures of the proximal femur relative to clinical results, implant failure, and surgical complications.

Materials and Methods: From 2007 to 2018, 17 patients (18 femurs) with a diagnosis of impending or existing pathological fracture of the proximal femur were treated with proximal femoral locking-plate fixation. Data collected included operative duration, estimated blood loss, ambulatory status, hardware failure events, and postoperative complications.

Results: Of the 18 femurs that were included, 13 were existing pathological fractures and 5 were impending fractures. The mean age of patients was 53.7 years (range: 28-89), and 12 of them were female. The mean follow-up time was 11.3 months (range: 1-67). Ten of 17 patients (62.5%) had progressive lung disease from pulmonary metastasis or from lung primary. No patient developed oxygen desaturation or cardiac arrest during the intraoperative or postoperative period. Thirteen of 17 patients (76.5%) could walk with or without an assistive device at the time of final follow-up. Two patients required close postoperative monitoring in the intensive care unit due to poor preoperative status, and both of those patients died within one month after surgery from other medical problems. No hardware failure occurred.

Conclusion: For pathological fracture of the proximal femur, proximal femoral locking-plate fixation is a treatment option that results in fewer perioperative and postoperative cardiopulmonary events and surgical complications. Most patients can ambulate with or without an assistive device at the final follow-up.

Keywords: Outcomes; proximal femur; locking-plate fixation; pathological fracture; LCP® Proximal Femur Plate (Siriraj Med J 2021; 73: 603-608)

INTRODUCTION

Pathological fracture of the proximal femur is not uncommon and management is challenging. Bone metastasis at the proximal femur is the third most common site after spine and pelvis.[1,2] Immediate fixation or prosthetic replacement provides pain control, return to previous ambulatory status, improved psychological well-being, and improved quality of life.[1-6] Intramedullary nailing of long bones is an accepted technique for management of existing or impending pathological fracture, especially of the proximal femur. Cephalomedullary nail fixation has been shown to be biomechanically superior to the locking-plate system.[7-9] However, serious complications, including pulmonary embolism, have been reported in

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patients treated with intramedullary nailing with or without reaming.[10-11] Proximal femoral locking plate fixation is an alternative implant for impending or pathological fracture in benign or metastatic bone tumors that can reduce the incidence of pulmonary embolism in pathological fractures of the proximal femur.[12-14] Wide excision of tumor with prosthetic reconstruction is a treatment option for patients with hypervascularized metastatic bone disease; however, increased blood loss is often observed during intralesional curettage. This procedure is also considered for patients with a single metastatic bone lesion who have a good prognosis following wide excision of the metastatic tumor, but this reconstruction is complicated and relatively expensive.[6,15,16]

In this study, we evaluated the treatment outcomes of patients who underwent proximal femoral locking-plate fixation for impending or existing pathological fracture of the proximal femur. The outcome parameters that were evaluated were clinical results, implant failure, and surgical complications.

MATERIALS AND METHODS

This was a retrospective observational clinical study. Patient medical charts from 2007 to 2018 were reviewed after the study was approved by our centre's Institutional Review Board (approval number 563/2555). The inclusion criteria were impending or existing pathological fracture and surgical fixation with a proximal femoral locking plate (Synthes LCP® Proximal Femoral Plate, DePuy Synthes Trauma, West Chester, PA, USA). The patients with impending fracture in metastatic bone disease had been scored more than 9 according to Mirels scoring system.[17] Other patients with impending fracture were considered when lesion involved more than 2/3 of bone circumferential with pain on weight bearing.

Operative technique

All surgeries were performed on a fracture table under image intensification. After placing patients under relative-hypotension anaesthesia, a longitudinal incision was made at the lateral aspect of the hip. The lesion was biopsied and the sample sent for pathological examination. After frozen-section results confirmed the diagnosis, meticulous intralesional curettage of the tumor, followed by open reduction of the pathological fracture was performed. After acceptable alignment was confirmed under image intensification, the locking plate was centred over the greater trochanter and the lateral aspect of the femoral shaft. Under image intensification, the fracture was reduced and provisionally held in position with Kirschner wires and reduction forceps. For pertrochanteric fractures, a partially threaded cancellous screw was inserted into a proximal 7.3-millimeter mL hole to achieve better fracture compression. This screw was subsequently replaced with a locking screw after the rest of the locking screws had been secured. Depending on the fracture configuration, the distal end of the plate was secured with a combination of locking and cortical screws.

Patients with metastatic bone disease received a cement-augmented implant. In those with benign lesions, allograft bone chips were packed into the defect. Intravenous antibiotic coverage with cephalosporin was given once preoperatively and continued for 72-hours postoperatively or until drains were removed. Suction drains were removed routinely once the drainage diminished to less than 50 milliliter (mL) in a 24-hour period. No patients received prophylactic anticoagulation. Active range of motion of the hip and knee was begun on postoperative day 1. Ambulation generally began on postoperative day 3 with progressive partial weight bearing with a walker or axillary crutches. Patients were allowed full weight bearing 3 months postoperatively. Patients were reviewed every 3 months for the first 2 years after surgery, then every 6 months for 3 years, and then annually thereafter. Data collected included operative duration, estimated blood loss, duration of hospital stay, number of days to regain previous ambulatory status, and incidence of implant failure or loss of fixation. Pulmonary status was monitored via oxygen saturation, which was recorded intra- and perioperatively. Plain radiographs of the affected extremity and lungs were reviewed from the time of surgery to the final follow-up for each patient.

Statistical analysis

Statistical analysis was performed using SPSS for Windows, Version 18, (SPSS Inc., Chicago, IL, USA). Shapiro-Wilk test was used to test for normality. Data are reported as mean and range or median and interquartile range (IQR). Postoperative ability to walk was tested using a binomial test with test proportion of 0.5 and calculated for a 95% confidence interval (CI).

RESULTS

A summary of patient clinical characteristics, perioperative data, and outcomes is presented in Table 1. Eighteen proximal femurs (13 existing pathological and five impending fractures) were treated in 17 patients (12 females, five males; mean age 53.7 years [range: 28-89]) were enrolled in this study. One patient underwent fixation on both femurs with a staged procedure performed with a 2-week interval between operations. Mean follow-up

TABLE 1. Summary of patient data

Fracture number	Age (years)	Gender	Diagnosis	Operative duration (min)	EBL (mL)	Hospital stay (days)	Time to ambulation (days)	Ambulatory status at final F/U	ICU stay	Lung pathology	O_2 saturation (%)
1*	39	Female	Carcinoma of lung	125	1,200	8	5	Walker	No	Yes (Primary tumor)	100
2#	36	Female	Carcinoma of breast	175	800	11	5	Walker	No	No	99–100
3*#	36	Female	Carcinoma of breast	100	200	8	5	Walker	No	No	100
4	62	Female	Carcinoma of lung	130	600	20	4	Walker	No	Yes (Primary tumor)	100
5	28	Female	Simple bone cyst	175	1,200	13	9	No AD	No	No	100
6	39	Female	Carcinoma of breast	180	1,200	31	10	Wheel chair	No	Yes (Pleural effusion)	100
7	70	Female	Carcinoma of breast	55	200	28	-	Bedridden	Yes	No	100
8	89	Female	Carcinoma of sigmoid colon	105	2,000	68	-	Bedridden	No	No	99–100
9	54	Female	Carcinoma of lung	180	500	18	30	Walker	No	Yes (Primary tumor)	100
10	53	Male	Ewing sarcoma	120	250	22	4	Walker	No	Yes (Metastases)	99
11*	53	Male	MPNST	190	1,000	21	5	No AD	No	Yes (Metastases)	100
12	82	Female	Carcinoma of lung	150	800	37	5	Walker	No	Yes (Primary tumor)	100
13	62	Female	Carcinoma of breast	135	400	16	7	Walker	No	No	99–100
14*	41	Male	Fibrous dysplasia	260	1,000	18	5	No AD	No	No	100
15	56	Male	Carcinoma of lung	80	200	41	6	Walker	No	Yes (Primary tumor)	100
16	57	Male	Hepatocellular carcinoma	115	700	56	-	Bedridden	Yes	Yes (Metastases)	100
17	36	Female	Carcinoma of lung	120	50	7	5	Walker	No	Yes (Primary tumor)	100
18*	71	Female	Carcinoma of lung	140	800	34	2	Walker	No	Yes (Primary tumor)	100

*Patient with impending fracture, # same patient

Abbreviations: MPNST = malignant peripheral nerve sheath tumor; AD = assistive device; EBL = estimated blood loss; ICU = intensive care unit; F/U = follow-up

duration was 11.3 months (range: 1-67). Mean operative duration was 140.8 minutes (range: 55-260). Mean intraoperative estimated blood loss was 688.9 mL (range: 50-2,000). Mean blood transfusion volume after operation was 1.6 units (range: 0-3 units). Average hospital stay was 25.4 days (range: 7-68). Mean number of days to achieve previous ambulatory status was 7.1 (range: 4-30).

Ten of 17 patients (62.5%) had progressive lung disease from pulmonary metastasis or lung primary. No patient developed oxygen desaturation intra- or postoperatively. Binomial test of postoperative ambulatory status revealed that a significantly greater number of patients (13 patients; three [17.6%] without an assistive device, and ten [58.8%] with a walker) achieved their previous ambulatory status postoperatively than did not (p=0.049; 95% CI: 0.54-0.99). No hardware failure occurred in this study. Two patients (11.8%) required close monitoring in the intensive care unit (ICU) postoperatively due to poor preoperative status. Both of those patients subsequently died from other medical problems, one 2-weeks postoperatively and the other one-month postoperatively.

The patient with pathological fracture from a simple bone cyst was followed for 67 months (Figs 1 A-C). This patient underwent a second operation for tumor recurrence with intralesional curettage and bone grafting 11 months after the first operation. She could walk normally and was pain-free at the final follow-up. One patient (fracture number 2) with pathological fracture from metastatic breast cancer underwent fixation with cement augmentation and was followed for 20 months. This patient had multiple bone metastases, but was alive and able to walk with a walker at the final follow-up (Figs 2 A-C).

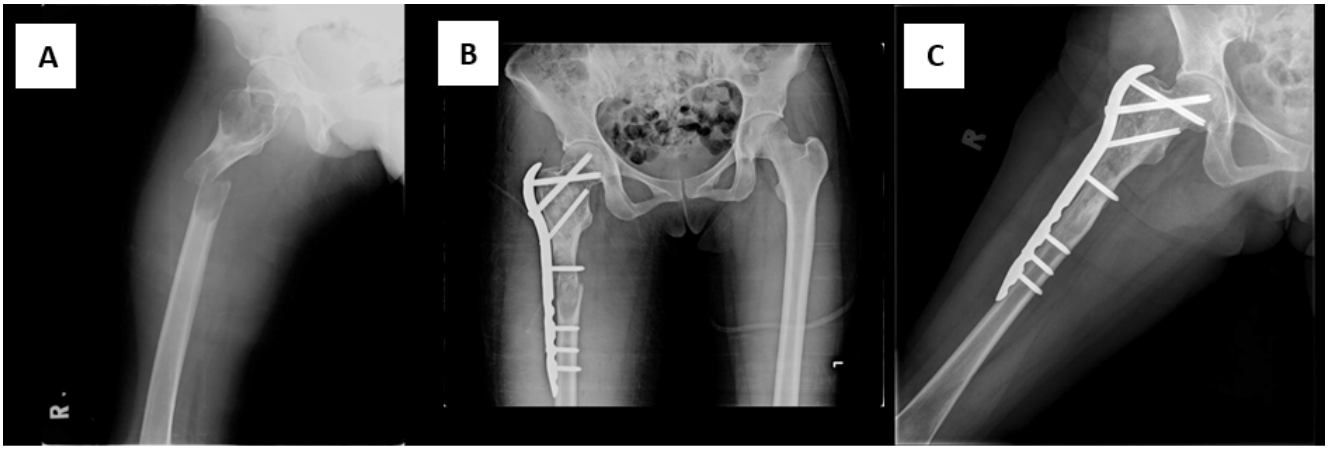

Fig 1. Preoperative radiograph of patient number 5 showing simple bone cyst with subtrochanteric pathological fracture (a). Postoperative radiograph following proximal femoral locking-plate fixation (b). Postoperative radiograph showing complete bone healing at the 67-month follow-up (c).

Fig 2. Preoperative radiograph of patient number 2 showing breast cancer metastasis with subtrochanteric pathological fracture (a). Postoperative radiograph following proximal femoral locking-plate fixation with cement augmentation (b). Postoperative radiograph at the 20-month follow-up (c).

DISCUSSION

Surgical fixation for pathological fracture of the proximal femur can relieve pain and re-establish patient mobility.[1,4] Cephalomedullary nail fixation is an accepted method for pathological fracture of the proximal femur. The biomechanical advantage of intramedullary nail systems has been reported.[7-9] A recent study demonstrated that cephalomedullary nailing was biomechanically superior to either a locking-plate or a 95-degree blade-plate construct.[7] However, techniques for nail insertion may cause problems, such as heterotopic ossification, superior gluteal nerve injury, hip abductor muscle weakness, and limping gait.[18-20]

A serious complication of intramedullary nail fixation is fat or tumor embolism that is probably generated by increased pressure during reaming within the closed intramedullary canal. These emboli can travel along the blood stream to the lung parenchyma and cause devastating pulmonary complications, and this has also been reported in fixation with an unreamed intramedullary nail.[10,21] Using transesophageal echocardiography, Coles, *et al.* quantified the embolic load to the lungs created by reamed and unreamed femoral nailing, and they found that emboli were generated with both methods.[22] Those authors concluded that unreamed nailing did not protect the patient from pulmonary embolization of marrow contents. Kerr, *et al.* reported cardiac arrest in six patients during intramedullary nailing procedures for femoral bone metastases.[23] Three of the six patients in that study had simultaneous fixation of both femurs, and four of the six died from embolus. Similarly, in a report by Charnley, *et al.*, one of 52 patients developed hypotension during insertion of the second femoral nail in a single-stage operation, and subsequently developed cardiac arrest and died in the recovery room. A postmortem study revealed massive pulmonary embolus. Those authors recommended that a second surgery be separated by a 2-week interval from the first surgery to avoid this complication.[24]

Another option for management of a metastatic lesion in the proximal femur is wide resection of the tumor and endoprosthetic reconstruction. However, although this method has a low mechanical failure rate, the complication rate varies widely, and the cost is comparatively high. Wide excision of a metastatic lesion has been recommended in patients with isolated hypervascularized tumors, such as in thyroid or renal cell carcinoma. Many studies suggested wide excision and endoprosthetic reconstruction of a metastatic lesion of the proximal femur in patients who might survive for a longer time. They recommended this reconstruction because the endoprosthesis has a lower rate of mechanical failure and a higher rate of implant survival than intramedullary nails.[6-15] Endoprosthetic reconstruction was reported to have the lowest rate of mechanical failure (less than 3.7%), with complication rates of 6-35%.[15,16,25] However the cost of this reconstruction, which is higher than that of other devices, must be considered when treating patients in developing countries.

Reports on the use of the LCP® Proximal Femoral Plate (Synthes, Inc.) in musculoskeletal oncology reconstruction are limited.[12-14,26] Virkus, *et al.* reported bone union in 23 of 25 pathological fractures, nonunions, or oncologic reconstructions, with the advantage of a lower rate of implant failure in locking plates at a mean follow-up of 18.2 months.[14] In this study, we included the patients with bone lesion of the proximal femur with lateral cortical bone destruction. These particular bone metastasis of the proximal femur might affect the stability fixation of lag screw of cephalomedullary nail fixation. All these patients in this study were treated by locking-plate fixation technique. In the present study, we demonstrated a locking-plate fixation technique for pathological fracture of the proximal femur with lateral cortical bone destruction that did not result in hardware failure, oxygen desaturation, and it yielded satisfactory outcomes. There have been reports of LCP® Proximal Femoral Plate (Synthes, Inc.) implant failure.[27,28] However, these failures occurred in patients with mechanical collapse due to varus deformity with inadequate posteromedial support of severely comminuted fractures. In the present study, all patients with metastatic lesions had cement-augmented implants, and bone defects in patients with benign bone tumors were packed with allograft bone chips. Secure fixation augmented with cement or bone grafting can, thus, lessen the chance of fixation failure, as our series suggests. Most of the patients in this study could ambulate independently with or without an assistive device postoperatively.

The limitations of our study were its retrospective nature and the small number of included patients. However, our results suggest that using LCP® Proximal Femoral Plate (Synthes, Inc.) fixation for pathological fracture may reduce the incidence of pulmonary embolism and promote pain-free postoperative ambulatory status in these patients. None of the patients in our study experienced hardware failure. Further studies, particularly with more patients and longer follow-up periods, are needed to confirm the benefits of this implant in the treatment of existing or impending pathological fracture of the proximal femur.

In conclusion, proximal femoral locking-plate fixation is a treatment option for patients with pathological fracture of the proximal femur that results in fewer perioperative and postoperative cardiopulmonary events and surgical complications. Most patients can ambulate with or without an assistive device at final follow-up.

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Conflicts of interest

No conflicts of interest

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