

# Metastatic Pathologic Fractures in Lower Extremities Treated with the Locking Plate

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**Purpose:** The skeleton is commonly affected by metastatic cancer. The purpose of this study was to evaluate the results of treating metastatic pathologic fractures in lower extremities using locking plates.

**Materials and Methods:** Between 2004 and 2010, we evaluated 12 patients (13 cases) of metastatic pathologic fractures in lower extremities, treated with the locking plate. Mean patient age was 62.2 years (range, 50-81 years), the locations of the fractures were; proximal femur in 2 cases, femoral mid-shaft in 3, distal femur in 3, proximal tibia in 4, and distal tibia in 1 case. The interval to wheelchair ambulation, pain relief and complications were evaluated. Additionally, we assessed operation time and postoperative blood loss.

**Results:** Mean time from operation to wheelchair ambulation was 3.2 days (range, 1-6 days). Mean VAS scores improved from a preoperative score of 8.1 points (range, 7-9 points) to a score of 2.7 points (range, 2-4 points) at 1 week postoperatively. No early complications associated with surgery were encountered. Mean operation time was 88.4 minutes (range, 70-105 minutes), and mean postoperative blood loss was 246.5 ml (range, 130-320 ml).

**Conclusion:** Internal fixation of metastatic pathologic fractures using a locking plate in the lower extremity can be an effective treatment option in the meta- or diaphyseal area of long bones with massive bony destruction or poor bone stock by offering early ambulation, pain relief and low postoperative complications.

**Key words:** pathologic fracture, metastatic cancer, locking plate

## Introduction

The skeleton is commonly affected by metastatic cancer,<sup>1)</sup> and metastatic deposits are the most common type of malignant tumor to affect the skeleton.<sup>2)</sup> Ultimately, 60% to 84% of all cases of metastatic bone disease invade bone.<sup>3)</sup> Furthermore, patients with metastatic cancer involving bone are at increased risk for fractures and immobility resulting in substantial medical-associated morbidities.<sup>4)</sup>

Increasingly, modern diagnostic methods are making it easier to detect metastases at an early stage, and improved methods of treatment offer the likelihood of prolonged life expectancy and improve quality of life and patient care. Current treatment options for patients with bone metastases are primarily palliative. Among those methods of treatments, local irradiation may be sufficient, but surgical

treatment is necessary for patients with a pathologic fracture caused by metastatic cancer.<sup>4)</sup> The aims of the surgical treatment for these instances are to preserve the function of the affected skeletal region, relieve pain, and facilitate early ambulation.

The benefits of the surgical treatment have been well documented, but the optimal method for fixation remains uncertain.<sup>5)</sup> Traditionally, operative treatment of long bone metastases usually consists of closed nailing in cases of a pathologic fracture with minimal bone destruction and fragment displacement.<sup>6-8)</sup> Otherwise, wide exposure, tumor removal, and conventional plate fixation with cement augmentation is used to treat pathological fractures associated with considerable bone destruction.<sup>9-12)</sup> Moreover, the introduction of a locking plate has made a significant impact on orthopaedic oncology as well as other traumatic fractures.<sup>7)</sup> However, the precise roles played by different surgical fixation techniques with respect to outcome and patient benefit have not been clearly defined.

The purpose of the present study is to evaluate the results and the advantages of the operative treatment of metastatic pathologic fractures in the lower extremity using locking plates.

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## Materials and Methods

We retrospectively reviewed 12 patients (13 cases) who underwent open reduction and internal fixation using a locking plate with or without cement augmentation for pathologic fractures in lower extremities caused by metastatic cancer between 2004 and 2010 at our institution.

Mean patient age was 62.2 years (range, 50–81 years) and all were male. Primary malignancies were; lung cancer in 7 patients, gastric

cancer in 2, thyroid cancer in 2, and renal cancer in 1. Fractures were located in the proximal femur in 2 cases, femoral mid-shaft in 3, distal femur in 3, proximal tibia in 4, and distal tibia in 1 (Fig. 1). One patient had concurrent pathologic fractures of the proximal femur and tibia. Non-displaced fractures were present in 5 cases and 8 had a displaced fracture. Multiple bony metastases were observed in all patients, and brain metastases were diagnosed in 4 patients.

The inclusion criteria were: 1) metastatic pathologic fractures of lower extremities, 2) massive bony destructions or poor bone stocks,



**Figure 1.** A 70-year-old man with a fracture of the distal femur secondary to metastasis of lung cancer. (A) Anteroposterior (AP) radiograph of the distal femur shows a displaced pathologic fracture. (B) The patient underwent an open reduction and internal fixation using a locking plate with cement augmentation.



**Figure 2.** An 81-year-old man with thyroid cancer showing a pathologic fracture of the femoral mid-shaft. (A) Preoperative radiograph shows an osteolytic lesion of the femoral shaft. (B) Coronal plane of preoperative CT scan demonstrates a cortical discontinuity around the lesion of the femoral shaft. (C) A minimally invasive plate osteosynthesis was performed with a locking plate.

Table 1. Demographic Data of Patients with an Impeding or Pathologic Fracture of the Lower Extremity Caused by Metastatic Cancer

Cases	Gender	Age (year)	Primary tumor	Metastases	Pathologic fracture site	Operation name	Survival after fracture (day)	Interval from operation to ambulation (day)	Preoperative VAS (points)	Postoperative VAS (points)	Postoperative blood loss (ml)	Operation time (minute)
1	M	81	Thyroid	Multiple (skeleton, Lymph nodes)	Femur mid-shaft	ORIF with LCP	84	1	8	3	260	70
2	M	61	Lung	Multiple (skeleton)	Proximal femur	ORIF with LCP	14	No*	8	3	200	65
3	M	61	Lung	Multiple (skeleton)	Proximal tibia	ORIF with LCP & cementing	14	No*	8	2	315	80
4	M	70	Stomach	Multiple (Skeleton, Brain)	Distal tibia	ORIF with LCP & cementing	32	3	7	4	130	65
5	M	70	Lung	Multiple (Skeleton, Lymph nodes)	Distal femur	ORIF with LCP & cementing	44	2	9	3	320	85
6	M	58	Lung	Multiple (Skeleton, Brain)	Distal femur	ORIF with LCP & cementing	220	6	9	2	200	90
7	M	50	Lung	Multiple (Skeleton, Brain)	Distal femur	ORIF with LCP & cementing	378	4	8	2	300	95
8	F	58	Thyroid	Multiple (Skeleton)	Proximal femur	ORIF with LCP & cementing	38	4	7	4	225	105
9	M	60	Lung	Multiple (Skeleton)	Mid-shaft femur	ORIF with LCP & cementing	65	2	8	2	255	105
10	F	66	Stomach	Multiple (Skeleton)	Proximal tibia	ORIF with LCP & cementing	149	2	8	3	230	100
11	F	56	Kidney	Multiple (Skeleton)	Proximal tibia	ORIF with LCP	241	5	9	3	295	95
12	M	57	Lung	Multiple (Skeleton, Brain)	Mid-shaft femur	ORIF with LCP & cementing	74	3	7	2	265	95
13	M	62	Lung	Multiple (Skeleton)	Proximal tibia	ORIF with LCP	107	3	9	2	210	100

ORIF, open reduction and internal fixation; LCP, locking compression plate.

\*One patient (2 cases) died due to aggravation of underlying chronic obstructive pulmonary disease and interstitial pneumonia at 14 days postoperatively.

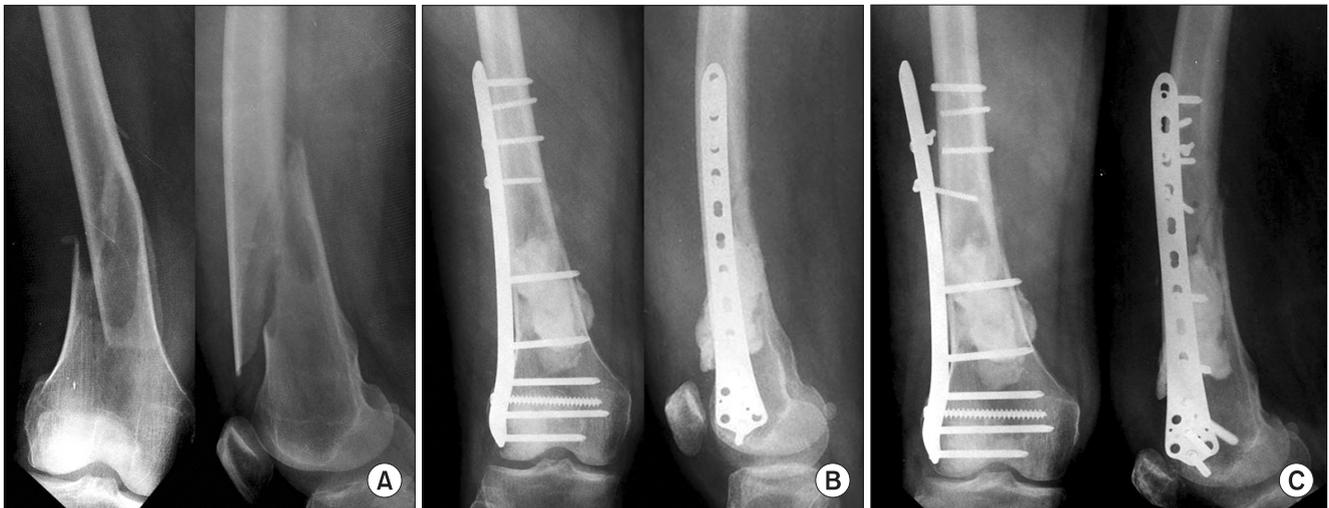
which were difficult to use an intramedullary device. Simple fixation of a pathologic fracture in the proximal femur or femoral mid-shaft was performed in 4 cases using minimal invasive techniques (Fig. 2). Tumor removal and locking plate fixation with bone cement augmentation were performed in 9 cases with considerable bony destruction (Table 1). Most patients were treated with external beam irradiation, and radiation therapy was started within 8 weeks postoperatively. In general, the dose of radiation therapy given was 30.0 Gy in 2 weeks (10 fractions).

The results of pathologic fracture treated with locking plate fixation were evaluated with an emphasis on patient benefits, defined as interval to wheelchair ambulation, pain relief (using the visual analogue scale (VAS), and a low complication level. Additionally, we

assessed operation time, postoperative blood loss, as determined using amounts of postoperative drainage and mean survival periods.

## Results

Mean time from operation to wheelchair ambulation was 3.2 days (range, 1–6 days), except for the 1 case who died at postoperative 2 weeks. Mean VAS scores improved from a preoperative score of 8.1 points (range, 7–9 points) to a score of 2.7 points (range, 2–4 points) at 1 week postoperatively (Table 1). No early complication associated with surgery was encountered, such as, periprosthetic fracture, deep infection, fat embolism, or pulmonary thromboembolism. One late complication of screw breakage and reduction loss at postopera-



**Figure 3.** A 58-year-old man with a pathologic fracture of the distal femur due to lung cancer. (A) AP radiograph shows an osteolytic lesion of the distal femur with a pathologic fracture. (B) The distal femur with a pathologic fracture was stabilized by using locking plate with cement augmentation. (C) AP and lateral radiograph obtained 3 months after internal fixation shows loss of reduction and failure of the internal fixation.

**Table 2. Results Compared with Intramedullary Nailing for the Treatment of Pathologic Fractures**

Authors	Cases	Operation time (minute)	Blood loss (ml)	Ambulation (day)	Complications (numbers)
Sharma et al. <sup>26)</sup>	21	140	900	3*	Superficial wound infection (2) Pneumonia (2) Loss of reduction (1)
Moholkar et al. <sup>27)</sup>	48	98	400	7 <sup>†</sup>	Chest infection (4) Urinary track infection (2) Superficial wound infection (2) Deep wound infection (1) Renal failure (1) Death (2)
Present study	13	88.4	246.5	3.2	Screw breakage (1)

\*Weight bearing ambulation, <sup>†</sup>Of the 42 patients, 69% were ambulatory by one week in their study.

tive 3 months occurred, which had been treated with curettage, cement augmentation and plate fixation for pathologic fracture of the distal femur. Reoperation using open reduction and internal fixation with additional anterior plating and screw change was performed and provided a satisfactory result (Fig. 3).

Mean operation time was 88.4 minutes (range, 70–105 minutes), and mean postoperative blood loss was 246.5 ml (range, 130–320 ml). Median survival of the 12 patients after the operation was 112.3 days (range, 14–378 days), and 1 patient (2 cases) died due to aggravation of underlying chronic obstructive pulmonary disease and interstitial pneumonia at 14 days postoperatively (Table 2).

## Discussion

Skeletal metastases are the results of hematogenous disseminations of cancer cells and a complex multistep process which involves interactions between tumor cells and normal host cells.<sup>13–15</sup> Incidences of between 25 and 100% have been reported for bony metastases in advanced myeloma and carcinomas of the breast, prostate, thyroid, lung, and kidney,<sup>13–15</sup> and although the incidence of a pathological long bone fracture in patients with metastatic bone disease is uncertain, but may be about 10%.<sup>11</sup>

Multiple metastatic bone disease is a catastrophic complication for most patients with cancer and usually indicates that the malignant process is incurable and that palliation is the only option. Metastatic destruction of long bones reduces bone load-bearing abilities, and result in pain, impaired mobility, hypercalcemia, and in pathological fracture, which cause greatest disability. In cases with an impending or actual pathologic fracture of a long bone by metastatic cancer, the purpose of surgical therapy, with a few exceptions, is palliative, and the aim of surgery is to improve the quality of remaining life with respect to pain relief, preserving the function of the affected skeletal component, preventing complications, shortening the time spent in hospital, and to facilitate patient care.<sup>16–18</sup>

Various methods and fixation techniques, including nailing and plating with or without cement augmentation, have been described to treat pathologic fractures of the long bones.<sup>6–11,19</sup> Intramedullary fixation devices are preferable for actual and impending fractures of long bones because of their superior abilities to withstand mechanical loads, as they are able to support entire lengths of affected bones where normal bone-healing cannot be expected.<sup>16,20</sup> However, intramedullary nailing presents the risk of pulmonary complications, such as, fat embolism, and the probability of intramedullary spread and systemic circulation of cancer cells during reaming and rod

insertion. Also, metaphyseal and intraarticular involvements of the long bones tend to prevent intramedullary devices providing secure fixation and stability. Pathologic fractures in the supracondylar regions of the femur and proximal and distal tibia can be challenging when secondary to comminution and the bone stock is poor. If there is sufficient bone stock, the use of conventional internal fixation devices augmented with cement will usually achieve stability. However, treatment by internal fixation using conventional plates stabilizes bone fragments against the deforming forces due to friction between plates and bone,<sup>21</sup> generated by the screws that force them together, and is consequently not recommended or possible for patients with poor bone stock or massive destruction.

Locking plates stabilize bone fragments using screws attached to the plates in a rigid, fixed-angle coupling. This locking of screws to plates makes the construct more resistant to screw loosening and pull out and metal failure.<sup>21</sup> Accordingly, locking plates provide more secure fixation and stability than conventional plates in cases with a poor bone stock and bony destruction caused by metastatic cancer. Also minimally invasive plate osteosynthesis technique using a locking plate could minimize additional vascular insult to periosteal and medullary blood supplies and soft tissue damage.

Reported rates of local complications, such as, deep infection, osteomyelitis and wound healing complications in patients surgically treated for metastases of the long bones range from 1.5 to 9%.<sup>22,23</sup> In the metastatic bone disease, immune and bone marrow suppression often increases risk of infection, hematoma and wound complications. Therefore, limiting the surgical time, exposure and blood loss is probably beneficial.<sup>5</sup> Also, intraoperative complications, such as, intraoperative death due to fat embolism and intraoperative peri-prosthetic fracture, and perioperative complications have been frequently reported.<sup>24,25</sup> In the present study, none of the complications mentioned above was observed, but a late complication of screw breakage and reduction loss due to inappropriate ambulation before bony union occurred at 3 months postoperatively in 1 patient, who was treated by curettage, cement augmentation, and plate fixation for a pathologic fracture of the distal femur. The overall outcomes of the 13 cases were satisfactory in terms of pain relief, early ambulation, postoperative blood loss, and operation time.

It should be appreciated that this study is limited by its retrospective design and the small number of patients enrolled. Accordingly, it is not possible to define clearly the availability and superiority of locking plates for pathologic fractures of the long bones by metastatic cancer, and further research is required to compare the results of locking plate fixation with other fixation methods. The low inci-

dence of postoperative complications, reduced levels of pain, and the early ambulation were observed in this study, and our results showed that locking plate fixation can be an effective treatment option in pathologic fractures of long bones, especially, in cases of metaphyseal lesion with massive bony destruction or poor bone stock, which is difficult to use an intramedullary device. Furthermore, minimally invasive techniques in plate application and long plate fixation enables us to minimize additional injury to periosteal and medullary blood supplies and soft tissue damage without intramedullary seeding or systemic spread of cancer cells.

In conclusion, internal fixation of metastatic pathologic fractures using a locking plate in the lower extremity might be an effective treatment option in the meta- or diaphyseal area of long bones with massive bony destruction or poor bone stock by offering early ambulation, pain relief and low postoperative complications.

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## 잠김 금속판을 이용한 하지의 전이성 병적 골절에 대한 치료

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**목적:** 골격계는 전이성 암에 의해 흔히 영향을 받는 부위이다. 본 연구를 통해 하지에서 발생한 전이성 병적 골절에 대한 치료로서 잠김 금속판을 이용한 치료 결과에 대해 알아보려고 한다.

**대상 및 방법:** 2004년부터 2010년까지 하지에 발생한 전이성 암에 의한 병적 골절에 대하여 잠김 금속판을 이용하여 치료받은 12명(13예)의 환자를 대상으로 평가를 시행하였다. 평균 환자 나이는 62.2세(50-81세)였으며, 골절은 각각 근위 대퇴골 2예, 대퇴골 간부 3예, 원위 대퇴골 3예, 근위 경골 4예, 원위 대퇴골 1예에서 발생하였다. 치료 결과로서 휠체어 보행 가능 시기, 통증 완화 정도 및 합병증을 평가하였으며, 또한 수술 시간 및 술 후 실혈량에 대하여 평가하였다.

**결과:** 수술 후부터 휠체어 보행까지는 평균 3.2일(1-6일)이 소요되었다. 평균 시각 통증 척도는 수술 전 8.1점(7-9점)에서 술 후 1주일째 2.7점(2-4점)으로 호전되었으며, 수술과 연관된 조기 합병증은 발생하지 않았다. 평균 수술 시간은 88.4분(70-105분)이었으며, 술 후 평균 실혈량은 246.5 ml (130-320 ml)이었다.

**결론:** 하지의 전이성 병적 골절에 대한 치료로서, 잠김 금속판을 이용한 내고정술은 심한 골 파괴나 골 결손을 보이는 장골의 골간단부 혹은 골간부 병변에 효과적인 치료 방법이며, 또한 조기 보행을 가능하게 하고, 통증 및 술후 합병증 감소에 도움을 줄 수 있을 것이다.

**색인단어:** 병적 골절, 전이성 암, 잠김 금속판