



## The outcome of locking plate fixation for the treatment of periarticular metastases

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**Periarticular bone metastasis may be treated with endoprosthetic reconstruction. The extensive surgery required may not, however, be appropriate for all patients. Our aim was to establish whether locking plates provide good functional outcomes and a durable construct when used in the management of metastatic disease.**

**Prospective data collection was performed. Twenty one patients underwent surgery for periarticular metastatic tumours. The median duration of follow-up for surviving patients is one year. There have been no cases of implant failure and no requirement for revision surgery. Pain relief was excellent or good in the majority of patients. Patients who had sustained a fracture prior to fixation had restoration of their WHO performance status. All patients had a dramatic improvement in their MSTS scores. The median pre-operative score was 15% (0%-37%) improving to a median score of 80% (75%-96%) post operatively. Locking plates were found to provide reliable fixation and excellent functional restoration in selected patients suffering from periarticular metastatic bone disease.**

**Keywords :** neoplasm ; metastasis ; fractures ; fracture fixation ; treatment outcome.

### INTRODUCTION

Almost half of patients who suffer a pathological fracture will die within 6 months of their fracture occurring (4,7,17,19). A number of patients will, however, survive several years following the treat-

ment of skeletal metastasis. In the context of multiple metastatic disease, the aim of orthopaedic intervention is to stabilise the skeleton so providing pain relief and restoring function (1). This must be achieved with an orthopaedic construct that will outlive the patient.

The management of periarticular metastasis is complex. The treatment of these lesions with endoprosthetic replacement is a significant undertaking. The physiological demands of the procedure and the rehabilitation period required are significant and are not always appropriate in a patient with a very limited life expectancy.

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Historically internal fixation has had a high failure rate in many series (4,18,19). Locking plates are devices that allow the insertion of fixed angle or angular stable screws or pegs (14). They do not require friction between the plate and bone to maintain fixation unlike conventional plates. There is a paucity of literature regarding the management of periarticular metastasis with internal fixation. The use of locking plates in the treatment of traumatic fractures has been well described but there is only limited data regarding their use in the treatment of periarticular metastasis. Our aim was to assess implant and patient related outcomes following the treatment of periarticular metastasis with locking plate fixation.

### PATIENTS AND METHODS

The study was undertaken at a supra-regional bone tumour unit. Data is collected prospectively on every patient referred to the unit. Since 2006, 190 patients with skeletal metastatic disease have been treated either operatively or non-operatively by our unit. There have been 21 patients with periarticular tumours treated with lock-

ing plate fixation. Indications for surgery included actual or impending fracture or significant pain unresponsive to non-operative treatment. Patients were discussed at the multi-disciplinary meeting prior to surgery to confirm that they had incurable metastatic disease and that surgery was being performed in the context of palliation. In the cases of multiple myeloma it was confirmed that disease was systemic and therefore not a plasmacytoma requiring en bloc resection.

Data was recorded regarding demographics, tumour factors, presence of fracture, duration of inpatient stay, complications, adjuvant radiotherapy and survival. Survival data was cross-referenced with GP and Regional Health Authority records and Kaplan Meier survival analysis was performed. Pain relief was assessed using the scoring system of Perez (10) (Table I). A functional assessment utilising the WHO/ECOG functional score (9) (Table II) and the Musculo-Skeletal Tumour Score (MSTS) (5) was performed (Table III). The MSTS was designed as a post-operative score. In this study we have also used it pre-operatively to assess the benefit of fixation. In order to do this the section of the score relating to emotional acceptance has been administered relating to the patients acceptance of their pre-operative pain and function.

Table I. — The Perez scoring system (10) to assess pain relief

Score	Definition
Excellent	Complete resolution of pain with no use of analgesia
Good	Nearly complete resolution with occasional use of analgesia
Fair	Some reduction in pain with regular use of analgesia
Poor	No difference in pain compared to pre-operative levels

Table II. — WHO/ECOG performance score (9)

Score	Definition
0	Asymptomatic (Fully active, able to carry on all pre-disease activities without restriction)
1	Symptomatic but completely ambulatory (Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature. For example, light housework, office work)
2	Symptomatic, < 50% in bed during the day (Ambulatory and capable of all self care but unable to carry out any work activities. Up and about more than 50% of waking hours)
3	Symptomatic, > 50% in bed, but not bedbound (Capable of only limited self-care, confined to bed or chair 50% or more of waking hours)
4	Bedbound (Completely disabled. Cannot carry on any self-care. Totally confined to bed or chair)
5	Death

Table III. — The Musculoskeletal Tumour Score (5).

The MSTS awards scores of 0-5 across a range of elements of limb function. There is a core component and then lower limb and upper limb specific components. A total score out of 30 is calculated and converted to a percentage to give the final MSTS

	Element Assessed.
All patients	Pain Function Emotional acceptance
Lower limb patients only	Use of supports Walking ability Gait
Upper limb patients only	Hand positioning Manual dexterity Lifting ability

## RESULTS

Complete data sets were available for all 21 patients with periarticular metastasis treated with locking plate fixation (Tables IV & V). There were eleven women and ten men with a mean age of 64 years. Seventeen cases involved metastatic

carcinoma and four multiple myeloma. Nine cases involved the upper limb and twelve the lower limb. The periarticular metastasis was the first presentation of malignancy in five cases and these patients all underwent biopsy as part of the diagnosis and staging prior to definitive surgery.

Open surgery was performed in all cases ; there were no cases of minimally invasive percutaneous fixation. Standard extensile approaches were utilized. The patients suffering from renal metastasis all underwent pre-operative embolisation. Cement augmentation of significant osseous defects was required in 16 cases. The median post operative in patient stay was 6 days (min 2 days, max 74 days, mean 10 days). Post operatively full weight bearing was allowed in all lower limb cases. In the upper limb passive range of movement was allowed for 2 weeks, progressing to active assisted and active resisted exercises as pain allowed. All patients were reviewed post operatively by an oncologist or a haematologist as appropriate and 13 underwent adjuvant radiotherapy.

Table IV. — Demographic details, diagnosis, location, cement augmentation, radiotherapy and survival

No.	Age	Diagnosis	Location	#	PMMA	RXT	Alive/Dead	F/U (Months)
1	62	Renal	Proximal tibia	Y	Y	N	Dead	5
2	61	Myeloma	Distal femur	Y	N	N	Dead	5
3	49	SCC	Proximal humerus	Y	Y	N	Dead	9
4	68	Gastric	Proximal tibia	Y	Y	Y	Dead	4
5	88	Prostate	Distal tibia	Y	Y	Y	Dead	18
6	53	Renal	Distal femur	N	Y	Y	Alive	13
7	39	Uterus	Proximal tibia	N	Y	Y	Alive	50
8	73	Lung	Distal femur	N	Y	N	Dead	6
9	68	Oesophagus	Proximal femur	N	Y	Y	Dead	5
10	62	Renal	Distal femur	Y	N	Y	Alive	16
11	63	Lung	Proximal humerus	N	Y	N	Dead	5
12	73	SCC	Distal humerus	N	Y	Y	Dead	18
13	77	Myeloma	Proximal humerus	Y	N	N	Dead	3
14	75	Myeloma	Proximal humerus	Y	N	Y	Alive	7
15	53	Renal	Proximal humerus	Y	Y	Y	Alive	5
16	63	Renal	Proximal humerus	Y	Y	Y	Alive	5
17	77	Lung	Proximal femur	Y	Y	Y	Dead	2
18	53	Renal	Distal femur	Y	N	Y	Alive	2
19	65	Malignant melanoma	Proximal humerus	Y	Y	N	Alive	8
20	61	Renal	Proximal tibia	N	Y	N	Dead	1
21	55	Myeloma	Proximal humerus	Y	Y	Y	Alive	3

Table V. — Complications and functional outcome

No	Complications	Post op pain score	WHO score pre-op	WHO score post op	MSTS pre-op	MSTS post-op
1	None	Excellent	3	1	0	80
2	None	Fair	4	1	0	53
3	None	Good	2	0	10	83
4	None	Excellent	3	0	7	93
5	None	Fair	2	0	17	60
6	Delayed wound healing	Fair	2	1	17	50
7	None	Excellent	2	0	20	87
8	Sinus	Excellent	2	0	27	93
9	Skin Metastasis	Fair	2	1	7	60
10	Local progression	Fair	4	2	0	40
11	None	Good	2	0	37	80
12	Temporary nerve dysfunction Local progression	Good	3	2	37	83
13	None	Excellent	3	2	20	80
14	None	Excellent	3	0	17	93
15	None	Excellent	3	0	17	93
16	None	Good	3	1	23	67
17	None	Good	4	2	0	57
18	None	Excellent	4	1	0	97
19	None	Excellent	3	0	23	93
20	None	Good	4	2	10	67
21	None	Excellent	3	0	20	90

No patients have been lost to follow-up. Twelve patients have died, all due to high-volume metastatic disease. The mean follow-up duration for all patients is nine months (Fig. 1). The mean time from surgery to death was seven months ; the mean follow-up duration of the nine surviving patients is 14 months (median 12 months). Illustrative cases are demonstrated in figure 2 and 3.

There have been no cases of implant failure and no cases of revision surgery. Three patients experienced a post operative complication. One patient experienced wound breakdown which required debridement and healed by secondary intention. This was the only case requiring further surgical intervention. One patient had transient ulnar nerve dysfunction which recovered fully. One patient developed a sinus secondary to low grade sepsis.

Three patients have experienced local disease progression. One developed soft tissue metastatic

tumour around the operative site and the other two patients had continued bone destruction due to metastatic disease despite radiotherapy. One of these patients died without requiring revision surgery and in the other the implant is still functioning and remains under review.

Using the scoring system of Perez (10), pain relief was found to be excellent in ten patients (48%), good in six (28%) and fair in five (24%). In the upper limb excellent or good pain relief was obtained in all cases. All patients had an improvement in their WHO/ECOG functional status. The median improvement was 2 points. Sixteen patients were asymptomatic or symptomatic but completely ambulatory (lower limb) or able to perform tasks such as light housework (upper limb). All patients had a dramatic improvement in their MSTS scores. The mean pre-operative score was 15% (min 0%, max 37%, median 17%) improving to a mean score of 75% (min 27%, max 97%, median 80%) post

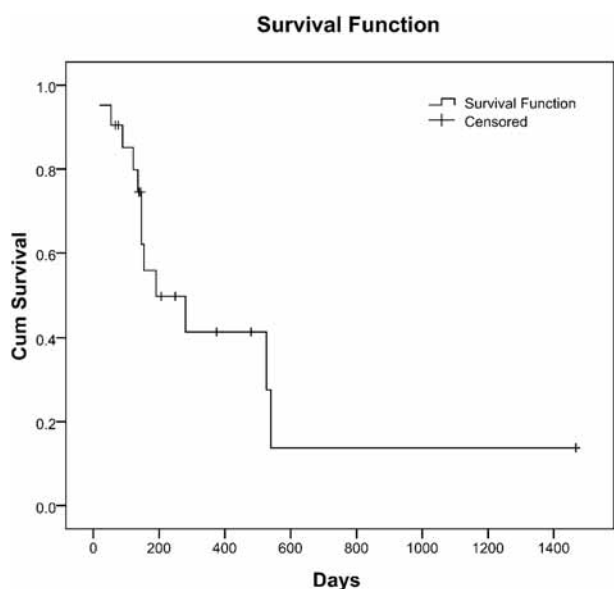


Fig. 1. — Kaplan Meier survivorship curve

operatively. In the upper limb cases, the pre-operative mean MSTS was 23% rising to 85% post operatively. In the lower limb the mean MSTS pre-operatively was 9% rising post operatively to a mean of 70%.

## DISCUSSION

This study has demonstrated good results when locking plates are used in the treatment of periarticular metastatic tumours. There have been no implant failures and no cases of revision surgery. There have been good patient related outcomes in terms of both pain relief and functional recovery with a low rate of complications.

The strength of this study is that all the data has been collected prospectively and there has been no loss to follow-up. A recent study of pathological fracture fixation had only 50% follow-up at a median of nine weeks post operatively, demonstrating the difficulty of achieving such a high follow-up rate (15). Few studies of orthopaedic intervention in skeletal metastatic disease incorporate measures of functional outcome. This study provides three outcome measures for all patients.

The relatively small number of patients in the study is a weakness. Until recently the largest study

of locking plate fixation in orthopaedic oncology included only nine patients suffering from metastatic carcinoma or multiple myeloma (16). Siegel *et al* (13) have recently published a series of patients treated with proximal humeral locking plates which included 22 patients with metastasis or myeloma. This used the MSTS to assess post-operative functional outcome but no formal assessment of pain relief or pre-operative function was made. We have used the WHO/ECOG score in addition to the MSTS pre and post operatively to give a more comprehensive assessment, not only of outcome, but also of the benefit of surgery. There have been no published studies regarding the outcome of locking plates used to treat lower limb metastatic disease.

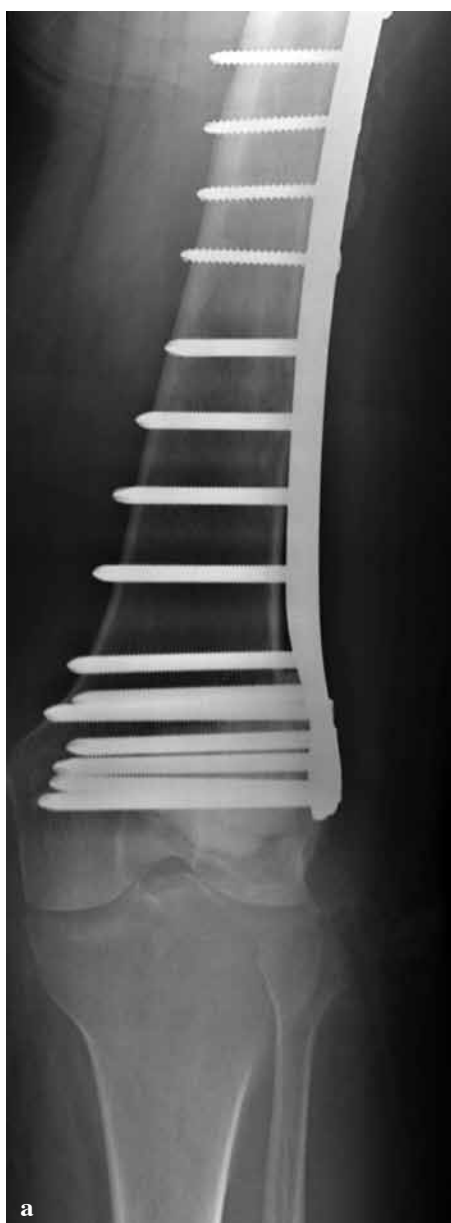
There were no implant failures in our series and no cases of revision surgery. Traditional internal fixation devices have a high failure rate in the treatment of metastatic disease (4,11,18,19). Wedin *et al* (7) demonstrated a 14% failure rate of internal fixation in the treatment of metastatic disease at a median time to failure of eight months. The median duration of follow-up of surviving patients in our study is 12 months. The 100% implant survival demonstrated in our series relates to several factors. The nature of fixed angle devices with screws locking into the plate makes them suitable for use in poor quality bone or in the presence of segmental bone loss. Polymethylmethacrylate augmentation was used in the majority of patients. This has previously been shown to reduce pain and provide more durable constructs in the treatment of metastatic disease (6,8). Good patient selection is vital. We have deliberately selected patients with limited life expectancy, either due to volume of their disease or the nature of their primary tumour. Patients with low-volume breast or renal metastasis are generally treated with endoprosthetic replacement to avoid the risk of implant failure associated with the prolonged life expectancy associated with these tumours.

Pain relief following surgery was excellent or good in the majority of patients. In the upper limb all patients obtained excellent or good pain relief. Spencer *et al* (15) studied the outcome of intramedullary nailing of humeral metastasis. Only 11% of patients had excellent pain relief, 83% good



**Fig. 2a, b & c.** — Radiographs demonstrating a lytic squamous cell carcinoma metastasis in the periarticular region of the distal humerus (a & b). Treatment by endoprosthesis reconstruction would have necessitated significant resection of the distal humerus, which was deemed inappropriate as the patient had a very limited life expectancy. Therefore distal humeral locking plates and cement augmentation were used to provide pain relief and restoration of function (c).

and 6% fair. We feel that the tendency to greater pain relief in our study is because the plate construct provides immediate absolute stability compared to the relative stability achieved with an intramedullary nail. Pain relief in the lower limb appears to be less predictable. All patients treated for lower limb metastases reported a reduction in their pain compared to pre-operative levels but most still required some form of oral analgesia.



**Fig. 3a & b.** — Radiographs demonstrating locking plate fixation and cement augmentation of a subarticular distal femoral metastasis from a primary lung carcinoma. When using locking plates to treat metastatic disease all the screw holes are utilized. This is because the bone lesion will not heal and therefore a rigid construct is preferable to reduce the risk of metalware failure. This is different to the concept used when locking plates are employed in the treatment of conventional fractures where a very rigid construct is usually best avoided.

This may be a reflection of selection bias. Patients received locking plate fixation rather than endoprosthesis reconstruction when they had aggressive tumours and a very limited life expectancy. The implant construct is stressed with weight bearing which may cause pain but radiological follow-up demonstrated all had solid bone implant constructs. The continued pain may have been due to persistent tumour activity.

The MSTS was originally described to assess the post-operative outcome of limb salvage sarcoma surgery (5). We have applied the scores pre-operatively and post-operatively. The use of the score pre-operatively has not been validated to our knowledge but it is of benefit in assessing the improvement following surgery. It is often assumed that pain relief

and function are improved following treatment of metastatic disease but this is rarely quantified. The WHO/ECOG scores provide a global assessment of the benefit of surgical intervention with a median improvement of two points being found. The MSTS scores clearly demonstrate significant benefit in terms of functional restoration as well as pain relief from surgical intervention for periarticular metastasis. The post surgical MSTS were higher in the upper limb. However the upper limb cases had a higher pre-operative baseline (23%) than the lower limb cases (9%). The increase in scores was not significantly different between upper limb and lower limb cases (mean increase 62 and 61 percent respectively).

Our results, using proximal humeral locking plates, compare favourably with published results for modular endoprostheses for the same indication. Scotti *et al* (12) had a mean MSTS of 73% for endoprostheses compared with 85% in this series for proximal humeral locking plate fixation. In contrast to endoprosthetic replacement of the proximal humerus, plate fixation does not violate the rotator cuff. A series of patients treated with proximal humeral locking plates for primary bone tumours, metastasis and myeloma has recently been published (16). Their results agreed with our findings, demonstrating excellent post operative function. There was a series mean MSTS of 94.6%, although the MSTS results were lower in those patients treated for metastasis and myeloma than for primary bone tumours.

All patients with lower limb metastases treated with a locking plate regained independent walking ability. Regaining mobility in patients who undergo treatment for metastasis in the femur can be difficult. Broos *et al* (2) found that only 71% of patients regained mobility following either internal fixation or endoprosthetic replacement of part of the femur. The outcome of endoprosthetic reconstruction of the proximal femur for the management of metastases is inferior to that following the treatment of primary bone tumours (3). Proximal femoral replacement may cause abductor deficiency which compromises rehabilitation. In the management of patients with limited life expectancy this compromise may not always be justified.

Unanswered questions remain. The exact roles of endoprosthetic replacement, plate fixation and intramedullary fixation have not yet been defined. A randomised trial comparing intramedullary nailing to locking plate fixation of metastatic humeral lesions would allow comparison of the devices. However, because of the apparent clinical superiority of locking plate fixation in our practice we have discontinued the use of intramedullary nailing except in the treatment of diaphyseal femoral and tibial lesions or if there is concern regarding the soft tissue envelope.

In summary, we have demonstrated good levels of pain relief and functional restoration with the use of locking plates in the management of periarticular metastatic tumours. There have been no cases of implant failure and a low complication rate, making this a good treatment option in the management of these complex cases.

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