The Comparison of Musculoskeletal Tumor Society Score (MSTS) Outcomes and Complications Between Intramedullary Nailing and Bipolar Arthroplasty in Patients with Pathological Fracture of Proximal Femur Due to Metastatic Bone Disease at the Third Month Post-Surgery

Putu Angga Dharmayuda¹, Made Bramantya Karna², I Gede Eka Wiratnaya²

 ¹Resident, Department of Orthopaedic and Traumatology, Faculty of Medicine, University of Udayana/Prof. Ngoerah General Hospital, Denpasar, Indonesia.
 ²Orthopaedic and Traumatology Consultant, Department of Orthopaedic and Traumatology, Faculty of Medicine, University of Udayana/Prof. Ngoerah General Hospital, Denpasar, Indonesia.

Corresponding Author: Putu Angga Dharmayuda

DOI: https://doi.org/10.52403/ijrr.20250569

ABSTRACT

INTRODUCTION: This study aims to compare the outcomes of the Musculoskeletal Tumor Society Score complications (MSTS) and between Intramedullary Nailing (IMN) and Bipolar Hemiarthroplasty (BHA) in patients with pathological fractures of the proximal femur due to Metastatic Bone Disease (MBD) at three months post-operation.

MATERIALS & METHODS: The study included 30 patients with MBD who experienced proximal femur fractures at RSUP Prof. Dr. I.G.N.G. Ngoerah Denpasar, Bali. A total of 16 patients underwent IMN. while 14 patients underwent BHA. Patient characteristics, MSTS scores, and complications such as implant failure and infection were analyzed using appropriate statistical tests. Data normality was tested with the Shapiro-Wilk test, and data homogeneity was tested with the Levene test.

RESULT: The mean age of the patients was 57.93 ± 12.97 years, with the majority

being female (86.7%). The MSTS score distribution at three months post-operation showed normal and homogeneous data distribution. The mean MSTS score of patients undergoing BHA was significantly higher than those undergoing IMN (24.28 \pm 2.78 vs. 17.87 \pm 2.41; MD 6.41; 95%CI 4.46-8.35; p < 0.001). There were no significant differences in the proportions of implant failure (IMN 12.5% vs. BHA 7.1%; p=0.552; OR=1.86; 95%CI [0.15-22.9]) or infection (IMN 6.3% vs. BHA 14.3%; p=0.448; OR=0.4; 95%CI [0.03-4.9]) between the two groups.

CONCLUSION: Bipolar Hemiarthroplasty resulted in significantly better MSTS scores compared to Intramedullary Nailing in patients with pathological fractures due to MBD at three months post-operation. However, there were no significant differences in complications such as implant failure and infection between the two surgical techniques.

Keywords: Metastatic Bone Disease, proximal femur fractures, Intramedullary

Nailing, Bipolar Hemiarthroplasty, MSTS score, complications

INTRODUCTION

Metastatic Bone Disease (MBD) occurs when malignant cancer cells spread from a primary site to bone tissue, making bones a common target after the lungs and liver. This leads to structural and functional damage, complicating treatment and worsening prognosis (Coleman et al., 2020). In 2020, Indonesia had 358,809 cancer cases, with breast, cervical, and lung cancers as leading causes of mortality. In the U.S., 400,000 patients develop bone metastases annually. Around 70% of breast and prostate cancers and 20-30% of lung and gastrointestinal cancers progress to MBD. In Indonesia, 56.81% of MBD cases occur in individuals aged 45-64, with the femur being the most affected site 34.09% (Van den Brande et al., 2022). Pathological fractures occur in 9%-29% of cases. In Indonesia, delays in seeking treatment contribute to fractures, higher mortality, and Factors like chemotherapy, morbidity. estrogen deficiency, poor nutrition, weakness, cytokines, and metastasis bone resorption, accelerate increasing fracture risk in female cancer patients (Coleman et al., 2006). Intramedullary nailing offers minimally invasive stabilization, while bipolar arthroplasty reduces pain and reoperation risk. Bipolar arthroplasty, replacing the hip joint with a prosthetic component, improves mobility and quality of life in proximal femur (Camnasio fractures et al., 2008). Intramedullary nailing and bipolar arthroplasty are common surgical options, each with risks. IM nailing may cause malunion, non-union, or refracture, while bipolar arthroplasty risks dislocation, infection, loosening, and limb length discrepancy. Both carry systemic risks like fat embolism or bleeding. Procedure choice depends on patient condition, prognosis, and functional goals (Suwannaphisit et al., 2021). The Musculoskeletal Tumor Society (MSTS) score evaluates pain, function, and emotional well-being in musculoskeletal patients post-surgery, tumor with a maximum score of 15. It assesses recovery based on daily activity performance, limb function, and psychological impact. Widely used in clinical research and orthopedic oncology, it compares treatment approaches and outcomes (Rizzo et al., 2024). With the increasing incidence of MBD in cancer patients and the availability of various surgical treatment options, this study aims to evaluate the functional outcomes of cancer patients with MBD and proximal femur fractures undergoing intramedullary nailing compared to bipolar arthroplasty. The outcomes will be measured using the Musculoskeletal Tumor Society Score (MSTS) and post-operative complications.

MATERIALS & METHODS

This study used a retrospective cohort design. From a sample population of patients with pathological femur fractures due to MBD, patients who underwent intramedullary nailing and bipolar arthroplasty were selected. Outcome data, including MSTS scores at the third month post-surgerv and postoperative complications, were analyzed. Data collection was planned to take place at RSUP Prof. Dr. IGNG Ngoerah Denpasar. The study was conducted from February 2024 to December 2024.

Patient Selection

Patients included in this study were those diagnosed with metastatic bone disease confirmed pathological through examination. study focused The on metastatic bone disease patients with pathological fractures in the proximal femur, specifically in the intertrochanteric subtrochanteric regions. Eligible and patients must have a single metastatic bone lesion based on radiographic imaging, including AP pelvis, AP femur, and lateral view X-rays. The study included both patients who have received chemotherapy

and those who have not. Additionally, patients must be willing to participate in the study, be over 18 years old, and had undergone either intramedullary nailing or bipolar arthroplasty at RSUP Prof. Dr. IGNG Ngoerah, Denpasar.

Data Extraction

The characteristics, demographics, and and results of objective subjective measurements were compiled and presented in a master table manually. The data summarized in the master table is then divided into two groups: patients who underwent intramedullary nailing and bipolar arthroplasty sample with pathological femur fractures due to MBD. Once the data was grouped, the analysis was started.

Data Analysis

Data collection was organized into tables using Microsoft Excel. Statistical data processing was conducted using SPSS version 29. Descriptive data of the research sample characteristics were presented as means and standard deviations (SD) for numerical data, and as frequencies (n) and percentages (%) for categorical data. Basic sample characteristics were analyzed descriptively, and differences in proportions of basic characteristics were assessed using the chi-square test. Data normality was evaluated using the Shapiro-Wilk test due to the sample size being fewer than 50. Levene's homogeneity test is conducted to assess data homogeneity, with homogenous data indicated by p > 0.05. For hypothesis testing, numerical sample data with a normal distribution is analyzed using an independent t-test, while non-normally distributed data is tested using the Mann-Whitney test. Categorical nominal dichotomous data is analyzed using the chisquare test, and if chi-square assumptions are not met, Fisher's exact test is used.

RESULT

In this study, a sample of 30 patients with MBD and pathological fracture of proximal femur was obtained at Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Bali. There were 16 patients who underwent surgery with intramedullary nailing and 14 patients who underwent bipolar hemiarthroplasty. This study sought differences in the results of the MSTS and complications of implant failure and infection between patients who underwent surgery with intramedullary nailing and patients who underwent bipolar hemiarthroplasty.

The characteristic results obtained an average patient age of 57.93 + 12.97 years. The age category > 60 years was obtained 16 people (53.3%), the age category 50-60 years was obtained 7 people (23.3%), and the age category <60 years was obtained 7 people (23.3%). There were 4 male patients (13.3%) and 26 female patients (86.7%). In the BMI of this patient group, there were 11 people (36.7%) with BMI <18.5 (thin), 16 people (53.3%) with BMI 18.5 - 24.9 (normal), 2 people (6.7%) with BMI 25 -29.9 (overweight), 1 person (3.7%) with BMI > 30 (obese). In the primary cancer type, there were 2 prostate cancers (6.7%), 11 breast cancers (36.7%), 4 cervical cancers (13.3%), 6 lung cancers (20%), and 7 other cancers (23.3%). In diabetes comorbidity, there were 5 people with diabetes (16.7%) and 25 (83.3%) people without diabetes. In hypertension comorbidity, there were 8 people with hypertension (26.7%) and 22 people without hypertension (73.3%). In bisphosphonate administration, there were 1 patient who had been given bisphosphonate (3.3%) and 29 patients (96.7%) who had not been given bisphosphonate. In corticosteroid administration, there were 3 patients who had been given corticosteroids (10%) and 27 patients (90%) who had not been given corticosteroids. In the amount of bleeding, the average bleeding was 306.67 ± 238.7 cc. The duration of surgery was 132.23 ± 44.2

minutes. In terms of patient characteristics, there was no statistically significant difference between the two groups presented in Table 1. This indicates that there were no confounding factors in this study. A statistically significant difference was found in the duration of surgery where hemiarthroplasty had a shorter duration of surgery.

Characteristics	Patient groups	Total	P Value	
	Intramedullary Hemiarthroplasty Nailing $(n=16)$ (%) Binolar $(n=14)$ (%)		n=30 (%)	
Usia	1 (uning (<i>n</i> -10) (70)			
<50 years	4 (25)	3 (21.4)	7 (23.3)	0.714++
50-60 years	4 (25)	3 (21.4)	7 (23.3)	
>60 years	8 (50)	8 (57,1)	16 (53,33)	
Gender				
Male	2 (12,5)	2 (14,3)	4 (13,3)	0,648*
Female	14 (87,5)	12 (85,7)	26 (86,7)	
Body Mass Index (BMI)				
Thin	3 (18,8)	8 (57,1)	11 (36,7)	0,144**
Normal	11 (68,8)	5 (35,5)	16 (53,3)	
Overweight	1 (6,3)	1 (7,1)	2 (6,7)	
Obesity	1 (6,3)	0 (0)	1 (3,3)	
Primary Cancer Types				
Cervix Cancer	3 (18,8)	1 (7,1)	4 (13,3)	0,203**
Breast Cancer	7 (43,8)	4 (28,6)	11 (36,7)	
Lung Cancer	4 (25)	2 (14,3)	6 (20)	
Prostat Cancer	1 (6,3)	1 (7,1)	2 (6,7)	
Other	1 (6,3)	6 (42,9)	7 (23,3)	
Fracture Types				
Neck Femur	1 (6,3)	3 (21,4)	4 (13,3)	0,086++
Intertrochanter	1 (6,3)	3 (21,4)	4 (13,3)	
Subtrochanter	14 (87,5)	8 (57,1)	22 (73,3)	
Diabetes Cormobidities				
Yes	2 (12,5)	3 (21,4)	5 (16,7)	0,433*
No	14 (87,5)	11 (78,9)	25 (83,3)	
Hypertension Comorbidities				
Yes	3 (18,8)	5 (35,7)	8 (26,7)	0,263*
No	13 (81,3)	9 (64,3)	22 (73,3)	
Administration of Bisphosphonates				
Yes	1 (6.3)	0 (0)	1 (3,3)	0,533*
No	15 (93,8)	14 (100)	29 (96,7)	
Corticosteroid Administration				
Yes	0 (0)	3 (21,4)	3 (10)	0,090*
No	16 (100)	11 (78,6)	27 (90)	
Age (Years) (Average \pm s.d)	59,79±15,81	56,31±10,13	57,93±12,97	0,147+
Amount of Bleeding (average ±	262,5±249,33	357,1±224,34	306,67±238,	0,085+++
s.d)			7	ļ
Operation Duration (average \pm s.b)	142,19±29,15	120,86±56,92	132,23±44,2	0,010+++

Tabla 1	Characteristics of	MDD notio	nta with n	othological	functions of	anorimal f	·
Table 1.	Characteristics of	widd patie	nis with pa	athological	fracture of	proximai i	emur

Note: *Fischer exact test;**Chi-square; ⁺Independent t-test;⁺⁺Kruskall Wallis; ⁺⁺⁺Mann-Whitney

The results of the study presented with an average \pm s.d. for numeric variable data, a normality test was carried out using the Shapiro-Wilk test because the total number of samples was <50. The normality test for

age and MSTS socre sample data showed that the data was normally distributed with a p value> 0.05. Furthermore, a homogeneity test was carried out using the Levene test, which obtained age and MSTS socre data

having a homogeneous distribution data. (p > 0.05)

Table 2. Research Results and Normality Tests on Research Samples						
Characteristics	Total n=30 (%)	Normality test	Homogeneity test			
MSTS Score (mean±SD)	20,86±4,13	0,168	0,677			
* Normality test Saphiro-Wilk; Homogeneity test Levene						

The distribution of MSTS score res data three months after surgery showed that the data distribution was normally distributed, so the hypothesis test was continued with an independent t-test.

Table 3. Analysis of the Difference in	Mean MSTS Score	e Between two grou	ps in the T	hird Month Post-
Operation.		-	-	

MSTS score result (N=30)	Average ± SD	95% CI	р	
	Intramedullary	Bipolar Hemiarthroplasty		
	Nall (II-10)	(11-14)		
Average	17,87±2,41	24,28±2,78	4,46 - 8,35	<0,001

*independent test t-test

The average MSTS score results in the third month after surgery showed that the MSTS score in patients who underwent Bipolar Hemiarthroplasty had a higher value than those who underwent Intramedullary Nailing. In the independent t-test mean difference test, the sample data showed that there was a difference in the mean MSTS score in patients with proximal femur fractures with MBD between those who underwent Intramedullary Nailing and

Bipolar Hemiarthroplasty surgery in the third month after surgery which was statistically significant (MD 6.41; 95%CI 4.46-8.35; p = <0.001) which is presented in the table 3.

The sample data for the study of infectious complications are presented in the form of dichotomous nominal categorical data (yes/no), so the hypothesis test is continued with the Fisher's exact test for differences in proportions.

 Table 4. Results of Analysis of Differences in the Proportion of Infectious Complications Between two groups in the Third Month Post-Operation.

Complications of infection	Operative treatment				P value
	Intramedullary Nailing (n=16)		Bipolar (n=14)	Hemiarthroplasty	
	n	%	n	%	
Yes	1	6,3	2	14,3	0,448
No	15	93,8	12	85,7	

*Fisher's exact test

Fisher's exact test was conducted to determine the difference in proportion between patient groups and the incidence of infectious complications in the third month after surgery. There was no statistically significant difference in proportion between operative procedures and infectious complications (p=0.448). The results are shown in the table 4.

The sample data of the Implant Failure complication research are presented in the form of dichotomous nominal categorical data (yes/no), then the hypothesis test is continued with the Fisher's exact test for differences in proportions.

Implant	Failure	Operative T	Operative Treatment			
Complication		Intramedullary Nailing		Bipolar	Hemiarthroplasty	
		(n=16)		(n=14)		
		n	%	n	%	
Yes		2	12,5	1	7,1	0,552
No		14	87,5	13	92,9	

 Table 5. Results of Analysis of Differences in the Proportion of Implant Failure Complications Between two groups in the Third Month Post-Operation.

*Fisher's exact test

Fisher's exact test was conducted to determine the difference in proportion between patient groups and the incidence of implant failure complications in the third month after surgery. There was no significant statistically difference in proportion between operative procedures implant failure complications and (p=0.552). The results are shown in table 5.

DISCUSSION

The results of this study indicate that the average MSTS score at the third month was higher in patients who underwent Bipolar Hemiarthroplasty compared to those who Intramedullary underwent Nailing (p <0.001). The difference in MSTS scores between IM nailing and bipolar arthroplasty has been a key focus in evaluating clinical outcomes in patients with pathological fractures caused by MBD. The MSTS score is an assessment system used to evaluate clinical outcomes in musculoskeletal tumor patients. particularly after surgical intervention. It assesses three main aspects: pain, function, and emotional well-being, each with a maximum score of 5, leading to a total maximum score of 15. This evaluation helps determine the patient's recovery level based on their ability to perform daily activities without pain, the function of the affected limb, and the psychological impact of the disease and treatment. The MSTS score is widely used in clinical research and orthopedic oncology practice to compare different treatment approaches and long-term functional outcomes (Rizzo et al., 2024).

Several studies have shown inconsistent results regarding the clinical outcomes of MSTS scores between the use of IM nailing

endoprosthetic and arthroplasty or reconstruction. In this study, the average MSTS score was higher in the bipolar group (24.2857 ± 2.78) arthroplasty compared to the IM nailing group (17.87 \pm 2.41) in cases of pathological fractures caused by MBD. When comparing both procedures, a significant difference was found between the two groups (p < 0.001), with the bipolar arthroplasty group having an average score 6.41 points higher. However, different results were reported by Li et al., who found a significant difference MSTS scores in 1 - 3months postoperatively, where IM nailing showed higher scores than bipolar arthroplasty during this period. However, after 12 months post-surgery, MSTS scores tended to be higher in the bipolar arthroplasty group compared to IM nailing (Yang et al., 2023). The decrease in MSTS scores in the long-term evaluation of IM nailing is suspected to occur because the tumor lesion removal in IM nailing is not as complete as in joint replacement methods, potentially leaving residual tumor cells that may continue to grow (Piccioli et al., 2015). Additionally, as patients age, the risk of IM nailing implant failure also increases, which can further reduce their quality of life (Zacherl et al., 2011).

Conversely, the study by Hindiskere et al. reported different findings. No significant difference in MSTS scores was observed at 6 and 12 months postoperatively between IM nailing and endoprosthetic reconstruction (Hindiskere et al., 2021). This can be explained by the generally limited survival time of patients with bone metastases. At 12 months postoperatively, IM nailing may allow for faster healing,

while endoprosthetic reconstruction enables patients to regain mobility and function more quickly, providing overall patient satisfaction (Hernan Garcia-Ruiz, 2019). The discussion above suggests that bipolar arthroplasty is superior in improving patients' short-term quality of life compared to IM nailing, which carries a risk of residual tumor cells and higher recurrence rates. However, long-term outcomes remain controversial, with some studies indicating that IM nailing can provide comparable results to bipolar hemiarthroplasty in longterm evaluations, particularly for patients with limited prognosis. Therefore, the choice of treatment should be tailored to each patient's clinical condition, considering tumor spread, life expectancy, and functional needs. Bipolar arthroplasty is recommended for patients with longer life expectancy and higher functional demands, while IM nailing may be a suitable alternative for those with more limited conditions. A comprehensive evaluation by the medical team is essential to determine the most optimal therapeutic strategy for each patient.

The results of this study indicate that there is no significant difference in the incidence of infection complications three months after IM nailing or bipolar arthroplasty for pathological fractures caused by MBD (p =0.448). This finding is supported by a previous study by Mansukhani et al., which analyzed early postoperative infection complications between proximal IM nailing and bipolar arthroplasty. Their study also found no significant difference between the two groups in terms of superficial or deep infections (p > 0.05) (Mansukhani, 2017). Meanwhile, a long-term evaluation over two years by Hindiskere et al. showed that only one patient in each group experienced a superficial infection, and one deep infection occurred in the endoprosthesis group. there was no significant Statistically, difference in infection rates between IM nailing and endoprosthetic reconstruction for pathological fractures of the proximal femur caused by MBD (Hindiskere et al., 2021). The discussion results indicate that there is no significant difference in infection complications between patients undergoing bipolar arthroplasty or IM nailing. This suggests that the choice between bipolar arthroplasty and IM nailing can be made based on the surgeon's and patient's preference, as both procedures show similar infection complication rates.

The results of this study indicate no difference in the incidence of implant failure complications, including implant loosening or non-union, three months after IM nailing and bipolar arthroplasty in pathological fractures caused by MBD (p=0.552). Implant failure complications following IM nailing and bipolar arthroplasty are crucial in assessing clinical outcomes in patients with pathological fractures due to MBD. Given the limited survival rate of MBD patients, minimizing postoperative complications is essential to ensure a better quality of life in their remaining time (Abbott et al., 2021); (Meares et al., 2019). In line with the results of this study, Meynard et al. reported no significant difference in the incidence of implant failure complications between IM nailing and arthroplasty procedures in 297 cases of pathological fractures due to MBD (Meynard et al., 2020). The clinical implications of these findings suggest that the choice between the two methods can focus more on other factors such as patient life expectancy, functional needs, and potential complications rather than just the risk of implant failure. With no difference in implant failure risk, the medical team can be more flexible in selecting the most appropriate treatment based on each patient's specific condition without concern that one method has a higher failure risk than the other.

CONCLUSION

This study concludes that there is a significant difference in MSTS scores between intramedullary nailing and bipolar

arthroplasty in patients with pathological fractures of the proximal femur due to MBD three months postoperatively. However, no significant differences were found in infection complications or implant failure between the two surgical methods.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: No conflicts of interest declared.

REFERENCES

- Abbott, A., Kendal, J. K., Hewison, C., Puloski, S., & Monument, M. (2021). Longitudinal survival trends of patients with cancer with surgically managed appendicular metastatic bone disease: Systematic review. Canadian Journal of Surgery, 64(6), E550–E560. https://doi.org/10.1503/CJS.015520
- Camnasio, F., Scotti, C., Peretti, G. M., Fontana, F., & Fraschini, G. (2008). Prosthetic joint replacement for long bone metastases: Analysis of 154 cases. Archives of Orthopaedic and Trauma Surgery, 128(8), 787–793. https://doi.org/10.1007/s00402-007-0464-y
- Coleman, R. E., Croucher, P. I., Padhani, A. R., Clézardin, P., Chow, E., Fallon, M., Guise, T., Colangeli, S., Capanna, R., & Costa, L. (2020). Bone metastases. Nature Reviews Disease Primers, 6(1). https://doi.org/10.1038/s41572-020-00216-3
- Coleman, R. E., Roodman, Smith, Body, Suva, & Vessella. (2006). Clinical features of metastatic bone disease and risk of skeletal morbidity. Clinical Cancer Research, 12(20 PART 2), 6243–6249. https://doi.org/10.1158/1078-0432.CCR-06-0931
- 5. Hernan Garcia-Ruiz. (2019). 乳鼠心肌提取 HHS Public Access. Hhs Public Access, 123(11), 40–43. https://doi.org/10.1158/0008-5472.CAN-17-1051.Osteoblast-secreted
- Hindiskere, S., Kim, H. S., Kim, Y., & Han, I. (2021). Surgery for proximal femur metastases: Endoprosthesis reconstruction

or intramedullary nailing? Annals of Joint, 6, 0–1. https://doi.org/10.21037/AOJ-20-96

 Mansukhani, S. A. (2017). A Comparative study of the Dynamic Hip Screw, the Cemented Bipolar Hemiarthroplasty and the Proximal Femoral Nail for the Treatment of Unstable Intertrochanteric Fractures. Journal of Clinical and Diagnostic Research, 11(4), 14–19.

https://doi.org/10.7860/jcdr/2017/21435.975 3

- Meares, C., Badran, A., & Dewar, D. (2019). Prediction of survival after surgical management of femoral metastatic bone disease – A comparison of prognostic models. Journal of Bone Oncology, 15(December 2018), 100225. https://doi.org/10.1016/j.jbo.2019.100225
- 9. Meynard, P., Seguineau, A., Laumonerie, P., Fabre, T., Foltran, D., Niglis, L., Descamps, J., Bouthors, C., Lebaron, M., Szymanski, C., Sailhan, F., & Bonnevialle, P. (2020). Surgical management of proximal femoral metastasis: Fixation or hip replacement? А 309 case series. Orthopaedics and Traumatology: Surgery and Research, 106(6), 1013-1023. https://doi.org/10.1016/j.otsr.2020.05.007
- Piccioli, A., Maccauro, G., Spinelli, M. S., Biagini, R., & Rossi, B. (2015). Bone metastases of unknown origin: epidemiology and principles of management. Journal of Orthopaedics and Traumatology, 16(2), 81–86. https://doi.org/10.1007/s10195-015-0344-0
- 11. Rizzo, A., Paderno, M., Saccomanno, M. F., Milano, F., & Milano, G. (2024). The Musculoskeletal Tumor Society Scoring system is a valid subjective and objective tool to evaluate outcomes of surgical treatment of patients affected by upper and lower extremity tumors. Musculoskeletal Surgery, 108(2), 201–214. https://doi.org/10.1007/s12306-024-00815-3
- Suwannaphisit, S., Anusitviwat, C., Tuntarattanapong, P., & Chuaychoosakoon, C. (2021). Comparing the effectiveness of blended learning and traditional learning in an orthopedics course. Annals of Medicine and Surgery, 72(December), 103037. https://doi.org/10.1016/j.amsu.2021.103037
- 13. Van den Brande, R., MJ Cornips, E., Peeters, M., Ost, P., Billiet, C., & Van de Kelft, E. (2022). Epidemiology of spinal

metastases, metastatic epidural spinal cord compression and pathologic vertebral compression fractures in patients with solid tumors: A systematic review. Journal of Bone Oncology, 35(June), 100446. https://doi.org/10.1016/j.jbo.2022.100446

- 14. Yang, W., Pan, Q., Huang, F., Hu, H., & Shao, Z. (2023). Research progress of bone metastases: From disease recognition to clinical practice. Frontiers in Oncology, 12(January), 1–14. https://doi.org/10.3389/fonc.2022.1105745
- Zacherl, M., Gruber, G., Glehr, M., Ofner-Kopeinig, P., Radl, R., Greitbauer, M., Vecsei, V., & Windhager, R. (2011). Surgery for pathological proximal femoral fractures, excluding femoral head and neck fractures: Resection vs. stabilisation.

International Orthopaedics, 35(10), 1537– 1543. https://doi.org/10.1007/s00264-010-1160-z

How to cite this article: Putu Angga Dharmayuda, Made Bramantya Karna, I Gede Eka Wiratnaya. The comparison of musculoskeletal tumor society score (MSTS) outcomes and complications between intramedullary nailing and bipolar arthroplasty in patients with pathological fracture of proximal femur due to metastatic bone disease at the third month post-surgery. International Journal of Research and Review. 2025; 12(5): 656-664. DOI: 10.52403/ijrr.20250569
