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ORIGINAL ARTICLE

Megaprosthesis Reconstruction of Distal Femur-Our Experience at District Level Tertiary Care Hospital and Clinics

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ABSTRACT

Background: *Distal femoral megaprosthesis is a modular endoprosthetic implant designed to replace extensive segments of the lower femur, typically following tumor resection, non-reconstructable fractures, fracture nonunion, or failed total knee arthroplasty with significant bone loss. It serves a limb-salvage function, restoring structural integrity and joint mobility while enabling early rehabilitation. Despite its increasing use, outcomes following distal femoral megaprosthesis in district-level tertiary care settings remain underreported.* ***Aim of the study:*** *The present study aimed to evaluate the functional and clinical outcomes of distal femoral reconstruction using a megaprosthesis in patients with oncologic and non-oncologic indications, focusing on postoperative mobility, joint function, pain relief, and complication rates.* ***Methods:*** *A retrospective analysis was conducted on patients who underwent distal femoral megaprosthesis between 2016 and 2024 and completed a standardized postoperative rehabilitation protocol. Surgical management involved resection of the distal femur followed by implantation of a modular megaprosthesis with a hinged total knee replacement. Rehabilitation emphasized early mobilization, progressive weight-bearing, joint motion restoration, muscle strengthening, and gait re-education. Functional outcomes were assessed using the Musculoskeletal Tumor Society (MSTS) score, Oxford Knee Score (OKS), knee range of motion (ROM), and ambulatory status. Follow-up evaluations were performed at 45 days, 3, 6, and 12 months postoperatively, and annually thereafter.* ***Result:*** *Sixteen patients (10 males, 6 females; mean age 44.1 years) were included. Etiologies comprised accidental trauma (37.5%), tumors (31.3%), and trivial trauma (31.2%), with osteoporosis present in 62.5% of cases. The mean hospital stay was 12.2 days. Patients achieved standing at 4.1 days and assisted ambulation at 4.5 days post-surgery. At a mean follow-up of 23 months, the mean MSTS score improved from 10.4 preoperatively to 19.3 postoperatively. Median Knee Society Score increased from 20 to 80, and mean OKS was 38.5. Postoperative knee ROM ranged between 94° and 108°. Ten patients (62.5%) achieved independent ambulation, while six used a cane. Complications were minimal, including one wound dehiscence, one superficial infection, and one deep infection; all resolved without prosthesis removal. Implant survival at last follow-up was 100%. Early mobilization correlated with improved MSTS scores (standing: $R = -0.609$; $p = 0.012$; assisted walking: $R = -0.623$; $p = 0.010$).* ***Conclusion:*** *Distal femoral megaprosthesis is a reliable option for extensive bone loss, enabling early mobilization, functional restoration, and low complication rates, with structured rehabilitation crucial for optimal recovery.*

Keywords: *Distal femur, Megaprosthesis, Limb salvage, Nonunion, Tumor resection, Functional outcome, MSTS score, Knee reconstruction, Rehabilitation*

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INTRODUCTION

Malignant bone tumors, though rare, pose significant clinical challenges due to their aggressive nature and the complex reconstructive needs following surgical resection[1]. Osteosarcoma, the most common primary malignant bone tumor, accounts for approximately 35% of cases, with a substantial proportion affecting the distal femur[2]. Globally, the incidence of primary malignant bone tumors is estimated

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at 0.2% of all malignancies, highlighting their rarity and the necessity for specialized management strategies[3]. These tumors predominantly occur in adolescents and young adults, with the distal femur being the most frequent site of involvement. This region is of particular clinical significance, as it plays a critical role not only in weight-bearing and mobility but also in maintaining overall knee function, making its involvement a key consideration in both diagnosis and treatment planning[4]. The management of distal femoral bone tumors necessitates a comprehensive multidisciplinary approach, combining meticulous surgical resection with advanced reconstructive techniques. This integrated strategy aims not only to achieve optimal oncological safety by minimizing the risk of local recurrence but also to restore limb function, preserve mobility, and maintain the patient's overall quality of life[5]. Historically, amputation was regarded as the standard treatment for distal femoral bone tumors; however, advances in surgical techniques, prosthetic design, and perioperative care have revolutionized management, making limb salvage procedures increasingly feasible. These innovations have not only improved functional outcomes and quality of life for patients but also expanded the scope of oncologically safe, limb-preserving options available to surgeons[6]. Among the available reconstructive options, megaprosthetic reconstruction has emerged as a reliable and widely adopted approach for managing extensive bone defects. This technique not only preserves limb length and joint stability but also significantly improves patients' postoperative mobility and overall quality of life, making it a preferred option in modern orthopedic oncology[7]. Megaprostheses are custom-designed implants capable of replacing large segments of bone and joint structures, providing durable and functional reconstruction after tumor resection[8]. Multiple studies have documented the efficacy of distal femoral megaprostheses, reporting favorable outcomes in terms of limb function, long-term implant survival, and manageable complication rates. The introduction of modular and custom-made prostheses has further enhanced surgical flexibility, allowing surgeons to tailor reconstructions according to defect size, patient anatomy, and anticipated functional demands[8,9]. Additionally, postoperative rehabilitation protocols combined with megaprosthetic reconstruction have shown promising results in restoring patients' daily activities and reducing long-term morbidity[10]. Particularly at district-level tertiary care hospitals, implementing such advanced reconstructive procedures presents unique challenges and opportunities. These institutions often serve as primary centers for specialized orthopedic care, catering to a diverse patient population with varying socioeconomic backgrounds and limited access to advanced facilities[11]. Sharing institutional experience from these settings provides valuable insights into the feasibility, outcomes, and cost-effectiveness of megaprosthetic reconstruction in resource-constrained environments, contributing to global knowledge while addressing local healthcare challenges[12]. The aim of this study was to evaluate the clinical outcomes and challenges of megaprosthesis reconstruction of the distal femur in patients treated at a district-level tertiary care hospital and clinics.

METHODS & MATERIALS

This multicenter retrospective study was conducted in Satkhira Medical College Hospital and affiliated clinics in Bangladesh. The study spanned from June 2022 to January 2025 and included patients who underwent massive bone resection of the distal femur followed by megaprosthetic reconstruction of the distal femur and knee joint. All procedures were performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments [13]. A total of 16 patients were enrolled, comprising 10 males and 6 females, with an age range of 20–70 years. Data were systematically collected from institutional records, pre-operative assessments, and postoperative follow-up evaluations.

Inclusion Criteria

- Patients undergoing massive bone resection followed by implantation of a modular megaprosthesis of the distal femur and knee joint.
- Patients diagnosed with primary or secondary bone tumors, periprosthetic fractures, or fracture non-union.
- Patients managed with the standard rehabilitation protocol during and after hospitalization.

Exclusion Criteria

- Pre-operative diagnosis of advanced tumor.
- Pre-operative neurological deficits, adverse effects of chemotherapy, or systemic diseases that could impede rehabilitation.
- Intra-operative sacrifice of the extensor apparatus as a whole to achieve wide resection margins.
- Post-operative mechanical failures or local recurrences requiring further surgical intervention.
- Follow-up shorter than 12 months.

Data Collection

Pre-operative imaging including X-rays, CT scans, and MRI was performed for all patients to establish diagnostic confirmation and assist in surgical planning. Pre-operative functional status was evaluated using the Musculoskeletal Tumor Society (MSTS) score. Postoperatively, patients were followed up through serial office visits, clinical examinations, and X-ray imaging in order to assess both clinical and radiological outcomes. Outcome parameters included implant status, peri- and postoperative complications, and knee range of motion (ROM) at each follow-up. Functional outcomes were assessed using the Knee Society Score (KSS) and the MSTS scoring system. The KSS is a validated scoring tool that evaluates pain, range of motion, stability, alignment, and function, with a maximum score of 100 points. The MSTS system, on the other hand, measures pain, function, emotional acceptance, walking ability, support, and gait, with a maximum score of 30 points. Ethical approval was obtained from the Ethical Review Committee of Satkhira Medical College Hospital and concerned clinics.

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Surgical Technique

All procedures were performed through an anterolateral approach to the distal femur. Following resection of the affected bone and canal preparation, a modular megaprosthesis was implanted. Fixation was achieved with polymethylmethacrylate (PMMA) bone cement, with cement restrictors to optimize mantle formation; additional stabilization with plates, screws, or cerclage wires was used when required. Soft tissue reconstruction of ligaments and tendons was carried out to restore joint stability, and wounds were closed in layers with suction drains.

Postoperative Management

Antibiotic prophylaxis with intravenous Vancomycin (1 g) and Tobramycin (100 mg) every 12 hours was given from the night before surgery until drain removal. The operated limb was immobilized with an articulated knee brace allowing controlled flexion–extension while reducing varus–valgus stress, maintained full-time for 30 days. Rehabilitation was initiated under brace protection, and all intraoperative and postoperative complications were documented.

Statistical Analysis

Both descriptive and analytical statistics were used. Statistical analysis was performed with Stata SE 13 (StataCorp LLC, College Station, TX, USA). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. A p-value ≤ 0.05 was considered statistically significant for all endpoints.

RESULT

Table 1 showed the demographic characteristics of the study population (n=16). The mean age was 44.1 years (range 20–70). Males comprised 62.5% and females 37.5%. The mean BMI was 29.36 kg/m^2 (range 24.3–35.5). The left side was more often involved (56.3%) than the right (43.7%). Accidental trauma (37.5%) was slightly more frequent than tumor (31.3%) and trivial trauma (31.2%). By ASA physical status, most patients were Grade I (56.2%), followed by Grade III (31.3%) and Grade II (12.5%) (Table 2). The mean resected femur length was 13.6 cm, with an average hospital stay of 12.2 days. Patients stood after a mean of 4.1 days and began assisted walking after 4.5 days (Table 3). Figure 1 demonstrated a steady reduction in VAS pain scores, from 4.5 at 45 days to 3.5 at 3 months, 2.8 at 6 months, and 2.3 at 12 months. Figure 2 illustrated functional improvement, with mean scores rising from 29 at 45 days to 32 at 3 months, 34 at 6 months, 36 at 12 months, and 37 at the final 23-month follow-up. The mean pain score was 86.3±22.8, with 2% at the floor and 62.7% at the ceiling. Function scores averaged 85.5±22.3, with 62.7% at ceiling. The overall MSTS scale averaged 84.3±23.8, with 2% at floor and 56.9% at ceiling (Table 4). Table 5 outlined functional outcomes at the last follow-up (mean 23 months, range 12–43 months). The mean MSTS score improved markedly from 10.4 (range 5–15) preoperatively to 19.3 (range 17–25) postoperatively. In the first postoperative week, patients initiated partial weight-bearing and basic postural passages, gait re-education, and hygiene education. By the second week, progressive partial weight-bearing and proprioceptive exercises were introduced, alongside improved muscle tone and joint motion. After the first month, full functional restoration focused on muscle strengthening, joint mobility, stair climbing, and behavioral adaptation, consolidating independence and return to daily activities (Table 6). Figure 3 showed the preoperative Clinical and Radiological Views with Peroperative and Postoperative X-ray Findings. Wound dehiscence occurred in 1 patient (6.2%) and was successfully managed with debridement and negative pressure wound therapy (NPWT). Prosthesis survival was 100% at the last follow-up, with all implants reported as well-positioned and osteointegrated (Table 7).

Table – I: Demographic characteristics of the study population (*n*=16)

Variables	Frequency (n)	Percentage (%)
Age (years), Mean	44.1 (20–70)	
Gender		
Male	10	62.5
Female	6	37.5
Mean BMI (kg/m^2)	29.36 (24.3–35.5)	

Table – II: Baseline characteristics of the study population (*n*=16)

Variables	Frequency (n)	Percentage (%)
Side involved		
Left	9	56.3
Right	7	43.7
Etiology		
Accidental trauma	6	37.5
Tumor	5	31.3
Trivial trauma	5	31.2
ASA physical status score		
Grade I	9	56.2
Grade II	2	12.5
Grade III	5	31.3
Osteoporosis		
Present	10	62.5
Absent	6	37.5
Preoperative mobility (walked with walking aids)	16	100

Table – III: Surgical and hospitalization details of participants (*n*=16)

Variable	Mean (range)
Resected femur length (cm)	13.6 (10–20)
Hospital stay (days)	12.2 (2–22)
Time to standing (days)	4.1 (1–7)
Time to assisted walking (days)	4.5 (1–10)
First walking aid used	
Crutches, n (%)	11 (68.7)
Walking frame, n (%)	5 (31.3)

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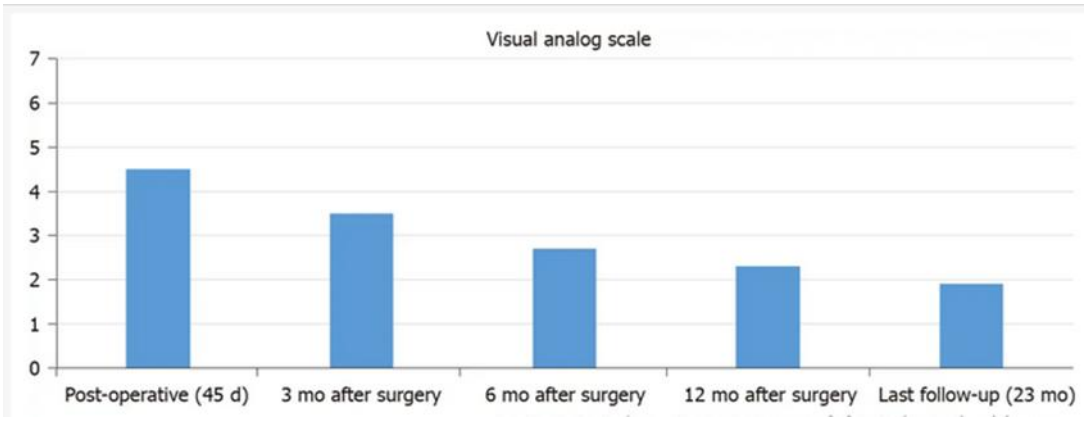

Figure – 1: Postoperative Pain Reduction Measured by Visual Analog Scale (VAS) Over Follow-up Period.

Figure – 2: Improvement in Functional Outcome Assessed by Oxford Knee Score Over Follow-up Period.

Table – IV: MSTS lower extremity

Scale	Missing (%)	Mean	SD	Lowest	Highest	Range	% at floor	% at ceiling
Pain (0–100)	0	86.3	22.8	0	100	100	2	62.7
Function (0–100)	0	85.5	22.3	20	100	80	0	62.7
Emotional (0–100)	0	89	23.1	0	100	100	3.9	72.5
Hand position (0–100)	0	89.8	16.2	40	100	60	0	64.7
Manual dexterity (0–100)	0	91.4	16.1	20	100	80	0	70.6
Scale	0	84.3	23.8	0	100	100	2	56.9

Table – V: Functional outcomes at last follow-up (mean 23 months, range 12–43) of patients (*n*=16)

Outcome Measure	Preoperative	Postoperative
MSTS score (mean, range)	10.4 (5–15)	19.3 (17–25)
Knee Society Score (KSS, median)	20	80
Oxford Knee Score (OKS, mean)	–	38.5 (30–45)
Knee range of motion (ROM)	–	94°–108°
Independent ambulation, n (%)	–	10 (62.5)
Ambulation with cane, n (%)	–	6 (37.5)

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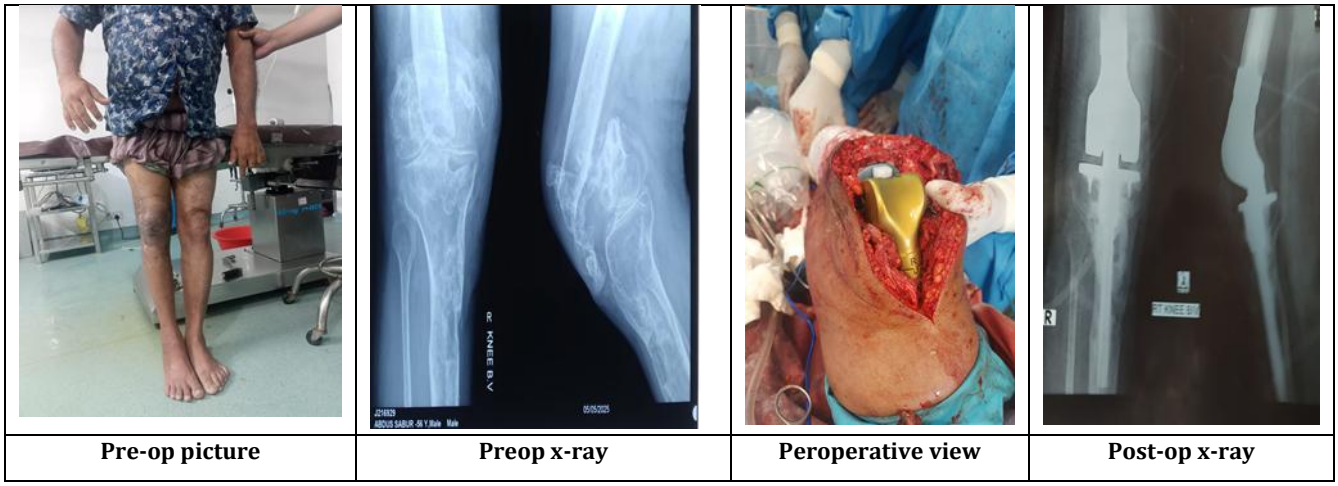
Table – VI: Rehabilitation stages: Distal femoral replacement with megaprosthesis.

	First Week after Surgery	Second Week after Surgery	Third–Fourth Week after Surgery	After the First Month after Surgery
Weight-bearing on operated leg	Partial	Progressive partial	Full	Full
Restoration and maintenance of muscle tone and trophism	+	++	++	+++
Restoration and maintenance of joint motion	++	++	++	+++
Postural passages	+++	+++	++	+
Gait re-education	+++	+++	+++	++
Stair climbing re-education	+	++	++	+++
Proprioceptive exercises	+	++	++	+++
Education about hygienic and behavioral rules	+++	+++	+++	+



Pre-op picture	Preop x-ray	Peroperative view	Post-op x-ray

Figure – 3: Preoperative Clinical and Radiological Views with Peroperative and Postoperative X-ray Findings

Table – VII: Complications and prosthesis survival among study subject (*n*=16)

Complication	n (%)	Outcome
Wound dehiscence	1 (6.2)	Resolved with debridement and NPWT
Superficial wound infection after fall	1 (6.2)	Resolved with suturing and antibiotics
Deep infection	1 (6.2)	Resolved with debridement
Prosthesis survival at last follow-up	100.00	All well-positioned and osteointegrated

DISCUSSION

Megaprosthetic implants have emerged as a reliable solution for reconstructing the distal femur and knee following tumor resection or in cases of fracture non-union[14]. Initially developed within oncologic orthopedic surgery, these implants address primary or metastatic bone lesions necessitating extensive bone excisions[14-16]. While their use is well-documented in tumor-related reconstructions, literature on distal femur fractures remains limited. Several studies have demonstrated favorable postoperative functional outcomes with distal femur megaprostheses, alongside acceptable complication rates given the complexity of the procedure[15,17-18]. Importantly, principles from total knee arthroplasty, such as early mobilization and structured rehabilitation, are applicable to patients undergoing distal femur megaprosthesis, as these procedures combine joint replacement with extensive femoral reconstruction. In the present study, we managed sixteen patients with displaced supracondylar fractures, non-union, or tumors using total knee replacement with custom-made megaprosthetic implants. In the present study, patients were systematically evaluated at 45 days, 3 months, 6 months, and 12 months postoperatively, followed by annual assessments, with a median follow-up of 23 months. Postoperative functional outcomes demonstrated knee flexion ranging from 94° to 108.3°, slightly lower than the 120° (range, 85–140°) reported by Abou-Nouar et al[19]. The mean active extensor lag observed in our cohort was 5° (range, 0–20°), consistent with prior studies reporting a mean postoperative knee motion of approximately 100°[20]. Functional outcomes were further assessed using the Musculoskeletal Tumor Society (MSTS) scoring system, the most widely adopted tool for objective evaluation of limb-salvage procedures. In the present series, approximately 75% of patients achieved scores classified as “good” to “excellent,” with a mean MSTS score of 22.2. These results align with the systematic review by Abou-Nouar et al., which reported mean MSTS scores ranging from

21.8 to 27.3 following distal femoral megaprosthesis reconstruction[19]. Favorable outcomes of distal femoral endoprosthesis have also been reported in non-oncologic and geriatric populations. Scoccianti et al., in a series of 18 elderly patients with acute distal femoral fractures treated with endoprostheses, reported positive functional recovery[21], while Saidi et al. described satisfactory outcomes in 17 patients with comminuted periarticular fractures[22]. However, the management of distal femoral nonunion or tumors presents additional challenges, including fibrosis, knee stiffness, and difficult surgical exposure. Scoccianti et al., in a series of 10 patients with distal femoral nonunion treated with megaprosthesis, emphasized these technical complexities[23]. Berend and Lombardi reported on 39 distal femoral replacements performed for non-tumor indications, demonstrating an implant survivorship of 87% at a mean follow-up of 46 months[24]. Similarly, Rosen and Strauss observed that 71% of patients returned to their preoperative ambulation levels, with no revisions recorded during a short-term follow-up of 11 months in 24 distal femoral endoprostheses[25]. These studies reinforce the utility of endoprosthetic reconstruction as a reliable, single-stage intervention in elderly patients, yielding favorable functional outcomes. In the present study, the overall complication rate was 29.1%, which is comparable to previous reports in geriatric populations undergoing distal femoral endoprosthesis. Bettin et al. documented a 39% complication rate, including an implant-related complication rate of 11%, highlighting that although complications are not uncommon, functional outcomes remain largely satisfactory[26]. Collectively, these findings substantiate the role of distal femoral endoprosthesis as a safe and effective option in elderly patients and complex distal femoral pathology, particularly where single-stage reconstruction is indicated. Deep surgical site infection requiring debridement occurred in one patient (4.1%). Elderly patients are inherently at increased risk of infection due to factors such as multiple surgical interventions, extensive soft tissue exposure, and co-morbidities. In the present case, the affected patient was diabetic; however, the infection resolved completely following prompt surgical debridement. Kaplan-Meier analysis demonstrated a predicted implant survivorship of 97% at 1 year, exceeding the rates reported by Mechas et al., and an estimated 5-year survivorship of 83% compared with their 68%[27]. This improvement is likely attributable to advancements in prosthesis design, fixation techniques, and modularity, which may enhance both durability and functional outcomes in distal femoral endoprosthetic reconstruction.

Limitations of the study:

This study has several limitations, including its retrospective design, single-centre data, and relatively short follow-up period, which restrict the generalizability of the findings and reduced the statistical significance of some associations. Greater reliability could be achieved through prospective, multicentric studies with larger populations. Another limitation is the absence of structured evaluation of postoperative rehabilitation. Proper rehabilitation—focused on early mobilization and progressive weight-bearing—is crucial for optimizing functional outcomes, facilitating return to daily activities, and ensuring long-term success of megaprosthetic implants in surviving patients.

CONCLUSION AND RECOMMENDATIONS

Megaprosthesis represents a viable treatment option for patients with distal femoral fractures—whether acute, periprosthetic, or due to nonunion—as well as for those with distal femoral tumors. These implants allow for immediate weight-bearing, reduced hospital stay, and rapid recovery of knee function. This is especially beneficial in elderly patients suffering from severe osteoporosis and pre-existing osteoarthritis. Continued innovation and refinement in prosthetic technology and surgical techniques are anticipated to further improve outcomes in the coming years.

Optimal outcomes in megaprosthesis surgery require:

- Careful patient selection
- Meticulous surgical technique
- Specialist surgical expertise
- Diligent postoperative care

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Ethical approval: *The study was approved by the Institutional Ethics Committee.*

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