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# Tumor arthroplasties performed after proximal femur pathological fractures and evaluation of their pelvic parameters

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## Abstract

**Aim:** Our aim in this study is to analyze patients who underwent arthroplasty for pathological fractures of the proximal femur and examine pelvic parameters in eligible patients.

**Material and Methods:** Age, gender, operation side of the patients, the area of the fracture in the proximal femur previous lumbar spine surgery, lumbar region metastasis, postoperative leg length difference, postoperative dislocation, whether revision was performed and the appropriate patient.

**Results:** 32 patients who underwent arthroplasty for pathological fracture of the proximal femur were identified. Dislocation was observed in 2 (6%) patients in the postoperative follow-up. The indication for the patient undergoing revision surgery was periprosthetic fracture after a fall. In 7 of the patients, the cause of the pathological fracture was primary bone tumor, while 24 of them were metastasis. The mean PI of these patients whose measurements were made from the lateral lumbar graphy were 54°, mean SD: 38°, mean PT: 11° and mean lumbar lordosis: 30°.

**Conclusion:** Arthroplasty can be successfully applied as an extremity-conserving surgery method in patients with proximal femur pathological fractures, and the preoperative health status and life expectancy of the patient also affect the results of the surgery.



## Introduction

Treatment approaches for proximal femur with pathological fragments are fixation, arthroplasty or reconstruction with modular tumor prosthesis after total excision [1, 2]. The treatment of proximal femoral lesions should be well managed for the patient's survival and quality of life. The success rate of fixation techniques decreases due to tumor progression and non-union [3]. Mobilization of patients may also be restricted depending on the duration of union after fixation surgery. Treatments that provide safe fixation that allow early weight-bearing and successful pain control in the patient should be preferred [1]. Early mobilization is provided in patients who undergo arthroplasty and less complications are seen compared to fixation techniques [4].

When we look at the anatomical structure of our body, the vertebral column ends at the sacrum and makes connection with the lower extremity through the pelvis (hence the sacrum). Duval-Beaupere [5] and Legaye [6] defined Sacral Slope (SS), Pelvic Incidence (PI) and Pelvic Tilt (PT) as pelvic parameters in their studies. In order to ensure success in arthroplasty surgeries, patient-related factors (age, gender, additional disease), surgical application performed (surgical experience, primary or revision surgery) and the properties of the implant applied are multifunctionally effective [7]. It is important that these parameters are within the mean values in order to increase the life of the prosthesis, by providing painless mobilization of the patients and to reduce the risk of postoperative dislocation.

In patients who are operated for proximal femur pathological fractures, an ideal prosthesis should be applied to increase patient satisfaction and reduce the risk of complications. So, how are the pelvic parameters that are important for the pelvic-spine relationship affected while doing this? Therefore, our aim in this study is to analyze patients who underwent arthroplasty for pathological fractures of the proximal femur and examine pelvic parameters in eligible patients.

## Materials and Methods

This study was conducted as a retrospective trial at our orthopaedic and travmatology department between Jan-

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uary 2010 and December 2020. Patients who were operated with a diagnosis of pathological proximal bone fracture were analyzed. This study protocol was approved by the ethics committee (2021.3/8). Informed consent was obtained from guardians of all participants.

The inclusion criteria were Patients who had only arthroplasty surgery after pathological fracture and had at least 6 months of follow-up in the postoperative period. Patients whose medical information could not be obtained and patients who underwent fixation were excluded. Among these patients, patients with lateral lumbar radiography for which pelvic parameter measurements could be made in the postoperative period were also evaluated. Patients with advanced lumbar spine surgery and advanced degenerative spine deformity were not included in the group whose pelvic parameters were evaluated.

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Age, gender, operation side of the patients, the area of the fracture in the proximal femur (femur neck, femur intertrochanteric, femur subtrochanteric), previous lumbar spine surgery, lumbar region metastasis, postoperative leg length difference, postoperative dislocation, whether revision was performed and the appropriate patient In the group, pelvic parameter (PI, PT, SS and Lumbar Lordosis) measurements were recorded. These measurements were made by the same doctor in order to prevent possible bias.

The line drawn from the midpoint of the sacral first vertebra to the midpoint of the femoral head (with two femoral heads overlapping) on the lateral pelvis graph is called sagittal pelvis thickness (SPT). The angle made by this line with the line drawn perpendicular to the sacral plateau is called Duval-Beaupere [3] and Legaye [4] 'pelvic incidence' (PI) [5] . PI is equal to the sum of the two angles, pelvic tilt (PT) and sacral slope (SS). PT is the angle between the perpendicular drawn at the midpoint of the femoral head and the SPT. Lumbar lordosis angle was found by calculating the angle between the upper edge of the first lumbar vertebra and the upper edge of the first sacral vertebra.

*Surgical Method*

The operation was performed at the earliest time after the oncology council of our hospital had it done. After the proper sterile environment was provided in the operating room, general anesthesia was performed together with spinal or spinal. The mass was excised in the form of wide surgical excision using the posterolateral approach in the lateral decubitus position. The excised mass was sent for pathological examination. The tumor prosthesis, which was formed in appropriate lengths with the removed mass, was applied with the cementless method. Soft tissues were fixed on the prosthesis in an appropriate order to ensure hip movements and to ensure stability.

*Statistical Analysis*

The statistical analysis was performed using SPSS software (version 20; SPSS, Inc., Chicago, IL, USA). Data are expressed as mean ± standard deviation or as percentiles. The distribution of the data was determined using visual (histograms and probability plots) and analytical methods (Kolmogorov–Smirnov and Shapiro–Wilk's test)

## Results

Fifty-eigth patients who underwent arthroplasty for pathological fracture of the proximal femur were identified. Of these, 32 were in accordance with the study criteria. Since 4 of these patients were operated in the lumbar region, 2 of them had lumbar vertebra metastases, 3 of them had advanced degenerative spine disease, and 14 of them did not have a lateral lumbar radiography to evaluate the ideal pelvic parameter, measurement could not be made. Eight patients who could be evaluated for pelvic parameters were determined.

The demographic and clinical characteristics of patients who underwent arthroplasty for proximal femur pathological fractures are provided in Table 1.The mean age of the patients in the study group was 60 ± 14, the number of female patients was 15 (46%), and the number of male patients was 17 (53%). While 16 of the patients had right extremity involvement, 16 had left extremity involvement. Pathological fracture location was in the femoral neck in 13 (40%) patients, in the intertrochanteric femur in 9 (28%) and in the subtrochanteric region in 10 (31%) patients. The average leg length difference of all patients was calculated as less than one centimeter. Twenty (62%) patients without spinal degeneration, 9 (28%) patients with spinal degeneration and 3 (9%) patients with spinal metastasis were detected. While tumor type arthroplasty was performed in 30 (93%) of the operated patients, classical total hip arthroplasty was performed in 2 (6%) patients. Dislocation was observed in 2 (6%) patients in the postoperative follow-up. One of these patients was treated with closed reduction method, while the other patient underwent revision surgery. The indication for the patient undergoing revision surgery was periprosthetic fracture after a fall.

In 7 of the patients, the cause of the pathological fracture was primary bone tumor, while 24 of them were metastasis. 5 of the bone-derived tumors were Chondrosarcoma, 1 was Ewing sarcoma and 1 was Multiple Myeloma (Figure 1). Metastasis diagnoses as follow; 8 lung carcinomas, 6 breast carcinomas, 3 prostate carcinomas, 2 GIS-derived adenosarcomas, 2 renal cell carcinoma, 1 ovarian carcinoma, 1 parathyroid carcinoma, and 1 squamous cell carcinoma (Figure 2).

Table 2 includes the characteristics of the patients whose pelvic parameters were measured. The mean PI of these patients whose measurements were made from the lateral lumbar graphy were 54°, mean SD: 38°, mean PT: 11° and mean lumbar lordosis: 30° (Table 3).

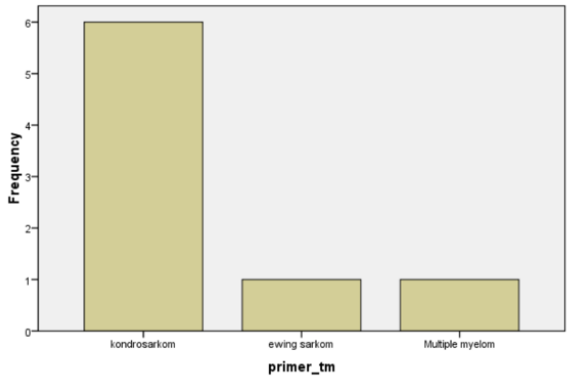


**Figure 1.** Diagnostic distribution of primary bone tumors.

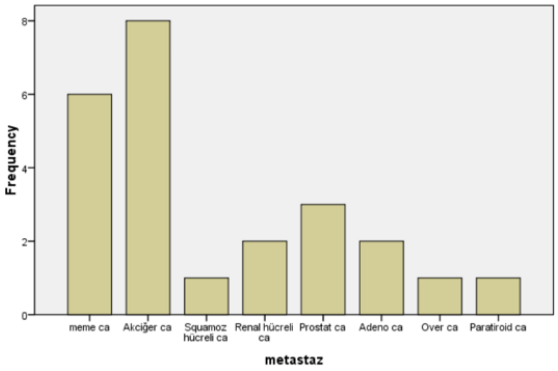


**Figure 2.** Diagnostic distribution of metastatic bone tumors.

**Table 1.** Demographic and clinical characteristics of patients who underwent arthroplasty for pathological fractures of the proximal femur

| | Total cohort (n:32) |
|---|---|
| Age | 60.34±14.89 |
| Gender | |
| Woman | 15 (46.9) |
| Man | 17 (53.1) |
| Side | |
| Right | 16 (50) |
| Left | 16 (50) |
| Diagnosis | |
| Neck | 13 (40.6) |
| Intertrochanter | 9 (28.1) |
| Subtrochanteric | 10 (31.3) |
| Leg length difference (cm) | 0 (0-1.50) |
| Spine | |
| None | 20 (62.5) |
| Degeneration | 9 (28.1) |
| Metastasis | 3 (9.4) |
| Implant | |
| Tumor arthroplasty(TA) | 30 (93.8) |
| Total Hip Arthroplasty(THA) | 2 (6.2) |
| Dislocation | |
| None | 30 (93.8) |
| There | 2 (6.2) |
| Revision | |
| None | 30 (93.8) |
| There is | 2 (6.2) |

Presented as mean ± SD or median (minimum-maximum) or n (%).

## Discussion

As the proximal femur is a region where primary bone tumors are frequently located, bone metastases are also common. In addition, this region is important due to its biomechanical properties and the risk of pathological fractures [8,9]. The main purpose in the treatment of proximal femur pathological fracture is to perform limb-sparing surgery and to mobilize the patient with minimal complications. This goal was achieved in the patients included in our study. Some studies have highlighted arthroplasty treatment with low implant failure [10,11]. There are also publications supporting arthroplasty because of early mobilization and low complication rates [4, 10]. The fact that there are two patients with dislocation and two patients requiring revision surgery in our study can be considered a success in a complex area such as tumor surgery.

The most common form of bone malignancy is metastasis [8, 12]. As a matter of fact, in our study, the number of pathological fractures due to metastasis was higher than bone-related involvement. While a total of 24 patients were diagnosed with metastasis, only 7 patients had bone-related involvement. Chondrosarcoma (6 patients), one of the primary bone tumors, was the most common cause of bone-related involvement in our study. We can say that the diagnosis of Chondrosarcoma comes to the fore since adult patients over the age of 18 were included in our study. Responsible for 80% of skeletal system metastases: Breast, Lung, Prostate, Kidney and Thyroid carcinomas [13]. Similarly, in our study, lung cancer (8 patients) and breast cancer (6 patients) were mostly seen as the diagnosis of metastasis, which are the most common cancers of the adult period. In this context, our study is compatible with the literature.

The pelvic parameters we measured from the postoperative lateral lumbar radiography are consistent with the mean values given in the Duval-Beaupere [5], Vialle R [14] and Legaye [6] study. While the mean value of PI was 55° ± 10 in the literature, it was 54° in our study and the mean value of PT was 13° ± 6 in our study. While it was stated that lumbar lordosis may be between 30° -75° in adults, it was found to be 30° in our study [15]. Since the antero-posterior distance in the pelvis is narrowed in people with low PI, a small pelvic ring is formed and this is called 'vertical pelvis' [14]. Since the antero-posterior distance increases in people with high PI, it is called "horizonal pelvis" [16]. While there is low SS in the vertical pelvis and therefore low pelvic bending ability, there are high pelvic retroversion possibilities in horizontal pelvis due to the high SS value [16].

Mac-Thiong et al. found that the ideal PT is less than 50% of the PI. While the SS can be at least 0°, its negative nature is incompatible with the human erectile posture [17]. We know that in arthroplasty surgeries; As PT increases, the sacral plateau becomes horizontal and the

**Table 2.** Analysis of patients whose pelvic parameters are measured

| | Age | Gender | Side | Diagnosis | Primer Tm | Leg Length Difference | Implant | Dislocation |
|---|---|---|---|---|---|---|---|---|
| 1. patient | 66 | Man | R | Intertrochanter | Lung mets. | 0 | TA | None |
| 2. patient | 66 | Man | L | Subtrochanteric | MM | 0 | TA | None |
| 3. Patient | 51 | Man | R | femoral neck fracture | Chondrosarcoma | 0 | TA | None |
| 4. Patient | 82 | Man | R | Subtrochanteric | Prostate met | 0 | TA | None |
| 5. Patient | 82 | Man | R | Intertrochanter | Prostate met | 1.5 | TA | None |
| 6. Patient | 71 | Woman | L | Subtrochanteric | Breast met | 0 | TA | None |
| 7. Patient | 57 | Man | R | Intertrochanter | Prostate met | 0 | TA | None |
| 8. Patient | 65 | Woman | L | Intertrochanter | Chondrosarcoma | 0.8 | TA | None |

**Table 3.** Pelvic parameters of the patients

| | Pelvic incidence | Pelvic tilt | Sacral Slope | Lumbar lordosis |
|---|---|---|---|---|
| 1.Patient | 57° | 8° | 49° | 45° |
| 2. Patient | 56° | 10° | 46° | 35° |
| 3. Patient | 45° | 7° | 38° | 30° |
| 4. Patient | 56° | 7° | 48° | 37° |
| 5. Patient | 45° | 10° | 34° | 31° |
| 6. Patient | 60° | 18° | 38° | 16° |
| 7.Hasta | 61° | 17° | 45° | 22° |
| 8.Hasta | 56° | 11° | 41° | 25° |

risk of anterior dislocation increases in patients with prosthesis [18]. The sacral plateau to which the lumbar spine is attached is affected by the pelvic position. The greater the pelvic incidence, the greater the SS and lumbar lordosis also increases [6]. SS is the angle that the sacral plateau makes with the line parallel to the ground. Since the sacral plateau forms the base of the spine, the sacral slope determines the position of the lumbar spine [6].

Among the strengths of this study were that we discussed a subject that has been recently popular and little known about. There are also studies on pelvic parameter evaluations of arthroplasties performed due to joint degeneration or trauma. However, we did not come across a publication investigating the pelvic parameters of arthroplasty surgeries after limb salvage surgery due to malignancy. To the best of our knowledge, our study is the first to investigate pelvic parameters after tumor prosthesis. Recovery of postoperative spino-pelvic compliance is directly related to quality of life and postoperative success [9, 19]. It is known that arthroplasty surgeries with the correct anatomical location are longer lasting.

Our study has some limitations. First; our study is retrospective and pelvic parameter evaluation graphs were calculated only from postoperative graphs. Second, we do not have the life expectancy of the operated patients and the treatments performed before and after the surgery.

Despite these limitations, arthroplasty can be successfully applied as an extremity-conserving surgery method in patients with proximal femur pathological fractures, and the preoperative health status and life expectancy of the patient also affect the results of the surgery, and the complication rate is reduced in surgeries where appropriate pelvic parameters are obtained. Our study also revealed the need for a prospective study on this issue in tumor arthroplasty surgeries.

Main Points:1. Arthroplasty can be successfully applied to proximal femur pathological fractures, 2. Preoperative health status of the patient also affect the results of the surgery. 3. Postoperative spino-pelvic compliance is directly related to quality of life and postoperative success.

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