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Functional results of patients treated with modular prosthetic replacement for bone tumors of the extremities

Tümör rezeksiyon protezi uygulanan kemik tümörlü olgularda fonksiyonel sonuçlar

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Amaç: Bu çalışmada çimentolu modüler tümör rezeksiyon protezi ile tedavi edilen ekstremite kemik tümörlü olguların fonksiyonel sonuçları değerlendirildi.

Çalışma planı: Kemik tümörlerine yönelik geniş rezeksiyon ve çimentolu tümör endoprotezi ile rekonstrüksiyon uygulanan 23 hasta (12 erkek, 11 kadın; ort. yaş 49; dağılım 14-81) incelendi. On iki hastada (%52.2; ort. yaş 63.5) metastatik, 11'inde (%47.8; ort. yaş 38) primer tümör vardı. Tümörler en sık femurda (n=17) görüldü; beş olguda humerus tutulumu vardı. Tüm olgularda çimentolu TMTS (Turkish Musculoskeletal Tumor Society) tümör rezeksiyon protezleri kullanıldı. Fonksiyonel sonuçlar MSTS (Musculoskeletal Tumor Society) skorlama sistemi ile değerlendirildi. Ortalama takip süresi 24 ay (dağılım 1-108 ay) olarak belirlendi (primer tümörlü grupta 30 ay; metastatik tümörlü grupta 3 ay).

Sonuçlar: Yedi hastada (%30.4) ameliyat sonrası dönemde komplikasyon gelişti. Bunların üçü lokal nüks idi. Takip dönemi içinde 11 hasta tümöre bağlı nedenlerle kaybedildi; üç hastada uzak metastaz gelişti; dokuz hastada ise tümör bulgusuna rastlanmadı. Sağkalım primer tümörlü grupta anlamlı derecede fazlaydı (p<0.001). Tüm olgular ameliyat sonrası dönemde desteksiz yürüyebiliyordu. Yaşayan olgularda ortalama MSTS skoru %58.9 (dağılım %40-%90) bulundu. Primer tümörlü grubun MSTS skorları (ort. %71.5, dağılım %60-%90) metastatik tümörlü gruba (ort. %47.4, dağılım %40-%73) göre anlamlı derecede yüksekti (p<0.001).

Çıkarımlar: Tümör rezeksiyonu sonrası kemikte geniş segmenter defekt oluşan durumlarda, çimentolu modüler endoprotezin uygun bir tedavi seçeneği olduğunu ve fonksiyonel sonuçlarının özellikle primer tümörlerde tatmin edici olduğunu düşünüyoruz.

Anahtar sözcükler: Kemik neoplazileri/cerrahi; femur neoplazileri; ekstremite kurtarma; protez ve implant; rekonstrüktif cerrahi işlem/yöntem; sağkalım.

Objectives: We evaluated functional results of patients who were treated with cemented modular prosthetic replacement for bone tumors of the extremities.

Methods: The study included 23 patients (12 males, 11 females; mean age 49 years; range 14-81 years) who underwent wide resection and cemented endoprosthetic replacement with the TMTS (Turkish Musculoskeletal Tumor Society) prosthesis for bone tumors. Twelve patients (52.2%; mean age 63.5 years) had metastatic, 11 patients (47.8%; mean age 38 years) had primary tumors. The most common site of involvement was the femur (n=17), followed by the humerus (n=5). Functional evaluations were made with the Musculoskeletal Tumor Society (MSTS) scoring system. The mean follow-up period was 24 months (range 1 to 108 months), being 30 months for primary, and 3 months for metastatic tumors.

Results: Postoperative complications were seen in seven patients (30.4%), being local recurrences in three patients. During the follow-up period, 11 patients died due to tumoral causes, distant metastasis developed in three patients, and nine patients were tumor-free. Survival was significantly better in patients with primary tumors (p<0.001). All the patients were able to walk without crutches in the postoperative period. The mean MSTS score was 58.9% (range 40% to 90%) in survivors, which was 71.5% (range 60% to 90%) for primary tumors, and 47.4% (range 40% to 73%) for metastatic tumors (p<0.001).

Conclusion: Reconstruction with cemented modular endoprostheses is an appropriate surgical alternative in the treatment of large segmental defects after resection of extremity tumors, with satisfactory functional results particularly in primary tumors.

Key words: Bone neoplasms/surgery; femoral neoplasms; limb salvage; prostheses and implants; reconstructive surgical procedures/methods; survival rate.

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Serious advancement in the treatment of the bone tumors has been achieved in the last 25 years with the new techniques and ideas upon both surgical and medical treatment and with the improvement of the imaging techniques. The improvement of the imaging technology has enhanced the rate of early diagnosis in the bone tumors. The more precise evaluation of the degree of tumoral invasion and metastatic lesions brought out some positive influence especially on surgical treatment options. Important improvement on the prognosis of the patients has been achieved with the use of new chemotherapeutic agents and the advances upon the radiotherapy techniques. With these improvements, survival rates of osteosarcomas for 5 years has been increased form 20% to 70% since 1970's.[1,2,3,4]

When we look at the literature on the bone tumors, no significant difference for recurrence and survival rates between limb sparing surgery and amputations were found.[3,5,6,7,8] Also excellent results on limb sparing surgery using endoprostethic replacement were noted.[9,10,11,12,13,14]

Available limb sparing techniques are consisting of some biological reconstruction techniques, including arthrodeses, reconstructions using allografts, autogenous vascular grafting, distraction osteogenesis, rotationplasty; endoprostethic reconstruction techniques and some combined surgical options which blends endoprosthethic and biological reconstructions.[15,16,17]

Endoprostethic reconstruction techniques are the options of choice for the bone tumors of the extremities with lesser rates of complications providing early postoperative stability and facilitating early rehabilitation.[13,18,19,20] Infections, loss of fixation and fractures are the kind of complications frequently seen with biological reconstruction techniques.[21,22,23]

Patients and methods

23 patients with bone tumors of the upper and lower extremities who have treated with large tumor resections and cemented endoprostethic reconstructions between 1997 and 2007 were retrospectively evaluated in this study (Table 1).

12 (52%) of the 23 patients who included in our study had metastatic bone tumors while 11 (48%) of them had primary bone tumors (Figure 1). 11 of the patients were female, 12 of them were male. 11 (48%) of the 23 patients had pathological fractures at admission. 10 (91%) of the 11 patients with pathological fractures had metastatic bone tumors.

Mean age of the all patients was 49 years (14-81) at the operation time. Besides mean age was 63,5 years (39-81) for the metatstatic tumor group and 38 years (14-67) for the primary tumor group. Pathological diagnoses were obtained in all patients with bone biopsies using Jamshidi needles before all else. Histopathological results retrieved osteosarcoma in 4 patients, malignant fibrous histiocytoma in 2 patients, haemangioendothelioma in 1 patient, primary lymphoma of the bone in 1 patient, multipl myeloma in 1 patient, undifferentiated pleomorfic sarcoma in 1 patient and giant cell tumor of the bone in 1 patient, while the results of the remaining 12 patients were concluded as bony metastases of carcinomas (Table 1).

Localization of the tumors were at the distal femur in 9 patients, proximal femur in 7 patients, femoral shaft in 1 patient, proximal tibia in 1 patient, proximal humerus in 4 patients, distal humerus in 1 patient. 7 of the 11 patients with primary tumors had tumors at the distal femur, 3 patients had tumors at proximal femur, 1 patient had tumor at the proximal tibia. 4 of the 12 patients with metastatic tumors had tumors at proximal femur, 4 patients had tumors at the proximal humerus, 2 patients had tumors at the distal femur, 1 patient had tumor at the femoral body and 1 patient had tumor at the distal humerus. All of the operations were performed by one senior surgeon and same type of bone cement and cemented TMTS (Turkish Musculoskeletal Tumor Society) tumor resection prostheses were used in all operations (Figure 2). Cemented TMTS bipolar hip tumor resection prostheses were used in 7 patients, cemented TMTS bipolar shoulder tumor resection prostheses were used in 4 patients, cemented TMTS total elbow tumor resection prosthesis used in one patient, cemented TMTS femoral intercalary tumor resec-

Table 1. Localizations of primary and metastatic tumors

	Primary	Metastatic	*Total*
Femur	10	7	17
Distal femur	7	2	9
Proximal femur	3	4	7
Femoral shaft	–	1	1
Humerus	–	5	5
Proximal humerus	–	4	4
Distal humerus	–	1	1
Proximal tibia	1	–	1

Figure 1.(a) Anterior-posterior and lateral radiographs and **(b)** MRI scans of a patient with osteosarcoma at the distal femur.

tion prosthesis used in one patient, cemented TMTS total knee tumor resection prosthesis for proximal tibia in one patient, and cemented TMTS total knee tumor resection prostheses for distal femur in 9 patients.

Functional results were determined using MSTS (Musculoskeletal Tumor Society) scoring system.[24] All living patients were asked to come for periodic control examination and their MSTS scores were recorded. The last examination records were used to calculate MSTS scores for the dead patients. Pain, functional capacity and emotional status were evaluated using MSTS scoring system (Table 2). Hand position, hand skills, weight carrying ability for the upper extremity tumors (Table 3) and walking distance, walking style, walking support use for the lower extremity tumors were the parameters evaluated (Table 4). Every parameter had scores from 0 to 5, and final result divided to the maximum point of 30, and the percentages of MSTS scores have been calculated.

Surgical technique

Tumor resection prostheses were applied primarily in the same session following tumor resections in 22 patients. In one patient, resection prosthesis was applied secondary to a failed surgical procedure (reconstruction with vascularized fibula graft after tumor resection). Straight longitudinal incisions were used for surgical interventions. Biopsy scars were excised with a 1,5 cm safety margin in all the patients. The tumor tissues were excised with maximum possible surgical safety margins. No extra reconstructive interventions needed for soft tissue coverage in any patients. Antibiotic prophylaxis with first generation cephalosporins for 72 hours and thromboprophylaxis with low molecular weight heparine for 3 weeks were performed in all patients. Isometric exercises and mobilization with crutches were started at the postoperative second day.

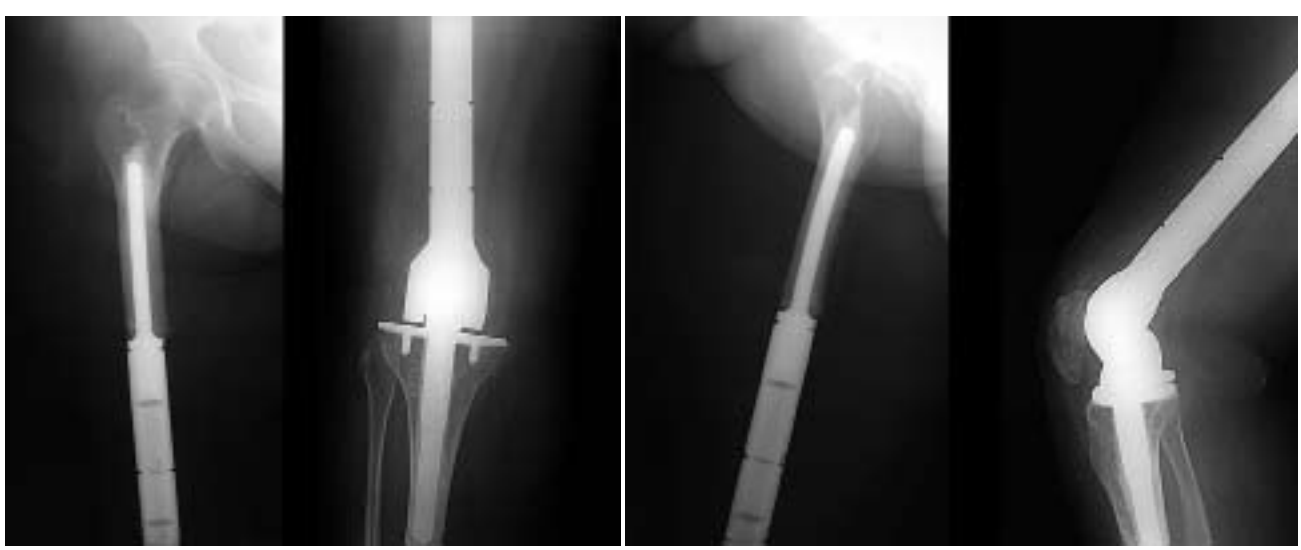

Figure 2. Radiographs of the same patient in Fig.1 showing reconstruction after tumor resection with cemented TMTS tumor resection prosthesis (postoperative 5 years). TMTS: Turkish Musculoskeletal Tumor Society.

Table 2. Common criteria for both upper and lower extremities

Status	Result	Score
Pain		
No pain	No drugs	5
Moderate pain	No drugs	4
Icapacitating pain	Non narcotic analgesics	3
Mild pain	Non narcotic analgesics	2
Restricting pain	Intermittant narcotic analgesics	1
Continious pain	Continious narcotic analgesics	0
Functional capacity		
No restriction	Not handicapped	5
Moderate restriction	Minor handicap	4
Recreational restriction	Minor handicap	3
Moderate occupational capacity loss	Minor handicap	2
Partial occupational capacity loss	Major handicap	1
Continious occupational capacity loss	Handicapped	0
Emotional status		
Strenous-greedy	Recommends	5
Happy	Recommends	4
Satisfied	May have it again	3
Abstaining	May have it again	2
Accepted	Unwilling	1
Unhappy	Resisting	0

Results

All patients were transferred to Oncology department at the postoperative second week. Patients were followed in a periodic manner at the orthopaedic policlinics while having oncological treatment. Clinical and radiological examinations were done at the periodic controls.

Metastatic tumor group and primary tumor group were found homogenous and compatible to normal distribution according to the One Sample Kolmogorov-Smirnov test in statistical analysis. No statistically significant difference was found in gender distribution between two groups according to Chi-square test (p=0,537). Distribution analysis for the age between two groups was performed using standard T-test. Mean age was found significantly higher in metastatic tumor group (p=0.001).

We have seen some complications in 7 patients (30 %) at the postoperative period. Dislocation of prostheses were seen in 2 (8,69 %) patients. One of these dislocations was treated by bracing after closed reduction, the other one needed an open reduction after a failed attempt to close reduction. Wound infection and necrosis was seen in one patient (4,34 %), and treated with a split thickness skin graft after several consecutive debridements. We have seen local recurrence in 3 patients (13 %). One of them was treated with hip disarticulation; one of them was treated with local tumor excision and soft tissue reconstruction from proximal tibia. One patient declined the offered treatment (hip disarticulation). One patient had patella fracture 2 years after distal femoral resection and endoprosthetic replacement. This patient was treated with casting.

Mean follow-up was 24 months (1-108 months) for both groups. It was found 30 months (4-108 months) in primary tumor group, and 3 months (1-48 months). Both groups were analyzed statistically according to follow-up durations using Mann-Whitney-U test and a statistically significant difference was found (p=0,001).

11 of 23 patients were found dead from tumoral reasons, 3 of them were found having distant metastases and 9 of them were found living disease free at the last examination. 10 of the 11 patients who

Table 2. Common criteria for both upper and lower extremities

Status	Result	Score
Upper extremity		
Hand position		
No restirction	180° elevation	5
Mild restriction	180° elevation	4
Elevation to shoulder level	90° elevation	3
Pronation-supination restrction	90° elevation	2
Elevation to waist level	30° elevation	1
Immobile	No elevation	0
Hand skills		
No restriction	Normal skills and sensation	5
Moderate restriction	Normal skills and sensation	4
Mild loss in fine hand skills	No button up	3
Significant loss in fine hand skills	Mild loss in sensation	2
No pinching	Significant loss in sensation	1
No grip	Anaesthesia	0
Weight lifting		
Normal weight	Normal muscle strength	5
Normal weight	Mild muscle strength	4
Light weights	Loss of muscle strength	3
Can move against gravity	Significant muscle strength loss	2
Can not move against gravity	Significant muscle strength loss	1
No movement	No muscle strength	0
Lower extremity		
Walking support use		
No support	No support	5
Mild brace requirement	Intermittant brace use	4
Brace requirement	Continious brace use	3
Mild cane requirement	Intermittant cane use	2
Requires one cane	Continious cane use	1
Double cane-crutch requirement	Continious cane-crutch use	0
Walking distance		
Normal	Same as preoperative period	5
No restriction	Same as preoperative period	4
Mild restriction	Not handicapped	3
Moderate restriction	Not handicapped	2
Handicapped	Indoor mobility	1
Immobile-dependent	Wheelchair	0
Walking style		
Normal	Same as preoperative period	5
No limping	Same as preoperative period	4
Mild limping	Cosmetic problem	3
Moderate limping	Cosmetic problem	2
Significant limping	Minor functional problem	1
Handicapped	Major functional problem	0

died as a result of tumoral disease were from the metastatic group. Distant metastases were found in 3 patients. These 3 patients were the patients having distal femoral osteosarcoma, malignant fibrous histiocytoma at the distal femur, undifferentiated pleomorphic sarcoma at the proximal femur. All the distant metastases were pulmonary metastases. These 3 patients had chemotherapy treatment for pulmonary metastases. The final status of the patients were evaluated statistically using Chi-square test,

and survival rates were found significantly higher in the primary tumor group (p<0,001). Mean prostheses using duration were found 43 months (4-108 months) in the primary tumor group, and 9 months (1-48 months) in the metastatic tumor group.

Social integration and returning to the predisease daily living activities were found fully recovered in all patients at the final follow-up examinations. Mean functional results measured using MSTS scoring system was found 58,9 % (40 %-90 %) for both groups. The same parameter was found 47,4 % (40 %-73%) for metastatic tumor group, and 71,5 % (60 %-90 %) for primary tumor group. Functional results with MSTS scoring system were evaluated using Mann-Whitney-U test. According to the result of this test, primary tumor group had better statistically significant results than metastatic tumor group (p=0,001).

Discussion

Reconstruction of large bony defects after resection of extremity tumors with modular tumor resection prostheses have become a preferred method of extremity salvage for many orthopaedic surgeons in the past 30 years. Serious improvement has occurred in this interval, especially, industrial development about prosthesis technology, the growing amount of experience about implantation techniques and advances in imaging studies, chemotherapeutical therapy and radiotherapy commited improvement on the prognosis and survival rates.

Extremity sparing procedures have been more put into practice in spite of amputations in bone tumor surgery. Replacing the bone and soft tissue defect and restoring the abilities and the functions of the joints after tumor resection is still a challenging matter for orthopaedic surgeons.[15,22,23,24] Joint restoration may be achieved by endoprosthetic replacement or reconstruction with allografts after tumor resection. Surgeons are not fond of restoring the defect and joints by using osteoarticular allografts because of failure rates of 40-50 %.[18,19,25] Endoprosthetic replacement in extremity tumors has many advantages as, early postoperative stability, chance for early rehabilitation, lower rates and in tumor surgery endoprosthetic replacements result with approximately 90 % surgical success rates.[15,22,23,24,26,27] Especially in young patients, some revisions for growing skeleton may be required in recent years, but with improvement of prosthesis technology, expandable prostheses are available at the present time. 30-40 % of patients with grade II osteosarcomas has survival rates less than 2 years, in most cases with high grade disease life expectancy and revision requirement may be limited.[15,25] None of our patients required revisions due to loosening and fractures.

We have achieved good-excellent functional results in our patients with MSTS scoring system in general. But functional results in metastatic tumor group and in patients with pathological fractures were found as intermediate and poor. Older age, systemic disease due to metastatic invasion and poor general health status were thought as a reason for these results. But early mobilization with endoprosthetic replacements made some effects on life quality and prevention of possible thromboembolic complications of the patients with pathological fractures.

The most frequent complication in our study was local recurrence (13 %). Our local recurrence rates were equivalent to the rates in literature (5-15 %).[3,8,23] Besides, these rates were found congruent to the rates of studies which local recurrences treated by amputations.[28,29] Infection rate in our study was 4,3 %. No definite amount on infection rates about extremity tumors were found in the literature, but infection rates in some studies may be represented as, %2,6 [15], %4,0 [16], %7,0 [13], %7,1 [17], %13,4 [14], %19 [30].

The weakest link in our study is seemed as the short follow-up period in patients especially with metastatic tumors and pathological fractures. Longer follow-up periods would have revealed more healty results in our study especially in the metastatic group. Early and immediate orthopaedic consultation in cancer patients with extremity complaints may be helpful for improvement of life quality and life expectancy.

As a result, reconstruction of extremity with modular tumor resection prostheses in the treatment of extremity tumors reveals as a safe and reliable option especially in the patients with primary bone tumors. There may be poorer results and short life expectancy in the patients with metastatic disease and pathological fractures.

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