sciendo Romanian Journal of Orthopaedic Surgery and Traumatology, Volume 3, Issue 1, January-June 2020. pp:15-19
doi:10.2478/rojost-2020-0004

Accepted: July 16th 2020

ORIGINAL ARTICLE

Functional results of various reconstruction techniques in primary malignant bone tumors

Ioan-Mihai Japie*, Dragoș Rădulescu* **, Adrian Bădilă* **, Alexandru Papuc*, Traian Ciobanu*, Dumitru Stănculescu**

*Department of Orthopaedics and Traumatology, University Emergency Hospital, Bucharest, Romania
**"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania

Correspondence to: Dragoș Rădulescu, MD,
Department of Orthopaedics and Traumatology, University Emergency Hospital, Bucharest,
169 Splaiul Independentei Street, District 5, Code 050098, Bucharest, Romania,
Phone: +4021 318 05 23,E-mail: dragosradulescu@yahoo.com

Abstract

Introduction: The aim of the study was to report the clinical and functional outcomes in patients undergoing limb salvage with various reconstruction techniques in primary malignant bone tumor.

Materials and methods: This study was performed between 2011 and 2018 on 52 patients with primary malignant bone tumors admitted to the Department of Orthopaedics and Traumatology of University Emergency Hospital, Bucharest. All the patients underwent surgical treatment (resection-reconstruction technique) followed by oncologic therapy. The mean follow-up was 3 years and 8 months and the minimum follow-up was 12 months.

Results: The best results were obtained in patients in whom resection of the tumor followed by reconstruction was possible, without affecting the adjacent joint through arthrodesis or arthroplasty. These patients had an average MSTS score of 75.2%. The patients who underwent reconstruction procedures by endoprosthesis also had good results with an average MSTS score of 72.3%, while patients with arthrodesis obtained rather modest results – the average MSTS score being 67.3%. When taking into consideration the location of tumors, the best MSTS scores were obtained in patients with tumors of the distal radius – 80%, followed by femoral and humeral diaphysis – 75.6%, distal femur – 75.2%, proximal femur – 73.3%, proximal humerus – 72.3%, tibial diaphysis – 72.2%, distal tibia – 70% and proximal tibia 68.7%.

Conclusions: The orthopedist must judiciously chose the surgical technique, taking into consideration the anatomical particularities and the needs of the patient. Given the functional results and the emotional acceptability, reconstruction with tumor prosthesis represents the first option.

Keywords: MSTS score, arthrodesis, tumoral prosthesis

Introduction

Primary malignant bone tumors affecting the limbs account for a small percentage of the total cancers, having an incidence of 10 cases per million per year [**1**]. These have a major social and economic impact because

they mostly affect young adults who are professionally active.

While developing the diagnostic techniques and the oncologic therapies, life expectancy of patients with malignant bone tumors rose considerably, leading to the need of perfecting the reconstruction techniques of bone defects, secondary to the removal of bone tumors, in order to obtain superior functional results and thus improve the quality of life [**2**].

Reconstruction with tumoral prosthesis represents the first surgical option, granting the preservation of articular mobility, ease and rapidity of intraoperative modular prosthesis assembly in order to restore the limb's length, the early initiation of medical rehabilitation with resumption of daily activity. However, there are cases when arthrodesis is preferred to the reconstruction with tumoral prosthesis, such as major deficiency of knee extensor muscles or tumors massively incorporating the soft tissues.

Materials and methods

This study was performed between 2011 and 2018 on 52 patients with primary malignant bone tumors admitted to the Department of Orthopaedics and Traumatology of the University Emergency Hospital, Bucharest. Following the clinical and imaging exams, the patients were diagnosed with bone tumors that affected the limbs. Biopsies were performed and followed by a pathological examination of the tumoral samples, hence establishing the definite diagnosis. According to the type of tumor, we included: 21 patients with osteosarcoma, 18 patients with chondrosarcoma, 6 patients with Ewing sarcoma, 3 with malignant fibrous histiocytoma, 2 with fibrosarcoma and 2 with primary malignant lymphoma of the bone. All the patients underwent surgical treatment (resection-reconstruction technique) followed by oncologic therapy. The mean follow-up was 3 years and 8 months, the minimum follow-up being 12 months.

The reconstruction technique was performed in femur in 32 patients, tibia in 13 patients, humerus in 6 patients and radius in one patient and consisted in modular prosthesis in 33 cases, resection arthrodesis in 15 cases and intercalary grafts, or cement spacer in 4 cases.

Results

In order to quantify the one-year postoperative results, we used the Musculo-Skeletal Tumor Society rating scale (MSTS) (**Table 1,2**). This scale was introduced in 1993 as a specific parameter that evaluates the functional and emotional postoperative status in patients with bone tumors of the limbs.

Table 1. MSTS score - upper extremity

Score	Pain	Function	Emotional	Hand positioning	Manual dexterity	Lifting ability
5	No pain	No restriction	Enthused	Unlimited	Unlimited	Normal load
4	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
3	Modest/Non-disabling	Recreational restriction	Satisfied	Not above shoulder or no/ Pronation/ supination	Loss of fine movements	Limited
2	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
1	Moderate/Disabling	Partial restriction	Accepts	Not above waist	Cannot pinch	Helping only
0	Severe disabling	Total restriction	Dislikes	None	Cannot grasp	Cannot help

Table 2. MSTS score - lower extremity

Score	Pain	Function	Emotional	Supports	Walking	Gait
5	No pain	No restriction	Enthused	None	Unlimited	Normal
4	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
3	Modest/ Non-disabling	Recreational restriction	Satisfied	Brace	Limited	Minor cosmetic
2	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
1	Moderate/ Disabling	Partial restriction	Accepts	One cane or crutch	Inside only	Major cosmetic
0	Severe disabling	Total restriction	Dislikes	Two canes or crutches	Not independent	Major handicap

In our study, the MSTS scale was calculated while taking into consideration the type of surgical intervention and the affected bone. The best results were obtained in patients in whom resection of the tumor followed by reconstruction was possible without affecting the adjacent joint through arthrodesis or arthroplasty. These patients had an average MSTS score of 75.2% (the lower and upper limits were 70%, respectively 80%). The patients who underwent reconstruction procedures through endoprosthesis also had good results with an average MSTS score of 72.3% (the lower and upper limits were between 66.67% and 76.67%), while patients with arthrodesis obtained rather modest results – the average MSTS score being 67.3% (the lower and upper limits were 56.67% and 70%).

When taking into consideration the location of tumors, the best MSTS scores were obtained in patients with tumors of the distal radius – 80%, followed by femoral and humeral diaphysis – 75.6%, distal femur – 75.2%, proximal femur – 73.3%, proximal humerus – 72.3%, tibial diaphysis – 72.2%, distal tibia – 70% and proximal tibia 68.7%. The poor MSTS scores were obtained in patients with reconstruction of proximal tibia, and this can be related to the insufficiency of extensor mechanism.

Discussions

In our study, the functional results one year after surgery were good and very good with an average of 72.3%, which can be translated into an increased grade of satisfaction and emotional acceptability, thus being similar with the results that Puri obtained in 2018 [**3**] and Bekmez in 2016 [**4**]. Regarding the type of fixation of tumor endoprosthesis, the recommendation is to use acrylic cement in old patients with osteoporosis, in those who underwent radiotherapy or in patients in whom the shape of the medullary canal makes it impossible to firmly fixate an uncemented prosthesis. On the other hand, the uncemented prosthesis has a lower rate of loosening, thus being recommended in young patients with superior bone quality [**5**].

The most frequent location of tumors of the upper limb is the proximal humerus. The poor results obtained after reconstruction with tumor prosthesis are the consequence of the removal of the rotator cuff, due to oncologic security. In this situation, the best option is arthrodesis of the shoulder that leads to a stable and free of pain limb and a certain mobility of the scapulothoracic joint and favorable functional results [**6**].

The tibiotalocalcaneal arthrodesis in bone defects of the distal tibia have the advantage of a solid stability of the lower limb, as well as a good functional result. In 2006, Shalaby indicated an average MSTS score of 70% [**7**], while in 2018, Xu noted an average score of 74.3% [**8**]. After reconstruction with tumor endoprosthesis, Abudu indicated an average MSTS score of only 64% [**9**].

Arthrodesis is not only reserved in case of tumors affecting the proximal humerus or

distal tibia, but also as an alternative in case of infectious or mechanical failure of tumor prosthesis. Most frequent types of arthrodesis are when using bone graft or acrylic cement. The advantage of using bone graft comes from the preservation of the bone stock, thus obtaining satisfactory functional results. In our study, the patients with arthrodesis obtained a medium MSTS score of 67.3%. The major disadvantage is delayed weight bearing of the lower limb until integration and consolidation of the bone graft, hence leading to a delay in resumption of daily activities. Chemotherapy and radiotherapy may cause failure of reconstruction by interfering with the osteogenesis of the graft-bone junction and increasing the time of consolidation [**10**].

The acrylic cement that is used in arthrodesis has various advantages such as: reduction of intraoperative time, surgeryof a single anatomical segment without the necessity of a bone graft sampling, early initiation of medical rehabilitation and resumption of daily activities and also lower costs. Acrylic cement does not need integration; hence, the procedure is not affected by chemotherapy. In order to obtain optimal results, acorrect sizing of the cement spacer is needed. Donati observed that most of the postoperative complications were due to the inadequate sizing of the cement spacer [**11**]. Another advantage of using acrylic cement is represented by thelower rate of postoperative complications. Capanna indicated an incidence of 14% of infections in the case of arthrodesis with acrylic cement compared with 26% in the case of arthrodesis with bone graft [**12**].

The main advantage of reconstruction with intercalary grafts, when this is possible, is that by this technique the adjacent joint is preserved, with a very good functional outcome. The disadvantage consists in high rate of non-union that can occur in 17% of the cases [**13**].

The risk factors that can lead to delayed union or non-union are: type of graft, fixation, length of resection, associated chemotherapy [**10**].

Conclusions

Reconstruction of limbs in orthopaedic oncology can be obtained through a vast variety of techniques. The orthopedist must choose judiciously the surgical technique, taking into consideration the anatomical particularities and the needs of the patient. Reconstruction with tumor prosthesis represents the first option, given the functional results and the emotional acceptability.

Conflict of Interest statements

Authors state no conflict of interest.

Informed Consent and Human and Animal Rights statements

Informed consent has been obtained from all individuals included in this study.

Authorization for the use of human subjects

Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies, is in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent commitee.

References

1. Von Eisenhart-Rothe R, Toepfer A, Salzmann M, Schauwecker J, Gollwitzer H, Rechl H. Primary malignant bone tumors. Orthopade. 2011 Dec;40(12):1121-42.
2. Bacci G, Picci P, Ferrari S et al. Primary chemotherapy and delayed surgery for nonmetastatic osteosarcoma of the extremities. Results in 164 patients preoperatively treated with high doses of methotrexate followed by cisplatin and doxorubicin. Cancer. 1993;72:3227e3238.

3. Puri A, Byregowda S, Gulia A, Crasto S, Chinaswamy G. A study of 853 high grade osteosarcomas from a single institution are outcomes in Indian patients different?. J. Surg. Oncol. 2018; 117:299–306.
4. Bekmez S, Ayvaz M, Yucekul A, Tokgozoglu M. Modular cementless prosthetic reconstruction after resection of lower extremity malignant tumor. Acta Orthopaedica et TraumatologicaTurcia. 2016; 50:674-680.
5. Capanna R, Scoccianti G, Frenos F, Vilardi A, Beltrami G, Campanacci DA. What Was the Survival of Megaprostheses in Lower Limb Reconstruction After Tumor Resection?. Clin OrthopRelat Res. 2015; 473:820-830.
6. Bilgin S. Reconstruction of proximal humeral defects with shoulder arthrodesis using free vascularized fibular graft. J Bone Joint Surg Am. 2012;94(13):e94.
7. Shalaby S, Shalaby H, Bassiony A. Limb salvage for osteosarcoma of the distal tibia with resection arthrodesis, autogenous fibular graft and Ilizarov external fixator. J Bone Joint Surg Br. 2006;88:1642-6.
8. Xu L, Zhou J, Wang Z, Xiong J, Qiu Y, Wang S. Reconstruction of bone defect with allograft and retrograde intramedullary nail for distal tibia osteosarcoma. Foot and Ankle Surgery. 2018; 24:149-153.
9. Abudu A, Grimer RJ, Tillman RM, Carter SR. Endoprosthetic replacement of the distal tibia and ankle join for aggressive bone tumor. Int Orthop. 1999;23:291-4.
10. Hornicek FJ et al. Factors affecting nonunion of the allograft-host junction. Clin OrthopRelat Res. 2001; (382):87-98.
11. Donati D, Giacomini S, Gozzi E, Sorin E, Borz S, Mercuri M. Knee arthrodesis with a temporary spacer performed in malignant tumor around the knee. Arch Orthop Trauma Surg. 2002;122:123-8.
12. Capanna R, Biagini R, Ruggieri P, Bettelli G, Cascadei R, Campanacci M. Temporary resection-arthrodesis of the knee using an intramedullary rod and bone cement. Int Orthop. 1989;13:253-8.
13. Donati D, Di Liddo M, Zavatta M, Manfrini M, Bacci G, Picci P et al. Massive bone allograft reconstruction in high-grade osteosarcoma. Clin OrthopRelat Res.2000;377:186-94.