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Characteristics and Outcome of Infections Associated with Endoprosthesis Following Resection of Bone Tumors

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Abstract

Background: Endoprosthetic replacement after limb-salvage surgery has become a standard option for musculoskeletal tumor reconstruction. However, infection remains one of the most serious complications, with significant impact on limb survival and functional outcomes. This study aimed to evaluate the characteristics, management strategies, and outcomes of infections following endoprosthesis after bone tumor resection.

Aim of Study: To evaluate the incidence, management strategies, and outcomes of postoperative infections following endoprosthetic reconstruction after bone tumor resection, with a focus on infection clearance, limb salvage, and functional results.

Patients and Methods: We retrospectively reviewed 216 patientswho underwent limb salvage with modular endoprosthesis following resection of bone tumors between 2003 and 2010 at Nasser Institute, Bone Bank, and Children's Cancer Hospital, Cairo. Cases complicated by infection (31 patients; 14.4%) were analyzed in detail. Patient demographics, tumor type, surgical site, adjuvant therapy, timing of infection, management modality, and functional outcomes were assessed. Functional outcome was evaluated using the Musculoskeletal Tumor Society (MSTS) score.

Results: Of the 31 infected cases (17 males, 14 females; mean age 19.7 years), the most common tumor was osteosarcoma (61.2%), followed by malignant fibrous histiocytoma (9.7%) and Ewing's sarcoma (6.5%). The most frequent sites were distal femur (45.1%) and proximal tibia (42%). Infection developed early (<3 months) in 14 patients (45.2%), and late (>3 months) in 17 patients (54.8%).Initial management included antibiotics and debridement, but many cases required staged surgery. Two-stage revision with re-implantation achieved infection control in 5 patients (16.1%), while amputation or hip disarticulation was required in 6 patients (19.3%). Conservative treatment with antibiotics alone was successful in a minority of cases. Overall infection eradication and limb salvage were achieved in approximately 64.5% of patients. The mean MSTS functional score in salvaged limbs was 72%.

Conclusion: Infection following endoprosthetic reconstruction for bone tumors remains a major complication, with an incidence of 14.4% in our series. Distal femur and proximal tibia resections were the most susceptible sites. While conservative measures may suffice in early low-grade infections, most cases required surgical intervention. Two-stage revision was the most effective limb-salvage strategy, although amputation remained necessary in nearly one-fifth of patients. Strategies to reduce infection risk including improved perioperative protocols and infection-resistant implant coatings are critical to improving long-term outcomes in oncologic endoprosthetic surgery.

Key Words: *Endoprosthesis – Resection – Functional outcome – Bone tumors.*

Introduction

THE management of primary malignant and aggressive benign bone tumors has undergone a dramatic transformation over the past four decades. Historically, amputation was the primary treatment modality, offering satisfactory local control but at the expense of function, cosmesis, and psychosocial well-being. With advances in diagnostic imaging, neoadjuvant and adjuvant chemotherapy, radiotherapy, surgical techniques, and biomaterials, limb-salvage surgery has become the preferred approach for the majority of patients, achieving comparable oncological control while preserving limb function **[1]**.

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Among the various reconstructive options available after wide tumor resection including allografts, autografts, rotationplasty, and arthrodesis modular endoprosthetic replacement (megaprosthesis) has gained increasing popularity. Endoprostheses offer immediate structural stability, allow early weight-bearing, and provide predictable functional outcomes. Moreover, their modularity facilitates intraoperative flexibility and makes them suitable for a wide variety of anatomical locations and resection lengths. For these reasons, endoprostheses are considered the "gold standard" reconstructive option in many high-volume musculoskeletal oncology centers worldwide **[2]**.

Despite these advantages, periprosthetic infection remains one of the most devastating and feared complications of endoprosthetic reconstruction. Reported infection rates in the oncologic setting range from 8% to 15%, markedly higher than the <2% rates typically observed in conventional total hip and knee arthroplasty. The increased risk in tumor patients is attributed to several factors: Extensive soft tissue dissection, long operative times, immunosuppression related to chemotherapy and radiotherapy, creation of large dead spaces, and the frequent use of massive implants that predispose to biofilm formation **[3]**.

The consequences of infection extend beyond prosthesis survival. Persistent or recurrent infection often necessitates implant removal, arthrodesis, or amputation, leading to loss of limb function and profound psychological and social impact. Functional outcomes are significantly reduced compared to non-infected reconstructions, and the overall quality of life for these patients is severely compromised. In some series, amputation rates of up to 20–25% have been reported in patients with infected endoprostheses, underscoring the seriousness of this complication **[4]**.

Multiple strategies have been described for managing infection after endoprosthetic reconstruction, including suppressive antibiotic therapy, surgical debridement with prosthesis retention, one-stage revision, two-stage revision with antibiotic-loaded spacers, use of vascularized fibular grafts, and arthrodesis. Each approach carries variable success rates, and the choice of treatment depends on factors such as the timing of infection (early vs late), the virulence of the infecting organism, host immunity, and the quality of the surrounding soft tissues **[5]**.

Two-stage revision is generally regarded as the most reliable method for infection eradication while preserving limb function, but it requires multiple operations and is not always feasible **[6]**. The present study aimed to evaluate the incidence, characteristics, management strategies, and outcomes of infections following endoprosthetic reconstruction after bone tumor resection.

Patients and Methods

Study design and setting:

This was a retrospective cohort study conducted at Nasser Institute Hospital, the Bone Bank, and the Children's Cancer Hospital in Cairo between 2003 and 2010. The study aimed to evaluate the characteristics, management, and outcomes of infections occurring after endoprosthetic reconstruction for bone tumors.

Participants:

A total of 216 patients underwent limb-salvage surgery with modular endoprosthesis following tumor resection during the study period. Among these, 31 patients (14.4%) developed postoperative infection and were included in this analysis. The infected cohort comprised 17 males (54.8%) and 14 females (45.2%), with a mean age of approximately 19.7 years (range: 11–52 years). The most frequent tumor type was osteosarcoma (61.2%), followed by malignant fibrous histiocytoma (9.7%) and Swing's sarcoma (6.5%). The commonest anatomical sites of resection were the distal femur (45.1%) and proximal tibia (42%).

Inclusion and exclusion criteria:

Eligible patients were those with primary malignant or benign aggressive bone tumors requiring wide resection, followed by limb-salvage reconstruction using modular mega-endoprosthesis. Patients of all ages and both sexes were included, regardless of whether they received adjuvant chemotherapy or radiotherapy. Exclusion criteria were patients reconstructed with expandable prostheses and those with soft tissue tumors without bone involvement.

Data collection:

Clinical and operative records were reviewed to collect demographic data, tumor histology, anatomical site and resection length, adjuvant therapy, timing of infection, clinical presentation, and the number and type of subsequent surgical interventions. Infections were classified as early if they occurred within three months of the primary surgery, or late if after three months. Management strategies were documented, including systemic antibiotics, surgical debridement and lavage, one- or two-stage revision, vascularized fibular grafting, arthrodesis and amputation or hip disarticulation.

Outcome measures:

Functional outcomes in patients with retained or revised prostheses were assessed using the Musculoskeletal Tumor Society (MSTS) scoring system, expressed as a percentage of the maximum possible score. Final outcomes were categorized as infection eradication with limb salvage, persistent infection under suppressive therapy, or limb loss.

Follow-up:

The minimum follow-up period was 1 year, and the maximum was 7 years, with a mean of 2.5 years. The endpoint of follow-up was either control of infection, amputation, or persistence of infection.

Statistical analysis:

Descriptive statistics were used to summarize demographic and clinical data. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between early and late infection groups were performed using chi-square or Fisher's exact test for categorical data, and Student's *t*-test for continuous variables. A *p*-value <0.05 was considered statistically significant.

Table (1): Demographic characteristics of patients with postoperative infection.

Variable	Number	%
Total patients with infection	31	14.4% of 216
Male	17	54.8%
Female	14	45.2%
Mean age (years)	19.7	Range: 11–52

As shown in Table (1): Out of 216 patients undergoing endoprosthetic reconstruction, 31 (14.4%) developed infection. The infected cohort included 17 males (54.8%) and 14 females (45.2%), with a mean age of 19.7 years (range: 11–52).

Table (2A): Histological types of tumors among infected patients.

Tumor type	Number	%
Osteosarcoma	19	61.2
Malignant fibrous histiocytoma (MFH)	3	9.7
Ewing's sarcoma	2	6.5
Chondrosarcoma	2	6.5
Giant cell tumor (GCT)	2	6.5
Myeloma	1	3.2
Rhabdomyosarcoma (RMS)	1	3.2
Hemangioendothelioma	1	3.2

As shown in Table (2A): Osteosarcoma was the most common histology (61.2%), followed by MFH (9.7%), Ewing's sarcoma (6.5%), and chondrosarcoma (6.5%). Less frequent tumors included giant cell tumor, myeloma, rhabdomyosarcoma, and hemangioendothelioma.

Table (2B): Anatomical site of tumors in infected patients.

Site	Number	%
Distal femur	14	45.1
Proximal tibia	13	42.0
Proximal femur	2	6.5
Proximal humerus	1	3.2
Distal humerus	1	3.2

As shown in Table (2B): The distal femur (45.1%) and proximal tibia (42.0%) were the most frequently affected sites, with smaller proportions in proximal femur, proximal humerus, and distal humerus.

Diagnosis:

The presenting symptoms in our patients were variable between pain, redness, hotness, collection at site of surgery or draining sinus.

The inflammatory markers (ESR, CRP) were requested for all patients when infection is suspected and repeated during follow-up period to detect response to treatment. In patients with draining sinus or collection cultures were obtained before starting antibiotics.

Table (3): Summary of duration to infection, type of infection and number of surgeries after developing infection.

Case	Interval to infection	Type of infection	No. of surgeries After infection
1	5 weeks	Collection	2surg. 1) Removal + spacer 2) Reimplantation
2	5 years	Draining sinus	4surg. 1) removal + spacer 2) VFG 3) Removal of sequestrum 4) Removal of nail + Ab spacer
3	7 months	Infection bulla	No surg.
4	8 years	Painful thigh + high infection markers	1surg. removal + spacer
5	8 months	Collection	3surg. 1) Debridment + lavage 2) Removal + spacer 3) VFG
6	2+10/12 years	Subcutaneous infection	3surg.1) Debridment + lavage 2) Removal + spacer 3) VFG
7	2 years	Draining sinus	1surg. Removal + spacer
8	13 months	Superficial infection	2surg.1) Removal + spacer 2) Revision of spacer
9	3 months	Draining sinus	3surg. 1) Debridment + lavage 2) Removal + spacer 3) Above knee amputation (wound was clean but patient preferred amputation)
10	10 months	Draining sinus	2surg. 1) Debridment + lavage 2) Removal + spacer
11	22 months	Draining sinus	No surg.
12	4+7/12 years	Draining sinus	7surg. 1) Debridment + lavage 2) Removal + spacer 3) Pedicled fibula + ilizarov 4) Legthening of fibula 5) Removal of ilizarov + cast 6) Debridment 7) Debridment + guttering
13	3 months	Deteriorating infection till prosthesis exposure	1surg. Above knee amputation
14	11 months	Collection	4surg. 1) Debridment + lavage 2) Removal + spacer 3) Pediculed fibula + ilizarov 4) Removal of ilizarov
15	2 months	Draining sinus	4surg. 1) Debridment + lavage 2) Removal + spacer 3) Debridment+ removal of spacer 4) Above knee amputation
16	2 months	Redness + hotness	No surg.
17	2 months +	Draining sinus	No surg.
18	1 year	Draining sinus	3surg. 1) Debridment + lavage 2) Removal + spacer 3) Prosthesis re-implantation
19	2 weeks	Collection	No surg.

Table (3): Count.

Case	Interval to infection	Type of infection	No. of surgeries After infection
20	3 months-	Draining sinus	3surg. 1) Debridment + lavage 2) Removal + spacer 3) Above knee amputation
21	3 months	Collection	1surg. Hip disarticulation
22	4 weeks	Collection	1surg. Debridment + lavage
23	4 weeks	Collection	1surg. Debridment + lavage
24	16 months	Draining sinus	2surg. 1) Debridment + lavage 2) Removal + spacer
25	8 months	Draining sinus	2surg. 1) Removal + spacer 2) Prosthesis re-implantation
26	2 months	Collection	5surg. 1) Removal + spacer 2) Prosthesis re-implantation with shortening. 3) Shortening of contralateral Femur. 4) Lengthening of prosthesis 5) Evacuation of collection + lavage.
27	13 months	Draining sinus	3surg. 1) Removal + spacer 2) Pedicled fibula + ilizarov 3) Removal of ilizarov + plate and grafting.
28	10 months	Collection	1surg. Debridment + lavage
29	6 months	Collection	6surg. 1) Debridment + lavage 2) Debridment + GC flap 3) Debridment + lavage 4) Removal + spacer 5) Debridment + trial to reconstruct acetabulum. 6) Prosthesis re-implantation.
30	3 months	Draining sinus	3surg. 1) Removal of prosthesis Without cup + spacer 2) Debridment + cup removal 3) Debridment + removal of anterior and posterior recontstruction paltes
31	2 weeks	Collection	2surg. 1) Removal + spacer + GC myo-cutaneous flap 2) Prosthesis reimplantation

Non-operative management:

Antibiotics were the first line of treatment in twenty cases of the thirty-one infected cases. Antibiotics were started empirical and if culture results were available antibiotics were adjusted accordingly.Antibiotics were given intravenously for at least two weeks, then oral antibiotics were continued for at least four more weeks. Patients in which antibiotics failed to clear the infection; surgical options either by debridement alone or by debridement and removal of prosthesis were considered.

Operative management protocol:

Pre-operative preparations:

Informing patients about the nature of the operation and possible outcomes.

After admission, the following protocol was applied to all patients:

- Skin preparation.
- Proper analgesia.
- Correction of any fluid and electrolytes imbalance.
- Proper correction of Hemoglobin in anemic patients.
- Cardiological consultation to cardiac patients to assess their cardiac condition and their fitness for surgery.
- Control of any other co-morbidities especially chest infection.
- Anesthesia consultation to assess fitness for surgery.

Informed consent:

All patients were consented about the surgery, possible risks, complication and follow-up protocol.

Operative technique:

Through the same approach used for tumor resection. In cases where a sinus was present, excision of the sinus tract was carried out with resection of the whole scar (ellipse resection). Samples for culture and sensitivity were collected in order to guide the postoperative antibiotic therapy approach. Then extensive debridement of all the necrotic tissues and the sleeve around the prosthesis was done. After that the patients for whom staged revision wasn't planed the following step was thorough wash of the prosthesis and the whole surgical field was done using jet lavage and not less than ten liters of saline, then closure was carried leaving suction drains.

On the other hand, if staged revision was the plan, after the extensive debridement as previously mentioned the endoprosthesis was removed (all the components) and all the cement previously used was removed and a careful curettage of the medulla of the bone was performed, then the whole area of the surgical field was washed using jet lavage with not less than ten liters of saline. For reconstruction, intra-medullary nails were used wrapped with antibiotic loaded cement to maintain space for the future second stage; then closure was carried out leaving suction drains.

Fig. (1): Plan X-rays of case 10 showing loosening of the femoral stem.

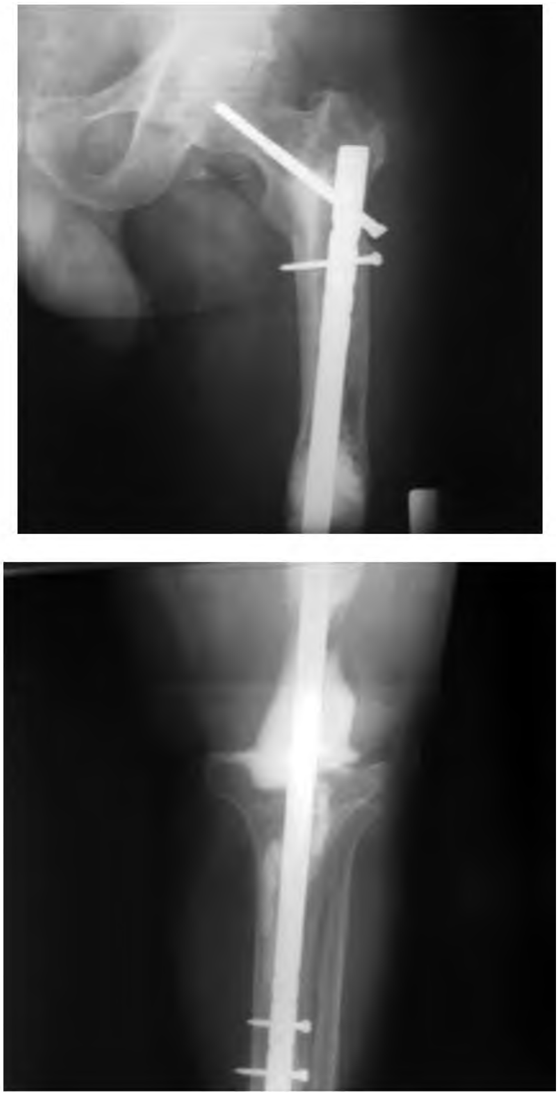

Fig. (2): X-ray of case number (10) cement spacer applied after removal of prosthesis.

Post-operative empirical antibiotics were given till culture results are available, then selective antibiotics according to culture and sensitivity were given for at least 6 weeks (intravenous for at least two weeks then oral for four more weeks). The second stage of surgery wasn't carried until the results of cultures were negative.

Through the same approach the cement spacer was removed by breaking the cement around the nail then removal of the nail was done, again cultures are taken and gentle curettage of the medulla was done followed by thorough lavage of the whole surgical field, then the second stage is carried on according to the pre-operative planning.

The second stage was prosthesis re-implantation in six cases, proper sizing of the replacement pieces was done with testing the joint's range of motion with possible gentle manipulation to improve the range if needed, closure was done with insertion of suction drains.

On the other hand, the second stage was fibular graft in six cases and in these cases, angiography was done pre -operatively to help in planning for the recipient site bundle and to make sure that the grafting is applicable.

Post-operative antibiotics was continued till the removal of the drains with close follow-up of the surgical wounds for any re- infection signs. Post-operative haemoglobin (Hb) was done to all patients and blood transfusion was given to all patients with Hb below 10. Post operative X-rays and base line inflammatory markers (ESR, CRP) were done and repeated for follow-up.

Fig. (3): Plain X-ray of case 27 after removal of prosthesis and applying cement spacer.

Fig. (4): Plain X-ray of case 27 after fusion with pedicled fibula and ilizarov.

Fig. (5): X-ray of case number (18) showing proximal tibial prosthesis after re-implantation.

Results

As shown in Table (4): At a mean follow-up of 2.5 years, infection clearance with limb salvage (prosthesis, spacer, or fibular graft) was achieved in 61.3% of patients. Specifically, prosthesis-salvage clearance accounted for 35.5% of cases, while 16.1% required amputation and 22.6% remained persistently infected.

As shown in Table (5): Late infections (>3 months) had a higher clearance rate (70.6%) compared to early infections (50%).

As shown in Table (6): Clearance was highest among patients >40 years (66.7%), followed by children/adolescents (64.7%), while young adults had lower success rates (50%).

As shown in Table (7): Among the 25 patients who received chemotherapy, clearance was achieved in 64%, compared to 50% in those who did not receive chemotherapy.

As shown in Table (8): Osteosarcoma and MFH showed the best clearance rates (68.4% and 100%, respectively), while no clearance was achieved in Ewing's sarcoma, chondrosarcoma, or rhabdomyosarcoma.

As shown in Table (9): Most patients required multiple surgeries, with two interventions being most common (31.6%). Three patients (15.8%) cleared infection on antibiotics alone, while some required up to six procedures.

As shown in Table (10), the majority of patients eventually achieved infection clearance with limb salvage, most commonly while retaining the prosthesis or using spacers. Functional outcomes, measured by MSTS scores, were variable, ranging from 11 to 27. Patients who retained the prosthesis generally demonstrated higher MSTS scores (22–27), reflecting better functional recovery, while those with persistent infection or who required amputation had poor or unrecorded functional outcomes.

Table (4): Outcomes at last follow-up.

Outcome	Number	%
Cleared infection on prosthesis	11	35.5
Cleared infection on spacer	5	16.1
Cleared infection on fibular graft	3	9.7
Persistently infected	7	22.6
Amputation / hip disarticulation	5	16.1
Mean MSTS score (limb salvage)	–	72

Table (5): Infection clearance according to timing of onset.

Timing of infection	Cleared	Failed	Total	% Cleared
Early (<3 months)	7	7	14	50.0%
Late (>3 months)	12	5	17	70.6%

Table (6): Infection clearance according to age group.

Age group (years)	Cleared	Failed	Total	% Cleared
1–18	11	6	17	64.7%
19–40	4	4	8	50.0%
>40	4	2	6	66.7%

Table (7): Infection clearance according to chemotherapy.

Chemotherapy	Cleared	Failed	Total	% Cleared
Received chemo	16	9	25	64.0%
No chemo	3	3	6	50.0%

Table (8): Infection clearance according to tumor type.

Tumor type	Cleared	Failed	Total	% Cleared
Osteosarcoma	13	6	19	68.4%
MFH	3	0	3	100%
Ewing's sarcoma	0	2	2	0%
Chondrosarcoma	0	2	2	0%
RMS	0	1	1	0%
GCT	1	1	2	50%
Myeloma	1	0	1	100%
Hemangioendothelioma	1	0	1	100%

Table (9): Number of surgeries required until clearance.

Surgeries needed	Number of patients	% Cleared
0 (antibiotics only)	3	15.8%
1 surgery	4	21.0%
2 surgeries	6	31.6%
3 surgeries	4	21.0%
4 surgeries	0	0%
5 surgeries	1	5.3%
6 surgeries	1	5.3%

Table (10): Summary of the final result, follow up duration and score of cases.

Case	Final Result	F/U duration	MSTS
1	Cleared infection/on prothesis	6 years	22
2	Still infected /VFG	3 years	11
3	Cleared infection/on prothesis	1 year	26
4	Cleared infection/on spacer	16 months	19
5	Cleared infection/VFG & fusion	1 year	24
6	Cleared infection/VFG & fusion	14 months	18
7	Cleared infection/on spacer	2 years	24
8	Cleared infection/on spacer	15 months	24
9	Cleared infection/ amputation although wound of spacer clean	2 years	Amputation
10	Cleared infection/on spacer	7 years	25
11	On & off sinus/on prosthesis	7 years	26

Table (10): Count.

Case	Final Result	F/U duration	MSTS
12	On & off sinus/ pedicled fibula	5 years	24
13	Cleared infection/ amputation	1 year	Amputation
14	On & off sinus/ pedicled fibula	3+9/12 years	19
15	Cleared infection/ amputation	3 years	Amputation
16	Cleared infection/ on prothesis	6 years	23
17	On & off sinus/ on prothesis	6 years	22
18	Cleared infection/ on prothesis	13 months	25
19	Cleared infection/ on prothesis	3 years	24
20	Cleared infection/ amputation	1 year	Amputation
21	Cleared infection/ amputation	14 months	Amputation
22	Cleared infection/ on prothesis	3 years	26
23	Cleared infection/ on prothesis	2+6/12 years	26
24	Cleared infection/ on spacer	13 months	19
25	Cleared infection/ on prothesis	4 years	25
26	Cleared infection/ on prothesis	2 years	27
27	Cleared infection/ pedicled fibula	15 months	15
28	On & off sinus/ on prothesis	1 year	25
29	Cleared infection/ on prothesis	16 months	15
30	Still infected /on spacer	14 months	18
31	Cleared infection/on prothesis	2 year	Never walked

Discussion

Periprosthetic infection remains one of the most devastating complications following limb-salvage surgery with endoprosthetic reconstruction for bone tumors. Despite advances in surgical techniques, implant design, and perioperative care, infection rates remain substantially higher in oncologic reconstructions compared to primary joint arthroplasty, largely due to the extensive resections, immunosuppression from chemotherapy, and compromised soft-tissue coverage inherent to tumor surgery *[10]*.

Regarding the incidence of infection following endoprosthetic reconstruction, the study revealed that out of 216 patients, nearly 14% developed an infection. It may be due to the high complexity of these surgical procedures, the extensive soft tissue dissection required, and the immunocompromised state of patients undergoing chemotherapy. This finding is consistent with Zan et al. *[11]*, who reported infection rates approaching one fifth in large series.

According to patient demographics, the infected cohort included slightly more males than females, with a mean age of approximately 20 years. It may be due to the higher prevalence of bone tumors such as osteosarcoma in adolescent and young adult males, combined with more aggressive surgical approaches required in this group. This is in line with Sacchetti et al. *[12]*, who also found male predominance among infected cases. However, Brown et al. *[13]*, reported no significant sex difference, suggesting tumor biology and surgical site factors may be more influential than gender.

Concerning tumor histology, osteosarcoma was the most common underlying diagnosis among infected patients, followed by malignant fibrous histiocytoma, Ewing's sarcoma, and chondrosarcoma. It may be due to osteosarcoma being the most frequent primary bone tumor in young patients, often requiring aggressive resections in high-risk anatomical sites, which predisposes to infection. This observation disagrees with Morii et al. *[14]*, who noted that histology itself may not directly increase risk, but rather the site and extent of resection are the main determinants.

Regarding anatomical sites, the distal femur and proximal tibia were the most frequently affected, together representing nearly nine out of ten cases. It may be due to these sites being the most common locations for primary bone sarcomas and requiring extensive endoprosthetic reconstruction with relatively poor soft tissue coverage, particularly in the proximal tibia. This result is supported by Topkar et al. *[15]*, who also found the proximal tibia at especially high risk of infection.

According to infection timing, slightly more than half of infections were late (>3 months), while the remainder occurred early (<3 months). It may be due to early infections being related to intraoperative contamination and wound complications, whereas late infections are often associated with hematogenous seeding or chronic biofilm formation on prosthetic surfaces.

Concerning clinical presentation, the most frequent manifestations were local collections and draining sinuses. It may be due to the chronicity of prosthetic infections and the difficulty in eradicating bacteria that form biofilms on prosthetic material, leading to persistent discharge rather than acute systemic symptoms. This finding is consistent with Ji et al. [16], who emphasized sinus formation as a hallmark of chronic prosthetic infection. In contrast, Kim et al. [17], described fever and systemic illness in a larger proportion of their infected cohort, reflecting differences in host immune response and infection chronicity.

Regarding the initial treatment of infections, systemic antibiotics were initiated in many patients as part of the initial management; however, antibiotics alone successfully eradicated infection in only 3 cases (15.8%). The majority of patients required additional surgical interventions including debridement, spacer insertion, fibular grafting, staged revision, or amputation often necessitating more than one procedure. These findings emphasize that prosthetic infections rarely respond to antibiotics alone and usually require a multimodal, surgery-based approach.

However, Khakzad et al. [18], noted that amputation remains unavoidable in a notable minority of cases, highlighting the limitations of conservative surgical measures. It may be due to the difficulty in eliminating biofilm-related infections on prosthetic surfaces, necessitating repeated surgeries and sometimes limb sacrifice.

According to infection clearance and prosthesis salvage, clearance was achieved in nearly two thirds of patients, with amputation required in about one fifthand persistent infection in almost one fourth. Functional outcomes in salvage cases were satisfactory. This aligns with Ji et al. [19], who reported acceptable function after successful salvage. Conversely, Sacchetti et al. [20], found lower clearance rates, attributing worse outcomes to poor soft tissue coverage. It may be due to differences in surgical technique, antibiotic protocols, and the timing of infection presentation, which significantly influence prosthesis retention rates.

Concerning infection timing, late infections showed higher clearance rates compared to early infections. This finding is consistent with Gonzalez et al. [21], who demonstrated that late infections are more indolent and often respond better to staged interventions, whereas early infections are usually aggressive and associated with wound healing complications.

According to chemotherapy exposure, patients receiving chemotherapy showed better clearance rates than those who did not, although the difference was modest. This finding is in line with Sacchetti et al. [22], who highlighted that controlled chemotherapy regimens did not necessarily increase infection risk when perioperative protocols were optimized. It may be due to institutional infection-prevention strategies during chemotherapy, which could offset the immunosuppressive effects.

Concerning tumor histology, osteosarcoma and MFH showed the best clearance rates, while no clearance was achieved in Ewing's sarcoma, chondrosarcoma, or rhabdomyosarcoma. This disagrees with Xin and Wei [23], who found no significant histology-based difference, attributing outcomes instead to surgical site and infection severity.

According to the number of surgical procedures, most patients required multiple interventions, with two surgeries being the most common, while a minority cleared infection with antibiotics alone. This finding is consistent with Theil et al. [24], who reported that repeated surgeries were often necessary, and single-stage cures were rare. It may be due to the chronicity of prosthetic infections and the difficulty of eradicating biofilm-forming organisms, which often require staged interventions for definitive clearance.

Conclusion:

Infection remains a serious complication following endoprosthetic reconstruction after bone tumor resection, with an incidence of 14.4% in our series. The distal femur and proximal tibia were the most susceptible sites, and osteosarcoma was the predominant underlying diagnosis. While early infections could sometimes be managed conservatively, most cases required surgical intervention. Two-stage revision with re-implantation represented one of the most effective limb-salvage strategies, achieving durable infection clearance in selected patients, while amputation was required in approximately one-fifth of the cohort. Functional outcomes of salvaged limbs were satisfactory, with a mean MSTS score of 72%. Efforts to reduce infection risk such as optimized perioperative protocols and advanced implant technologies remain critical to improving long-term outcomes in oncologic endoprosthetic surgery.

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خصائص و نتائج حالات العدوى المصاحبة للتعويض الكامل بعد استئصال أورام العظام

أصبح استبدال الأطراف الصناعية بعد جراحة إنقاذ الأطراف خيارًا قياسيًا لإعادة بناء أورام الجهاز العضلي الهيكلي. ومع ذلك، لا تزال العدوى من أخطر المضاعفات، إذ تؤثر بشكل كبير على بقاء الأطراف ونتائجها الوظيفية. هدفت هذه الدراسة إلى تقييم خصائص واستراتيجيات إدارة ونتائج العدوى بعد جراحة إنقاذ الأطراف الصناعية بعد استئصال أورام العظام. هدفت هذه الدراسة إلى تقييم خصائص واستراتيجيات إدارة ونتائج العدوى بعد جراحة إعادة بناء الأطراف الصناعية بعد استئصال ورم العظام.

هدف الدراسة: تقييم معدل حدوث واستراتيجيات إدارة ونتائج العدوى بعد جراحة إعادة بناء الأطراف الصناعية بعد استئصال ورم العظام، مع التركيز على إزالة العدوى وإنقاذ الأطراف والنتائج الوظيفية.الطريقة: راجعنا بأثر رجعي ٢١٦ مريضًا خضعوا لجراحة إنقاذ الأطراف باستخدام أطراف صناعية معيارية بعد استئصال أورام العظام بين عامي ٢٠٠٣ و٢٠١٠ في معهد ناصر، وبنك العظام، ومستشفى سرطان الأطفال بالقاهرة. تم تحليل الحالات التي تفاقمت بسبب العدوى (٣١ مريضًا؛ ١٤,٤٪) بالتفصيل. تم تقييم التركيبة للمرضى، ونوع الورم، وموقع الجراحة، والعلاج المساعد، وتوقيت العدوى، وطريقة الإدارة، والنتائج الوظيفية. تم تقييم النتائج الوظيفية باستخدام مقياس جمعية أورام الجهاز العضلي الهيكلي.

النتائج: من بين ٣١ حالة مصابة (١٧ ذكرًا و١٤ أنثى؛ متوسط الأعمار ١٩,٧ عامًا)، كان الورم الأكثر شيوعًا هو ساركوما العظام (٦١,٢٪)، يليه ورم النسيج الليفي الخبيث (٩,٧٪)، ثم ساركوما يوينغ (٦,٥٪). وكانت المواقع الأكثر شيوعًا هي الجزء السفلى من عظم الفخذ (٤٥,١٪) والجزء العلوى من عظم الساق (٤٢٪). تطورت العدوى مبكرًا (أقل من ٣ أشهر) لدى ١٤ مريضًا (٤٥,٢٪)، ومتأخرًا (أكثر من ٣ أشهر) لدى ١٧ مريضًا (٥٤,٨٪). تضمن العلاج الأولى المضادات الحيوية وإزالة الأنسجة الميتة، لكن العديد من الحالات تطلبت جراحة على مراحل. حققت عملية المراجعة على مرحلتين مع إعادة الزرع السيطرة على العدوى لدى ٥ مرضى (١٦,١٪)، بينما تطلبت عملية البتر أو فصل مفصل الورك لدى ٦ مرضى (١٩,٣٪). كان العلاج التحفظى بالمضادات الحيوية وحدها ناجحًا فى أقلية من الحالات. تم القضاء على العدوى بشكل عام وإنقاذ الأطراف لدى حوالى ٦٤,٥٪ من المرضى. وبلغ متوسط درجة MSTS الوظيفية فى الأطراف المُنقذة ٧٢٪.

الخلاصة: لا تزال العدوى التي تلي إعادة بناء الأطراف باستخدام المفاصل الصناعية لأورام العظام تُمثل مضاعفات رئيسية، حيث بلغت نسبة حدوثها ١٤,٤٪ فى سلسلتنا. كانت عمليات استئصال الجزء السفلى من عظم الفخذ والجزء العلوى من عظم الساق أكثر المواقع عرضة للإصابة. وبينما قد تكفى الإجراءات التحفظية فى حالات العدوى المبكرة منخفضة الدرجة، إلا أن معظم الحالات تطلبت تدخلاً جراحياً. كانت عملية المراجعة على مرحلتين هى الاستراتيجية الأكثر فعالية لإنقاذ الأطراف، على الرغم من أن البتر ظل ضرورياً لدى ما يقرب من خُمس المرضى. تُعد استراتيجيات الحد من خطر العدوى – بما فى ذلك تحسين بروتوكولات ما حول الجراحة وتغليف المفاصل الصناعية بمواد مقاومة للعدوى – بالغة الأهمية لتحسين النتائج طويلة المدى فى جراحة الأطراف الصناعية للأورام.