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ORIGINAL ARTICLE

External and internal hemipelvectomy: A retrospective analysis of 68 cases

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External and internal hemipelvectomy are rare surgical treatment methods applied in primary malignant tumors of the pelvis, pelvic metastases, infections or severe trauma.[1,2] Bone and soft tissue tumors of the pelvis are rare and difficult to treat due to the complex anatomical structure of the region. At the time of hospital admission, the tumor size is usually large and surgical treatment is difficult due to its close relationship with neurovascular, intestinal and urogenital structures.[2] The diagnosis process starts with clinical suspicion and physical examination and, then, appropriate imaging techniques are used. After the radiological work-up, a biopsy procedure is performed to identify the histopathological diagnosis.[3]

The indication for internal or external hemipelvectomy is determined depending on the tumor size, stage, location, proximity to neurovascular structures and abdominal organs.[1,2,4] Internal

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ABSTRACT

Objectives: This study aims to investigate the factors that may be associated with surgical site infection and mortality in pelvic resection surgeries.

Patients and methods: A total of 68 patients (40 males, 28 females; mean age: 43±16.2 years; range, 11 to 70 years) who underwent internal or external hemipelvectomy between January 2010 and January 2020 were retrospectively analyzed. We reviewed data concerning histopathological diagnosis, surgical technique, pelvic resection type, tumor size, postoperative infection, duration of follow-up, and mortality.

Results: The mean follow-up was 45.5±42.2 months. Among 68 patients, 29 (42.6%) cases underwent external hemipelvectomy and 39 (57.4%) cases underwent internal hemipelvectomy. Reconstruction was performed in 14 (20.6%) patients who underwent internal hemipelvectomy. Of all patients, 61 had primary malignant pelvic tumors and two had metastatic pelvic tumors. Of the other five patients, two had a giant cell tumor, two had a pelvic hydatid cyst, and one had an aneurysmal bone cyst. The three most common pelvic tumors were chondrosarcoma (n=25, 36.7%), osteosarcoma (n=13, 19.1%), and Ewing sarcoma (n=8, 11.8%). Surgical site infections were observed in 34 (50.0%) patients. Of 34 patients, 15 (22.1%) had superficial infections and 19 (27.9%) had deep surgical infections. The superficial and deep infection rates were higher in the external hemipelvectomy group compared to internal hemipelvectomy (p=0.02). Patients with postoperative infection had a mean survival period of 36.0 months compared to 79.8 months in patients without infection (p=0.037). The patients treated with internal hemipelvectomy had a mean survival of 97.0 months compared to 25.7 months in patients treated with external hemipelvectomy (p<0.0001). The effect of Enneking stages of malignant pelvic tumors on survival was investigated using the Kaplan-Meier analysis. Cumulative survival decreased, as the stage progressed (p<0.0001).

Conclusion: The type of surgical technique affects the possibility of postoperative infection. Postoperative infection, surgical method, and stage of the tumor are associated with survival.

Keywords: External hemipelvectomy, hemipelvectomy, internal hemipelvectomy, mortality, pelvic tumors, postoperative infection.

hemipelvectomy is complete or partial resection of bone and soft tissues in the unilateral pelvis with preservation of the lower extremity.[4] Internal hemipelvectomy may be preferred in cases which the tumor can be removed with wide margins without sacrificing neurovascular structures. In cases of internal hemipelvectomy, reconstruction procedures can be performed depending on the type of pelvic resection and the general condition of the patient. Modular hemipelvic endoprosthesis, vascularized or non-vascularized fibular autografts and recycled autografts are the most preferred reconstruction methods.[1] External hemipelvectomy is a surgical technique in which the unilateral lower extremity is resected together with the unilateral pelvis. External hemipelvectomy is performed in cases which the tumor invades the neurovascular structures feeding the lower extremity and a clear surgical margin cannot be obtained without sacrificing the neurovascular structures.[4] In recent years, the number of patients undergoing limb-sparing surgery (internal hemipelvectomy) has been increasing due to developments in diagnostic methods, surgical techniques, radiotherapy and chemotherapy.[5]

The main goal of surgery is to provide local tumor control while preserving the patient's quality of life as much as possible.[4,5] Infection, delayed wound healing, soft tissue defect, neurological damage, visceral and vascular injury are the main complications that can be seen frequently.[2,4-12] Surgical site infection and wound problems are the most common complications after pelvic resection. After most pelvic resection procedures, multiple surgical debridements may be required due to surgical site infection.[2]

In the present study, we aimed to investigate whether postoperative infection would be associated with surgical technique, type of pelvic resection, tumor size, and pelvic reconstruction. In addition, we aimed to analyze the effect of postoperative infection, surgical technique, histopathological diagnosis and stage on mortality.

PATIENTS AND METHODS

This single-center, retrospective, observational study was conducted at Ankara University Faculty of Medicine Orthopedic Oncology Center, Department of Orthopedics and Traumatology between January 2010 and January 2020. The records of a total of 68 patients (40 males, 28 females; mean age: 43±16.2 years; range, 11 to 70 years) who underwent internal or external hemipelvectomy and were followed for minimum two years or until death were analyzed. All patients who underwent pelvic resection at our institution, regardless of etiology, were included in the study. We excluded patients with a follow-up period of less than two years. We collected data regarding histopathological diagnosis, type of the surgical technique, postoperative infection, duration of follow-up, and mortality. A written informed consent was obtained from each patient. The study protocol was approved by the Ankara University Faculty of Medicine Institutional Review Board (Decree No: I5-302-21). The study was conducted in accordance with the principles of the Declaration of Helsinki. A detailed medical history, physical examination, routine blood tests, conventional X-rays, computed tomography (CT), and magnetic resonance imaging (MRI) were mandatory for appropriate preoperative evaluation. Chest CT, whole-body bone scintigraphy or positron emission tomography (PET)/CT were also required. All patients underwent biopsy preoperatively for definitive histopathological diagnosis. We staged tumors using the system of the Musculoskeletal Tumor Society (Enneking Staging System), which classifies lesions by grade and local anatomic extent.

The patients were discussed in the Multidisciplinary Tumor Board which includes surgical oncologists, medical oncologists, radiation oncologists, radiologists and pathologists. Clinical treatment plans were determined according to Multidisciplinary Tumor Board recommendations. A total of 29 (42.6%) patients underwent external hemipelvectomy and 39 (57.4%) patients were treated with internal hemipelvectomy. Nineteen (27.9%) patients received chemotherapy. In three (7.7%) patients, radiotherapy was administered. Ten (25.6%) patients received both radiotherapy and chemotherapy.

Pelvic resection types were classified using the system of Enneking and Dunham.[11] Definitive histopathological diagnoses and mass diameters were determined by examining the postoperative pathology reports. The patients were divided into two groups according to the largest diameter size in the pathology report. A cut-off value of 10 cm was used.

The hospital records were examined and it was determined whether the patients had postoperative wound problems and surgical site infection. The criteria used to establish postoperative surgical site infection were as follows: purulent drainage from the incision site, demonstration of microorganisms in the culture of fluid or tissue from the wound, presence of at least two of the signs of infection such as localized swelling, tenderness, pain, redness and warmth.[7]

Surgical site infections were classified as superficial or deep. Infections involving the skin and subcutaneous tissue associated with the incision site were grouped as superficial infections. Those involving the fascia, muscles, or deep pelvic soft tissues were classified as deep infections.

The patients who underwent pelvic resection surgery were followed postoperatively at regular intervals of three months for the first one year, every six months for the next two years and, then, annually. Postoperative follow-up times from the date of the surgery and mortality status were obtained according to hospital records.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. Potential differences were assessed using the chi-square analysis. The Kaplan-Meier method was used to calculate the cumulative probability of survival. The effects of surgical technique, presence of postoperative infection, histopathological diagnosis and stage on survival were investigated. A p value of <0.05 was considered statistically significant.

RESULTS

Of 68 patients, 29 (42.6%) underwent external hemipelvectomy. Posterior gluteal flap was preferred in 22 of the patients who underwent external hemipelvectomy, and anterior myocutaneous flap from the thigh was used in other seven cases. Among 68 patients, 39 (57.4%) cases underwent internal hemipelvectomy. According to the Enneking and Dunham classification system of the pelvic resections, nine (23.1%) type I, two (5.1%) type II, nine (23.1%) type III, one (2.6%) type IV, two (5.1%) type I-IV, eight (20.5%) type I-II, six (15.4%) type II-III, two (5.1%) type I-II-III pelvic resections were applied. The mean follow-up was 45.5±42.2 months (Table I).

TABLE I
Patient characteristics and surgical data

	Outcomes		
Variables	n	%	Mean±SD
Sex			
Male	40	58.8	
Female	28	41.2	
Mean age at diagnosis			43.0±16.2
Mean follow up (months)			45.5±42.2
Surgical technique			
External hemipelvectomy	29	42.6	
Internal hemipelvectomy	39	57.4	
With reconstruction	14	20.6	
Without reconstruction	25	36.8	
Pelvic resection types in internal hemipelvectomies			
Type I	9	23.1	
Type II	2	5.1	
Type III	9	23.1	
Type IV	1	2.6	
Type I-IV	2	5.1	
Type I-II	8	20.5	
Type II-III	6	15.4	
Type I-II-III	2	5.1	
Treatments other than surgery			
Chemotherapy	19	27.9	
Radiotherapy	3	7.7	
Radiotherapy + chemotherapy	10	25.6	

SD: Standard deviation.

Reconstruction was not performed in 25 of 39 patients who underwent internal hemipelvectomy. In 14 (20.6%) patients, reconstruction procedures were performed. Among these patients, seven cases were reconstructed with modular hemipelvic endoprosthesis. Non-vascularized fibular autograft was used in three patients. Biological reconstruction using liquid nitrogen-treated autograft was preferred in three patients. Autografts were fixed with screws and plates. Sacral instrumentation with pedicle screws was performed in two patients (Figure 1).

Of 68 patients, 61 had primary malignant pelvic tumors and two had malignant pelvic metastases. Other five patients underwent internal/external hemipelvectomy for non-malignant reasons. Of these five patients, two had a giant cell tumor, two had a pelvic hydatid cyst, and one had an aneurysmal bone cyst. According to the histopathological diagnosis, the three most common pelvic tumors were chondrosarcoma (n=25, 36.7%), osteosarcoma (n=13, 19.1%) and Ewing sarcoma (n=8, 11.8%). Other histopathological types and Enneking stages are described in Table II.

Surgical site infections were observed in 34 (50.0%) patients. Of 34 patients, 15 (22.1%) had superficial infections and 19 (27.9%) had deep surgical infections. Vacuum-assisted closure (VAC) therapy was used in 17 (25.0%) patients. Thirty (44.1%) patients were reoperated due to infection and debridement was performed. In one patient, we had to convert internal to external hemipelvectomy due to non-manageable surgical site infection (Table III). Intravenous antibiotic prophylaxis containing cefazolin (infusion of 1,000 mg during an 8-h period three times daily) was administered to all patients for two days postoperatively. If colon resection was performed during surgery, gentamicin and metronidazole were also added to antibiotic prophylaxis. Cultures were obtained from patients who showed signs of postoperative surgical site infection. According to the culture results, antibiotic regimens were expanded by consulting the infectious diseases department.

Superficial infection occurred in eight (27.6%) patients and deep infection occurred in 12 (41.4%) patients who underwent external hemipelvectomy.

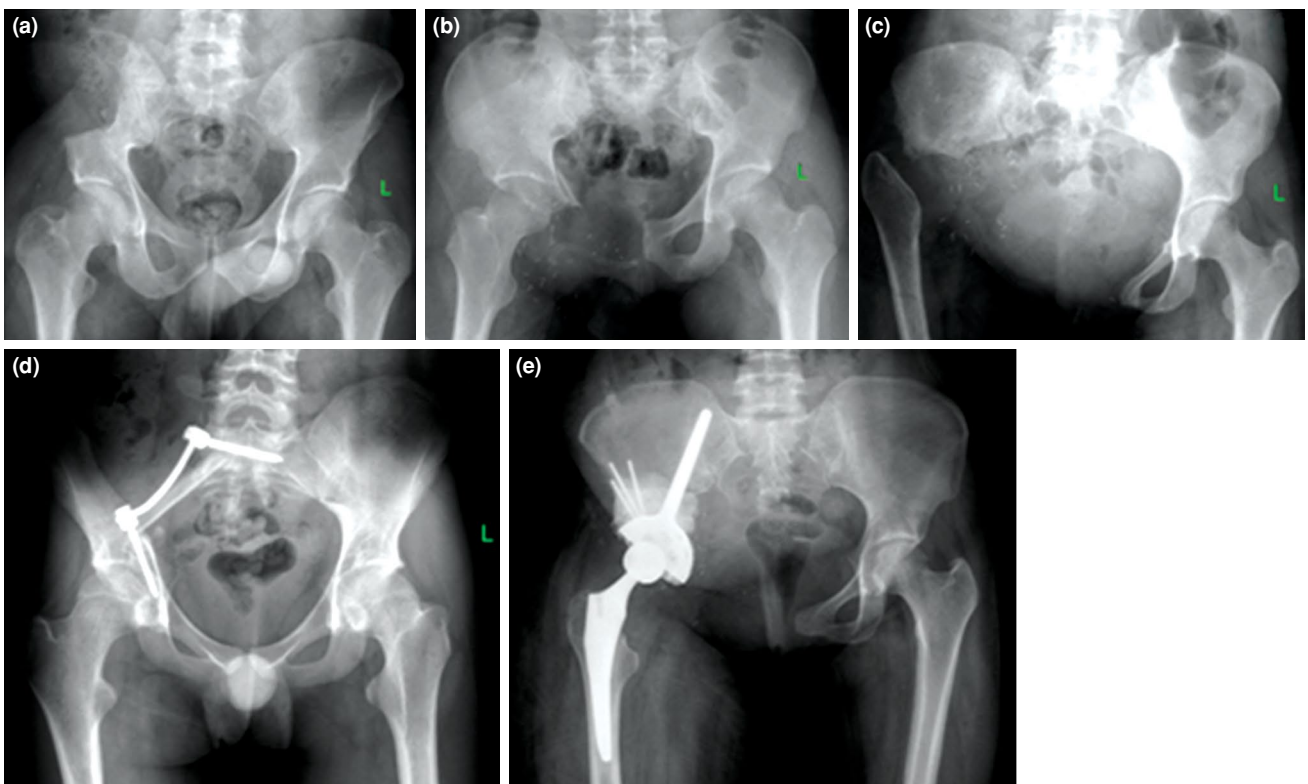

FIGURE 1. Postoperative X-rays. **(a)** Type I resection without reconstruction. **(b)** Type III resection without reconstruction. **(c)** Type II-III resection without reconstruction. **(d)** Type I resection reconstructed with non-vascularized fibular autograft and pedicle screws. **(e)** Type II-III resection reconstructed with modular hemipelvic endoprosthesis

TABLE II
Histopathological type and frequency of primary (non-metastatic[a]) malignant pelvic tumors in 61 patients, by Enneking Stage[b]; January, 2010 to January, 2020

Malignant pelvic tumors Histopathological types	Enneking stage IA	IB	IIA	IIB	III	Totals
Chondrosarcoma	3	12	4	6	-	25
Osteosarcoma	-	-	2	9	2	13
Ewing sarcoma	-	-	2	5	1	8
Malignant mesenchymal tumor	-	-	-	4	1	5
Squamous cell carcinoma	-	-	-	1	3	4
Pleomorphic sarcoma	-	-	-	1	1	2
Liposarcoma	-	-	-	2	-	2
Fibrosarcoma	-	-	-	1	-	1
Lymphangiosarcoma	-	-	-	1	-	1
Totals	3	12	8	30	8	61

[a] Of 68 total patients, 61 had primary malignant pelvic tumors, and 2 had malignant pelvic tumors that were metastases from other primary sites. Other 5 patients underwent internal/external hemipelvectomy for nonmalignant reasons. Of these 5 patients; 2 had giant cell tumor, 2 had pelvic hydatid cyst and 1 had aneurysmal bone cyst.
[b] Enneking Staging System stratifies both bone and soft-tissue tumors by grade, local anatomic extent, and absence/presence of metastases.

In patients who underwent internal hemipelvectomy, seven (17.9%) had superficial infection and seven (17.9%) had deep infection. The superficial and deep infection rates were higher in the external hemipelvectomy group (p=0.02) (Table III).

We examined the effect of reconstruction after internal hemipelvectomy on postoperative infection rates. A total of 21.4% of the patients (3/14) treated with reconstruction had superficial infections developed, compared to 16.0% (4/25) of the patients without reconstruction. A total of 21.4% of the patients (3/14) treated with reconstruction had deep infections, compared to 16.0% (4/25) of the patients without reconstruction. When the patients who underwent internal hemipelvectomy were evaluated, superficial and deep infections were more common in patients with reconstruction than in patients without reconstruction. However, this difference was not statistically significant (Table IV).

The effect of tumor size on postoperative infection rates in patients who underwent internal hemipelvectomy was investigated. The patients were divided into two groups according to the largest diameter size in the pathology report. Using a cut-off value of 10 cm, superficial or deep infection rate was 37.9% (11/29) for the "≥10 cm diameter group" and 30.0% (3/10) for "<10 cm diameter group". This difference was not statistically significant (Table IV).

The effect of pelvic resection type on postoperative infection rates in patients who underwent internal hemipelvectomy was evaluated. Type I and type III

TABLE III
Surgical procedure types and postoperative infection status of pelvic resection surgeries, at mean follow-up 45.5 (±42.2) months; January, 2010 to January, 2020

	Infection							
	Superficial		Deep		Without infection			
Surgical procedures	n	%	n	%	n	%	Total	*p*[a]
External hemipelvectomy	8	27.6	12	41.4	9	31.0	29	
Internal hemipelvectomy	7	17.9	7	17.9	25	64.1	39	0.02
Totals	15	22.1	19	27.9	34	50.0	68	

[a] The Chi Square test was used to assess the potential differences between the external and internal hemipelvectomy surgeries. Differences were considered statistically significant for p value<0.05.

TABLE IV
Postoperative infection status of the 39 patients treated with internal hemipelvectomy surgery at mean follow-up 45.5 (±42.2) months; January, 2010 to January, 2020

	Infection							
	Superficial		Deep		Without infection			
	n	%	n	%	n	%	Total	p^a
Reconstruction status								
Internal hemipelvectomy with reconstruction	3	21.4	3	21.4	8	57.1	14	0.53
Internal hemipelvectomy without reconstruction	4	16.0	4	16.0	17	68.0	25	
Tumor size[b]								
>10 cm	6	20.7	5	17.2	18	62.1	29	0.52
<10 cm	1	10.0	2	20.0	7	70.0	10	

[a] The Chi Square test was used to assess the potential differences according to reconstruction status and tumor size. Differences were considered statistically non-significant for p value>0.05
[b] The patients were divided into two groups according to the biggest diameter size in the pathology report. "10 cm" was determined as a cut-off value.

resections in which the acetabulum was preserved were mechanically more stable and mobilized earlier. Therefore, type I and type III resections were considered as one group and all other resections as the other group. Superficial or deep infection rate was 16.7% (3/18) for the "type I or type III resection group" and 52.4% (11/21) for the other group. This difference was statistically significant (p=0.02) (Table V).

According to Kaplan-Meier analysis, the estimated mean overall survival time was 70.2 months (standard error [SE]: 7.382; 95% confidence interval [CI]: 55.743-84.680). The majority of chondrosarcomas in our case series were low grade (15/25, 60.0%). We excluded patients with benign pelvic tumors (n=5) and low-grade chondrosarcomas (n=15). Survival analysis was reperformed in 48 patients, excluding 20 out of the 68 patients. We revealed that patients treated with internal hemipelvectomy had an estimated mean survival of 97.0 months (SE: 11.023; 95% CI: 75.408-118.619) after operation compared to 25.7 months (SE: 9.048; 95% CI: 7.931-43.399) in patients treated with external hemipelvectomy. The type of hemipelvectomy (internal or external) had a statistically significant influence on the cumulative survival (p<0.0001) (Figure 2). The effect of postoperative infection on survival was evaluated using the Kaplan-Meier analysis. We found that patients with postoperative infection (superficial or deep) had an estimated mean survival of 36.0 months (SE: 8.441; 95% CI: 19.497-52.587) after operation, compared to 79.8 months (SE: 12.407; 95% CI: 55.463-104.097) in patients without postoperative infection. The postoperative infection status had a

TABLE V
Postoperative infection status of the 39 patients treated with internal hemipelvectomy surgery according to pelvic resection typesb at mean follow-up 45.5 (±42.2) months; January, 2010 to January, 2020

	Infection					
Internal hemipelvectomy	Superficial or deep infection		Without infection			
Pelvic resection type	n	%	n	%	Total	p^a
Type I or Type III	3	16.7	15	83.3	18	0.02
Type II or Type I+II or Type II+III or Type I+II+III or Type I+IV	11	52.4	10	47.6	21	

[a] The chi-square test was used to assess the potential differences according to reconstruction status and tumor size. Differences were considered statistically non-significant for *p* value >0.05.
[b] The patients were divided into two groups according to pelvic resection types. Type I and Type III resections were determined as a single group, considering that they were more mechanically stable. All other resection types formed the other group.

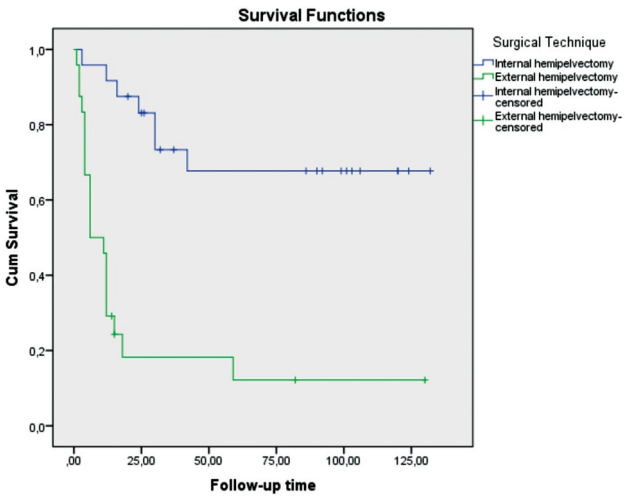

FIGURE 2. Cumulative survival of patients treated with the external hemipelvectomy (n=24[a]) compared to patients treated with the internal hemipelvectomy (n=24[a]). The statistical analysis shows a p value of 0.0001.

[a] Benign tumors (n=5) and low-grade chondrosarcomas (n=15) were not included in the survival analysis. Survival analysis was performed with 48 patients, excluding 20 of 68 patients.

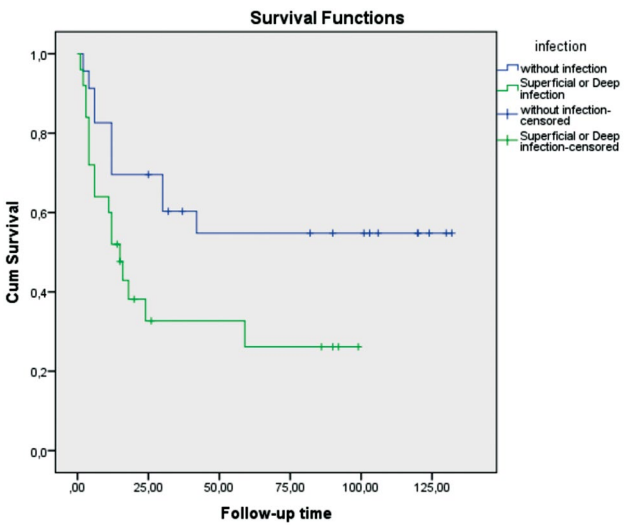

FIGURE 3. Cumulative survival of patients with postoperative infection (superficial or deep) (n=25[a]) compared to patients without postoperative infection (n=23[a]). The statistical analysis shows a p value of 0.037.

[a] Benign tumors (n=5) and low-grade chondrosarcomas (n=15) were not included in the survival analysis. Survival analysis was performed with 48 patients, excluding 20 of the 68 patients.

statistically significant effect on the cumulative survival (p=0.037) (Figure 3).

The effect of Enneking stages of malignant pelvic tumors on survival was investigated using the Kaplan-Meier analysis. Cumulative survival decreased as the stage progressed (Figure 4). According to

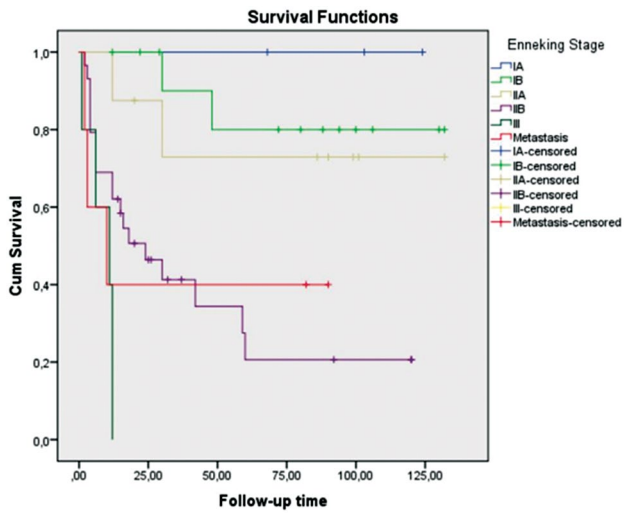

FIGURE 4. Cumulative survival of patients treated with the external/internal hemipelvectomy according to Enneking Stage system. The statistical analysis shows a *p* value of 0.0001.

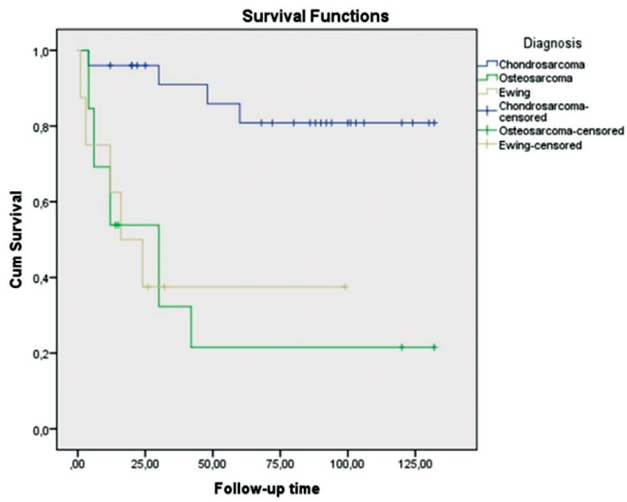

FIGURE 5. Cumulative survival of patients treated with the external/internal hemipelvectomy according to three most common histopathologic diagnosis (Chondrosarcoma: 25, Osteosarcoma: 13, Ewing sarcoma: 8). The statistical analysis shows a *p* value of 0.0001.

log-rank, Breslow and Tarone-Ware analysis, there was a statistically significant relationship between the stage and the survival (p<0.0001).

The effect of histopathological diagnosis of malignant pelvic tumors on survival was investigated using the Kaplan-Meier analysis. The survival values of the three most common pelvic tumor types (chondrosarcoma, osteosarcoma and Ewing sarcoma) were compared. Accordingly, the patients with a

chondrosarcoma had an estimated mean survival of 113.8 months (SE: 8.305; 95% CI: 97.566-130.122). Patients with osteosarcoma had an estimated mean survival of 42.8 months (SE: 14.768; 95% CI: 13.852-71.747). Patients with an Ewing sarcoma had an estimated mean survival of 44.1 months (SE: 15.213; 95% CI: 14.306-73.943). The estimated survival values of patients with a diagnosis of chondrosarcoma were better than the others ($p<0.0001$) (Figure 5). This may be related to the low grade of most of the chondrosarcomas in the study (15/25, 60.0%).

DISCUSSION

Internal hemipelvectomy is considered in cases which the tumor can be removed with wide margins without sacrificing neurovascular structures. External hemipelvectomy is preferred, if resection cannot be performed within clear margins or if a functionless limb would remain.[1,4,5] The number of the patients undergoing limb-sparing surgery is increasing, as a result of the advances in surgical techniques, radiotherapy and chemotherapy.[5] In our case series, 57.4% of the patients (n=39) underwent internal hemipelvectomy, while 42.6% of the patients (n=29) underwent external hemipelvectomy. In the case series of Guder et al.,[4] internal hemipelvectomy was preferred in 13 of 34 (38.2%) patients and external hemipelvectomy was preferred in 21 (61.8%) patients. Couto et al.[13] reported that they performed internal hemipelvectomy in 34.3% of the patients (n=12) and external hemipelvectomy in 65.7% of the patients (n=23). Freitas et al.[5] reported that they performed internal hemipelvectomy in 24 (75.0%) patients and external hemipelvectomy in eight (25.0%) patients.

There is no consensus in the literature regarding the necessity of reconstruction after internal hemipelvectomy.[1,5] Some surgeons advocate reconstruction procedures for restoring pelvic stability and a better functional outcome.[1,6] On the other hand, some surgeons claim that reconstruction after hemipelvectomy has high complication rates and prolongs the operation time. These authors propose that satisfactory functional results can be obtained from patients without reconstruction.[1,8] The need for reconstruction should be evaluated individually for each patient. Pelvic resection type should be considered while making the reconstruction decision.[1] Type I and type III pelvic resections usually do not require reconstruction, because they are mechanically stable.[1,2,4,8] Their functional outcomes are satisfactory. These patients usually regain independent ambulation. Reconstruction is generally preferred in type II and combined resections in which periacetabular resection is applied.[1,2,4,8] In our case series, reconstruction was performed in 14 of 39 (35.9%) patients who underwent internal hemipelvectomy. Eleven of 14 (78.6%) patients who underwent reconstruction had periacetabular pelvic resection (type II or combined). Three (21.4%) patients underwent reconstruction after type I or type III resection.

Postoperative complications are common in hemipelvectomy surgeries. In the literature, the rate of postoperative complications ranges from 20 to 62%.[1,9,10,12,14,15-18] Surgical site infections and wound problems are the most common complications for hemipelvectomies.[1,2,16] Guder et al.[4] reported that wound infection occurred in 61.7% of cases (21/34). In the case series of Senchenkov et al.,[12] 39% of the patients (62/160) had surgical site infection. Benatto et al.[14] reported that infection rate was 36% (11/31) in their case series. In our case series, surgical site infections were observed in 34 (50.0%) patients. Of 34 patients, 15 (22.1%) had superficial infections and 19 (27.9%) had deep surgical infections. In our series, superficial and deep infections were rarer in internal hemipelvectomies, compared to external hemipelvectomies. While 17.9% superficial and 17.9% deep infection were observed in internal hemipelvectomies, these rates were 27.6% and 41.4%, respectively, in external hemipelvectomies.

There are studies in the literature stating that reconstruction increases the infection rate. Angelini et al.[2] reported that wound infection was more common in patients who underwent pelvic reconstruction after resection. In their case series consisting of 270 internal hemipelvectomies, there were 20 infections in 133 patients without reconstruction (15%) and 35 infections in 137 patients with reconstruction (26%). In our case series, wound infection was more common in patients with reconstruction. While the rate of deep infection was 21.4% in patients with reconstruction, it was 16.0% in patients without reconstruction. However, this difference was not statistically significant. The low number of cases may have caused this situation. It was seen that type I and type III resections in which the acetabulum was preserved had lower infection rates. Mechanical stability and early movement may have reduced infection rates.

The pelvis contains many lymph nodes and lymph vessels. Lymphatic vessels are frequently damaged and disrupted in pelvic resection surgeries, and if not detected intraoperatively, it can cause postoperative lymph leakage.[21] The collection of lymphatic fluid can lead to postoperative wound discharge and

infection. Type II and type III resections are more likely to damage lymphatics due to their anatomical proximity to the lymphatic vessels. Type I resections are safer, as they are far from the lymphatics. This may explain the lesser rate of infection in type I resections in our study.

There are cases in the literature about conversion from internal to external hemipelvectomy due to infection. Angelini et al.[2] reported that external hemipelvectomy as a final treatment was necessary in four of 270 patients (1.5%) as a result of infection. In case series consisting of 20 patients reconstructed with prosthesis, Ozaki et al.[19,20] reported that three patients underwent implant removal and one patient underwent external hemipelvectomy. In our case series, one patient underwent external hemipelvectomy after internal hemipelvectomy due to persistent infection.

Urogenital injuries are not rare in hemipelvectomy surgeries. Senchenkov et al.[12] reported that 1.8% of the patients (3/160) had urogenital injuries. In our case series, urogenital injuries were observed in two (2.9%) patients. One of the two patients, capsular injury occurred in prostate capsule and intraoperative repair was performed by the urology team. The other patient was admitted to the hospital with wound discharge at the postoperative third month. It was learned that the discharge started immediately after the prophylactically placed double J catheter was removed. Multiple debridements and VAC treatment were applied. The liquid accumulated in the VAC collection cup was clear and similar to urine. The urea and creatinine values in the sample sent from the liquid were compatible with the urine. The patient was consulted to the urology department and a double J catheter was inserted again. After the catheter application, the wound problem was resolved, since the urine leakage was prevented. It should be kept in mind that late noticed urinary injury may present with the complaint of discharge at the wound site.

Senchenkov et al.[12] found that increased surgical time was associated with the increased rates of wound infection. In our retrospective study, we could not obtain data about operative time in some of the patient files. Therefore, we could not investigate the relationship between operative time and infection. Since our study was in a retrospective design, we could not perform the functional scoring of some of the patients.

This study is also limited by its retrospective design. The lack of the functional scores and operative times are the other limitations of the study. However, this study is among the largest series on hemipelvectomy surgeries in a single institute.

In conclusion, external and internal hemipelvectomy are rare surgical treatment methods that are often applied for pelvic tumors. Due to the complex anatomical structure of the pelvis, pelvic resections are difficult surgeries that require clinical experience. It is necessary to make a detailed surgical plan preoperatively. Before planning surgery, radiological and histopathological evaluation should be completed. Patients should be consulted to general surgery and urology preoperatively. Complication rates are high in pelvic resection surgeries, and the most common complication is superficial or deep surgical site infection. Surgical site infection reduces survival and increases morbidity. Superficial or deep surgical site infection rates are lower in the internal hemipelvectomy, compared to external hemipelvectomy. Although there is no statistically significant difference, reconstruction procedures increase the rate of infection in internal hemipelvectomies. Histopathological diagnosis is associated with survival. Estimated survival decreases, as the stage of the tumor progresses.

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