Full length article

Surgical management of pelvic bone sarcoma with internal hemipelvectomy: Oncologic and Functional outcomes

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ARTICLE INFO

Article history:

Received 17 September 2016

Received in revised form 10 April 2017

Accepted 27 April 2017

Available online 6 May 2017

Keywords:

Bone sarcoma

Pelvis

Internal hemipelvectomy

Limb salvage

Outcomes

ABSTRACT

Introduction: The management of pelvic sarcoma is challenging and goals of surgery are adequate oncologic local control, maintenance of optimum function with good quality of life.

Methods: We have evaluated the results of internal hemipelvectomy including age, type of resection, reconstruction, radiotherapy or chemotherapy. From 2010 to 2016, 23 patients with pelvic bone tumors (13 with Ewing's sarcoma, 9 with Osteosarcoma, 1 with chondrosarcoma) were treated by surgical resection.

Results: The mean follow-up was 18 months (0.5–5) years. In 12 patients reconstruction was performed and 11 were without reconstruction. A total of 3 patients (13%) had an infection develop at a mean follow up of 1 month. Surgical debridement's and antibiotics in three patients led to complete recovery. One patient had sciatic nerve injury. One patient had injury to femoral vein; was treated with femoral vein reconstruction. Two patients (9%) developed a local recurrence and were treated with best supportive treatment. Distal pulmonary metastases were seen in four patients and treated with supportive treatment. Five-year disease-specific survival rates of all patients were 83%. The mean functional MSTs score was 18(14–24).

Conclusions: Proper selection of patients, preoperative planning and wide surgical margins with reconstruction provides good functional outcomes following internal hemipelvectomy. The surgical site infection and flap necrosis tend to be minor complication and can be managed leading to optimal outcomes and justifies the need for this complex surgery. The oncological and functional outcome after internal hemipelvectomy suggests that it's an effective method for treatment of patients with pelvic sarcomas.

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1. Introduction

Malignant tumors of pelvis include osteosarcoma, Ewing's sarcoma and chondrosarcoma¹. The management of pelvic sarcoma is challenging and goals of surgery are adequate oncologic local control, maintenance of optimum function with good quality of life. The overall results of the patients are governed by multiple factors including the extent of tumor, resection type and reconstruction method and response to chemotherapy. The limb salvage surgery for pelvic sarcoma performed with internal

hemipelvectomy. There are four types of pelvic resections i.e. Iliac (type I), Periacetabular (type II), Pubic bone (type III), Sacrum (type IV) and combined resections^{1–3}.

Due to uncommon location and delay in diagnoses pelvic tumors are often large in size and proximity to major neurovascular structures, bowel and bladder poses a herculean task to oncosurgeons.² Recent advances in diagnoses, chemotherapy regimens, and multidisciplinary approach have led to limb salvage in these complex tumors around pelvis region.^{1–4} Resection of pelvic sarcomas involves removal of affected bone, adjoining muscles and leads to instability and loss of pelvic ring architecture.^{1,2,5–7} Following the resection of pelvic sarcomas reconstruction method plays important role to prevent functional impairment.^{5–8} Polypropylene mesh graft can be used for soft-

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tissue reconstruction in internal hemipelvectomy.⁷ Biological reconstruction after internal hemipelvectomy provides good functional outcomes.^{5,8} Endoprosthetic replacement and hip transposition are alternative methods for reconstruction following hemipelvectomy surgery. The overall infection rate described in literature after internal hemipelvectomy is from 10% to 50%.^{1–5,10,11} Other complications can include local recurrence, hematoma, delayed healing skin problems and nerve injuries, bowel and bladder injuries.^{1–5,8}

The objective of this study was to evaluate the oncological and functional outcome after Internal hemipelvectomy surgery.

2. Methods

The study included 23 patients with a malignant pelvic bone tumor surgically treated between 2010 and 2016. 23 patients with pelvic bone tumors (13 with Ewing's sarcoma, 9 with Osteosarcoma, 1 with chondrosarcoma) were treated by surgical resection. We have evaluated the results of internal hemipelvectomy including demographic data, type of resection, reconstruction, radiotherapy or chemotherapy. The medical records, imaging, oncologic and functional status were reviewed for these patients.

The diagnoses was established with radiograph imaging, magnetic resonance imaging followed by needle biopsy under image guidance or computed tomography. Histopathological diagnosis was established by trained musculoskeletal pathologist. Staging investigation included bone scan and computed tomography of chest. Patients with Ewing's sarcoma and osteosarcoma were administered neoadjuvant chemotherapy as per hospital protocol.

The surgical planning for internal hemipelvectomy was performed with plain radiograph of pelvis, magnetic resonance imaging and 3 D computed tomography. Trained radiologist opinion was obtained preoperatively for defining the bony cuts with safe oncologic margins. The patient and relatives were properly counseled about treatment plan and a written informed consent about surgery was obtained.

The surgical planning consisted of oral plegic for bowel preparation and low molecular heparin 0.6 units on preoperative evening. Whole blood and blood products were preserved in blood bank as per the patient's hemoglobin levels. The patient was administered general anesthesia followed by epidural spinal anesthesia for hemipelvectomy surgery. The Enneking classification was used and is having four types of pelvic resections i.e. Iliac (type I), Periacetabular (type II), Pubic bone (type III), Sacrum (type IV) and combined resections.^{1–3} Combinations of these resections were also performed. The incision was made according to the type of intended pelvic resection. The previous biopsy scar was eclipsed out from the incision. The major neurovascular vessels, femoral and sciatic nerves were preserved and mobilized from the tumor. Osteotomies were made through the pelvic bone using gigly saw and osteotome. Frozen section study was done for evaluating the status of bony and soft tissue margin. The reconstruction method used was polypropylene mesh in selected cases as per the instability of hip joint. The mesh was used as an anchoring structure from greater trochanter to remaining pelvic bone. The joint capsule was reconstructed use of a polyethylene mesh to form a tube like structure and was fixed to the pelvis with transosseous sutures and formed a pouch for the femoral greater trochanter. All remaining muscles were sutured along with mesh by prolene no. 0. The incision was closed after achieving proper homeostasis with two drains. Postoperative ankle pump and static quadriceps exercises were started from next post operative day. The resected tumor specimens were examined for surgical margins (free of tumor or involved of tumor) and histological response to chemotherapy. The patients were on regular follow-up every 1

month for the first 3 months, 3 monthly for 1 year and 6 months for next 3 years. The patients were assessed clinically for local recurrence and plain radiograph bone scan and computed tomography of chest was performed. Musculoskeletal Tumor Society (MSTS) scoring system was used to assess the functional status of the patients. Kaplan-Meier method was used to assess the oncologic outcomes and survival rate outcomes. The physiotherapy protocol included Type 1 hemipelvectomy: Non weight bearing walking for 2 weeks followed by partial weight bearing for 6 weeks and full weight bearing 8 weeks after surgery. Type 2: Non weight bearing walking for 4 weeks followed by partial weight bearing for 12 weeks and full weight bearing 16 weeks after surgery. Type 1+2: Non weight bearing walking for 4 weeks followed by partial weight bearing for 12 weeks and full weight bearing 16 weeks after surgery. Type 2+3: Non weight bearing walking for 4 weeks followed by partial weight bearing for 12 weeks and full weight bearing 16 weeks after surgery. Type 3+2: Non weight bearing walking for 4 weeks followed by partial weight bearing for 12 weeks and full weight bearing 16 weeks after surgery. Type 3: Non weight bearing walking for 2 weeks followed by partial weight bearing for 6 weeks and full weight bearing 8 weeks after surgery.

The mean follow-up was 18 months (0.5–5) years. In 12 patients reconstruction was performed and 11 were without reconstruction. A total of 3 patients (13%) had an infection develop at a mean follow up of 1 month. Surgical debridement's and antibiotics in three patients led to complete recovery. One patient had sciatic nerve injury and one patient had injury to femoral nerve; was treated with femoral vein reconstruction. Two patients (9%) developed a local recurrence and were treated with best supportive treatment. Distal pulmonary metastases were seen in four patients and treated with best supportive treatment. Two- and five-year disease-specific survival rates of all patients were 80.1% and 60%, respectively. The mean functional MSTS score was 18 (16–22).

3. Results

There were 9 female and 14 male patients with an average age of 25 years (range 11–40 years). The mean follow-up was 18 months (range, 0.5–5 years). Type 1 resection was done in 7, Type 2 was done in 2, Type 1+2 resection was done in 4, Type 2+3 resection in 1, Type 3+2 resection in 4, Type 3 resection in 5 (Figs. 1–3). After resection, various methods of reconstruction were adopted [Table 1]. In 12 patients reconstruction was performed; in 11 were without reconstruction. Screw fixation was performed in 5 patients to achieve stability around the pelvis. Prolene mesh was

Fig. 1. Preoperative radiograph of osteosarcoma pelvis with iliac bone involvement (Arrow towards tumor).

Fig. 2. Computed tomography of osteosarcoma pelvis (Arrow towards tumor).

Fig. 3. Postoperative radiograph showing type 1 internal hemipelvectomy.

used to pseudoarthrosis in 7 patients. Pseudoarthrosis was performed a hip transposition, stabilizing the femoral head to the sacrum, residual ilium or ischium using a prolene meshes to create a pseudocapsule.

The mean surgical time was 6.5 h (range, 5–8 h) and mean blood loss was 3000 ml (range, 2500–4200 mL). The oncologic margin was achieved free of tumor in 21 cases and marrow was positive in two cases where a revised bone cut was taken and final surgical margin was free of tumor.

A total of 3 patients (13%) had an infection develop at a mean follow up of 1 months. Surgical debridement's and antibiotics in three patients led to complete recovery. Two patients had wound necrosis and required subsequent debridement and one patient required split thickness skin grafting (Fig. 4). One patient had sciatic nerve injury. One patient had injury to femoral vein; was treated with femoral vein reconstruction. One patient had foot drop due to injury to lumbar nerve root (L5). One male patient had sexual dysfunction. Femoral vein was injured during tumor dissection and saphenous vein graft was used for reconstruction and patient was having limb edema over one year duration.

Two patients (9%) developed a local recurrence. Pulmonary metastases were observed in four patients and these two patients had local recurrence and other two had multiple pulmonary metastases and were treated with best supportive treatment. The

oncologic outcomes are; 19 patients are currently alive and free of tumor free and 4 patients died of disease. The five-year disease-specific survival rates of all patients were 83%. The mean functional MSTS score was 18 (14–26).

4. Discussion

Primary malignant bone tumors involving the pelvis account for 10–15% of all primary malignant bone tumors.^{1–3} The management of primary malignant tumors in the pelvis is performed with a team approach. The multidisciplinary team of orthopedic oncosurgeon, oncosurgeon, medical oncologist, radiologist, pathologist and radiation oncologist are actively involved for care giving. Limb-salvage surgery and combined with chemotherapy and/or radiotherapy provides a proper oncologic outcome and survival with good functional outcomes in pelvic sarcomas. Functional and oncologic outcomes pelvic sarcoma patients are poor as compared to the extremity sarcoma patients.^{1–3,11,13}

The diagnosis of pelvic sarcomas is based on clinical examination, plain radiograph, MRI, CT scan followed by biopsy. These patients require staging investigation i.e. bone scan, CT thorax followed by chemotherapy in osteosarcoma and Ewing's sarcoma. The surgical planning is done with plain radiograph, MRI and 3 D reconstruction of pelvis so that proper bone cuts can be performed to achieve wide surgical margin. The aim of the surgical management with internal hemipelvectomy is to achieve wide surgical margin. The incision used for surgery is based on type of hemipelvectomy. Utilitarian incision is used for adequate exploration and resection

of the majority of pelvic tumors.¹⁴ The incision begins at the posterior inferior iliac spine

and extends along the iliac crest to the anterior superior iliac spine and it is separated into two arms.¹⁴ First arm along the inguinal ligament up to the symphysis pubis and second arm curves over the anterior thigh.¹⁴

The dissection of femoral neurovascular bundle is critical step during hemipelvectomy surgery. Wide margin should be achieved and frozen section plays a role in checking the optimized margin. Blood loss is a major concern during this surgery and estimated blood loss in literature is around 3000 to 4000 ml.^{1–5,13,14} The orthopedic surgeon and anesthesiologist should be prepared to tackle this major blood loss with proper planning for blood and related products replacement during and after surgery. The average surgical time as per the published studies is 5 to 8 h. The mean estimated blood loss in current study was approximately 3000 mL and the mean surgical time was 6.5 h.

There are multiple options available for reconstruction after internal hemipelvectomy which includes use of bone grafts, screws, plates, irradiated tumor bone, prosthesis, prolene mesh.^{1–5,13} The method of reconstruction depends upon the type of resection and instability after removal of tumor and surrounding soft tissues and the surgeon's preference. The complications following use of metal implant and bone grafts include high risk of infection, implant failure and loosening.^{2–5} The reconstruction methods used in type 2 hemipelvectomy are associated with higher complications and leads to significant morbidity due to involvement of weight bearing area of hip joint. Complications may lead to removal of bone graft and implant and may also lead to external hemipelvectomy.

The results of Internal hemipelvectomy following resection without reconstruction method are showing good functional outcomes.^{4–6} In this method the remaining bone after tumor resection and surrounding muscles and joint capsule are repaired and patient is allowed non weight bearing walking and leads to healing and fibrosis. Polypropylene mesh graft for soft tissue reconstruction is used in selected cases of pelvic malignant tumors.

Table 1
Results and functional outcomes following hemipelvectomy surgery.

Patient:	
Male	14
Female	9
Age	25(11–40) years
Diagnosis:	
Ewings sarcoma	13
Osteosarcoma	9
Chondrosarcoma	1
Neoadjuvant therapy:	
Chemotherapy	22
Adjuvant therapy:	
Chemotherapy	22
Polychemotherapy plus radiotherapy	4
Type of hemipelvectomy	
Type 1	7
Type 2	2
Type 1 + 2	4
Type 2 + 3	1
Type 3 + 2	4
Type 3	5
Surgical margins:	
Wide	23
Reconstruction Method	
Screw fixation:	5
Mesh fixation:	7
Without fixation:	11
Oncological outcome:	
No evidence of disease	19
Died of disease	4
MSTS Score	18(14–24)
5 EFS(Event Free Survival)	83%

4–6 In current study reconstruction was performed in 12 and 11 patients were without reconstruction.

The complications described in published literature on hemipelvectomy includes infection,hematoma collection, skin flap necrosis,local recurrence,damage to femoral vesssel and sciatic nerve injury.^{1–5,8–13,15–21} The rate of postoperative complication varies from 20 to 60% and most common among these are infection followed by wound healing complications.^{1–6,10–14,18–21} In current study 13% patients had surgical site infection after surgery within one month period. The patients were treated with antibiotics as per culture sensitivity and required multiple debridements. Both patients required split thickness skin graft for wound coverage and healed well. These complications were not life-threatening and most required only debridement.

One patient had foot drop due to injury to lumbar nerve root (L5). Femoral vein was injured during tumor dissection and saphenous vein graft was used for reconstruction and patient was having limb edema over one year duration.

The incidences of local recurrence (15%–35%) and distant metastasis (20–40%) were in literature published on internal hemipelvectomy for management of malignant tumors of pelvis.^{1–5,15–21} The death rate following this complex surgery at two year and five year is also higher because of complex surgical anatomy and aggressive behavior of the tumor. In current study two patients (9%) developed a local recurrence and pulmonary metastases were observed in four patients and the results were comparable with the previous studies.

The functional outcomes following internal hemipelvectomy published by Puri et al. shows he mean Musculoskeletal Tumor Society functional score was 22 (range12–27).⁴ Lackman et al. has shown that the patients in this study rated their ability to participate in daily activities as 86% of normal (TESS) and MSTS scores were averaged 69% of normal.¹⁴ The functional outcomes of current study showed to be mean functional MSTS score was 18 (14–26) and were comparable with the published literature. The outcome was poor in patients with type 2 resection due to complete loss of acetabular cup as compared to other type of hemipelvectomy. The common complaint after hemipelvectomy is of limb length discrepancy and it is managed with shoe raise.

Fig. 4. Clinical image showing surgical site infection and flap necrosis and healed wound following internal hemipelvectomy.

The limitations of this study include retrospective nature of the study and heterogeneity of the tumors included in the study. Definitely these limitations can be overcome by a future prospective studies and multicentre trials of these complex surgeries.

5. Conclusions

Proper selection of patients, preoperative planning and wide surgical margins with reconstruction provides good functional outcomes following internal hemipelvectomy. The surgical site infection and flap necrosis tend to be minor complication and can be managed leading to optimal outcomes and justifies the need for this complex surgery. The oncological and functional outcome after internal hemipelvectomy suggests that it's an effective method for treatment of patients with pelvic sarcomas.

Funding

Nil.

Conflict of interest

None.

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