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ORIGINAL ARTICLE

# The extended posterior approach for resection of sacral tumours

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## Abstract

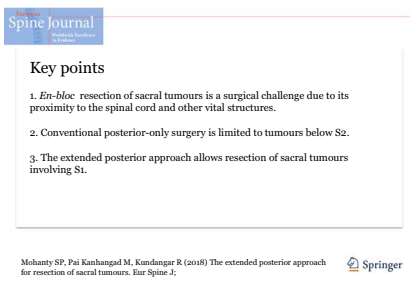
**Purpose** The conventional posterior approach is mostly advocated for excision of sacral tumours below S2. We describe an operative technique of single-stage *en bloc* resection of sacral tumours, extending up to S1, through an extended posterior approach.

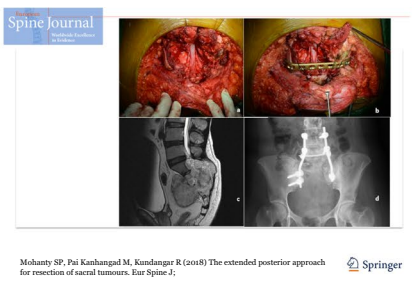
**Method** Nine patients, who had undergone resection of sacral tumours, by the described technique formed the basis of this study. Four patients had chordomas, whereas schwannoma, neurilemmoma, giant-cell tumour, malignant paraganglioma and recurrent Ewing's sarcoma were seen in one patient each. They were followed up at regular intervals with a mean follow-up of 45.4 months. Perioperative complications, their functional and oncological outcomes at final follow-up were analysed.

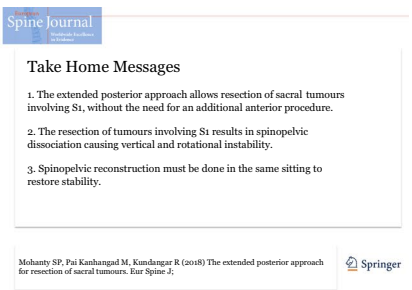
**Result** None of the patients had any perioperative complications like uncontrolled haemorrhage, injury to the rectum, deep vein thrombosis or pulmonary embolism. One patient had a superficial wound infection which subsided with regular dressing, and another patient developed a wound breakdown that required an additional flap procedure. At final follow-up, six patients were able to walk without any assistive devices, six patients had normal bladder function, and five patients had normal bowel function. Five patients did not have any recurrence at final follow-up, whereas two were alive with the disease and two had died.

**Conclusion** The reported technique allows *en bloc* resection of sacral tumours up to S1, through a posterior-only approach. It is less invasive with minimal morbidity. The functional and oncological outcomes are similar to those reported by other investigators.

**Graphical abstract** These slides can be retrieved from electronic supplementary material.




**Keywords** Sacral tumours · Surgical resection · Posterior approach

## Introduction

Primary neoplasms arising from the sacrum are relatively uncommon. They are often missed at an early stage due to their vague clinical and ill-defined radiological features. Chordomas are the most common primary malignant tumours, whereas giant-cell tumours are one of the most

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frequently seen benign lesions arising from the sacrum. By the time they are diagnosed, these locally aggressive tumours are fairly large and may have some complications [1, 2]. Computed tomographic (CT) scan and magnetic resonance imaging (MRI) have helped determine the exact location, character and extent of these tumours and are essential in the preoperative planning.

A majority of the sacral tumours are radioresistant and do not respond to chemotherapy. Thus, wide excision is the treatment of choice as intralesional resection is associated with increased local recurrence and decreased survival [3]. A properly done *en bloc* resection gives a prolonged disease-free survival. However, the vicinity of the spinal cord and surrounding structures makes these surgeries challenging. Injury to the rectum and sacral nerve roots may occur intraoperatively leading to post-operative neurological dysfunction. Different surgical approaches and techniques have been described for successful excision of these tumours. Depending upon the size and extent of the tumours, they can be resected through a single-stage posterior or anterior approach, combined anteroposterior approach, a two-stage anterior–posterior approach or a combined extended ilioinguinal and posterior approach; each of which has its advantages and limitations [1–9]. We describe the surgical technique for a single-stage *en bloc* resection of sacral tumours through a posterior approach.

## Materials and methods

In a retrospective study, nine consecutive patients with destructive lesions in the sacrum, who presented between 2010 and 2014, were analysed. All patients underwent preoperative anteroposterior and lateral radiographs of the lumbosacral spine including both sacroiliac joints and posteroanterior chest radiographs. CT scan and MRI of the whole spine were done to determine the exact location and extent of the tumour. Bone scans were done to determine whether the condition was solitary or multifocal. Biochemical investigations were done to rule out Myeloma or secondaries. Fine-needle aspiration cytology was done in seven cases, whereas two patients had undergone open biopsy, at the time of presentation. All patients were operated and followed up by the senior author (SPM). The surgical technique was similar in all cases, and the tumours were resected *en bloc*, in a single stage, through a posterior approach. Institutional ethical committee clearance was obtained prior to the commencement of the study.

### Preoperative preparation

Bowel preparation was started 2 days prior to surgery. One sachet of Peglec (PolyEthyleneGlycol and electrolytes) in 2 l of water was given *per os*. Adequate hydration was ensured with 2–3 l of fluid intake per day. Phosphate enemas were given 12th hourly, and the patient was maintained on a liquid diet 1 day prior to surgery.

### Operative technique

An indwelling Foley's catheter was introduced for continuous drainage of the bladder, and a surgical pack was introduced into the rectum for its easy identification during surgery. All cases were done under deliberate hypotension. The anaesthetised patient was positioned prone on a Relton-Hall four-poster frame, with hips and knees flexed to 90°. The proximal limit the tumour to be excised was marked under fluoroscopy. A curved bucket-handle-shaped incision was made. The apex of the incision was 5–7 cms cranial to the predetermined proximal resection margin. A full-thickness distal-based skin flap was elevated to expose the sacrum and sacroiliac joints. The origin of the gluteus maximus and the medial attachments of the sacrotuberous ligaments were identified and divided close to their sacral attachments, bilaterally. The caudal roots of the sciatic nerves and the piriformis muscles were then identified. After dividing the piriformis, sacrospinous and sacrococcygeal ligaments, the retroperitoneal space was reached, on both sides. Soft tissues anterior to the sacrum were separated by blunt dissection, and the proximal extent of the tumour was identified. Care was taken to ensure the pseudo-capsule of the tumour was not breached. An $8 \times 8$ cm gauze piece was passed anteriorly, from one side to the other, to protect the retroperitoneal structures. The haemorrhoidal plexus and rectum were protected during the blunt dissection. The posterior elements of S1 and S2 were removed using a Kerrison rongeur exposing the dural sac, S1, S2 and S3 nerve roots, which were traced distally and preserved. The dural sac was ligated distal to the S3 roots and divided, thereby exposing the posterior surface of the body of the sacrum (Fig. 1). In cases where the tumour extended proximal to S2, osteotomy of the ilium was done on both sides, to expose the sacroiliac joints. The proximal resection of the tumour was carried out with an osteotome or a rongeur, through normal bone. This helped mobilise the tumour posteriorly separating it from the anterior retroperitoneal pelvic structures. Finally, the anococcygeal ligament was divided, and the tumour was removed *en bloc* (Fig. 2). In cases where the osteotomy of the ilium was done, the pelvis was then stabilised with

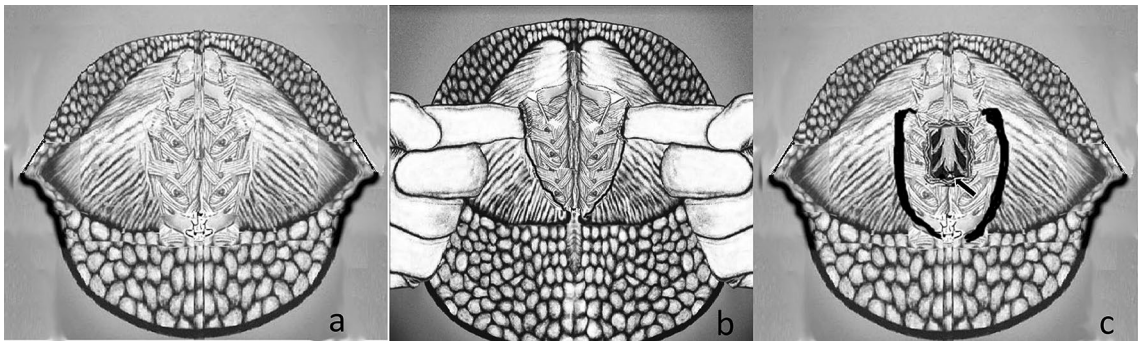


**Fig. 1** Illustration showing **a** curved bucket-handle incision and retracted full-thickness skin flap exposing the sacrum and sacroiliac joints, **b** division of the bilateral proximal attachment of the gluteus maximus and separation of anterior retroperitoneal soft tissues by blunt dissection, **c** ligation (arrow) and amputation of the dural sac distal to the S3 roots following laminectomy

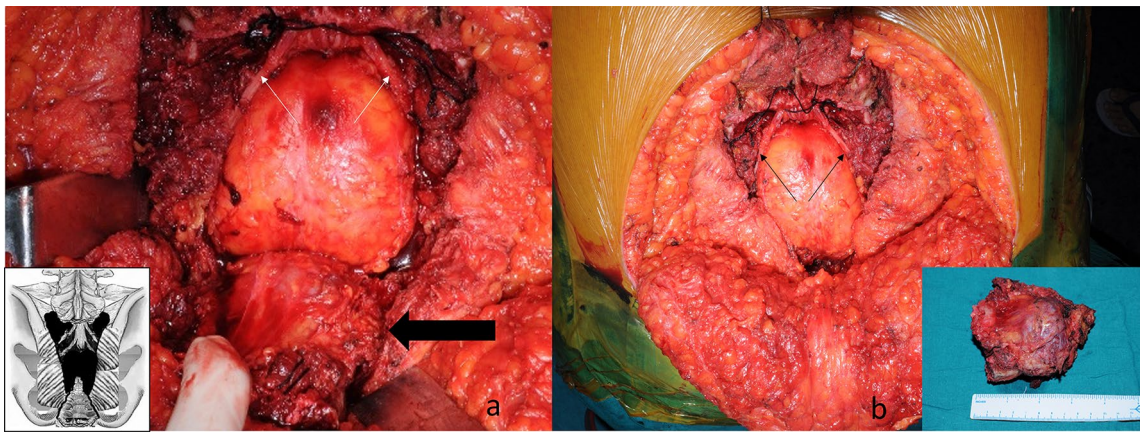


**Fig. 2** Intraoperative photograph showing **a** tumour (bold arrow) mobilised posteriorly after proximal resection through normal sacrum. Preserved S3 roots (light arrow) seen. Inset: Illustration **b** Intraoperative photograph following resection of the tumour with preserved S3 roots (light arrow). Inset: Resected tumour

a contoured plate or spino-pelvic fixation with pedicle screw-based constructs (Fig. 3). Meticulous haemostasis was achieved. The wound was closed in layers over suction drains.

## Post-operative protocol

Post-operatively, all patients were nursed in the prone and lateral position for the initial 5 days. They were mobilised after suture removal on the tenth post-operative day, with the help of a walking aid, depending upon their neurological status. The patients diagnosed to have chordomas received post-operative adjuvant radiotherapy. It consisted of 60 Gy in 30 fractions over 6 weeks, using a linear accelerator. All patients were followed up at regular intervals of 3 months in the first year and every 6 months in the second year and annually thereafter. They were advised to present immediately in case of recurrence of pain or neurological deficit. At follow-up, local and chest radiographs were taken to rule out recurrence or metastasis. In cases where metastasis or recurrence was suspected, CT scan or MRI was done (Fig. 4). At final follow-up, functional outcomes were measured depending on their ambulatory status, bowel and bladder continence, while recurrence and metastasis were used to determine the oncological outcomes [3, 6].

## Results

In the current study, there were six female and three male patients with a mean age of presentation of 43 years. All patients had low back pain, while only two had features of radiculopathy. Out of the nine patients, only two patients presented with neurological deficit. The details of clinical symptoms, diagnosis, extent of the tumour and duration of follow-up are shown in Table 1. None of the patients had any intraoperative complications like injury to the rectum or uncontrolled haemorrhage. The average blood loss was

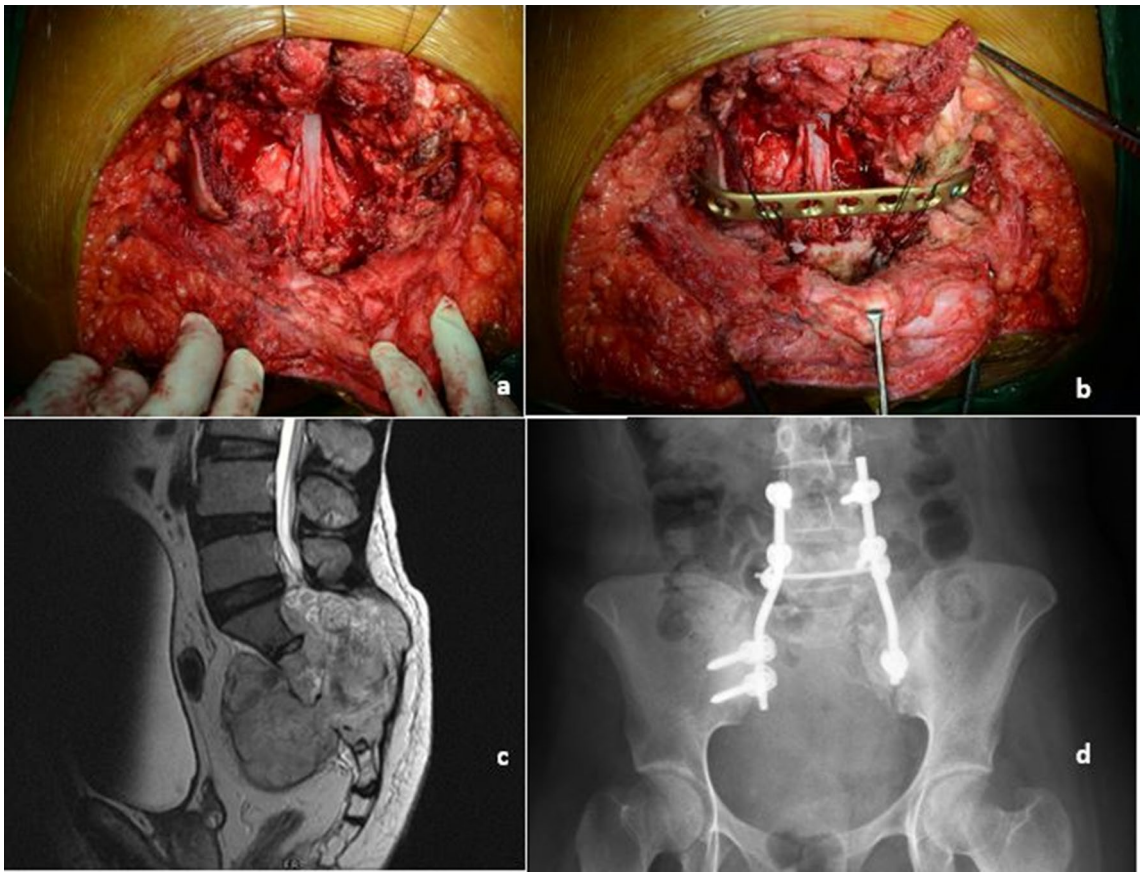


**Fig. 3** Intraoperative photographs showing **a** bilateral ileal osteotomy for removal of tumour involving S1. **b** Spino-pelvic reconstruction was done with a contoured plate. **c** T2-weighted MRI showing tumour involving S1. **d** Spino-pelvic fixation with a pedicle screw-based construct after tumour resection

approximately 1600 mL. One patient had a superficial wound infection which subsided with regular dressing, and another patient developed a wound breakdown that required an additional flap procedure. In the post-operative period, neither deep vein thrombosis nor pulmonary thromboembolism was seen in any case.

The details of blood loss, functional and oncological outcomes are shown in Table 2. At final follow-up, six patients were able to walk without any assistive device, two used a walker, and one patient was wheelchair-bound. Six patients had normal bladder function, while three required clean intermittent catheterisation. Five patients had normal bowel function, while four relied on digital rectal evacuation. Of the two patients with preoperative sciatica, only one patient had relief following surgery. Five patients did not have any recurrence at final follow-up, while four patients had a local recurrence. The surgical margins were contaminated in three of these patients. The patient with recurrent Ewing's sarcoma developed pulmonary metastasis and finally succumbed to the disease. The mean time of recurrence from index surgery was 23 months. At the conclusion of the study, two patients had expired, two patients were alive with the disease, whereas five patients had no evidence of disease.

## Discussion

Sacral tumours have a vague clinical presentation, often presenting late, as large lesions. Most of these tumours do not respond to chemotherapy and conventional radiotherapy, making surgical excision the treatment of choice. Surgical *en bloc* resection is challenging due to their location and size. These tumours may be resected through a single-stage posterior or anterior approach, combined anteroposterior approach, a two-stage anterior–posterior approach or a combined extended ilioinguinal and posterior approach [1–9]. Wei et al. classified sacral tumours into four groups according to their growth pattern [9]. They advocated posterior-only approach in all type I and type II, III tumours below S1. For large type II and III tumours extending proximal to S1, a combined anterior–posterior resection was preferred. For type IV lesions, a simple anterior approach was

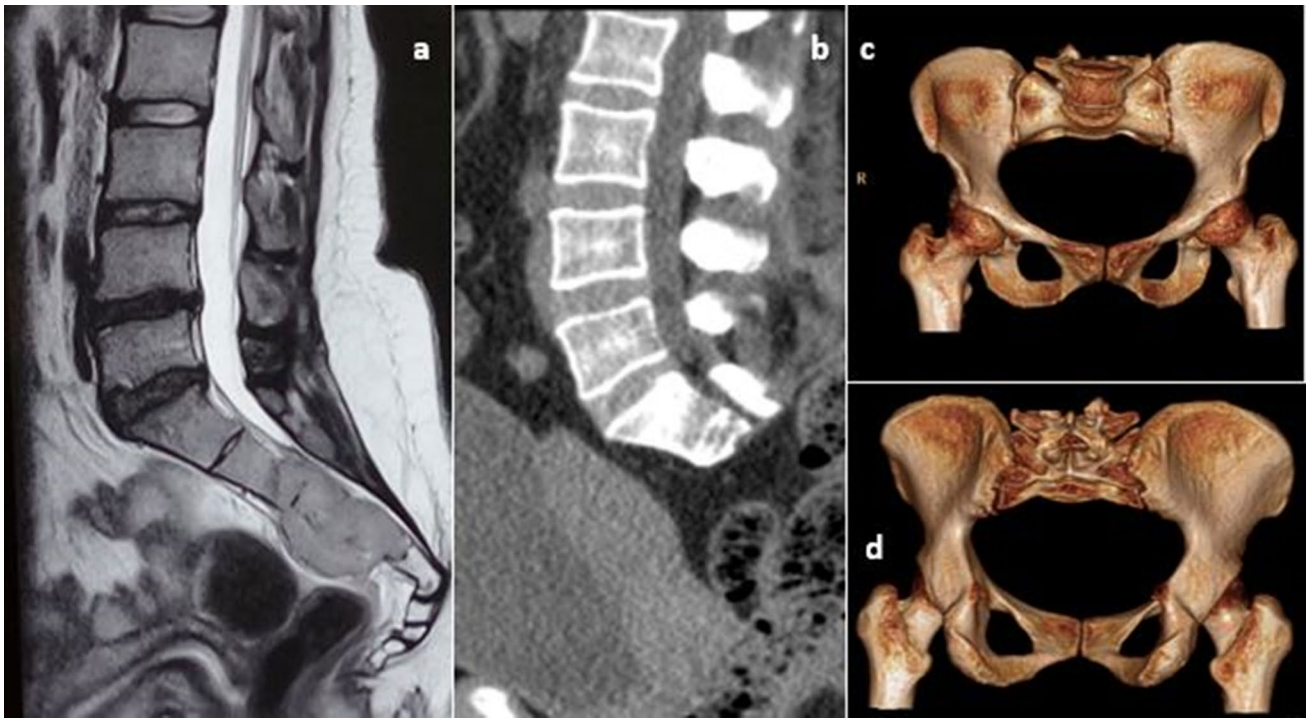


**Fig. 4** **a** Preoperative T2-weighted MRI showing giant-cell tumour extending from S2-S4. **b** Post-operative sagittal CT following *en bloc* resection of the tumour. **c**, **d** CT with 3D reconstruction at 30 months follow-up

**Table 1** Clinical data of patients

| Sl no | Age | Sex | Clinical symptoms (duration in months) | Diagnosis | Extent of the tumour | Wei's type | Follow-up |
|---|---|---|---|---|---|---|---|
| 1 | 50 | F | Low backache (5) | Chordoma | S2-S5 | II | 8 years |
| 2 | 38 | M | Low backache (4) | Chordoma | S2-S4 | II | 6 years |
| 3 | 48 | F | Low backache (6)<br>Swelling (4) | Chordoma | S3-coccyx | II | 5 years |
| 4 | 63 | M | Low backache (2)<br>Urinary retention (5 days) | Malignant Paraganglioma | S3-S5 | III | 9 months (DOD[a]) |
| 5 | 39 | M | Low backache with right radiculopathy (5) | Chordoma | S2-S5 | II | 4 years |
| 6 | 40 | F | Low backache (2) | Schwannoma | S2-S3 | II | 4 years |
| 7 | 45 | F | Low backache (12) | Neurilemmoma | S1-S2 | II | 3 years |
| 8 | 19 | F | Low backache with weakness of both lower limbs(2) | Recurrent Ewing's sarcoma | S1-S4 | III | 4 months (DOD[a]) |
| 9 | 45 | F | Low backache with bilateral radiculopathy(3) | Giant-cell tumour | S2-S4 | II | 30 months |

[a]*DOD* died of disease

recommended. In our series, seven of the nine tumours were Wei type II and two were Wei type III tumours. While Wei et al. recommended a combined anterior–posterior approach in these cases, the curved bucket-handle incision allowed greater access in separation of anterior retroperitoneal structures from the tumour. Furthermore, in the two cases where the tumour extended proximal to S2, bilateral iliac bone osteotomy allowed adequate separation of the tumour from retroperitoneal structures. These modifications allowed resection of tumours that grew anteriorly through a single-stage posterior approach. The advantages of a single-stage posterior approach are a shorter operation time and less blood loss. However, in cases where the tumour extends proximal to S1, a combined anteroposterior or two-staged anterior–posterior approach is advocated. It ensures that the internal iliac vessels and ureters are mobilised and separated

**Table 2** Margins and oncological outcomes

| Sl no | Margins | Tumour recurrence following index surgery | Metastasis | Management of recurrence/metastasis | Present status[b] |
|---|---|---|---|---|---|
| 1 | Positive | 5 years | No | Radiotherapy | AWD |
| 2 | Negative | No | No | – | NED |
| 3 | Positive | 18 months | No | Radiotherapy | AWD |
| 4 | Negative | No | No | – | DOD |
| 5 | Negative | No | No | – | NED |
| 6 | Negative | No | No | – | NED |
| 7 | Negative | No | No | – | NED |
| 8 | Positive | 2 months | 3 months | Chemotherapy | DOD |
| 9 | Negative | 1 year[a] | No | Surgical excision | NED |

[a]Soft tissue recurrence

[b]*AWD* alive with disease, *NED* no evidence of disease, *DOD* died of disease

from the tumour, to prevent inadvertent injury during posterior resection. It also allows the harvest of a pedicled rectus abdominis flap to assist in closure of the posterior wound [6].

In this series, all tumours were excised through a single-stage posterior approach. The positioning of the patient on a Relton-Hall frame with the hips and knees flexed to 90 degrees allowed not only better visibility of the operating field but also decompressed abdominal contents. This along with deliberate hypotension resulted in a nearly bloodless operating field. The iliac vessels were not encountered in any of our cases and did not necessitate their ligation. The bucket-handle-shaped incision, with a cranial apex, was preferred to a straight midline incision described by Angelini et al., as it allowed easier lateral soft tissue dissection with better exposure of the sacroiliac joints [2]. To prevent exposure of the rectum and other pelvic viscera in case of post-operative wound-related complications, the cranial apex with a distal-based flap was chosen over a caudal apex. The laminectomy at S1 and S2 allowed the identification of the caudal roots of the sciatic nerve. The ligation and amputation of the dural sac distal to the S3 roots ensured the proximal resection was through a normal vertebra while minimising the neurological complications, resulting in a better functional outcome [2]. In cases where resection was proximal to S1, bilateral osteotomy of the ilium allowed easy dissection of anterior retroperitoneal soft tissues. These modifications enabled resection of tumours involving S1 through a posterior-only approach. However, this resulted in the complete dissociation between the spine and the pelvis causing vertical and rotational instability. [10–12] To reestablish the pelvic stability, posterior spino-pelvic reconstruction was done in the same sitting. Similar modifications have been described by other authors [2, 9].

Waisman et al., in their series of five sacral chordomas resected through the posterior approach, reported that only one patient developed urinary and faecal incontinence following surgery, with no mortality at 5-year follow-up [4]. Asavamongkolkul et al. resected 21 sacral tumours through the posterior approach. All patients had some form of bowel and bladder incontinence and were dependent on catheters and enemas. Two patients had a recurrence, and one patient had passed away due to distant metastasis, at 7-year follow-up [5]. Angelini et al. modified the Osaka technique for resection of sacral tumours through a midline posterior-only approach. In their series, eight patients developed bowel and bladder dysfunction. Nine patients were disease free, while four patients had developed recurrence, with all patients alive at final follow-up (mean 35.5 months) [2]. The functional and oncological outcomes in our patients were comparable to these studies, where sacral tumours were resected through a posterior-only approach.

In tumours resected through anterior–posterior approach, most of the investigators have reported a higher frequency of wound complications with guarded outcomes compared to our series [13–16]. However, this comparison is not reasonable as the tumours excised through these approaches were relatively large, extending proximal to S1. The role of radiation in sacral chordomas is controversial. The effective dose of radiation for these tumours is much higher than the dose tolerated by the spinal cord and the rectum. However, intensity-modulated radiotherapy and image-guided radiotherapy enable targeted delivery of higher doses of radiation, with minimal harm to adjacent organs. Adjuvant radiotherapy may help prolong disease-free interval and control symptoms of recurrent lesions [17–20]. Two of our patients with recurrence have remained symptom free with adjuvant radiotherapy. In recent times, there has been an integration of customised cutting blocks and robot-assisted surgery in resection of sacral tumours [21]. Preliminary reports by Yin et al. have shown that robot-assisted sacral tumour resection is associated with lower blood loss and shorter hospitalisation [22]. However, further studies are necessary to determine its long-term functional and oncological outcomes.

Thus, sacral tumours can be resected safely through a single-stage posterior approach. The modified posterior approach described in this study is relatively simple, carries minimal intraoperative complications and can be used for resection of tumours up to S1. The functional and oncological outcomes are comparable to other surgical procedures described in the literature. However, the small sample size, medium-term outcome and its retrospective nature are the drawbacks of this study.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Institutional ethical clearance was obtained before starting the study.

**Human and animal rights** This article does not contain any studies with animals performed by any of the authors.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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