

## Orthopaedic Forum

## Computer navigation assisted tumor surgery for internal hemipelvectomy - Early experience

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## ABSTRACT

Internal hemipelvectomy is a surgically challenging entity, owing, among other reasons, to a complex anatomy. The apprehension of an inadequate margin or injury to critical structures adds to the complexity of these major surgical procedures. Computer assisted tumor surgery (CATS) has been increasingly used to improve outcomes of internal hemipelvectomy over the last decade. We analyzed the surgical and postoperative details of first four patients undergoing internal hemipelvectomy with CATS assistance at our institute, the first ever report in an Indian setting. The patients were analyzed for blood loss (mean 1300 ml), operative time (mean 306 min) and hospital stay (mean 7 days). The histopathological margins were free of disease in all the patients, even as the average closest bony margin was 0.9 cm. Sparing of sacral nerve root was made possible by the close yet free margins in two patients. In this retrospective analysis of a small series of patients with computer navigation assisted internal hemipelvectomy, we found this technique to be feasible and effective in achieving the oncological aim of negative margins with preservation of critical structures.

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## 1. Introduction

Internal hemipelvectomy is one of them most challenging procedures in orthopedic oncology, performed for limb saving wide excision of pelvic bone tumors.<sup>1</sup> The oncological outcomes of this procedure are comparable to those of external hemipelvectomy, a procedure with a much higher morbidity.<sup>2</sup> Internal hemipelvectomy with CATS assistance has been shown to be associated with higher chances of getting adequate margins, without compromising on oncological outcomes.<sup>3–5</sup> We describe our initial experience with CATS internal hemipelvectomy, the first report of the use of this technology for orthopedic oncology from India.

## 2. Material and methods

We analyzed first four internal hemipelvectomies done with CATS assistance done in our department. All four surgeries were carried out by the same primary surgeon (AT) with his team between August 2019 and Dec 2019. The extent/type of internal

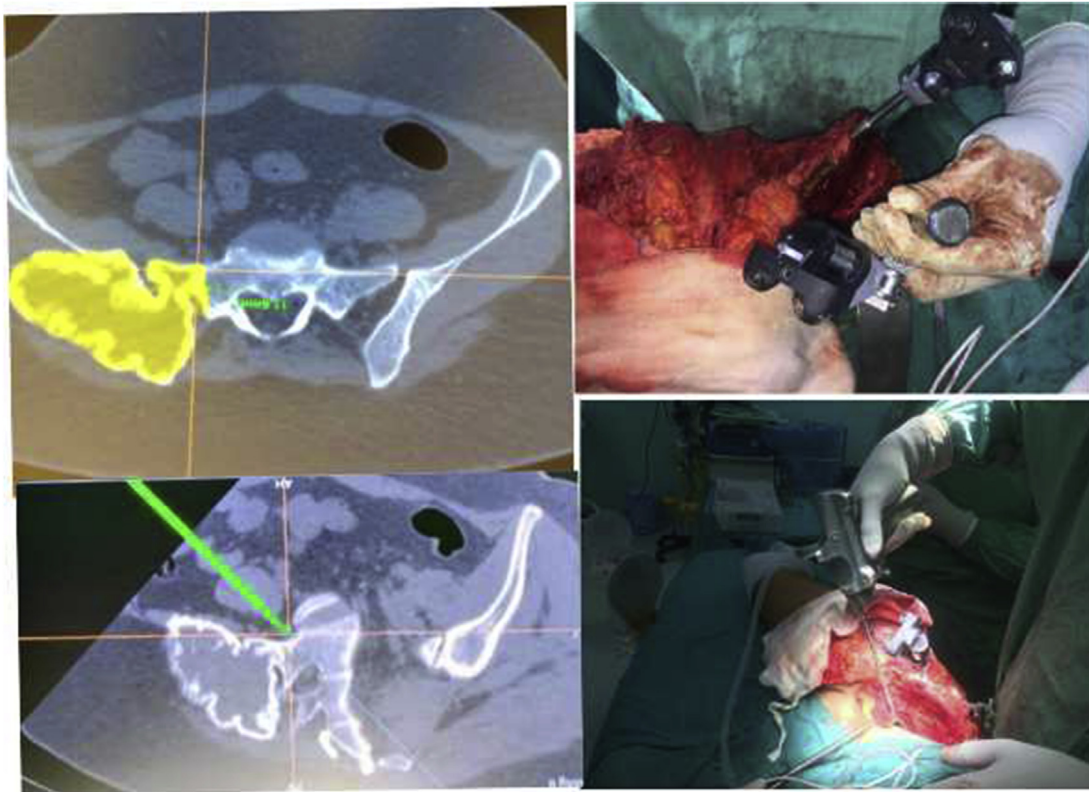
hemipelvectomy was planned according to tumor location and requirement of margins. All surgeries were carried out using the standard utilitarian incision.

An intraoperative navigation technique was used with additional planning using the planning software (OrthoMap 3D, Stryker) on Stryker Nav 3 tumor navigation system.<sup>6</sup> A detailed preoperative planning on the navigation system was done on fused CT and MRI images. Registration was done using paired-point and surface landmarks on the fused images. Surface-point matching used the navigation probe to select a minimum of 50 points on the exposed normal pelvic bone. These were incorporated into the navigation system, which allowed the registration error to be calculated. An overall registration error of <1 mm was considered acceptable. Using navigation guidance, the planned resection margins from the fused images were marked on the bone with diathermy or drill holes, and the resection was completed after completing the osteotomy along these points with either osteotomes or saw, all instruments being registered too (Fig. 1). The software was programmed to indicate margins of at least 1 cm on all bony cuts, and this was reduced only where closer margins were needed to save a critical structure.

Two patients received pre and post op chemotherapy, while post op RT was received by one patient. The success of registration and achievement of planned resection planes, postoperative margins

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**Fig. 1.** Large pelvic tumor involving sacroiliac area, close to sacral nerve root. With the use of navigated instruments, sacral nerve root was preserved while maintaining oncological safety. CBM was 1 cm, margins free.

including closest bony margins, surgical time, blood loss, and hospital stay were analyzed as the end outcomes. Because we now use CATS for all internal hemipelvectomies, doing all internal hemipelvectomies with CATS, ethics approval was not sought for this retrospective analysis.

### 3. Results

The details can be seen in [Table 1](#). There were two male and two female patients, with an average age of 23.5 years (8–42 years). There were no intraoperative complications related to the navigation procedure or equipment, and in no patient was the navigation procedure abandoned after it had been started. All four CATS hemipelvectomy resection levels and planes were within 1 cm of planned planes. The duration of surgery ranged from 240 to 390 min (mean 306.25 min). The average blood loss was 1300 ml (range 300–2000 ml). The hospital stay ranged from four to 10 days (mean seven days). The closest bony margin (CBM) ranged from 0.5 to 1 cm. The mean intraoperative navigation registration error was 0.43 mm (range 0.3 mm–0.6 mm). The margins were microscopically free in all patients. Wound complications were seen in two

patients, one of which required secondary suturing.

### 4. Discussion

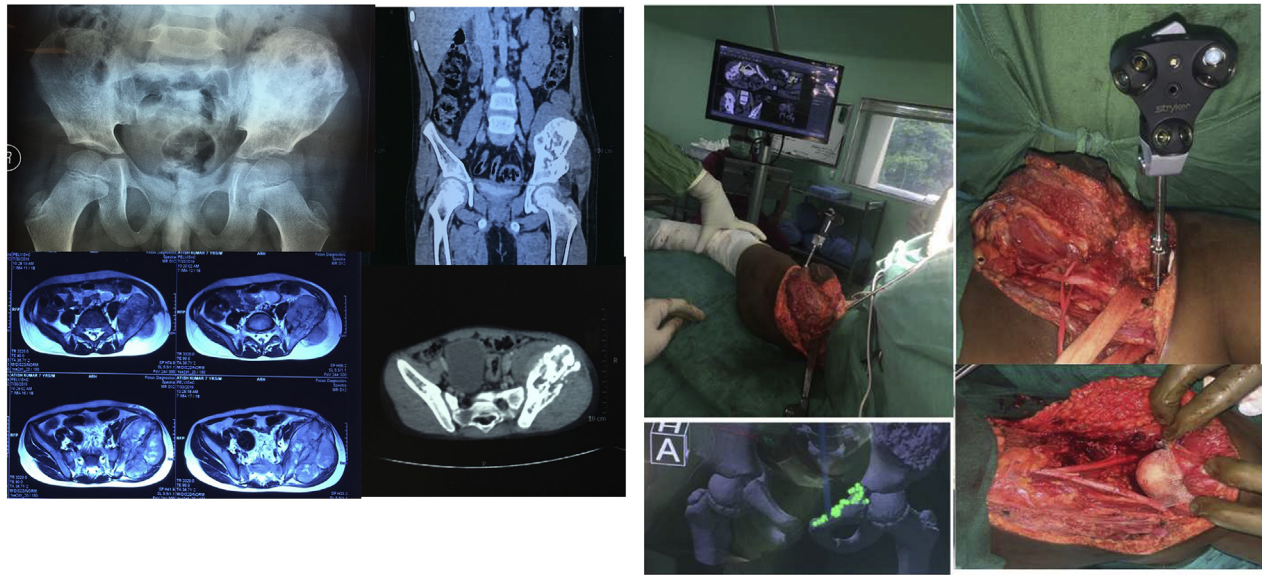
The advantages of CATS for internal hemipelvectomy include safer margins, lesser blood loss and shorter operative time.<sup>7</sup> CATS is being increasingly used for improved precision of musculoskeletal tumor surgery, ensuring oncologically safer margins are achieved while saving critical structures.<sup>4,6,8,9</sup> 3 Amidst several studies from across the world, use of CATS from India has never been reported. We report the feasibility and effectiveness of CATS for internal hemipelvectomy, the first such study in an Indian setting.

Pelvic sarcomas are known to be associated with a higher risk of having positive histopathological margins.<sup>10</sup> CATS has been reported by many workers to result in negative margins in a higher percentage of internal hemipelvectomies as compared to unassisted pelvectomies.<sup>3–5</sup> At the same time, the precision provided by CATS, enables many surgeries which would otherwise be considered more morbid or inoperable to be considered less morbid or operable.<sup>8</sup> We were able to achieve negative margins even where closer margins were needed for functional/anatomical preservation

**Table 1**  
Details of patients who underwent CATS internal hemipelvectomy.

SN	Age	Sex	Diagnosis	Location	MD (cm)	HPT	BL (ml)	DOS (min)	NA (mm)	Margin	CBM (cm)	HS (days)	Complications
1	8	Male	Ewing Sarcoma	Left iliac	6.3	I + II + III	300	240	0.6	Free	0.5 (Sacral)	9	wound dehiscence
2	22	Female	Osteo sarcoma	Right SI joint	5.5	I Extended	1500	390	0.4	Free	1 (Sacral)	10	skin flap necrosis
3	22	Female	GCT	Right sacral ala & iliac crest	8.2	I Extended	1400	270	0.3	Free	1 (Sacral)	5	
4	42	Male	Chondro sarcoma	Left acetabulum	8	II	2000	325	0.4	free	1 (Iliac)	4	

CAN: computer assessed navigation; SN: serial number; GCT: gait cell tumor; MD: maximum dimension; HPT: hemipelvectomy type; BL: blood loss; DOS: duration of surgery; NA: navigation accuracy; CBM: closest bony margin; HS: Hospital stay.



**Fig. 2.** Ewing sarcoma of pelvis in a 7 years old boy. CATS internal hemipelvectomy was done with pseudoarthrosis with meshplasty. CBM was 0.5 cm, margins free.

(Fig. 1). While we did not deliberately modify our intended margins for CATS patients, in three out of these four patients the sacral margin was limited by the tumor being very close to the sacral nerve roots (one of them being a seven year old with CBM of 0.5 cm) (Fig. 2). The fourth patient too had a CBM of 1 cm. This was guided by the 1 cm margin that we set on the software, except where it was further reduced to save critical structures. In the absence of randomized studies involving the same surgical teams (given the rarity and nature of these major surgeries), proving unequivocal benefit of CATS for internal hemipelvectomy is difficult. But literature supporting this view is growing.<sup>3–5,7,11</sup> Another area generating interest for improving precision in pelvic tumor surgery is patient specific instrumentation.<sup>12</sup>

The major limitation of our study is that this is an early experience of the use of CATS for internal hemipelvectomy in a very small number of patients. In this retrospective analysis we found the use of CATS assisted internal hemipelvectomy to be feasible and safe. It has the potential to reduce duration of surgery and most importantly, resection margins (thereby reducing surgical morbidity), without compromising on oncological safety.

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