A Comparative Study for Wide Excision of Malignant Tumors Distal to S2

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Abstract. *Background and Aim: We conducted a retrospective study comparing 5 patients (Group A) who underwent posterior excision of tumors distal to S2 using a modified threadwire saw (MT-saw) with 5 similar patients (Group B) who underwent tumor excision using chisels and airtomes. Patients and Methods: The data of 10 patients were obtained from intra-operative records. A flexible silver guide probe connected to an MT-saw by a suture thread was devised for use in osteotomy passing through the S1 sacral canal in the lateral sacrum. Operative time, blood loss and excisional margins were compared between the two groups. Results: Group A had a shorter average operative time (2 hours 24 minutes) and smaller average blood loss (2,124.6 ml) than Group B. In Group A, one patient incurred an S1 nerve root injury, and all patients had wide histological margins. In Group B, one patient had an S1 nerve root injury and another tumor contamination due to a fracture. Conclusion: The MT-saw greatly facilitated lateral sacral osteotomy and reduced the risk of tumor cell spread, permitting faster, safer excision with a wider margin.*

En bloc excision of sacral tumors is a difficult procedure. Recurrence is common (1, 2). Massive bleeding can occur, and operative times are long. Osteotomy *via* the lateral sacrum is often time-consuming. Tomita and Kawahara (3) devised a threadwire saw (T-saw: diameter 0.5 mm). We have improved this device by connecting a flexible silver guide probe to the modified threadwire saw (MT-saw: diameter 1 mm), for use in performing osteotomies of the lateral sacrum and posterior inferior iliac spine. Passage of the guide probe and MT-saw through the sacral canal and sacral foraminae facilitates preservation of nerve roots and blood vessels (4, 5). A review of the anatomy of the sacrum indicates that the anterior sacral foraminae are more cephalad than the S1/2 disc, thus allowing sacral excision with a wide bony margin using the guided MT-saw (5). In the present study, we compared the results of excising tumors distal to S2 with conventional methods employing chisels and osteotomes (Group B) (2) versus using the guided MT-saw (Group A). We assessed the results of wide excisions, for sacrocogygeal chordomas, performed at one institute.

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Key Words: Malignant sacral tumors, tumor distal to S2, modified threadwire saw, sacral canal osteotomy, wide margin.

Patients and Methods

From August 1983 to August 2003, the first author surgically treated 31 patients with malignant sacral tumors at different sites. The results of excising tumors distal to S2 (Figure 1, 2) with the guided MT-saw (Group A) (Figure 3) were compared to those using conventional methods employing chisels and osteotomes (Group B). From among these 31 patients, we randomly selected 5 constituting Group A (4 males and 1 female) and 5 forming Group B (3 males and 2 females). Patients in Group A underwent surgery between August 1997 and August 2003, those in Group B between August 1983 and July 1997. In Group A, the age range was 40 to 72 years, the average age 55.2 years. The tumors excised in Group A were 3 chordomas and 2 recurrent rectal carcinomas involving the sacrum. The procedures performed in Group A were as follows: colostomy including the rectum, 2 cases; colostomy excluding the rectum, 2 cases; excision only, 1 case. In Group A, 4 anterior and posterior combined approaches and one posterior approach were used. No patients in Group A underwent preoperative or postoperative radiation therapy.

In Group B, the age range was 33 to 64 years, the average age 47.6 years. The tumors excised in Group B were 3 chordomas and 2 recurrent rectal carcinomas involving the sacrum. All patients in Group B underwent colostomy including the rectum *via* a combined anterior and posterior approach.

Results

A comparison of Group A with Group B patients is given in Table I. The operative time of Group A was shorter than in Group B by 2 hours 24 minutes and blood loss was also less than that of Group B by 2,124.6 ml. The difference in operative time was not statistically significant ($p=0.09$), but the difference in blood loss was ($p<0.05$) (Figure 4). The reduced bleeding in Group A was apparently attributable to

Table I. *Comparison of the procedure (Group A*) with the conventional procedure (Group B), in terms of operative time and blood loss, for posterior excision of tumors distal to S2.*

Case No.	Age (years)/ Gender	Diagnosis	Location	Surgical approach/ method and adjuvant	Op time/blood loss (ml); posterior-procedure without anterior-procedure (total)	Preseved nerve roots	Complications/ recurrence	Follow-up status (years+ months)
Group A								
1	52/M	Chordoma	S2-CX	AP / WE + colostomy without rectum	4 h 3 min / 4264 (16 h 55 min / 6600)	Lt-S1, Rt-L5	S1 nerve root injury / None	CDF (9+8)
2	72/M	Chordoma	S2-CX	P / WE	5 h 10 min / 1600	Bil-S1	Colostomy for rectal fistula / None	DOD (0+6) (Sepsis to renal failure)
3	61/M	Chordoma	S2-S4	AP / WE + colostomy without rectum	6 h 10 min / 2310 (11 h 15 min / 720)	Bil-S1	None / None	CDF (6+2)
4	40//F	Recurrent rectal carcinoma	S2-CX	AP / WE + colostomy with rectum	5 h 5 min / 2606 (15 h 10 min / 6536)	Bil-S1	None / None	NED (5+1)
5	51/M	Recurrent rectal carcinoma	S2-CX	AP / WE + colostomy with rectum	4 h 30 min / 1201 (17 h 20 min / 7650)	Bil-S1	None / None	DOD (2+5) (Lung meta)
Average 55.2 years					Average 4 h 59 min / 2396.2			
Group B								
1	43/M	Chordoma	S2-CX	AP / WE + colostomy with rectum	11 h 10 min / 7036 (14 hrs / 8100)	Bil-S1	None / None	AWD (23+8) (Lung meta)
2	64/M	Chordoma	S2-CX	AP / WE (contamination due to fracture) + colostomy with rectum+ RT 70 Gy	9 h / 4276 (13 h 30 min / 4476)	Lt-S1 Rt-L5	Rt-S1 nerve root injury / Recurrence	DOD (8+7) (Lung meta)
3	46/M	Chordoma	S2-CX	AP / WE + colostomy with rectum	6 h 20 min / 3420 (11 h 30 min / 3990)	Bil-S1	None / None	CDF (14+0)
4	52/F	Recurrent rectal carcinoma	S2-CX	AP / WE + colostomy with rectum	5 h 40 min / 4877 (10 h 31 min / 6450)	Bil-S1	Fistula / None	DOD (2+0) (Lung meta)
5	33/F	Recurrent rectal carcinoma	S2-CX	AP / WE + colostomy with rectum	4 h 45 min / 2995 (18 h 52 min / 5676)	Bil-S1	Ureter injury / None	DOD (0+4) (Lung meta)
Average 47.6 years					Average 7 h 23 min / 4520.8			

AP, anterior and posterior combined approach; Bil, bilateral; CDF, continuous disease free; CX, coccyx; DOD, dead of disease; DOO, dead of other disease; Gy, Gray; Lt, left; meta, metastases; NED, no evidence of disease; Op, operative; P, posterior approach; Rt, right; RT, radiation therapy; WE, wide excision. *Clinical features of Group A (five cases) are based on those reported in Osaka *et al*. (5)

the reduced operative time. Coagulation of the sacral epidural vessels is an important factor in surgical blood loss. In Group A, all surgical margins were wide on histological review and there were no recurrences. One patient in Group A suffered a nerve root injury during osteotomy. In Group B, there were complications due to contamination of the chordoma tissue resulting from a fracture and the patient received radiation therapy (70 Gy). This patient suffered a fracture in the S1 body. This fracture did not show union and the patient needed a crutch. One patient had an S1 nerve root injury, and another a ureteric injury.

In Group A, 3 patients remained disease free. One patient died of recurrent rectal carcinoma with lung metastasis 2 years 5 months after surgery. One elderly patient developed a rectal fistula after excision, necessitating colostomy 1 month later and died of sepsis secondary to renal failure 6 months after chordoma excision. In Group B, one patient had been operated on 23 years prior to this study, and lung metastases developed 18 years after surgery. This patient is alive with lung metastases (no recurrence). One patient died from recurrent chordoma 8 years 7 months after surgery, and of the two patients with recurrent rectal carcinoma, one died from lung metastases at 2 years, the other at 4 months, after surgery. All patients received follow-up MRI performed by the first author and assistant orthopaedic surgeons (Table I).

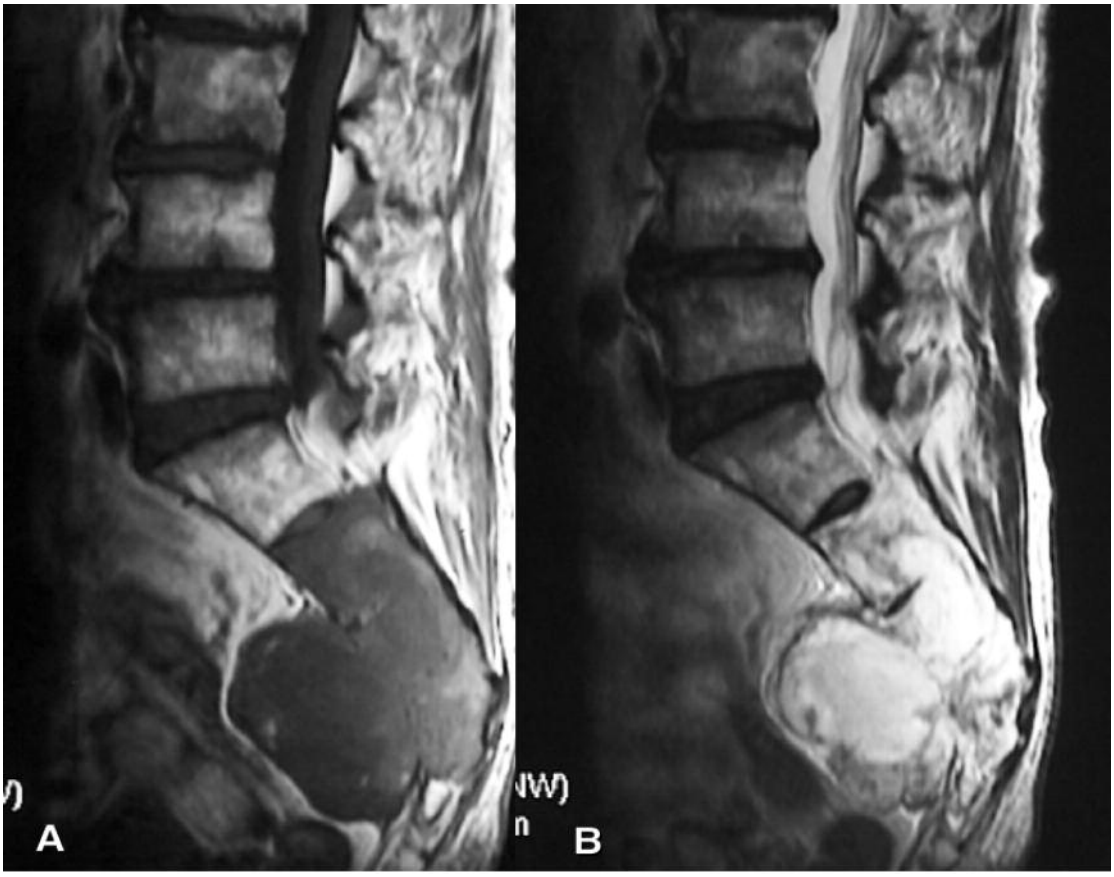

Figure 1. *Magnetic resonance images showing a huge mass in the sacrum and anterior area of a sagittal section. T1-weighted image shows a low-intensity mass (A). T2-weighted image shows a high-intensity mass involving the S2 posterior sacral body (B).*

Discussion

Excision of malignant sacral tumors presents a surgical challenge. Incision of such tumors is frequently accompanied by massive blood loss, nerve injury and infection. When excising tumors that are distal to S2, laminectomy is performed at S1 in order to preserve the S1 nerve roots. Preservation of these nerve roots significantly improves postoperative quality of life in terms of ambulation (2).

Hata *et al*. (6) developed a T-saw for easier sectioning of bone in sacral and thoracolumbar surgery (7, 8). We have developed a flexible silver guide probe connected to an MT-saw of our own design (4), which is slightly larger than the T-saw for use in performing osteotomies of the lateral sacrum and posterior inferior iliac spine. This probe is inserted into and passed through the sacral canal, and is then passed up through the anterior sacral foraminae to protect the S1 roots (5). The sacral nerves, sciatic nerves, and superior and inferior gluteal blood vessels are similarity protected. Recently, control of blood loss during sacral surgery using aortic balloon occlusion was reported (9), and photon, proton radiation therapy may provide improved outcome (10).

In the present study of excision of tumors distal to S2, we compared results between conventional methods of excision using chisels and osteotomes (1, 2) and excision with our MT-saw (5). When the guided MT-saw was used, the anterior sacral foraminae of the osteotomy line were more cephalad than the S1/2 disc; in terms of sacral anatomy the excisional margin was wide, and the procedure was faster and easier. Bleeding with the MT-saw procedure (average, 2124.6 ml) was significantly less than with conventional methods ($p<0.05$) (Student's *t*-test) because the blood in epidural vessels coagulated within the sacral canal during the MT-saw procedure. The operative time for the MT-saw procedure (average, 2 hours 24 minutes) was shorter than that for conventional methods, but the difference was not significant ($p=0.09$). The MT-saw reduces the risk of tumor spillage or contamination with tumor cells due to intra-operative fracture, as compared to conventional methods. In addition, use of the MT-saw with the flexible silver probe

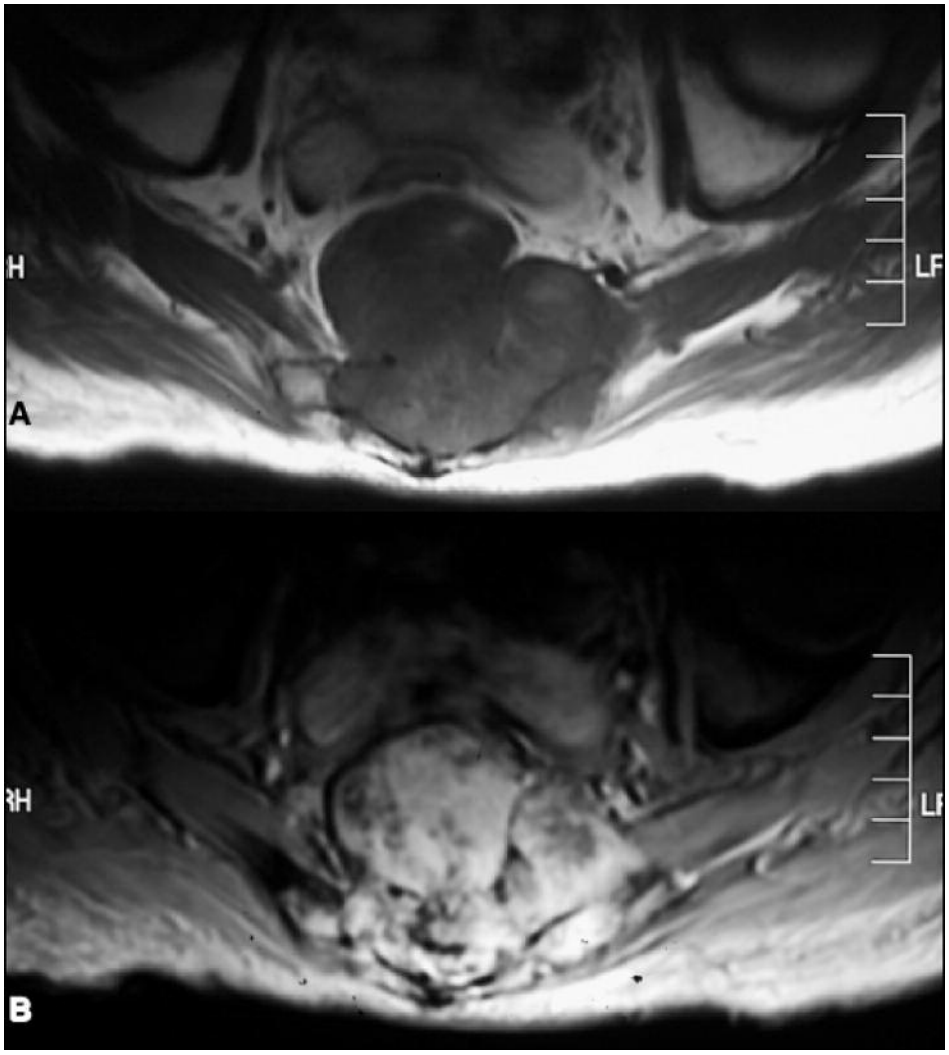

Figure 2. *T1-weighted (A) and T2-weighted (B) MRI axial sections. The tumor can be seen to involve the sacrum and the piriformis muscles.*

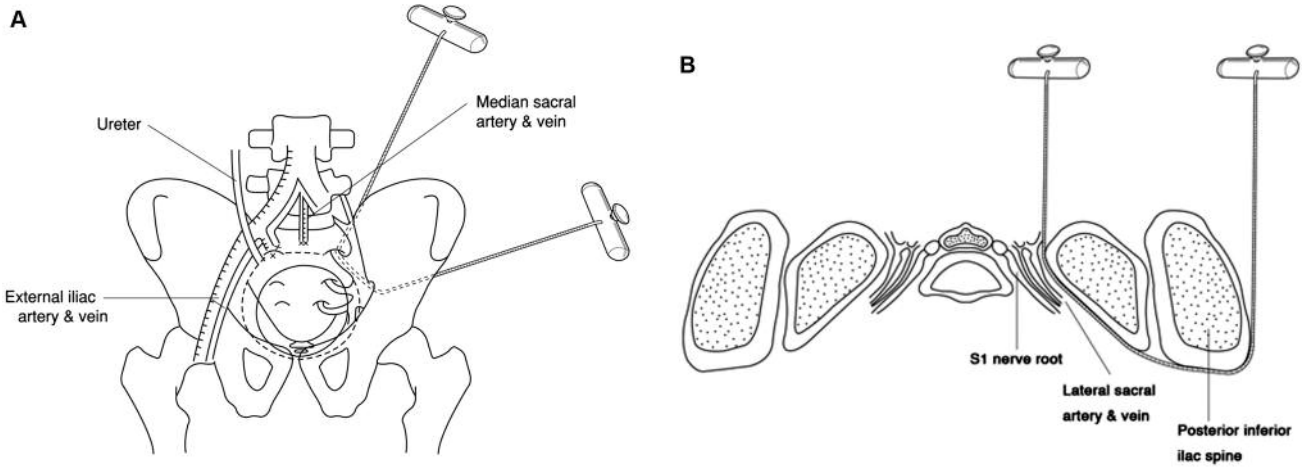

Figure 3. *Radical excision using the MT-saw in anterior (A) and transverse view (B) show nerve roots, blood vessels and osteotomy of the pars lateralis of the sacrum and posterior inferior iliac spine using the threadwire saw.*

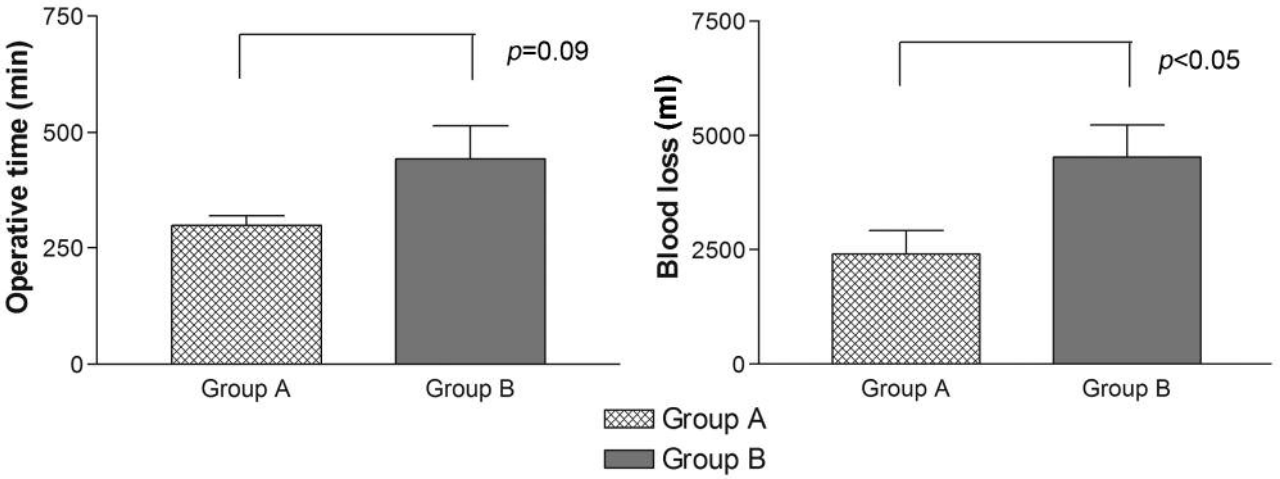

Figure 4. *Comparison between MT-saw (Group A) method and conventional method (Group B). Operative time (p=0.09) and blood loss (p<0.05); the significance of differences was analyzed using Student's t-test (p-values).*

allows for greater precision in osteotomies, particularly *via* the lateralis of the S1 and the posterior inferior iliac spine. Osteotomies of the sacral body are performed *via* the sacral foramina on the cephalad side of the S1/2 disc, preserving S1 nerve roots. This procedure allows for faster, safer excision with a wider margin.

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