

## Technical Note

# Intraoperative navigation-guided resection of anomalous transverse processes in patients with Bertolotti's syndrome

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Received: 06 May 17 Accepted: 01 August 17 Published: 26 September 17

## Abstract

**Background:** Bertolotti's syndrome is characterized by enlargement of the transverse process at the most caudal lumbar vertebra with a pseudoarticulation between the transverse process and sacral ala. Here, we describe the use of intraoperative three-dimensional image-guided navigation in the resection of anomalous transverse processes in two patients with Bertolotti's syndrome.

**Case Descriptions:** Two patients diagnosed with Bertolotti's syndrome who had undergone the above-mentioned procedure were identified. The patients were 17- and 38-years-old, and presented with severe, chronic low back pain that was resistant to conservative treatment. Imaging revealed lumbosacral transitional vertebrae at the level of L5-S1, which was consistent with Bertolotti's syndrome. Injections of the pseudoarticulations resulted in only temporary symptomatic relief. Thus, the patients subsequently underwent O-arm neuronavigational resection of the bony defects. Both patients experienced immediate pain resolution (documented on the postoperative notes) and remained asymptomatic 1 year later.

**Conclusion:** Intraoperative three-dimensional imaging and navigation guidance facilitated the resection of anomalous transverse processes in two patients with Bertolotti's syndrome. Excellent outcomes were achieved in both patients.

**Key Words:** Bertolotti's syndrome, pseudoarticulation, sacrum, transverse process

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**Website:**[www.surgicalneurologyint.com](http://www.surgicalneurologyint.com)**DOI:**

10.4103/sni.sni\_173\_17

**Quick Response Code:**

## INTRODUCTION

Bertolotti's syndrome is characterized by enlargement of the transverse process at the most caudal lumbar vertebra with a pseudoarticulation between the transverse process and sacral ala.<sup>[1-3]</sup> The precise etiology of Bertolotti's syndrome remains controversial. Certainly, increased stress above the transitional segment renders the adjacent disc prone to degeneration. Here, we describe the use of intraoperative three-dimensional (3D) image-guided navigation in the resection of anomalous transverse

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**How to cite this article:** Babu H, Lagman C, Kim TT, Grode M, Johnson JP, Drazin D. Intraoperative navigation-guided resection of anomalous transverse processes in patients with Bertolotti's syndrome. *Surg Neurol Int* 2017;8:236.  
<http://surgicalneurologyint.com/Intraoperative-navigation-guided-resection-of-anomalous-transverse-processes-in-patients-with-Bertolotti's-syndrome/>

processes. The rarity and diagnostic complexity of Bertolotti's syndrome are reviewed.

## CASE REPORTS

With appropriate IRB approval, we retrospectively identified two patients diagnosed with Bertolotti's syndrome who had undergone intraoperative 3D navigation-guided surgical resection of anomalous transverse processes.

### Patients

Two patients (17- and 38-year-old females) presented with nonradicular, chronic low back pain (LBP) lasting approximately 4–5 years. Both patients had significant pain on lumbar flexion and extension. The 38-year-old patient also had pain involving the left posterior superior iliac spine joint and positive left standing flexion and Patrick's tests (FABER test). Trigger point injections in one patient, and a steroid injection in the other, into the pseudarthrotic facet resulted in transient pain relief. Imaging studies [computed tomography (CT) and magnetic resonance imaging (MRI)] for both patients revealed anomalous transverse processes at the L5–S1 level and pseudoarticulation with the sacrum, which were consistent with Bertolotti's syndrome [Figure 1].

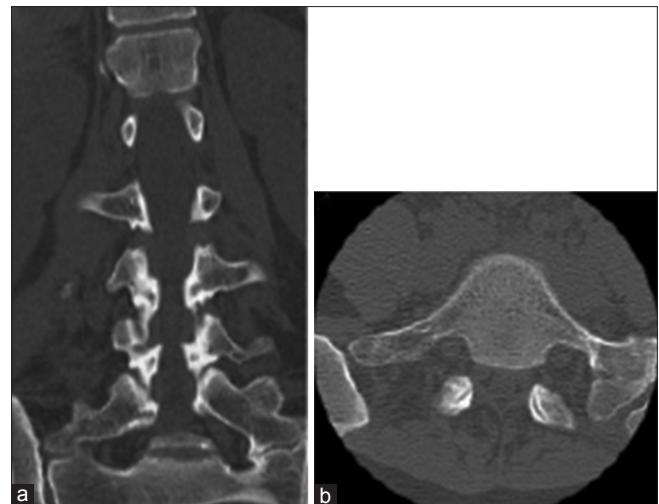
### Technical aspects of surgical resection

The patients were positioned prone on a Jackson table. Preoperative O-arm® (3D CT) images were obtained from the superior endplate of L4 to the sacrococcygeal joint to clearly delineate the L5–S1 intervertebral space. The L5–S1 level was identified by sterile palpation and a 2-cm midline incision was made down to the thoracolumbar fascia. The spinous process of L4 was exposed and a navigation clamp was placed.

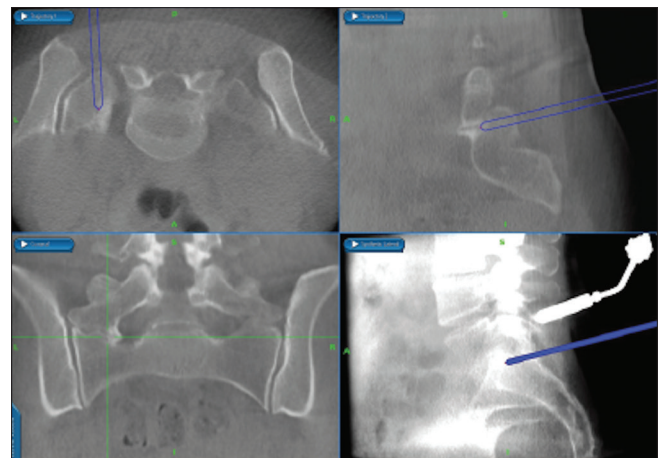
The O-arm was used to localize the L5-S1 transitional segment [Figure 2]. A paramedian vertical incision was made over the posterior superior iliac spine and the anomalous transverse process was exposed. Under the operating microscope, the transverse processes and adjacent muscular and ligamentous attachments were carefully removed to expose the sacral ala. A high-speed drill was used to resect the L5 transverse process up to its junction with the vertebral body. Adequate resection of the anomalous transverse process was confirmed with the O-Arm [Figure 3; right panel]. At 6 and 9 months, respectively, both patients were asymptomatic.

## DISCUSSION

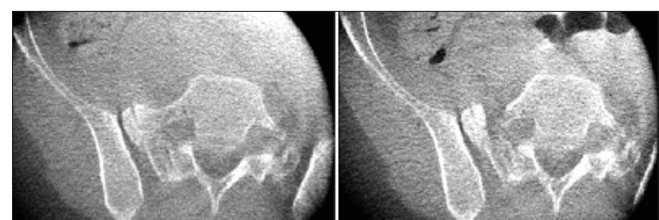
Bertolotti's syndrome was first described in 1917 by Italian physician Mario Bertolotti. The incidence ranges from 4% to 15% and the prevalence is between 4% and 36%. Quinlan *et al.* reviewed 35 patients with Bertolotti's syndrome and reported a mean age of



**Figure 1: Patient 1: Computed tomography of the lumbar spine in coronal (left panel, a) and axial (right panel, b) planes that reveal the transitional segments of L5 and pseudoarticulation with the sacral ala**



**Figure 2: Navigation workstation-based localization of the transitional segment after incision and soft tissue dissection**



**Figure 3: O-arm® images obtained prior to (left panel) and after complete resection of the transitional segment (right panel)**

32.7 years (range: 15 to 60 years).<sup>[2]</sup> The most common symptoms of Bertolotti's syndrome include chronic LBP with or without radiculopathy. Plain anterior and posterior radiographs, CT, and MRI are useful in visualizing the pathology and ruling out other causes of LBP. Surgical management involves excision of the pseudoarthrosis either alone or in combination with an interbody fusion. Anterior and posterior approaches

**Table 1: Synopsis of studies describing patients with Bertolotti's syndrome treated with surgical resection**

Author & year	N	Mean age, yrs	Median follow-up, mos	Procedure	Postoperative complications, n	Complete resolution of LBP, n (%)	Partial resolution of LBP, n (%)
Babu <i>et al.</i> , 2017 (Current Study)	2	28	8	Intraoperative 3D image-guided resection (posterior approach)	None (0)	2 (100)	0 (0)
Li <i>et al.</i> , 2013	7	43	12	MISS tubular resection	Hematoma (1) Radiculopathy (1)	3 (43)	2 (29)
Takata <i>et al.</i> , 2014	1	45	NR	MISS resection and discectomy	None (0)	0 (0)	1 (100)
Malham <i>et al.</i> , 2013	2	38	24	Anterior pseudoarthrectomy	None (0)	1 (50)	1 (50)
Almeida <i>et al.</i> , 2009	2	55	NR	Resection	None (0)	2 (100)	0 (0)
Ugokwe <i>et al.</i> , 2008	1	40	6	MISS resection	None (0)	0 (0)	1 (100)
Reitsma <i>et al.</i> , 2002	2	38	12	Resection	None (0)	2 (100)	0 (0)
Santavirta <i>et al.</i> , 1993	16	NR	NR	Fusion (n=8), resection (n=8)	NR	7 (44)	10 (63)

MISS: Minimally invasive spine surgery, LBP: Low back pain, NR: Not reported

have been reported in the literature with the latter being most commonly employed (including in the present cases).

Li *et al.* described 7 patients who underwent minimally invasive paramedian tubular-based resection of anomalous transverse processes; 5 (71%) of these patients experienced either complete or partial resolution of pain after surgery.<sup>[1]</sup> Santavirta *et al.* reported 16 patients treated with posterolateral fusion (n = 8, 50%) and resection of the transitional articulation (n = 8, 50%); 6 patients (38%) required repeat surgeries.<sup>[3]</sup> Other small series have described favorable results following surgical decompression/resection [Table 1].

## CONCLUSION

Bertolotti's syndrome is readily diagnosed on imaging of the spine. Intraoperative 3D imaging and a navigation

guidance-based approach resulted in complete resection of anomalous transverse processes in two patients, and excellent outcomes were achieved.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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