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## Case Report

# Spinal Tumor Resection with Intraoperative Computed Tomography Navigation in Tumor-Induced Osteomalacia: A Case Report

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## ABSTRACT

This is the first report using intraoperative CT navigation for Tumor-induced Osteomalacia (TIO) lesions of the spine. TIO is a rare paraneoplastic disorder caused by tumors secrete Fibroblast growth factor 23 secreted by tumor tissue. Surgical resection of the main tumor is the only definitive treatment. However, the tumor is usually small, and it hard to find it, and it tends to be seen when the recurrence is caused by the difficulty of whole tumor resection. A 57-year-old woman presented with a rare case of TIO located in T10 vertebra body. Using the intraoperative CT navigation, we resected the tumor in the T10 vertebral body very effective for accurate localization of the tumor and helpful for guidance of resection area and confirmation for excision of tumor. As a treatment for TIO, we report a tumor resection with intraoperative computed tomography navigation that made it possible to resect tumor in T10 vertebrae precisely and safely, which is small and difficult and dangerous access.

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## Introduction

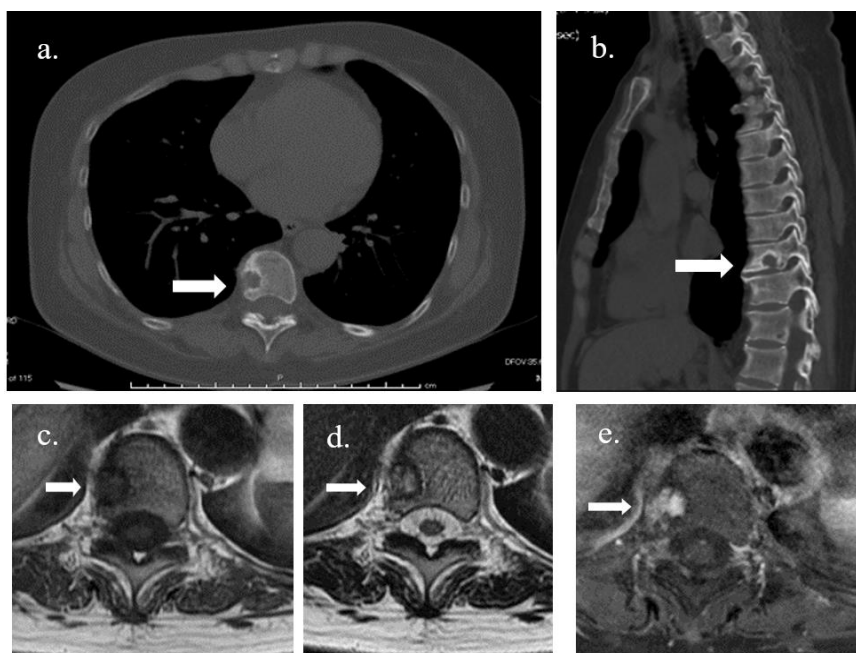
The ideal treatment for Tumor-Induced Osteomalacia (TIO) is complete tumor resection with wide margins of the responsible tumor to avoid recurrence [1]. However, complete tumor resection is sometimes difficult, for example, tumor in the spine, because of its small size and/or difficult or dangerous location to access. As a treatment of TIO, we report a tumor resection using intraoperative computed tomography (CT)-guided navigation that made it possible to resect a tumor at the T10 vertebra precisely and safely.

## Case Report

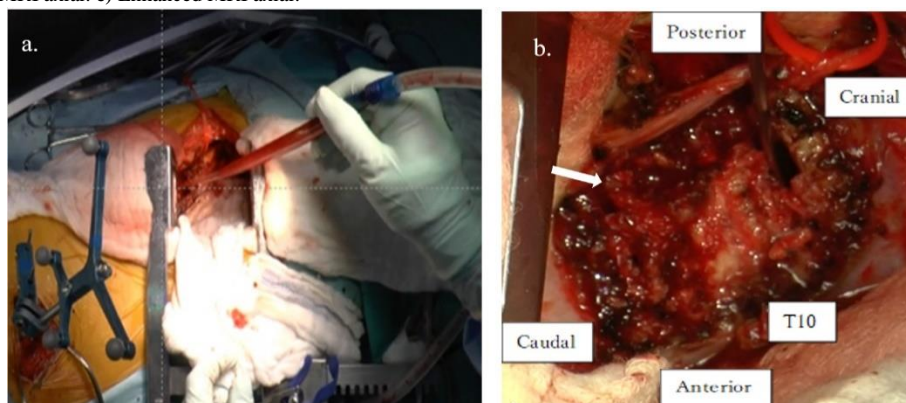
A 57-year-old woman presented to our department for consultation regarding TIO treatment and resection of the tumor in the T10 vertebral

body. The patient had a history of multiple rib fractures one year prior to the presentation and a 2-year history of back and buttock pain that progressively worsened. She was suspected of having TIO based on her history of multiple rib fractures and laboratory data. These laboratory test results showed the following: elevated plasma parathyroid hormone (PTH) (104pg/mL) with low serum phosphorus (1.7mg/dL), normal serum calcium (9.6mg/dL) and high serum fibroblast growth factor 23 levels (FGF23) (97pg/mL). Anatomic imaging with CT and magnetic resonance imaging (MRI) showed a 15x20mm in size tumor involving the posterior right lateral side of the T10 vertebral body (Figure 1). The preoperative CT-guided biopsy was histopathologically compatible with a Phosphaturic Mesenchymal Tumor (PMT). The patient agreed to undergo the transthoracic tumor resection utilizing intraoperative CT-guided navigation.

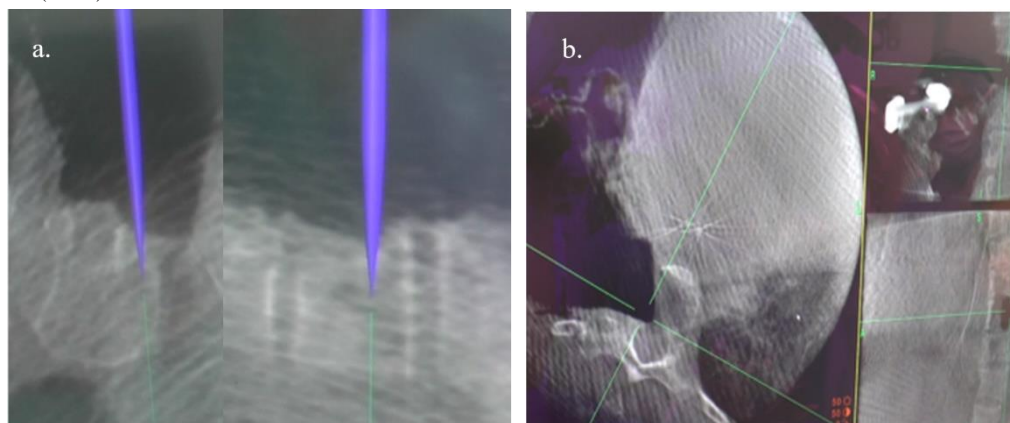
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**Figure 1:** Anatomical imaging in Tumor-Induced Osteomalacia. Right lateral of the vertebral body of T10. **a)** CT axial. **b)** CT sagittal. **c)** T1-weighted MRI axial. **d)** T2-weighted MRI axial. **e)** Enhanced MRI axial.



**Figure 2:** Intraoperative photographs. **a)** Intraoperative overall photograph. **b)** Approaching the right side of the T10 vertebral body. Phosphaturic mesenchymal tumor (arrow).



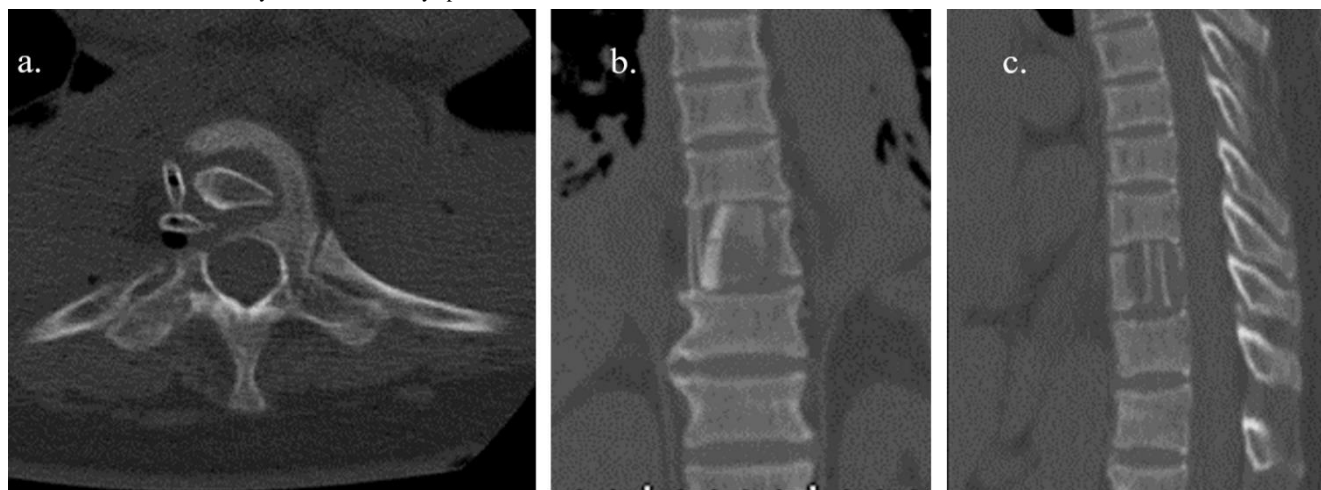
**Figure 3:** Intraoperative navigation and 3D images. **a)** Based on the intraoperative navigation images, we checked the tumor location and resected the total area of the tumor. **b)** Once tumor resection was performed, we performed a second intraoperative 3D scan to confirm that no tumor was left.

The patient was positioned on the left side under general anaesthesia, and intraoperative neurological monitoring was applied. After a diagonal 15-cm skin incision was made along the eighth right rib,

followed by removal of about 12cm of the rib; incision of the rib periosteum and pleura; and degassing the right lung, the lateral side of vertebral bodies between T9 and T11 was visible (Figure 2). A dynamic

reference frame for the spinal navigation was placed on the right iliac crest, and then a 3D scan was acquired. Based on these intraoperative 3D images, we identified the tumor location and performed a piece-by-piece tumor resection (Figure 3a). Thereafter, we immediately performed a second intraoperative 3D scan to confirm that no tumor was left (Figure 3b). Iliac bone graft was used to reconstruct the tumor resection defect. Tumor resection was safely and successfully performed with no

intraoperative complications. Postoperative day 3 CT images confirmed a complete tumor removal with adequate resection margins (>5mm) (Figure 4), and serum phosphorous levels increased to 3.4 mg/dL at the time of 3 weeks after tumor resection. Postoperative histopathology revealed PMT. At 1-year postoperatively, the patient's follow-up has been uneventful, and her clinical course has been good.



**Figure 4:** Postoperative CT images confirming no residual tumor. Postoperative CT images confirmed that the tumor was resected with enough margins and the iliac bone graft was well-positioned. **a)** CT axial. **b)** CT coronal. **c)** CT sagittal.

## Discussion

TIO is a rare paraneoplastic syndrome and is curable by the causative tumor resection [2]. To date, approximately 500 cases of TIO have been reported [3]. TIO is commonly located in the craniofacial regions and limbs [1]. Only 20 spine tumor cases have been reported in the literature [4]. The refractory rate of TIO overall was reported to be 18.3% but highest in spine tumors (77.8%) [5]. Due to the complexity of spinal anatomy, complete resection of PMTs is often difficult and may easily lead to many complications [6]. Our case of TIO, PMT located in the 10<sup>th</sup> thoracic vertebral body, was exceedingly rare and with high refractory risk. We performed tumor resection with an intraoperative CT navigation. It enabled visualization of accurate localization of the tumor and guidance in the resection area and ensured the complete resection of the tumor with wide margins without any complications. To our knowledge, no previous study has reported navigation-assisted tumor resecting surgery in patients with TIO located at the thoracic vertebrae. This approach should be considered an effective and safe treatment option in similar cases.

## Author Contributions

Koichi Endo and Hideyuki Arima wrote and prepared the manuscript, and all of the authors participated in the study design. All authors have read, reviewed, and approved the article.

## Conflicts of Interest

None.

## Funding

None.

## Consent

An informed consent was obtained from the patient.

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