### Abstract

**Background Data:** Spinal Giant Cell Tumor (SGCT) is rare with incidence of 2-15% out of GCT in all bones and incidence in the mobile segment of spine is 2-4%. Due to high recurrence rates a wide variety of available treatment modalities have been explored for the management.

**Purpose:** We are presenting 2 cases, thoracic and lumbar Giant Cell Tumor with pathological vertebral fractures, treated with subtotal spondylectomy and 360° stabilization following preoperative Selective Arterial Embolization (SAE) without use of denosumab with no recurrence on follow up.

**Study Design:** Case presentation.

**Patients and Methods:** Presenting 2 cases 1 thoracic and another lumbar pathological fractures, diagnosed with giant cell tumor based on CT scan and MRI appearance and confirmed with histopathology of transpedicular biopsy specimen. Both were managed with preoperative selective arterial embolization followed by near total spondylectomy through anterior and posterior combined approach and fusion, without denosumab therapy.

**Conclusion:** Preoperative SAE makes intrallesional total excision of tumor easy by reducing hemorrhage. Total intrallesional resection of vertebrae through anterior retroperitoneal and posterior approach is associated with satisfactory local control of lesion.
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
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</thead>
<tbody>
<tr>
<td>Do you have any conflicts of interest?</td>
<td>No, I do not have any conflicts of interest</td>
</tr>
<tr>
<td>Please download, review <a href="#">The Submission Agreement</a>, and check the &quot;I Accept&quot; box below to indicate your consent to its terms.</td>
<td>I Accept</td>
</tr>
</tbody>
</table>
May 4, 2023

Editorial Department of Egyptian Spine Journal,

Respected Editor,

I am submitting a manuscript for consideration of publication in Egyptian Spine Journal. The manuscript is entitled “GIANT CELL TUMORS OF DORSAL AND LUMBAR SPINE: MANAGEMENT WITH 360 DEGREE FUSION”.

It has not been published elsewhere and that it has not been submitted simultaneously for publication elsewhere.

Thank you very much for your consideration.

Yours Sincerely,

Dr. Nishad Situt,
Sancheti Institute of Orthopaedics and Rehabilitation, Pune, Maharashtra, India - 411005
E-mail: situt.nishad@gmail.com

ORCID id: 0000-1676-2486
Title: GIANT CELL TUMORS OF DORSAL AND LUMBAR SPINE: MANAGEMENT WITH 360 DEGREE FUSION

Running Title – Spinal Giant Cell Tumor – 360 degree fusion

Authors –

Dr. Shailesh Hadgaonkar ¹
Email: drshadgaonkar@gmail.com

Dr. Nishad V Situt ²*
Email: situt.nishad@gmail.com

Dr. Pramod D Bhilare ³
Email: pramod.bhilare@gmail.com

Dr. Parag K Sancheti⁴
Email: parag@sanchetihospital.org

1,2,3 = Department of Spine Surgery, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India 411005.

4 = Dean, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India 411005.

Corresponding Author:

Dr. Nishad V Situt

Contact number: 9420036513

Email: situt.nishad@gmail.com

ORCID id : 0000-1676-2486
Statements and Declarations –

Author contributions: (CRediT Author Statement)

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Dr. Shailesh Hadgaonkar and Dr. Pramod Bhilare. The first draft of the manuscript was written by Dr Nishad Situt and critical revision were done by Dr. Pramod Bhilare. Dr. Parag Sancheti: Supervision, project administration.

All authors commented on previous versions of the manuscript.

All authors read and approved the final manuscript.
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Royalties: Funds are coming in to you or your institution due to your patent
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Section 1. Identifying Information

1. Given Name (First Name)  SHAILESH
2. Surname (Last Name)  HADGAONKAR
3. Date  04-May-2023

4. Are you the corresponding author?  ☑ No

Corresponding Author's Name  DR NISHAD SITUT

5. Manuscript Title
GIANT CELL TUMORS OF DORSAL AND LUMBAR SPINE: MANAGEMENT WITH 360 DEGREE FUSION

6. Manuscript Identifying Number (if you know it)

Section 2. The Work Under Consideration for Publication

Did you or your institution at any time receive payment or services from a third party (government, commercial, private foundation, etc.) for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.)?

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Dr. HADGAONKAR has nothing to disclose.

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1. Given Name (First Name)  
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2. Surname (Last Name)  
   Situt

3. Date  
   04-May-2023

4. Are you the corresponding author?  
   ☑ Yes  ☐ No

5. Manuscript Title  
   GIANT CELL TUMORS OF DORSAL AND LUMBAR SPINE: MANAGEMENT WITH 360 DEGREE FUSION

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Dr. Situt has nothing to disclose.

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2. Surname (Last Name)  
   BHILARE

3. Date  
   04-May-2023

4. Are you the corresponding author?  
   [ ] Yes  [ ] No
   Corresponding Author’s Name  
   DR NISHAD SITUT

5. Manuscript Title  
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2. Surname (Last Name)  SANCHETI  
3. Date  04-May-2023  
4. Are you the corresponding author?  ☑ No  
   Corresponding Author's Name  DR NISHAD SITUT  
5. Manuscript Title  GIANT CELL TUMORS OF DORSAL AND LUMBAR SPINE: MANAGEMENT WITH 360 DEGREE FUSION  
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Dr. SANCHEZ has nothing to disclose.

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To,
Co-Editor and reviewers,
Egyptian Spine Journal.
Subject – Rebuttal Letter for the manuscript of a case report titled Giant cell tumors of dorsal and lumbar spine: management with 360 degree fusion.

Thank you for the reply to the submitted manuscript of a case report with below mentioned title. Sending you the list of corrections as per reviewer’s comments.
Manuscript Number: EMID:b0cd9eefbddd463b
Manuscript Title: Giant cell tumors of dorsal and lumbar spine: management with 360 degree fusion.

**List of corrections:**

<table>
<thead>
<tr>
<th>Reviewer no</th>
<th>Headings</th>
<th>Author Queries / comments</th>
<th>Comments / correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td></td>
<td>Those are 2 interesting cases.</td>
<td>Thank you for your valuable comments.</td>
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<tr>
<td></td>
<td></td>
<td>The abstract is well structured with clear objectives</td>
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<td></td>
<td></td>
<td>The images are very clear and very illustrative of both cases</td>
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<td></td>
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<td>The discussion includes a very good literature review of the different treatment modalities of the pathology</td>
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<tr>
<td>2)</td>
<td></td>
<td>meaning of the abbreviations CT, MRI, PET- CT and FDG-18 should be mentioned on first use.</td>
<td>Full forms of the above-mentioned abbreviations have been added at their first use.</td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
<td>&quot;Due to high recurrence rates and a wide variety of available treatment modalities have been</td>
<td>Due to high recurrence rates a wide variety of available treatment modalities have been</td>
</tr>
<tr>
<td>Introduction</td>
<td>Different modalities of treatments have been tried for SGCT like arterial embolization, use of denosumab, surgical resection of tumor, post resection radiotherapy etc</td>
<td>Different modalities of treatments have been tried for SGCT like arterial embolization, use of denosumab, and surgical resection of tumor with or without post resection radiotherapy</td>
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<td>Surgical resection is challenging as it surrounds spinal cord</td>
<td>Surgical resection is challenging due to nearby important structures like the spinal cord, nerve roots, aorta and vena cavae.</td>
<td></td>
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<td>Post-operative challenges like local recurrence and malignant transformation have been observed.</td>
<td>Post-operative complications include mainly local recurrence and malignant transformation.</td>
<td></td>
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<tr>
<td>Case presentation, case 1</td>
<td>normal sr. calcium</td>
<td>normal serum calcium</td>
<td></td>
</tr>
<tr>
<td>Case presentation, case 2</td>
<td>Then for corpectomy, right lateral position was given, anterior retroperitoneal approach was utilized to approach L4 body.</td>
<td>Then for corpectomy, anterior retroperitoneal approach in the right lateral position was utilized.</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Spinal Giant Cell Tumor (SGCT)&quot; meaning of the abbreviation SGCT was previously mentioned</td>
<td>SGCT</td>
<td></td>
</tr>
<tr>
<td><strong>Use of few of the above-mentioned modalities become challenging in spine due to proximity to spinal cord; which leads to incomplete resection of tumor and increased incidence of local recurrence- 25-30%</strong></td>
<td><strong>En block excision of SGCT is challenging due to proximity to spinal cord that favor piecemeal excision with higher recurrence rate</strong></td>
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<td><strong>Luksanapruska et al reviewed patients with SGCT they recommended...</strong></td>
<td><strong>Luksanapruska et al reviewed patients with SGCT and they recommended...</strong></td>
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<td><strong>However total spondylectomy is associated with more complications like intraoperative bleeding, post op neurological deficit etc</strong></td>
<td><strong>However total spondylectomy is associated high morbidity and mortality</strong></td>
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<td><strong>Xu et al in their retrospective study of 102 patients in mobile segment SGCT studied 2 years recurrence free survival rate and observed that patients who underwent anterior only surgery has poorest recurrence free survival rate than subtotal and total spondylectomy.</strong></td>
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<td><strong>What does the abbreviation &quot;RFS&quot; stand for?</strong></td>
<td><strong>Recurrence free survival</strong></td>
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<td><strong>Preoperative Selective Arterial Embolization</strong></td>
<td><strong>SAE , PVA (abbreviations used)</strong></td>
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(SAE) is done with Gelfoam particles or Poly Vinyl Alcohol (PVA)

| Conclusion | Total intralesional resection of vertebrae through anterior retroperitoneal and posterior approach | Total intralesional resection of vertebrae through anterior retroperitoneal or thoracotomy approach and posterior approach is associated with satisfactory local control of lesion. |
| Figure legend | T2 WI | T2 weighted images |
| | T1 WI | T1 weighted images |
| | AP | Antero-posterior |
| | sagittal and axial rection | sagittal and axial section |

I am worry about the stability of the construct in case 2 as the authors used only one level above and one level below the corpectomy level. I do believe that L4 corpectomy will cause a major instability that needs posterior fixation for 2 levels above and 2 levels below

As anterior reconstruction was very stable with expandable cage with posterior support as well in a thin young female with good quality bone and strong screw purchase only 1 level above and below level was fixed to preserve motion segments.
Kindly consider our case report for publication in your journal.
Thank you.

Yours Sincerely,
Dr. Nishad Situt,
Sancheti Institute of Orthopaedics and Rehabilitation, Pune, Maharashtra, India -411005
E-mail: situt.nishad@gmail.com

ORCID id: 0000-1676-2486
Giant Cell Tumours of Dorsal and Lumbar Spine: Management With 360 Degree Fusion
Shailesh Hadgaonkar, MD., Nishad V Situt, MD., Pramod D Bhilare, MD., Parag K Sancheti, MD.
Spine Surgery Department, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India 411005.

Abstract

Background Data: Spinal Giant Cell Tumor (SGCT) is rare with incidence of 2-15% out of GCT in all bones and incidence in the mobile segment of spine is 2-4%. Due to high recurrence rates a wide variety of available treatment modalities have been explored for the management.

Purpose: We are presenting 2 cases, thoracic and lumbar Giant Cell Tumor with pathological vertebral fractures, treated with subtotal spondylectomy and 360° stabilization following preoperative Selective Arterial Embolization (SAE) without use of denosumab with no recurrence on follow up.

Study Design: Case presentation.

Patients and Methods: Presenting 2 cases 1 thoracic and another lumbar pathological fractures, diagnosed with giant cell tumor based on CT scan and MRI appearance and confirmed with histopathology of transpedicular biopsy specimen. Both were managed with preoperative selective arterial embolization followed by near total spondylectomy through anterior and posterior combined approach and fusion, without denosumab therapy.

Conclusion: Preoperative SAE makes intralesional total excision of tumor easy by reducing hemorrhage. Total intralesional resection of vertebrae through anterior retroperitoneal and posterior approach is associated with satisfactory local control of lesion.

Keywords: spinal giant cell tumor, spinal tumor, spondylectomy, selective arterial embolization, anterior-posterior combined fusion.

Corresponding Author:
Nishad V Situt, MD.
Spine Surgery Department, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India 411005.
Email: situt.nishad@gmail.com
ORCID: 0000-1676-2486

Introduction:
The giant cell tumor (GCT) also known as osteoclastoma is a locally aggressive benign primary bone tumor, commonly seen in skeletally mature individuals in the metaphysis of long bones.[1] Spinal Giant Cell Tumor (SGCT) is rare with incidence of 2-15% out of GCT in all bones, sacrum forms the most common site for SGCT seen in 1.7-8.2% cases and incidence in the mobile segment of spine is 2-4%. It commonly presents as pain in an over affected region of spine and may be associated with variable amount of weakness depending up on degree of cord compression. Different modalities of treatments have been tried for SGCT like arterial
embolization, use of denosumab and surgical resection of tumor with or without post resection radiotherapy etc [2,3] Surgical resection is challenging due to proximity to vital structures like spinal cord, nerve roots and major vessels [4]. Post operative complications include mainly local recurrence and malignant transformation [2]. We are presenting 2 cases, first with thoracic (D8) and second with lumbar (L4) GCT with collapsed unstable vertebra treated with subtotal spondylectomy and 360° stabilization following preoperative Selective Arterial Embolization (SAE) without use of denosumab with no recurrence on follow up.

Case presentation:

Case 1
A 30 year old male presented in the spine clinic of tertiary care orthopedic hospital with complaints of dorsal back pain for 3 months which was radiating along the right side of the trunk. On examination bilateral knee and ankle reflexes were brisk and the Babinski sign was positive, however there was no sensory or motor deficit. On radiological examination x-ray was suggestive of D8 vertebral osteolytic lesion with pathological fracture with reduced vertebral body height. On blood investigations he was having anemia with Hb 9 mg/dl, Erythrocyte Sedimentation Rate (ESR) was 56, normal serum calcium, phosphorus and vitamin D values. Magnetic Resonance Imagining (MRI) of thoracic spine (Figure 1) was suggestive of pathological fracture at D8 vertebral body with convexity of posterior cortex of body. Hypointensity on T1 as well as T2 weighted images and hyperintensity on Short Tau Inversion Recovery (STIR) images with paraspinal soft tissue edema which was going in favour of neoplastic etiology. Computed Tomography (CT) guided trans-pedicular biopsy (figure 2 A, B) was done and was sent for microbiological and histopathological evaluation, which was suggestive of GCT (figure 2 C). Preoperative SAE was done 4-6 hours prior to definitive surgical intervention. Complete obliteration of the vessel was confirmed. Anterior corpectomy and reconstruction of the anterior column followed by posterior stabilization was planned during the same session. In the left lateral position, the right thoracotomy approach with rib resection was utilized to approach the D8 body. Piecemeal near-total corpectomy was done and reconstructed with mesh cage and screw with clip and rod construct. Followed by posterior midline exposure in prone position and D6-10 instrumented fusion done with pedicle screws and rods (Figure 3 B, C).

Case 2
A 25 years old female presenting in the spine clinic of tertiary care orthopedic hospital with complaints of lower back pain of non-radiating nature for 4 months. For which x-ray was done elsewhere and she was diagnosed with fracture of L4 vertebra for which she was on conservative management with bed rest. Fifteen days back, the patient's symptoms aggravated after an episode of jerk while traveling by car. On examination axial tenderness was present at lower lumbar region with no sensory or motor neurological deficit. Fresh x-ray was suggestive of L4 vertebral osteolytic expansile lesion within the body with a thinned out anterior cortex with pathological fracture. CT scan was suggestive of involvement of right pedicle and body (Figure 4). MRI showed hyperintense signals in T1 and T2 weighted images and hyperintensity on STIR images with convexity of posterior margin of L4 vertebral body suggesting neoplastic etiology (Figure 5). Positron Emission Tomography (PET-CT) scan showed increased uptake of Fluorodeoxyglucose
(FDG) -18 tracer (Figure 6 A) with no other location of increased uptake. C-arm guided L4 transpedicular biopsy was done and the sample was sent for microbiological and histopathological evaluation. The diagnosis of GCT was confirmed on histopathological evaluation (figure 6 B). Preoperative SAE of the feeding vessel was done 4-6 hours prior to definitive surgical intervention (Figure 6 C, D). Complete obliteration of the vessel was confirmed. Posterior stabilization followed by anterior corpectomy and reconstruction of the anterior column was planned. In a prone position through posterior midline approach L3-5 stabilization done, no screws were inserted in the L4 vertebra. L4 laminectomy and right pedicle excision was done. Then for L4 corpectomy, anterior retroperitoneal approach in right lateral position was utilized. Piecemeal near total corpectomy was done and reconstructed with an expandable cage (Figure 7 C). Wound closed in layers. Patient was mobilized in bed for 4 weeks.

Patients were followed up for 4 years and 1 year respectively with follow up CT scans and showed no recurrence.

Discussion

SGCT is a relatively rare entity with incidence of 2-15 % of bone GCT (spinal + appendicular). The incidence of SGCT in the axial skeleton is more in the sacrum (1.7-8.2%) than in the mobile segment of the vertebral column (2-4%). Common age group for SGCT is 20-45 years with equal male to female ratio.[2,3]

En-bloc resection, Curettage, extended curettage – (mechanical and chemical), radiotherapy, arterial embolization are different modalities used for management of GCT in long bones.[3] En-bloc excision become challenging in spine due to proximity to spinal cord; which leads to incomplete resection of tumor and increased incidence of local recurrence- 25-30%.[5] Luksanapruska et al reviewed patients with SGCT and they recommended approach to tumor depends on Weinstein, Boriani, Biagini classification;[6] if posterior elements are also involved then total spondylectomy with 3 column reconstruction is indicated; however total spondylectomy is associated high morbidity and mortality.[2] Total spondylectomy has better recurrence free survival rate than subtotal spondylectomy.[7] Intralesional curettage is associated with increased local recurrence.[8]

Anterior and posterior approach ensures complete resection of tumor and instrumentation through both approaches, total or subtotal spondylectomy mandates anterior reconstruction along with posterior instrumented fusion.[9] In our 2 cases we performed gross-total spondylectomy with 360° stabilization. Posterior fixation with anterior column reconstruction ensures adequate tumor resection, less incidence of recurrence, and prevents delayed collapse of anterior column. Total spondylectomy is challenging and not possible in all cases due to proximity with neural structure and other vital vascular structures which increase the risk of recurrence, adjuvant therapy plays an important role in such cases.

Preoperative SAE is done with Gelfoam particles or Poly Vinyl Alcohol (PVA), it reduces blood flow to tumor mass which significantly reduces intraoperative bleeding, maintaining clean surgical field and allows piecemeal resection.[2] SAE doesn’t influence recurrence of SGCT.[7] It reduces tumor vascularity, size and stimulates re-ossification. Preoperative SAE was studied by Zhou et al in 28 patients with SGCT, they performed intralesional resection of tumors and
reconstruction within 48 hrs of embolization, the average blood loss was 1500 ml as compared to without embolization which was 7500 ml as per literature review. In our cases we used preoperative PVA embolization within 12 hours of surgery, which reduced intraoperative bleeding significantly, helped in intralesional resection of tumor and allowing both the procedures to be done at same time.

In the past few years, the role of denosumab in the treatment of bone GCT and SGCT has been extensively studied. It can either be used as monotherapy if en-bloc excision of tumor is not possible or wide local excision is too morbid. Adjuvant denosumab therapy is debatable - few studies recommend it after intralesional resection of GCT. Neoadjuvant therapy with denosumab 120 mg is recommended monthly for 3-4 months, which cause neocortex formation and osteoid formation within the lesion, on histological evaluation disappearance of giant cells, it is replaced by fibrous tissue with is less vascular. However few studies have observed cellular atypia and haphazard osteoid deposition within the tumor showing resemblance with osteosarcoma. Scoccianti et al observed 47 % recurrence with use of denosumab as compared to 12% recurrence with resection alone and Chinder et al observed 42% recurrence with denosumab use and 18.5 % recurrence with curettage. Palmerini et al in their study observed higher recurrence rate after discontinuation of long term denosumab. Hence in both the cases we are reporting, denosumab therapy pre or post operatively was not used.

Post operative radiotherapy is indicated in cases where incomplete resection is done, to reduce recurrence rate. Use or postoperative RT is controversial as complications like myelitis, malignant transformation, bone graft related complications. Other indications are recurrent GCT, inoperable tumor.

**Conclusion**

SGCT is a highly vascular tumor with high incidence of local recurrence, preoperative SAE makes intralesional total excision of tumor easy by reducing hemorrhage. Total intralesional resection of vertebrae through anterior retroperitoneal or thoracotomy approach and posterior approach is associated with satisfactory local control of lesion.

**Abbreviations:**

CT Scan – Computed Tomography Scan
FDG- Fluorodeoxyglucose
GCT – Giant Cell Tumor
MRI – Magnetic Resonance Imaging
PET-CT – Positron Emission Tomography – Computed Tomography
PVA – Poly Vinyl Alcohol
SAE – Selective Arterial Embolization
SGCT – Spinal Giant Cell Tumor
STIR – Short Tau Inversion Recovery
WI – Weighted Images

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Preoperative Denosumab With Curettage and Cryotherapy


الملخص العربي

ورم الخلايا العملاقة في العمود الفقري الظهري والقطني: الإدارة من خلال اندماج 360 درجة

البيئات الخلفية: ورم الخلايا العملاقة في العمود الفقري (GCT) نادر الحدوث بنسبة 2-15٪ من GCT في جميع العظام ونسبة الإصابة في الجزء المتحرك من العمود الفقري هي 2-4٪. نظرًا لارتفاع معدلات التكرار، تم استكشاف مجموعة واسعة من طرق العلاج المتاحة للإدارة.

الغرض: نحن نعرض حالتين، ورم الخلايا العملاقة الصدرى والقطني مع كسور فقرية مرضية، تم علاجهما عن طريق استئصال الفقار الجزئي وتثبيت 360 درجة بعد الانصمام الشرياني الانتقائي قبل الجراحة (SAE) دون استخدام دينوسوماب مع عدم تكرار ذلك عند المتابعة.

تصميم الدراسة: عرض الحالة.

المرضى والطرق: عرض حالتين، إحداهما كسور مرضية في الصدر والآخرى في أسفل الظهر، تم تشخيصهما على أنها ورم في الخلايا العملاقة بناءً على مظهر الأشعة المقطعية والتصوير بالرنين المغناطيسي وتم تأكيدها من خلال التشريح المرضي لعينة زعامة عبر العمود الفقري. تم إجراء كلاهما عن طريق الانصمام الشرياني الانتقائي قبل الجراحة مباعًا باستئصال الفقار الكلي تقريبًا من خلال النهج المشترك الأمامي والخلفي والاندماج، دون علاج بالدينوسوماب.

الخلاص: قلب الجراحة SAE يجعل الاستئصال الكلي للورم داخل الآفة سهلًا عن طريق الحد من النزيف، ويرتبط الاستئصال الكامل لل الفقرات داخل الآفة من خلال النهج الأمامي خلف الصفاق والخلفي بالسيطرة المحلية المرضية على الآفة.

A B C D E F
Figure 1: A, B) T2 weighted images sagittal and axial - D8 lesion with hypointense signals with convex posterior surface of body with cord compression. C, D) T1 weighted images sagittal and axial - D8 lesion with hypointense signals with paravertebral soft tissue invasion. E, F) sagittal and coronal STIR images – hyperintense lesion with paraspinal invasion.

A

B

C

Figure 2: A, B) sagittal and axial image during CT guided transpedicular biopsy with jamshidi needle in situ (white arrow). C) Higher power histopathology slide image – multinucleated giant cells (black arrow) surrounded by spindle cells.

A

B

C

Figure 3: A) Intraoperative image of expandable cage after intralesional resection through anterior retroperitoneal. B, C) Post operative xrays AP, lateral view- anterior column reconstruction with expandable cage and screws with clip, posterior fixation with pedicle screws.
4: A, B) Lumbar Anteroposterior and lateral xray - L4 body osteolytic lesion pathological fracture with reduced height thinned anterior cortex (white arrow). C) Sagittal cut of Lumbar CT scan – L4 osteolytic lesion within body with break in end plates (white chevron). D) Axial section CT of L4 vertebra with Weinstein, Boriani, Biagini Classification involving 3 to 9 o’clock region.

5: A, D) Sagittal and axial section T2 WI – showing hypointense lesion in L4 body with convex posterior surface of body (white notched arrow). B, E) Sagittal and axial section T1 WI – showing hypointense lesion in L4 body with no surrounding soft tissue involvement (white arrow). C) Sagittal section STIR – hyperintense signals (white chevron).
6: A) PET CT showing increased FDG uptake in L4 vertebra. B) High power histopathology image showing multinucleated giant cells (black arrow) surrounded by spindle cells. C) Pre embolization digital subtraction angiogram - feeding vessel to tumor. D) Post embolization digital subtraction angiogram.

7: A) Intraoperative image of anterior left retroperitoneal approach after tumor resection. B) post operative xray- anterior column reconstruction with expandable cage and posterior stabilization with pedicle screws.