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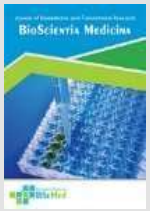

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Complete Neurological Recovery Following 360-Degree Decompression and Fusion for T11 Giant Cell Tumor: A Case Report

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A B S T R A C T

Background: Giant cell tumors (GCTs) are benign but locally aggressive bone tumors that rarely affect the spine. The thoracic spine is an even rarer location for GCTs, and their presentation with paraplegia poses a significant challenge. This case report describes the successful surgical management of a T11 GCT-causing paraplegia, highlighting the importance of early diagnosis and aggressive surgical intervention. **Case presentation:** A 27-year-old female presented with acute paraplegia and a history of chronic lower back pain. Imaging revealed a destructive lesion in the T11 vertebral body with spinal cord compression. The patient underwent a 360-degree decompression, en bloc tumor resection, and posterior spinal fusion. Histopathological analysis confirmed the diagnosis of GCT. The patient experienced complete neurological recovery within five days postoperatively and remained symptom-free at the 5-year follow-up. **Conclusion:** This case demonstrates the feasibility of achieving complete neurological recovery in patients with T11 GCT and paraplegia through aggressive surgical intervention. Early diagnosis and complete tumor resection followed by spinal stabilization are crucial for optimal outcomes.

1. Introduction

Giant cell tumors (GCTs) of bone, while classified as benign, present a unique clinical challenge due to their locally aggressive nature and propensity for recurrence. These neoplasms, characterized by the presence of multinucleated giant cells interspersed within a stroma of mononuclear cells, primarily affect the epiphyseal and metaphyseal regions of long bones in young adults. The most common sites of involvement include the distal femur, proximal tibia, and distal radius. Although GCTs can occur in any bone, their presence in the spine is relatively uncommon, accounting for approximately 1-9% of all cases.[1,2] The pathogenesis of GCTs remains incompletely understood, but it is believed to involve a complex interplay of genetic and environmental factors. The hallmark of these tumors is the overexpression of receptor activator of nuclear factor kappa-B ligand (RANKL), which stimulates osteoclastogenesis and bone resorption. The resulting imbalance between bone formation and resorption leads to the characteristic lytic and expansile lesions observed in GCTs.[3]

The clinical presentation of spinal GCTs varies depending on the tumor's location, size, and extent of involvement. Patients may experience localized pain, radiculopathy, or myelopathy, which can progress to neurological deficits such as weakness, sensory loss, or even paralysis if left untreated.[4] The diagnosis of spinal GCTs often poses a challenge, as their clinical and radiographic features can mimic other conditions, including metastatic disease, aneurysmal bone cysts, and osteomyelitis. A high index of suspicion is crucial, especially in young adults presenting with spinal pain and neurological symptoms. Imaging studies, particularly magnetic resonance imaging (MRI), play a pivotal role in the diagnosis and evaluation of spinal GCTs. MRI provides detailed information about the tumor's location, size, extent of bone and soft tissue involvement, and relationship to critical neurovascular structures. Computed tomography (CT) scans can also be helpful in assessing the degree of bone destruction and planning surgical intervention.[5] However, a definitive diagnosis of GCT requires histopathological examination of a biopsy specimen, which typically reveals the characteristic multinucleated giant cells and mononuclear stromal cells.

The management of spinal GCTs necessitates a multidisciplinary approach involving neurosurgeons, orthopedic surgeons, oncologists, and rehabilitation specialists. The primary goal of treatment is to achieve complete tumor resection while preserving neurological function and spinal stability. Surgical intervention remains the cornerstone of treatment, with various techniques employed depending on the tumor's location, size, and extent of involvement.[6] En bloc resection, where the tumor is removed as a single piece along with a margin of healthy tissue, is the preferred surgical approach whenever feasible. This technique offers the highest chance of achieving complete tumor removal and minimizing the risk of local recurrence. However, en bloc resection may not always be possible, especially in cases with extensive tumor involvement or those located in critical areas such as the sacrum or cervical spine. In such scenarios, intralesional curettage, where the tumor is scraped out from within the bone, may be performed, often in conjunction with adjuvant therapies such as radiotherapy, embolization, or the use of Denosumab, a monoclonal antibody that inhibits RANKL.[7]

The prognosis for patients with spinal GCTs is generally favorable, with long-term survival rates exceeding 90%. However, the risk of local recurrence remains a significant concern, particularly in cases with incomplete resection or those involving the sacrum. Regular follow-up with imaging studies is essential to monitor for recurrence and initiate prompt treatment if necessary.[8] The thoracic spine is an uncommon location for GCTs, accounting for less than 10% of all spinal GCT cases. The presentation of thoracic GCTs with paraplegia is even rarer and poses a unique challenge due to the potential for irreversible neurological damage. The surgical management of these tumors requires meticulous planning and execution to achieve complete tumor resection while preserving spinal cord function and stability. This case report presents a rare and illustrative case of a young female patient with T11 GCT-causing paraplegia. The patient underwent successful surgical treatment with a 360-degree decompression, en bloc tumor resection, and posterior spinal fusion, resulting in complete neurological recovery. This case highlights the importance of early diagnosis, aggressive surgical intervention, and comprehensive rehabilitation in achieving optimal outcomes for patients with spinal GCTs, even in the face of significant neurological compromise. The 360-degree decompression technique, which involves accessing the tumor from both anterior and posterior approaches, has emerged as a valuable tool in the surgical management of spinal GCTs. This approach allows for complete visualization and removal of the tumor, particularly in cases with extensive involvement or those located in challenging anatomical regions such as the thoracic spine. By combining anterior decompression for adequate tumor resection with posterior stabilization for spinal stability, this technique offers a promising solution for achieving optimal outcomes in these complex cases.[9]

The successful outcome in this case also underscores the importance of a multidisciplinary approach in the management of spinal GCTs. The collaboration between neurosurgeons, orthopedic surgeons, oncologists, and rehabilitation specialists is crucial for ensuring comprehensive care and maximizing the patient's chances of recovery. Furthermore, this case emphasizes the critical role of early diagnosis and prompt surgical intervention in preventing irreversible neurological damage and improving long-term outcomes. This case report presents a rare and instructive case of a T11 GCT-causing paraplegia, successfully treated with a 360-degree decompression, en bloc tumor resection, and posterior spinal fusion. The patient's complete neurological recovery highlights the importance of early diagnosis, aggressive surgical intervention, and comprehensive rehabilitation in the management of spinal GCTs. This case contributes to the growing body of literature on the successful treatment of these challenging tumors and provides valuable insights for clinicians involved in the care of patients with spinal GCTs.

2. Case Presentation

The patient, a 27-year-old female, presented to the outpatient clinic with the alarming symptom of acute paraplegia, the loss of motor and sensory function in both lower extremities, which had manifested over the preceding three weeks. The sudden onset of paraplegia was preceded by a three-month history of progressively worsening lower back pain. The pain had intensified in recent weeks, accompanied by the emergence of weakness and abnormal sensations (paresthesias) in her legs. The patient denied any history of trauma, infection, or other significant medical events that could explain her symptoms. Her family history was also unremarkable. The initial physical examination revealed the severity of her condition: the patient exhibited a complete absence of motor and sensory function below the T11 vertebral level, indicating a significant disruption of the spinal cord's ability to transmit signals. The neurological examination was otherwise normal, suggesting that the underlying pathology was localized to the thoracic spine.

Laboratory tests were conducted to rule out systemic causes of her symptoms. The results were largely unremarkable, except for a slightly elevated erythrocyte sedimentation rate (ESR), a non-specific marker of inflammation that can be associated with various conditions, including infections and tumors. To pinpoint the source of the patient's paraplegia, imaging studies were performed. The initial thoracic X-ray revealed a concerning picture: a kyphotic deformity, an abnormal forward curvature of the spine, was evident in the thoracolumbar region. Additionally, the T11 vertebral body, one of the bones in the middle portion of the thoracic spine, showed signs of collapse and a radiolucent lesion, suggesting bone destruction. The X-ray findings prompted further investigation with magnetic resonance imaging (MRI), a powerful tool for visualizing soft tissues and the spinal cord. The MRI scan provided a more detailed view of the pathology: a destructive lesion was identified within the T11 vertebral body, extending into the posterior elements of the spine and encroaching upon the spinal canal. This encroachment resulted in significant compression of the spinal cord, particularly on the right side, explaining the patient's neurological deficits. The combination of clinical presentation, laboratory findings, and imaging results raised a strong suspicion of a spinal tumor, with giant cell tumor (GCT) being a likely possibility given the patient's age and the tumor's location and characteristics. To confirm the diagnosis, a CT-guided biopsy of the T11 lesion was performed. This minimally invasive procedure involves using CT imaging to guide a needle into the lesion to obtain a tissue sample for microscopic examination. The biopsy specimen was sent for histopathological analysis, which revealed the presence of multinucleated giant cells interspersed within a stroma of mononuclear cells, a hallmark of GCT. This confirmed the diagnosis of GCT of the thoracic spine. Following the diagnosis, a multidisciplinary team convened to discuss the optimal treatment strategy. The patient's young age,

the tumor's location and extent, and the presence of paraplegia necessitated aggressive surgical intervention. The team decided on a 360-degree decompression and posterior spinal fusion procedure. This complex surgery involves accessing the tumor from both the front (anterior) and back (posterior) of the spine to achieve complete removal and stabilize the spine.

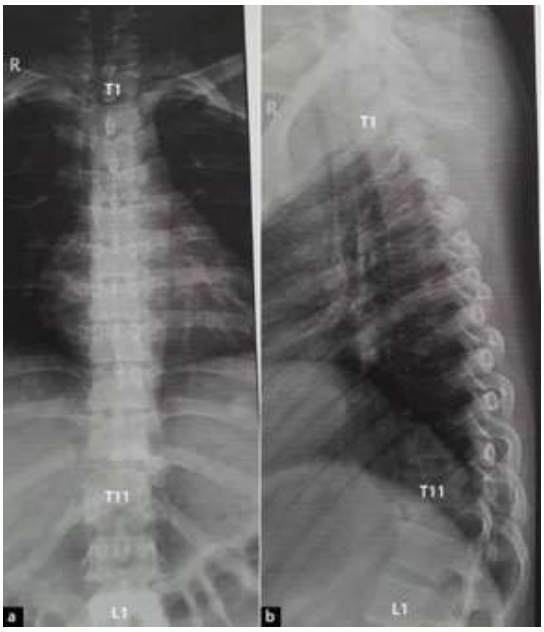

Figure 1. Initial, preoperative (a) anterior-posterior and (b) lateral X-ray.

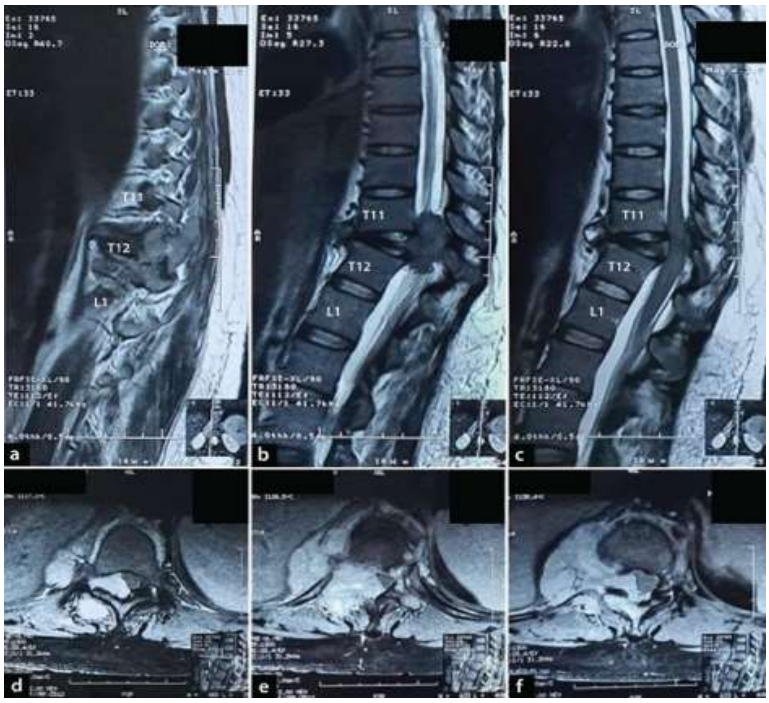

Figure 2. Preoperative sagittal and axial MRI image. (a) Right sagittal paramedian projection at the level of the pedicle's inner border. (b) Right sagittal paramedian and (c) Median projection at the level of the spinal cord. Axial projection at the (d) lower border of the T11 body, (e) T11/T12 intervertebral disc, and (f) upper border of the T12 body.

The patient underwent the planned 360-degree decompression and posterior spinal fusion surgery. The procedure began with a posterior approach, where the surgeons performed a laminectomy (removal of the lamina, the bony arch at the back of the vertebra), pediculectomy (removal of the pedicles, the bony pillars connecting the vertebral body to the lamina), and costotransversectomy (removal of the rib and its attachment to the vertebra) at the T11 level. This allowed access to the spinal canal and the tumor. Next, a corpectomy (removal of the vertebral body) was performed to access the tumor from the front. The surgeons meticulously dissected the tumor from the surrounding tissues, taking care to protect the spinal cord and nerve roots. En bloc resection, the removal of the tumor as a single piece along with a margin of healthy tissue, was achieved, ensuring complete tumor removal and minimizing the risk of recurrence. The resulting spinal defect was then reconstructed using an expandable cage filled with autologous bone graft (bone tissue harvested from the patient's own body). This cage provides structural support and promotes bone fusion. Posterior spinal instrumentation, involving the placement of screws and rods along the spine from T9 to L2, was performed to stabilize the spine and facilitate healing.

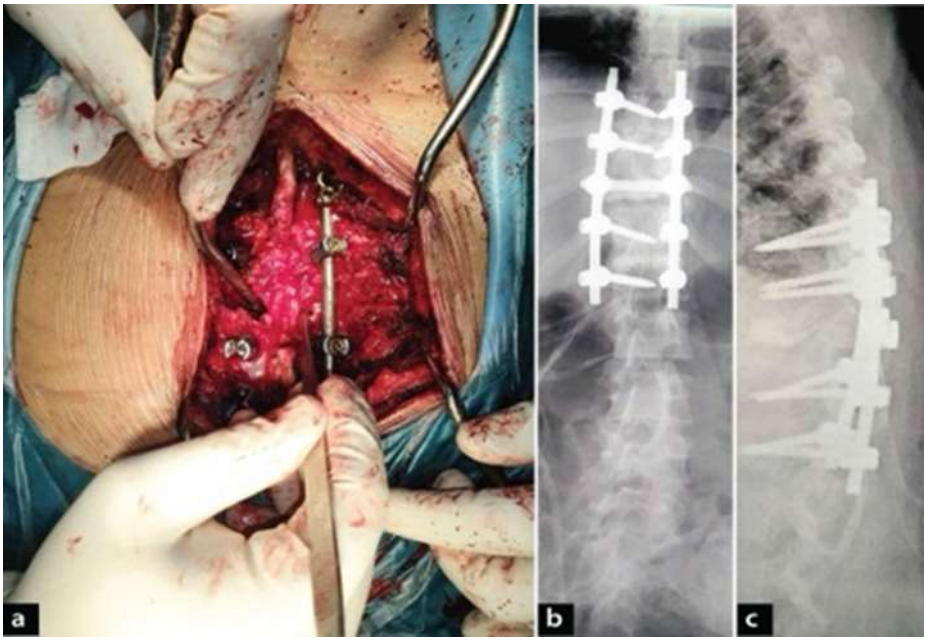

Figure 3. Intraoperative image (a) and immediate postoperative plain radiograph (b and c). Posterior fusion of T9-L2 is shown in (b) anterior-posterior and (c) lateral projection.

Following surgery, the patient was closely monitored in the intensive care unit. Remarkably, she experienced a rapid and significant neurological recovery. Within two days, she regained some motor function and sensation in her lower extremities. By the fifth postoperative day, she was able to stand and walk independently without any assistance or signs of autonomic dysfunction. The patient's recovery continued steadily, and at the four-month follow-up visit, she reported no pain and had regained full motor and sensory function in her lower extremities. An MRI scan confirmed the absence of any residual tumor or recurrence. The patient was able to resume her normal activities of daily living and remained asymptomatic at the five-year follow-up. This case presentation illustrates the successful management of a rare and challenging case of T11 GCT-causing paraplegia. The patient's complete neurological recovery underscores the importance of early diagnosis, aggressive surgical intervention, and comprehensive rehabilitation in achieving optimal outcomes for patients with spinal GCTs.

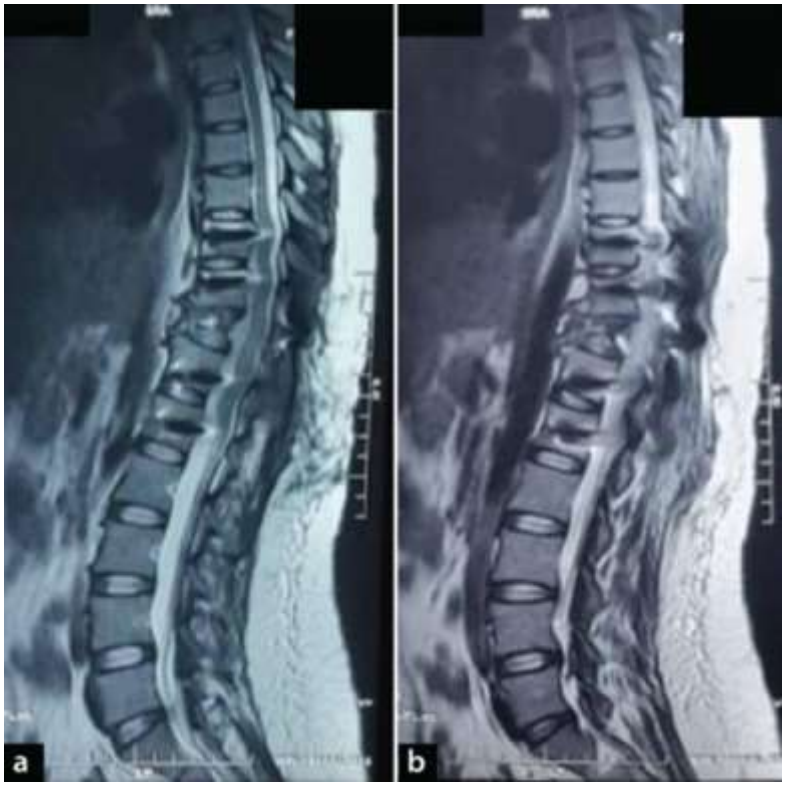

Figure 4. Four-month follow-up sagittal MRI. (a) The median section at the level of the spinal cord. (b) The paramedian section at the level of the pedicle. Show no recurrence of previous spinal GCT at the level of T11.

3. Discussion

The statement that "GCTs, although classified as benign, exhibit a locally aggressive behavior that can lead to significant morbidity" encapsulates the paradoxical nature of these tumors. The term "benign" implies a lack of malignant potential, suggesting a relatively indolent course and favorable prognosis. However, the reality of GCTs is far more complex. The term "locally aggressive" underscores their propensity to invade and destroy surrounding tissues, often leading to pain, pathological fractures, and functional impairment. The potential for significant morbidity, even in the absence of metastasis, highlights the need for vigilant management and a thorough understanding of the underlying pathophysiology. The hallmark of GCTs, the presence of multinucleated giant cells, has long intrigued researchers and clinicians. These giant cells, with their numerous nuclei and abundant cytoplasm, are reminiscent of osteoclasts, the cells responsible for bone resorption. The observation that these giant cells express high levels of tartrate-resistant acid phosphatase (TRAP) and other osteoclast-associated markers further strengthens this association. The current understanding suggests that these giant cells are derived from the monocyte-macrophage lineage and play a crucial role in the bone destruction characteristic of GCTs. The mononuclear stromal cells, on the other hand, are believed to be the true neoplastic component of the tumor, orchestrating the recruitment and activation of the giant cells through the production of various cytokines and growth factors.[10-12]

The pathogenesis of GCTs is intricately linked to the RANK/RANKL/OPG signaling pathway, a critical regulator of bone remodeling. RANKL, a cytokine produced by osteoblasts and stromal cells, binds to its receptor RANK on osteoclast precursors, triggering

their differentiation and activation. Osteoprotegerin (OPG), a decoy receptor for RANKL, acts as a natural inhibitor of osteoclastogenesis by binding to RANKL and preventing its interaction with RANK. In GCTs, an imbalance in this pathway, characterized by increased RANKL expression and decreased OPG production, tips the scales in favor of bone resorption. The resulting overabundance of activated osteoclasts leads to the characteristic lytic and expansile lesions observed in these tumors. The osteolytic nature of GCTs has profound clinical implications. The destruction of bone tissue can weaken the affected bone, predisposing it to pathological fractures, even with minimal trauma. In the spine, the consequences can be even more dire. The collapse of a vertebral body can lead to spinal instability, deformity, and compression of the spinal cord or nerve roots. The thoracic spine, with its relative rigidity and limited space within the spinal canal, is particularly vulnerable to the effects of GCTs. Even small tumors in this region can cause significant neurological compromise, ranging from pain and sensory disturbances to weakness, paralysis, and loss of bowel or bladder control.[12-14]

The case presented in this report exemplifies the challenges associated with GCTs in the thoracic spine. The patient's presentation with acute paraplegia underscores the potential for rapid and devastating neurological deterioration. The tumor's location in the T11 vertebra, a critical region for spinal cord function, further compounded the complexity of the case. The successful outcome achieved through aggressive surgical intervention and comprehensive rehabilitation highlights the importance of a multidisciplinary approach and the potential for complete neurological recovery even in the face of severe spinal cord compression. The intricate interplay between the giant cells and the mononuclear stromal cells, the dysregulation of the RANK/RANKL/OPG signaling pathway, and the resulting osteolytic lesions all contribute to the unique clinical behavior of GCTs. Understanding these pathophysiological mechanisms is crucial for developing effective treatment strategies and improving outcomes for patients with this challenging condition. Continued research in this field is essential for unraveling the remaining mysteries surrounding GCTs and paving the way for novel therapeutic approaches that can target the underlying molecular drivers of tumor growth and recurrence.[14-16]

The pathogenesis of giant cell tumors (GCTs) is a complex and multifaceted process that involves the interplay of various cellular and molecular factors. The hallmark of these tumors is the presence of multinucleated giant cells, which are believed to be derived from the monocyte-macrophage lineage. These giant cells, while not inherently malignant, play a crucial role in the tumor's locally aggressive behavior by mediating bone resorption and tissue destruction. The mononuclear stromal cells, on the other hand, are considered the true neoplastic component of the tumor, orchestrating the recruitment and activation of the giant cells through the production of various cytokines and growth factors. The RANK/RANKL/OPG signaling pathway, a key regulator of bone remodeling, is central to the pathogenesis of GCTs. The overexpression of RANKL, a cytokine that stimulates osteoclastogenesis, and the downregulation of OPG, a decoy receptor for RANKL, create an imbalance that favors bone resorption over bone formation. The resulting osteolytic lesions, characterized by the destruction of bone tissue, can lead to significant morbidity, including pain, pathological fractures, and functional impairment.[15-17]

In the context of the spine, the consequences of GCTs can be particularly severe. The collapse of a vertebral body due to bone destruction can lead to spinal instability, deformity, and compression of the spinal cord or nerve roots. The thoracic spine, with its relative rigidity and limited space within the spinal canal, is especially vulnerable to the effects of GCTs. Even small tumors in this region can cause significant neurological compromise, ranging from pain and sensory disturbances to weakness, paralysis, and loss of bowel or bladder control. The case presented in this report, where a T11 GCT resulted in paraplegia,

underscores the potential for devastating neurological sequelae if these tumors are not promptly diagnosed and treated. The molecular underpinnings of GCTs are complex and involve a multitude of genetic and epigenetic alterations. The most common genetic alteration is a telomeric translocation involving chromosomes 11 and 22, resulting in the fusion of the COL1A1 and USP6 genes. This fusion gene encodes a chimeric protein that promotes cell proliferation and survival, contributing to the tumor's growth and aggressiveness. Other genetic alterations, including mutations in the H3F3A gene and alterations in the PI3K/AKT/mTOR signaling pathway, have also been implicated in GCT pathogenesis.[10,11]

The tumor microenvironment also plays a crucial role in GCT development and progression. The mononuclear stromal cells, in addition to producing RANKL, secrete a variety of other cytokines and growth factors that promote angiogenesis, recruit inflammatory cells, and suppress the immune response. This creates a permissive environment for tumor growth and invasion. The giant cells, through their bone-resorbing activity, further contribute to the tumor's destructive potential and facilitate its expansion into surrounding tissues.[12] The clinical presentation of spinal GCTs is often insidious, with pain being the most common initial symptom. The pain may be localized to the affected spinal segment or radiate along the distribution of the compressed nerve roots. As the tumor grows and compresses the spinal cord, neurological deficits may ensue, ranging from mild weakness and sensory disturbances to complete paralysis and loss of bowel or bladder control. The rate of progression can vary, but in some cases, as exemplified in this report, the neurological decline can be rapid and devastating.

The diagnosis of spinal GCTs relies on a combination of clinical, radiographic, and histopathological findings. Imaging studies, particularly MRI, are essential for characterizing the lesion and assessing its extent. The typical MRI appearance of a GCT is a well-defined, expansile, lytic lesion with a heterogeneous signal intensity. The tumor may extend into the surrounding soft tissues and cause compression of the spinal cord or nerve roots.[13] However, a definitive diagnosis requires a histopathological examination of a biopsy specimen, which reveals the characteristic multinucleated giant cells and mononuclear stromal cells. The management of spinal GCTs is complex and requires a multidisciplinary approach. The primary goal of treatment is to achieve complete tumor resection while preserving neurological function and spinal stability. Surgical intervention remains the cornerstone of treatment, with various techniques employed depending on the tumor's location, size, and extent of involvement. En bloc resection, where the tumor is removed as a single piece along with a margin of healthy tissue, is the preferred approach whenever feasible. This technique offers the highest chance of achieving complete tumor removal and minimizing the risk of local recurrence. However, en bloc resection may not always be possible, especially in cases with extensive tumor involvement or those located in critical areas such as the sacrum or cervical spine. In such scenarios, intralesional curettage, where the tumor is scraped out from within the bone, may be performed, often in conjunction with adjuvant therapies such as radiotherapy, embolization, or the use of Denosumab, a monoclonal antibody that inhibits RANKL. The prognosis for patients with spinal GCTs is generally favorable, with long-term survival rates exceeding 90%. However, the risk of local recurrence remains a significant concern, particularly in cases with incomplete resection or those involving the sacrum. Regular follow-up with imaging studies is essential to monitor for recurrence and initiate prompt treatment if necessary. The pathogenesis of GCTs is a complex process involving the interplay of various cellular and molecular factors. The hallmark giant cells, driven by an imbalance in the RANK/RANKL/OPG signaling pathway, mediate bone resorption and contribute to the tumor's locally aggressive behavior. In the spine, GCTs can cause significant morbidity due to their potential for vertebral collapse, spinal instability, and neurological

compromise. The case presented in this report highlights the challenges and rewards associated with the management of spinal GCTs, particularly those affecting the thoracic spine and causing paraplegia. The successful outcome achieved through aggressive surgical intervention and comprehensive rehabilitation underscores the importance of early diagnosis, a multidisciplinary approach, and a commitment to long-term surveillance. Continued research in this field is essential for unraveling the remaining mysteries surrounding GCTs and developing novel therapeutic strategies that can improve outcomes and reduce the risk of recurrence.[17-19]

The clinical presentation of spinal giant cell tumors (GCTs) is a complex interplay of factors that can significantly impact the patient's quality of life and the course of their disease. The variability in presentation stems from the tumor's location within the spine, its size, and the rate at which it grows. These factors, in turn, influence the extent of nerve compression and the resulting neurological deficits. Pain is the most common presenting symptom in patients with spinal GCTs. The pain is often localized to the affected spinal segment, reflecting the tumor's direct invasion of the bone and surrounding tissues. The pain can be described as dull, aching, or throbbing, and it may worsen with activity or movement. The insidious onset and gradual progression of pain often lead to delays in diagnosis, as patients may attribute their symptoms to musculoskeletal strain or other benign conditions. As the tumor expands, it can compress adjacent nerve roots as they exit the spinal canal. This compression can lead to radicular pain, a sharp, shooting pain that radiates along the distribution of the affected nerve. The specific dermatomes involved depend on the level of spinal involvement. For example, compression of the T11 nerve root, as seen in the present case, can cause pain radiating along the flank and abdomen. In addition to pain, nerve root compression can also cause numbness, tingling, or weakness in the corresponding dermatomes. These sensory and motor deficits can significantly impact the patient's functional status and quality of life. The severity of the neurological deficits depends on the degree of nerve compression and the duration of the compression.[18-20]

In advanced cases, the tumor can grow large enough to compress the spinal cord itself, leading to myelopathy. Myelopathy is a broad term encompassing a range of neurological symptoms resulting from spinal cord dysfunction. The clinical manifestations of myelopathy can vary depending on the level and severity of spinal cord compression. Common symptoms of myelopathy include gait disturbances, such as unsteadiness, difficulty walking, or a tendency to trip or fall. Patients may also experience spasticity, an increase in muscle tone that can lead to stiffness, muscle spasms, and difficulty with movement. In severe cases, myelopathy can progress to paraplegia, the complete loss of motor and sensory function in both lower extremities. The patient in this case presented with acute paraplegia, highlighting the aggressive nature of GCTs and the potential for rapid neurological deterioration. The sudden onset of paraplegia suggests that the tumor had reached a critical threshold, causing significant spinal cord compression and disrupting the transmission of neural signals. The patient's history of chronic back pain indicates that the tumor had been growing slowly for some time, gradually compressing the spinal cord until a tipping point was reached.[19-21]

The diagnosis of spinal GCTs can be challenging, as their clinical and radiographic features can overlap with other conditions. The differential diagnosis includes metastatic disease, aneurysmal bone cysts, osteomyelitis, and other primary bone tumors. A high index of suspicion is crucial, especially in young adults presenting with spinal pain and neurological symptoms. Imaging studies, particularly MRI, play a vital role in the diagnosis and evaluation of spinal GCTs. MRI provides detailed information about the tumor's location, size, extent of bone and soft tissue involvement, and relationship to critical neurovascular structures. The typical MRI appearance of a GCT is a well-defined, expansile, lytic lesion with a heterogeneous signal intensity. The tumor may

extend into the surrounding soft tissues and cause compression of the spinal cord or nerve roots. While imaging studies can provide valuable clues, a definitive diagnosis of GCT requires histopathological confirmation. This is typically achieved through a CT-guided biopsy, a minimally invasive procedure that allows for the safe and accurate sampling of the tumor tissue. The biopsy specimen is then examined under a microscope by a pathologist, who looks for the characteristic multinucleated giant cells and mononuclear stromal cells that define GCT. The clinical presentation of spinal GCTs is a complex and dynamic process influenced by various factors, including the tumor's location, size, and rate of growth. Pain, radicular symptoms, and myelopathy are the most common manifestations, with paraplegia representing a severe and potentially devastating complication. The diagnosis of spinal GCTs requires a combination of clinical acumen, imaging studies, and histopathological confirmation. Early diagnosis and prompt treatment are crucial for preserving neurological function and improving patient outcomes.[20-22]

The management of spinal giant cell tumors (GCTs) presents a formidable challenge that necessitates a multidisciplinary approach, encompassing the expertise of neurosurgeons, orthopedic surgeons, oncologists, and rehabilitation specialists. The primary objective of treatment is to achieve complete eradication of the tumor while meticulously preserving neurological function and ensuring the stability of the spinal column. The complexity of this endeavor is further amplified when the tumor encroaches upon critical neural structures or resides in anatomically challenging locations, such as the thoracic spine, as exemplified in the present case. The patient in question, afflicted with a T11 GCT that had precipitated paraplegia, underwent a 360-degree decompression and posterior spinal fusion, a surgical strategy meticulously tailored to address the unique challenges posed by the tumor's location and extent. This approach represents a paradigm shift in the surgical management of spinal GCTs, offering a comprehensive solution that combines aggressive tumor resection with immediate spinal stabilization. The 360-degree decompression technique, as the name suggests, entails accessing the tumor from both anterior and posterior approaches. The anterior approach, typically involving a thoracotomy or a transthoracic approach, provides direct access to the vertebral body, enabling the surgeon to visualize and remove the tumor under direct vision. This approach is particularly advantageous in cases where the tumor has extensively infiltrated the vertebral body or has extended into the adjacent soft tissues. The posterior approach, on the other hand, involves a laminectomy or laminotomy to access the posterior elements of the spine and the spinal canal. This approach facilitates decompression of the spinal cord and nerve roots, which is crucial in cases where the tumor has caused neurological compromise.[21-23]

The synergistic combination of anterior and posterior approaches in the 360-degree decompression technique offers several distinct advantages. First, it allows for complete visualization and removal of the tumor, regardless of its location or extent. Second, it enables the surgeon to address any spinal instability caused by the tumor or the surgical resection, thereby minimizing the risk of postoperative complications such as deformity or neurological deterioration. Third, it facilitates early mobilization and rehabilitation, which are essential for optimizing functional outcomes and enhancing the patient's quality of life. En bloc resection, the removal of the tumor as a single piece along with a margin of healthy tissue, is the gold standard for surgical treatment of GCTs. This technique offers the highest chance of achieving complete tumor removal, thereby reducing the risk of local recurrence. The rationale behind en bloc resection is to eliminate all microscopic extensions of the tumor, which may not be readily apparent on imaging studies or during surgery. By removing a margin of healthy tissue around the tumor, the surgeon ensures that no residual tumor cells are left behind, which could potentially lead to recurrence. However, en bloc resection is not always feasible,

particularly in cases where the tumor is large, extensively infiltrative, or located in close proximity to critical neurovascular structures. In such scenarios, intralesional curettage, a less aggressive technique that involves scraping out the tumor from within the bone, may be considered. Curettage is often combined with adjuvant therapies such as radiotherapy, embolization, or the use of Denosumab, a monoclonal antibody that inhibits RANKL, to reduce the risk of recurrence. While curettage may be less effective than en bloc resection in achieving complete tumor removal, it may be the only viable option in certain cases where the risks of en bloc resection outweigh the benefits.[22-24]

In the present case, the en bloc resection of the T11 GCT was successful in achieving complete tumor removal with negative margins. This was confirmed by the absence of any residual tumor on postoperative imaging studies and the lack of recurrence at the 5-year follow-up. The resulting spinal defect was reconstructed with an expandable cage filled with autologous bone graft. This biocompatible and osteoconductive material provides immediate structural support to the spine and serves as a scaffold for new bone growth, ultimately leading to fusion and stabilization of the affected segment. Posterior spinal instrumentation, involving the placement of screws and rods along the spine, was performed to further enhance spinal stability and facilitate healing. The instrumentation spans from T9 to L2, encompassing the levels above and below the resected vertebra, thereby providing a wide zone of stabilization. This construct not only prevents postoperative deformity but also allows for early mobilization and rehabilitation, which are crucial for optimizing functional outcomes. The patient's rapid and complete neurological recovery following surgery is a testament to the effectiveness of the 360-degree decompression and posterior spinal fusion approach. The restoration of motor and sensory function within days of the operation underscores the importance of early decompression and complete tumor resection in cases of spinal cord compression. The absence of any neurological deficits or recurrence at the 5-year follow-up further validates the success of the surgical intervention and the importance of long-term surveillance.[21-23]

This case report highlights the potential for achieving excellent outcomes in patients with spinal GCTs, even in the face of significant neurological compromise. The 360-degree decompression and posterior spinal fusion technique, coupled with en bloc resection, offers a promising solution for managing these challenging tumors. The importance of early diagnosis, aggressive surgical intervention, and comprehensive rehabilitation cannot be overstated. Continued research and innovation in the field of spinal tumor management will undoubtedly lead to further advancements in treatment and improved outcomes for patients worldwide. The patient's rapid and complete neurological recovery following surgery is a testament to the effectiveness of this approach. The restoration of motor and sensory function within days of the operation underscores the importance of early decompression and complete tumor resection in cases of spinal cord compression. The absence of any neurological deficits or recurrence at the five-year follow-up further validates the success of the surgical intervention and the importance of long-term surveillance.[22-24]

The prompt recognition of the patient's symptoms and the expeditious initiation of diagnostic and therapeutic measures played a crucial role in preventing further neurological deterioration. The early decompression of the spinal cord, achieved through the 360-degree approach, relieved the pressure on the neural structures and allowed for the restoration of blood flow and axonal function. The complete resection of the tumor, confirmed by negative margins, eliminated the source of compression and minimized the risk of recurrence, contributing to the patient's long-term well-being. The 360-degree decompression and posterior spinal fusion technique, although technically demanding, offers several advantages in the management of spinal GCTs. The combined anterior and posterior access allows for

optimal visualization and removal of the tumor, regardless of its location or extent. The en bloc resection further enhances the chances of complete tumor removal, thereby reducing the risk of local recurrence. The posterior spinal fusion provides immediate stability to the spine, preventing deformity and facilitating early mobilization and rehabilitation. The patient's recovery was not solely dependent on the surgical intervention. The postoperative rehabilitation program, tailored to her specific needs and goals, played a crucial role in restoring her function and improving her quality of life. The intensive physical and occupational therapy sessions helped her regain strength, mobility, and independence, enabling her to resume her normal activities of daily living. The patient's young age, good overall health, and positive attitude likely contributed to her successful recovery. Younger patients tend to have better regenerative capacity and resilience, which can facilitate healing and functional restoration. The absence of comorbidities and a strong motivation to recover can also positively influence the rehabilitation process and long-term outcomes.[17-20]

The absence of any neurological deficits or recurrence at the five-year follow-up is a testament to the durability of the surgical intervention and the effectiveness of the postoperative management. The patient's ability to resume her normal activities and maintain a high quality of life underscores the importance of a comprehensive and patient-centered approach to the treatment of spinal GCTs. This case also highlights the importance of long-term surveillance in patients with spinal GCTs. Although the risk of recurrence is relatively low after complete resection, it is not negligible. Regular follow-up with imaging studies is essential to monitor for any signs of recurrence and initiate prompt treatment if necessary. The patient's adherence to the follow-up schedule and her vigilance in reporting any new symptoms were crucial in ensuring her continued well-being. The successful outcome in this case of T11 GCT with paraplegia serves as a beacon of hope for patients and clinicians alike. It demonstrates the potential for complete neurological recovery even in the face of severe spinal cord compression. The 360-degree decompression and posterior spinal fusion technique, coupled with en bloc resection and comprehensive rehabilitation, offers a promising solution for managing these challenging tumors. Continued research and innovation in the field of spinal tumor management will undoubtedly lead to further advancements in treatment and improved outcomes for patients worldwide.[24,25]

4. Conclusion

This case report serves as a beacon of hope for patients and clinicians alike, demonstrating the potential for complete neurological recovery even in the face of severe spinal cord compression due to GCTs. The successful outcome achieved in this case underscores the importance of a multidisciplinary approach, early diagnosis, and aggressive surgical intervention. Continued research and innovation in the field of spinal tumor management will undoubtedly lead to further advancements in treatment and improved outcomes for patients worldwide.

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