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CASE REPORT

Radiation-induced lumbosacral plexopathy and pelvic insufficiency fracture: A case report of unique coexistence of complications after radiotherapy for prostate cancer

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ABSTRACT

Case reports of plexopathy after prostate cancer are usually neoplastic. Radiation-induced lumbosacral plexopathy and insufficiency fractures have clinical significance due to the need to differentiate them from tumoral invasions, metastases, and spinal pathologies. Certain nuances, including clinical presentation and screening methods, help distinguish radiation-induced plexopathy from tumoral plexopathy. This case report highlights the coexistence of these two rare clinical conditions. Herein, we present a 78-year-old male with a history of radiotherapy for prostate cancer who developed right foot drop, severe lower back and right groin pain, difficulty in standing up and walking, and tingling in both legs over the past month during remission. The diagnosis of lumbosacral plexopathy and pelvic insufficiency fracture was made based on magnetic resonance imaging, positron emission tomography, and electroneuromyography. The patient received conservative symptomatic treatment and was discharged with the use of a cane for mobility. Radiation-induced lumbosacral plexopathy following prostate cancer should be kept in mind in patients with neurological disorders of the lower limbs. Pelvic insufficiency fracture should also be considered if the pain does not correspond to the clinical findings of plexopathy. These two pathologies, which can be challenging to diagnose, may require surgical or complex management approaches. However, in this patient, conservative therapies led to an improvement in quality of life and a reduction in the burden of illness.

Keywords: Case report, insufficiency fracture, neuropathy, prostate cancer, radiation therapy.

Lumbosacral plexopathy is a rare complication of radiation therapy for pelvic malignancies, including lymphomas, testicular cancer, and gynecologic cancers.[1-3] Neoplastic infiltration of the lumbosacral plexus has been reported in approximately 0.71% of patients with a history of cancer,[2] while radiation-induced lumbosacral plexopathy is even rarer, with a reported incidence of 0.16%.[3] There is only a single reported case specifically related to prostate cancer.[4] The etiology of radiation-induced plexopathy is thought to involve direct injury from radiation, microvascular injury, and radiation-induced fibrosis.[1]

The clinical presentation of radiation-induced lumbosacral plexopathy can vary in terms of severity of neurological symptoms, ranging from numbness to motor deficits in both lower extremities. In some cases, it can even lead to incontinence, resulting in immobilization and a decreased quality of life.[1,5] Differential diagnosis from tumoral invasion or other spinal pathologies is important in cases of radiation-induced plexopathy. In the clinical

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presentation, the most notable finding in radiation-induced plexopathy, as compared to tumoral plexopathy, is the presence of bilateral muscular weakness in the lower extremities rather than pain.[6]

Pelvic radiation therapy is also a known risk factor for pelvic insufficiency fractures.[7] The therapy reduces the elastic resistance of the pelvic bones, making them susceptible to fractures under physiological stress.[8] Pelvic insufficiency fractures are considered an uncommon complication of radiotherapy for prostate cancer. A study conducted on 28,354 patients found that the five-year incidence of pelvic insufficiency fractures in prostate cancer was the lowest, with a rate of 3.7% (95% confidence interval 3.4-4%) among pelvic malignancies.[7,8] It is important to note that pelvic insufficiency fractures can sometimes be mistaken for metastasis due to the involvement observed in radionuclide imaging. The diagnosis of insufficiency fractures relies on identifying the vertical fracture path in the sacral alae that extends to the sacroiliac joint.[8] Treatment for pelvic insufficiency fractures is typically conservative, while metastasis management can be complex,[8] underscoring the significance of accurate differential diagnosis despite its rarity.

In the literature, only one more recent case of lumbosacral plexopathy following radiation therapy for prostate cancer was reported.[4] Here, we present a unique case in which both lumbosacral plexopathy and pelvic insufficiency fractures coexist following radiotherapy for prostate cancer. These are rare complications individually, making their simultaneous occurrence noteworthy.

CASE REPORT

A 78-year-old male patient presented to the outpatient clinic of the physical medicine and rehabilitation department with complaints of right foot drop, lower back and right groin pain, and difficulty in walking for the past month. The patient's medical history revealed an incidental diagnosis of low-risk prostate adenocarcinoma two years ago during a routine health check-up. Following the diagnosis, the patient underwent 28 radiotherapy sessions and subsequently received androgen deprivation therapy for six months. The radiation therapy was administered with the guidance of the European Association of Urology and European Society for Radiotherapy and Oncology in terms of image-guided radiation therapy with an on-board imaging technique and a total dose of 56 Gy for suspicious lymph node areas and 70 Gy for the prostate.[4] After treatment, the follow-up of prostate-specific antigen was interpreted as negative, indicating a favorable response to therapy. However, during the remission period, the patient began experiencing lower back pain, right foot drop, and difficulty in walking. Additionally, the groin pain had become severe, particularly worsening with movement and persisting even at rest over the last 10 days. Notably, there was no history of trauma or fall reported by the patient.

Upon examination, the patient was found to be immobilized and experiencing tingling sensations spreading to the legs. The patient also complained of severe right groin pain, which the patient rated at a pain intensity level of 10 out of 10 points on the numeric Visual Analog Scale. Before visiting the clinic, the patient had been prescribed zoledronic acid (5 mg intravenous) for osteoporosis and various nonsteroidal anti-inflammatory drugs at appropriate doses but had not experienced any relief from his symptoms. In addition, surgical intervention was not recommended for pelvic insufficiency fracture, leading us to conservative treatment. At admission, the patient took 150 mg/day of tramadol and 50 mg of fentanyl every 72 h to manage the pain. During the physical examination, it was noted that the patient experienced pain in the right hip joint with movements in all directions. Additionally, weakness was observed in the right ankle and big toe dorsiflexor muscles. The patient also exhibited hypoesthesia (reduced sensation) in the sole and lateral aspect of the right foot, as well as a hypoactive right Achilles reflex.

Figure 1 represents the pelvic X-ray imaging of the patient. The lumbar spinal and pelvic magnetic resonance imaging (MRI) of the patient revealed reactive edematous signal changes in the pelvic floor muscles, corresponding to the area where radiotherapy was administered. The MRI also showed a Stage 2 osteoporotic insufficiency fracture on the inferior surface of the sacrum and a Stage 1 osteoporotic insufficiency fracture on the iliac surface of the right sacroiliac joint (Figure 2). The axial and coronal sections of the sacral insufficiency fracture are presented in Figures 3 and 4, respectively. In the T2-weighted STIR (short tau inversion recovery) sequence of the lumbar MRI, hyperintense edematous changes were observed in the L5 vertebral body and the upper endplate of S1 (Figure 5). Furthermore, the patient underwent 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET). The results of the whole-body PET-MRI did not show any 18F-FDG uptake and ruled out the suspicion of metastasis.

The electrodiagnostic examination of the patient revealed normal conduction of the median, ulnar, and saphenous nerves bilaterally. However, the bilateral superficial peroneal nerve and left sural nerve sensory action potentials could not be obtained. The conduction velocity of the right sural nerve was found to be low. Compound motor action potentials of the bilateral peroneal nerves could not be obtained, and the compound motor action potentials amplitudes of the bilateral tibial nerves were low.

In needle electroneuromyography (ENMG), normal electrophysiological findings were observed

FIGURE 1. Pelvic radiograph of the patient.

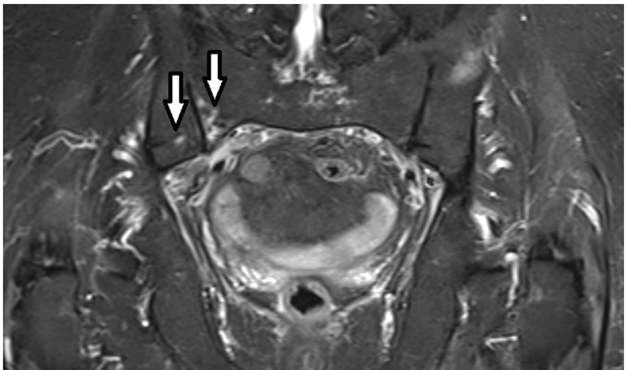

FIGURE 2. White arrows represent the insufficiency fractures of inferior sacral and iliac surfaces of right sacroiliac joint in axial pelvic magnetic resonance imaging.

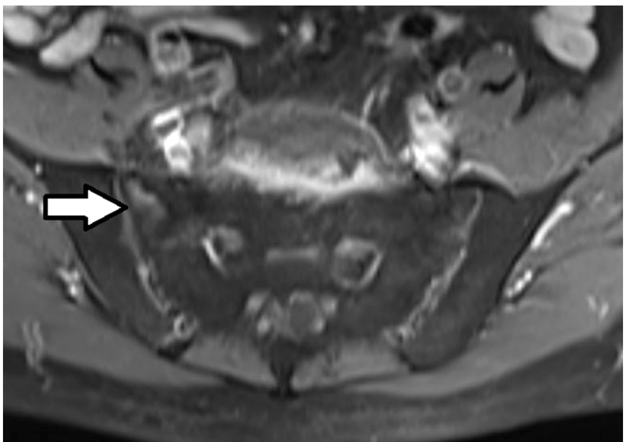

FIGURE 3. White arrow represents the axial section of sacral insufficiency fracture.

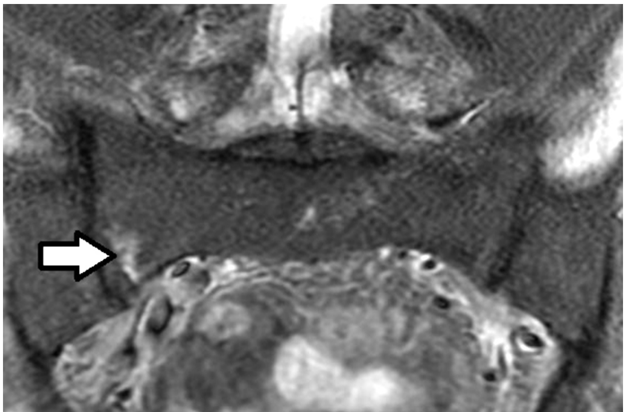

FIGURE 4. White arrow represents the coronal section of sacral insufficiency fracture.

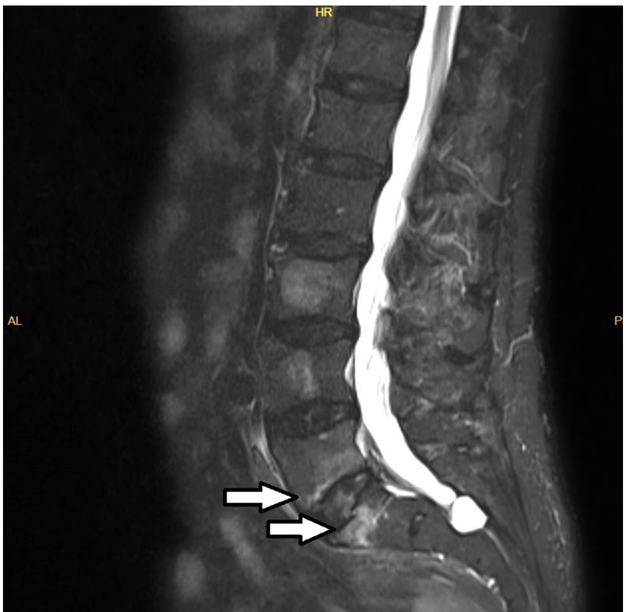

FIGURE 5. White arrows represent hyperintense edematous changes in the L5 vertebral body and S1 upper-end plate in sagittal lumbar magnetic resonance imaging.

in the bilateral quadriceps and adductor magnus muscles. However, spontaneous activity potentials were observed in the bilateral tibialis anterior, gastrocnemius, and gluteus medius muscles. Additionally, chronic neurogenic changes were observed in the tibialis anterior and gastrocnemius muscles. These findings suggest partial damage to the bilateral lower lumbosacral plexus in a subacute-chronic process (Figure 6). To further evaluate the condition, a lumbar plexus MRI was performed, which did not reveal the presence of any tumoral mass or pathological signal changes indicative of invasion and excluded metastasis.

The patient's laboratory results were within the normal range, including complete blood counts, biochemistry panel, thyroid function test, erythrocyte sedimentation rate, and C-reactive protein. The causes of plexopathy, including diabetes mellitus, infection (serologies for human immunodeficiency virus, hepatitis B and C, cytomegalovirus, Epstein-Barr virus, syphilis, and Borrelia spp.), and autoimmune and neuroimmune screening, including antinuclear, antineuronal, and antineutrophil cytoplasmic antibodies, were excluded by the blood testing. The prostate-specific antigen level was 0.03 μg/L (normal range: 0-4), indicating a low value. The 25 (OH) vitamin D3 level was 52.7 nmol/L, which is above the threshold for deficiency (<50 nmol/L). Dual-energy X-ray absorptiometry results showed osteopenia in the L1-4 vertebrae (T-score: -2.1) and the femur neck (T-score: -1.2), indicating a decrease in bone density.

To manage the patient's symptoms, a treatment plan was implemented. The patient was prescribed gabapentin at a dosage of 1800 mg/day for pain relief. Additionally, cholecalciferol (vitamin D3) supplementation was prescribed at a dose of 20,000 IU twice a week to address the deficiency. Superficial heat therapy, transcutaneous electrical stimulation to the

Electroneuromyography findings summary

Muscle	Side	Ins. activity	Fibs.	Pos. wave	Fasc.	MYO discharge	Normal MUP	Poly	Low amp.	High amp.	Duration	Recruit	Int pattern
Tibialis anterior	R	Normal	+1	+1	0	0	+3	+1	0	+1	Normal	Full	Reduce
Gastrocnemius lateral H	R	Normal	+1	+1	0	0	+3	N	0	+1	Normal	Full	Full
Tibialis anterior	L	Normal	+1	+1	0	0	+3	N	0	+1	Normal	Full	Full
Gastrocnemius lateral H	L	Normal	+1	+1	0	0	+3	N	0	+1	Normal	Full	Reduce
Quadriceps	R	Normal	0	0	0	0	+3	N	0	0	Normal	Full	Full
Adductor magnus	R	Normal	0	0	0	0	+3	N	0	0	Normal	Full	Full
Quadriceps	L	Normal	0	0	0	0	+3	N	0	0	Normal	Full	Full
Adductor magnus	L	Normal	0	0	0	0	+3	N	0	0	Normal	Full	Full
Gluteus medius	L	Normal	+1	+1	0	0	+3	N	0	0	Normal	Full	Reduce
Gluteus medius	R	Normal	+1	+1	0	0	+3	N	0	0	Normal	Full	Reduce

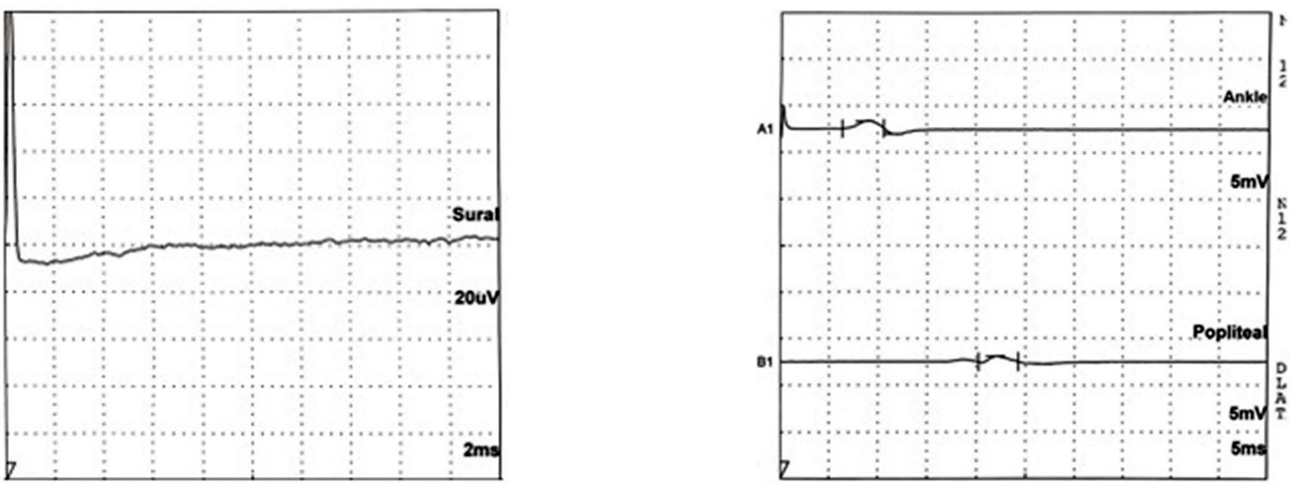

FIGURE 6. The summary diagram of needle electroneuromyography.
Ins: Insertional; Fibs: Fibrillations; Pos: Positive; Fasc: Fasciculation; Amp: Amplitude.

right hip and lumbar region, and functional electrical stimulation were applied as part of the treatment. Range of motion exercises and strengthening exercises for the lower extremities were performed. Gradual weight-bearing mobilization was initiated with the assistance of a crutch and walker, keeping pain tolerance in mind.

For pain management, a fluoroscopy-guided caudal injection was administered. The injection consisted of a mixture of 1 mL of betamethasone, 5 mL of normal saline, and 5 mL of bupivacaine 0.5%. Following the interventions, the patient no longer required analgesic medication, and the pain intensity decreased to 3 mm on the Visual Analog Scale. The patient was discharged with the ability to mobilize using a cane.

DISCUSSION

This report focuses on two entities that should not be overlooked in patients with a history of radiation therapy for prostate cancer. These entities, lumbosacral plexopathy and pelvic insufficiency fracture, are particularly notable due to their coexistence.[9] Both conditions are difficult to differentiate and have clinical presentations that can be confusing.

Among complications of radiation therapy following prostate cancer besides lumbosacral plexopathy, there exist other pelvic organ- and bone-affecting toxicities, including radiation-induced proctitis, cystitis, vertebral stenosis or collapse, and avascular bone necrosis.[4] The clinical presentation of radiation-induced lumbosacral plexopathy typically involves neurological deficits in the lower limbs, rather than pain. A recently published case report of a 78-year-old male who developed radiation-induced lumbosacral plexopathy due to prostate cancer five years after the treatment also highlighted a remarkable neurological deficit in the clinical findings.[4] The lower extremity paraparesis and distal leg hypoesthesia were in the frame. However, in our case, the patient presented with significant pain that required opioid medication and interventional procedures. The coexisting pelvic insufficiency fracture, which can be mistaken for malignancies, was evaluated as the cause of the pain. On the other hand, specific screening findings of a pelvic insufficiency fracture supported our diagnosis.

The clinical manifestation of radiation-induced lumbosacral radiculoplexopathy can manifest months after treatment with mild and reversible symptoms or even many years later with persistent and severe symptoms.[5,10] While the most commonly reported occurrence period for plexopathy is one to five years after treatment, there are extreme cases documented in the literature, ranging from 1 month to 31 years.[6] In our patient's case, the complaints began 18 months after radiotherapy.

Studies have reported cases of lumbosacral plexopathy occurring after radiotherapy for Hodgkin lymphoma and testicular, rectal, and bladder cancers.[3,5] However, such cases of prostate cancer are rare in the literature. In a case report describing bilateral lumbosacral plexopathy in a patient with prostate cancer, it was concluded that the plexopathy developed due to perineural invasion of the tumor, which is different from our case.[11] The screening findings in our case ruled out perineural invasion or any compressive lesion.

Additionally, a review mentioned the occurrence of lumbosacral plexopathy after treatment for prostate cancer.[12] The study aimed to identify prognostic factors related to survival time after spine stereotactic body radiotherapy (SBRT). The researchers scanned a database of 605 cancer patients who underwent spine SBRT. Late toxicities of spine SBRT were categorized based on cancer type, and it was reported that only one out of 98 prostate cancer patients had lumbosacral plexopathy. However, no diagnostic or clinical follow-up information regarding the plexopathy was provided.

Differentiating radiation-induced radiculoplexopathy from tumor invasion or spinal pathology is crucial, and MRI can be utilized for this purpose.[13] In our case, lumbar plexus MRI ruled out any tumor invasion or spinal pathology. When considering the distinguishing clinical features of radiation plexopathy compared to tumoral plexopathy, radiation plexopathy typically presents bilaterally, with more prominent symptoms of paresthesia and muscular weakness rather than pain. Additionally, both PET and MRI findings are negative in cases of radiation plexopathy.

Electroneuromyography findings can also be beneficial in the differential diagnosis. Specifically, the presence of serial and spontaneous discharges in ENMG that exhibit slow and irregular firing frequencies is described as myokymia. It has been reported that myokymic discharges can serve as supportive findings in distinguishing radiation-induced plexopathy from tumoral plexopathy.[10] Similar to our case, Almeida et al.[4] reported a 78-year-old patient with lumbosacral plexopathy following radiation therapy for prostate cancer, and they detected myokymia, which guided them in the differential diagnosis. Furthermore, Thomas et al.[6] concluded that myokymia may be observed in approximately half (57%) of the cases. However, it is important to note that the absence of myokymia does not rule out the diagnosis, and our case should be considered within the remaining 43% of cases.

Pelvic insufficiency fractures are also rare complications of radiotherapy in pelvic malignancies, typically occurring between two to 63 months after radiotherapy.[7,14] The resemblance of imaging findings to metastasis underscores the importance of accurate differential diagnosis. In a study by Iğdem et al.,[8] it was reported that three out of 134 patients were initially misdiagnosed as having metastasis due to pathological uptake in radionuclide imaging. Differential diagnosis was achieved using MRI and computed tomography images, and the characteristic feature of pelvic insufficiency fractures was identified as medullary edema surrounding the hypointense fracture line. In our case, MRI revealed similar characteristics of pelvic insufficiency fractures, and no pathological involvement was observed in the radionuclide imaging.

The management of both lumbosacral plexopathy and pelvic insufficiency fractures typically involves conservative and symptomatic approaches, as we have planned for our patient. Early mobilization was supported through physical therapy modalities and exercises to achieve pain control. By evaluating our case in terms of these crucial diagnoses, we aimed to reduce the psychological, physical, and economic burden. This approach serves as an important strategy for preventing complications.[15]

A limitation of this report is the absence of myokymia on ENMG. However, this limitation highlights an important message: the absence of myokymia does not necessarily rule out radiation-induced lumbosacral plexopathy, as it can be absent in almost half of the cases. The strength of our report is that it is the first to present the coexistence of lumbosacral plexopathy and pelvic insufficiency fractures in a patient with prostate cancer following radiation therapy. These conditions can be easily mistaken for malignancy. Another strength is that, to the best of our knowledge, it is the second case report of lumbosacral plexopathy following radiation therapy for prostate cancer.

In conclusion, it is important to consider the possibility of lumbosacral plexopathy in patients who present with new-onset neurological problems in the lower extremities. The diagnosis of pelvic insufficiency fractures should be considered if the pain does not correspond to the clinical findings of plexopathy. Both conditions have clinical significance as they can be mistaken for metastasis. Accurate diagnosis is crucial for guiding appropriate therapeutic management. While initial management may be straightforward, it is important to recognize that the management of these conditions can become multidisciplinary and complex and may even lead to challenging situations. Therefore, a holistic approach should be taken when evaluating patients to ensure comprehensive care.

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Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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