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Delayed spinal cord infarction following anterior cervical surgical decompression

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Full clinical cases submission template

TITLE OF CASE ***Do not include "a case report"***

Delayed Spinal Cord Infarction Following Anterior Cervical Surgical Decompression

SUMMARY ***Up to 150 words summarising the case presentation and outcome (this will be freely available online)***

Anterior Cervical Discectomy and Fusion (ACDF) for cord compression is a safe and effective procedure with good outcomes. However, worsening of myelopathy is the most feared adverse event of the surgery. We report the case of a 36 year old male patient who presented with an acute non-traumatic C5/6 cervical disc herniation causing incomplete quadriparesis. He underwent an uncomplicated ACDF at C5-6, and after an initial period of improvement, he developed a delayed onset of an anterior cord syndrome on day 3, without any discerning cause. We have reviewed similar cases reported in the literature and believe that our patient's post-surgical course is consistent with a delayed ischemic/reperfusion injury to the cord following surgical decompression and restoration of blood flow through the anterior spinal artery and we make suggestions for management of such clinical events.

BACKGROUND ***Why you think this case is important – why did you write it up?***

The complications of ACDF most often reported in the literature include dysphagia, dural tear, hoarseness secondary to superior or recurrent laryngeal nerve injury, esophageal tear, vertebral artery injury and graft relation problems. Worsening of myelopathy or progression of existing neurological deficit is the most feared adverse event of this procedure and that is most often secondary to an epidural hematoma. However, in the setting of surgical relief of an acute compressive myelopathy, the worsening could be due to a vascular insult such as ischemia/reperfusion injury. Non-traumatic cervical disc herniation is rarely the cause of acute quadriparesis with the earliest case reported in literature as recent as 1973. Since then a further 9 cases have been added in the English literature and two cases have been described in Japanese language.

CASE PRESENTATION ***Presenting features, medical/social/family history***

A 36-year-old otherwise healthy male patient with no known medical comorbids presented through the Emergency Room (ER) with complaints of neck stiffness and cervico-brachial radiculopathy with radiation of pain along the lower back since the last 2 weeks and motor weakness of the limbs since the last 2-3 hours. He denied any trauma or other inciting event. At the onset of the present illness, he had complained of tightness in the chest and was misdiagnosed as acute coronary syndrome. More recently he had tried physiotherapy and analgesics with no relief of symptoms. Neck movements were immobilized with a soft collar. He had no alarming family history. Routine blood tests, including serum biochemistry, haematology and coagulation profile was normal At initial examination, he was hypotensive with a BP of 90/50 mm Hg. He was alert and oriented and his cervical spine range of motion was limited particularly right sided rotation and extension. Neurological examination revealed normal bulk of all muscle groups, decreased tone and power below C4. On the modified Medical Research Council –MRC scale motor power in the upper limbs was grade 3/5 in the right biceps and 2/5 in the left biceps. In the lower limbs power was grade 2/5, due to which gait couldn't be assessed, with incomplete sensory impairment (ASIA/Frankel C). He had preserved light touch; two point discrimination and vibration sense. Deep tendon reflexes were diminished and the plantar response was equivocal. The sensation of bladder distension was intact and the anal and bulbocavernous reflexes were present. Anal tone was present. Long tracts signs were mute secondary to element of spinal shock. With a clinical diagnosis of acute cervical cord compression, an MRI scan of the cervical spine was obtained.

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INVESTIGATIONS ***If relevant***

Pre-operative Magnetic Resonance Imaging (MRI) scan of the cervical spine (Figure 1(a-b)): This showed a diffuse disc bulge at C5/6 with central protrusion causing severe canal stenosis, cord compression and moderate bilateral neural foramina encroachment. There was associated T2 hyperintense signal representing cord edema just superior to the compression.

DIFFERENTIAL DIAGNOSIS ***If relevant***

TREATMENT ***If relevant***

Intravenous methylprednisolone (30 mg / kg body weight) bolus was given immediately after the first MRI (within almost 3 hours of the acute cord compression) and was continued at 5.4 mg / kg / hour over the next 24 hours. The hypotension responded to fluid resuscitation. Surgical decompression was offered to the patient and the procedure commenced within 8 hours of onset.

A standard anterior cervical discectomy and fusion was performed, using a high definition intra-operative microscope, via a right sided approach with plating of a 9mm iliac crest bone graft. At surgery it was very clear that the disc had received trauma. It was remarkable by being edematous and disrupted. A semicircular disc fragment that had herniated into the spinal canal was recovered and adequate decompression was confirmed by exploring the space with a nerve hook in cephalocaudad direction. There was no cerebrospinal fluid (CSF) leak or bleeding from the disc space during the exploration and no cardiovascular instability during the procedure. From a surgical point of view the surgery was uncomplicated apart from the observation of non-pulsatile spinal theca after removal of the disc fragment.

OUTCOME AND FOLLOW-UP

In the immediate post-operative period neurological assessment showed some improvement in the pre-operative quadriparesis. On the modified Medical Research Council –MRC scale motor power improved by one grade to 3/5 in the left biceps and both lower extremities. The rest of the exam remained same. On post-operative day 3, the patient abruptly experienced respiratory distress with oxygen desaturation and this necessitated re-intubation and ventilation. The patient was stable from cardiac stand point. Blood Pressure 136/95mmHg and Pulse was 110. This was also confirmed by the cardiology. Neurological assessment showed absence of breathing effort and no motor power in the lower limbs. Differential diagnosis with respect to the etiology included
epidural hematoma, graft extrusion or migration or spinal cord injury secondary to ischemic/reperfusion. A cervical spine radiograph showed the cervical plate and graft in place (Figure 2). An MRI scan of the cervical spine was repeated and this disclosed signal changes in the cord showing hyper intense signals on T1 and T2-weighted sequences at C5-C6 level suggesting haemorrhage with edema (Figure 3(a-b)). Following gadolinium injection of contrast there was patchy enhancement with luxury perfusion. There was no cord compression. The overall appearances in the report were consistent with haemorrhagic infarction of the cord. He had a prolonged Intensive Care Unit (ICU) stay of 12 days followed by shift-out to special care unit on a portable ventilator when he had recovered some abdominal-ventilatory effort and grade 2-3/5 power in the upper limbs. He was discharged to rehabilitation with a tracheostomy, gastrostomy and intermittent support by portable ventilator. At last follow up, 12 months after surgery, he was ventilator independent. He showed improvement in the neurological examination. Bulk was normal and comparable, tone was mildly increased to Grade 2 (Ashworth grading system). On the modified Medical Research Council –MRC scale motor power in all extremities was -4/5. He had intact but decreased sensations till C 4 but intact dorsal columns. Deep tendon reflexes were +3 and the plantar response was extensor. The sensation of bladder distension and anal prick was vague but present with improved power in the limbs.

DISCUSSION ***Include a very brief review of similar published cases***

Non-traumatic cervical disc herniation is rarely the cause of acute quadriparesis with the

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earliest case reported in literature as recent as 1973.[1] Since then a further 9 cases have been added in the English literature and two cases have been described in Japanese language.[1-9,10,11] Acute paraplegia has also been associated with acute cervical disc and four instances of such a rare occurrence have been reported,[12-15] the most recently in 2015 by Bayley et al.[12] Of the nine reported cases of acute cervical quadriparesis that we reviewed (Table 1), six were males and three females. Majority of these patients belonged to Asian origin. The ages ranged from 29-63 years. The most common level of herniated disc was C4-5 and C6-7, followed by C5-6 as in our case and C3-4. The most common symptoms were of neck pain followed by numbness and the time range from onset of symptoms to surgical intervention ranged from 6 weeks to 7 months. Our case is unique with respect to the time taken from symptoms to intervention, which was 2 weeks.

The onset of symptoms of acute cervical myelopathy can be provoked by trivial activities such as a, change of position, to stressful causes such as labor, and notably during general anesthesia for another procedure.[7,14,16-20] Multilevel degeneration and congenitally narrow canal superimposed on cervical spondylosis are reported risk factors. Kato et al. reported a case of acute paraplegia during an MRI exam, in a patient with pre-existing spondylosis.[13] Siam et al. reported a case in which pre-existing cervical spondylosis together with the rapid and momentary rise of the intradiscal pressure secondary to excessive neck movement on bending forward lead to disk rupture at C5/6 that caused immediate severe compression of the spinal cord.[8] This mechanism was observed to be identical to the case reported by Liu et al. although ,symptoms like weakness were apparent after 2 h in their case.[14] In the current literature, all similar patients were treated surgically. The outcomes varied from complete recovery in four cases to no recovery in three cases. Three cases including our patient had incomplete recovery (Table1).

In our patient, a sizable herniated disc seemed to have compressed the cord compromising flow in the anterior spinal artery and producing a large area of cord edema as depicted by (Figure 1). Surgical decompression of the herniated disc resulted in early improvement of cord function but we postulate that restoration of spinal cord blood flow may have led to disruption in the blood spinal cord barrier and triggered a reperfusion injury resulting in delayed neurologic deterioration above and below the surgical level. A similar mechanism was postulated by Chin et al. in his report of a 59 year old male patient who had an incomplete sub-C6 acute quadriparesis secondary to reperfusion injury. Post-event MRI appearance on sagittal T2-weighted sequence and the clinical results of incomplete quadriparesis, without a clear understanding of the pathophysiology led him, to use the term "white cord syndrome." Our patient exhibited similar features.

Spinal cord ischemia/reperfusion injury originates from an insufficiency of blood supply to the anterior spinal artery and its branches and appears contingent on factors such as oxygen-derived free radical damage.[14,21-22] Mitochondria-dependent apoptosis, TNF-alpha production, specific phospholipid signaling cascades and glutamate-mediated excitotoxicity are factors resulting in neuronal injury in human and animal models.[22-25] The experimental literature has shown benefit of various neuroprotective agents particularly potent antioxidants and statins and these may attenuate the neural injury following spinal cord ischemic/reperfusion injury.[22,26-28] Thus, the experimental data suggests that there may be a role for perioperative use of such agents in the context of surgery for acute cord compression.

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Table 1

Summary of previously reported cases with similar clinical presentation

Authors	Year	Age (years)/ sex	Previous complaint	Spinal canal stenosis	Level (s)	Other levels affected	Presented with	Neurologic recovery	Operation	Follow-up
Lourie et al.	1973	37/M	Neck pain 2 months	-	**C6-7**	-	Quadriparesis	Complete	ACDF	6 Yrs
Joanes	2000	63/M	None	-	**C4-5**	+	Quadriparesis Sub C-5	Incomplete satisfactory	LAMINECTOMY	12 months
Suzuki et al.	2003	29/M	5 months numbness all limbs	+	**C6-7**	+	Quadriparesis	Incomplete	ACDF + LAMINOPLASTY	36 months
Goh and Li	2004	57/M	None	+	**C4-5**	+	Quadriparesis	Incomplete	ACDF	6 months
Sanadand et al.	2005	42/M	None	-	**C4-5**	-	Flaccid Quadriplegia	Incomplete	ACDF	18 Days
Song and Lee	2005	44/F	Neck pain 6 weeks	+	**C6-7**	+	Myelopathy + Quadriparesis	Complete	ACDF	6 months
Tsai et al.	2006	32/F	6 months numbness left middle finger	+	**C3-4**	+	Progressive Myelopathy + Quadriparesis	Complete	ACDF	18 months
Siam et al.	2012	48/F	Left arm pain + neck pain 2 months	-	**C5-6** + C5-7	+	Quadriparesis Sub C-5	Complete	ACDF	12 months
Chin et al.	2012	59/M	Bilateral arm + neck pain 7 months	+	**C5-6** + C3-6	+	Quadriparesis Sub C-6	Incomplete satisfactory	ACDF	16 months
This case	2016	36/M	2 weeks neck pain + arm pain	+	**C5-6**	+	Quadriplegia Sub C-6	Incomplete	ACDF	12 months

LEARNING POINTS/TAKE HOME MESSAGES ***3 to 5 bullet points – this is a required field***

- Urgent assessment and timely relief of ischemia would appear to be the critical factor in preventing reperfusion injury and its consequent irreversible neurological damage.
- The role of antioxidants, statins and other neuroprotective agents is supported by the experimental literature and may be considered as prophylaxis against spinal cord ischemic/reperfusion injury in the perioperative management of acute spinal cord compression.
- Acute C5/6 disc herniation may mimic pain presentation similar to acute coronary syndrome.

REFERENCES ***Vancouver style (Was the patient involved in a clinical trial? Please reference related articles)***

1. Lourie H, Shende MC, Stewart DH. The syndrome of central cervical soft disk herniation. JAMA. 1973;226(3):302-5.
2. Joanes V. Cervical disc herniation presenting with acute myelopathy. Surgical neurology. 2000;54(2):198.
3. Suzuki T, Abe E, Murai H, Kobayashi T. Nontraumatic acute complete paraplegia resulting from cervical disc herniation: a case report. Spine. 2003;28(6):E125-E8.
4. Goh H, Li Y. Non-traumatic acute paraplegia caused by cervical disc herniation in a

patient with sleep apnoea. Singapore medical journal. 2004;45(5):235-8.
5. Sadanand V, Kelly M, Varughese G, Fourney DR. Sudden quadriplegia after acute cervical disc herniation. The Canadian Journal of Neurological Sciences. 2005;32(03):356-8.
6. Song K-J, Lee K-B. Non-traumatic acute myelopathy due to cervical disc herniation in contiguous two-level disc spaces: a case report. European Spine Journal. 2005;14(7):694-7.
7. Tsai H-H, Li T-Y, Chang S-T. Nontraumatic acute myelopathy associated with cervical disk herniation during labor. J Back Musculoskelet Rehabil. 2006;19(2-3):97-100.
8. Siam AE, Gouda-Mohamed G-M, Werle S, Boehm H. Acute nontraumatic cervical disk herniation with incomplete tetraplegia. A case report and review of literature. European Orthopaedics and Traumatology. 2013;4(4):267-72.
9. Chin KR, Seale J, Cumming V. "White cord syndrome" of acute tetraplegia after anterior cervical decompression and fusion for chronic spinal cord compression: a case report. Case reports in orthopedics. 2013;2013.
10. Kawaguchi Y, Miyasaka A, Sugaya K. Acute paraplegia due to cervical disk herniation: a case report. Rinsho Seikei Geka. 1991;26:1395-8.
11. Warabi S, Sano S, Torihama Y, Hirose T, Kimura M. Progressive myelopathy caused by multiple cervical disc herniation: a report of two cases. Seikei Geka. 1995;46(7414.10).
12. Bayley E, Boszczyk BM, Cheong RSC, Srivastava A. Major neurological deficit following anterior cervical decompression and fusion: what is the next step? European Spine Journal. 2015;24(1):162-7.
13. Kato Y, Nishida N, Taguchi T. Paraplegia caused by posture during MRI in a patient with cervical disk herniation. Orthopedics. 2010;33(6):448-.
14. Liu C, Huang Y, Cai H-X, Fan S-W. Nontraumatic acute paraplegia associated with cervical disk herniation. The journal of spinal cord medicine. 2010;33(4):420.
15. Ueyama T, Tamaki N, Kondoh T, Miyamoto H, Akiyama H, Nagashima T. Non-traumatic acute paraplegia associated with cervical disc herniation: a case report. Surgical neurology. 1999;52(2):204-7.
16. Chen S-H, Hui Y-L, Yu C-M, Niu C-C, Lui P-W. Paraplegia by acute cervical disc protrusion after lumbar spine surgery. Chang Gung Med J. 2005;28(4):254-7.
17. Fujioka S. Tetraplegia After Coronary Artery Bypass Grafting in a Patient with Undiagnosed Cervical Stenosis. Anesthesia & Analgesia. 2005;101(6):1884.
18. Gorur A, Aydemir NA, Yurtseven N, Bilal MS. Tetraplegia after coronary artery bypass surgery in a patient with cervical herniation. Innovations: Technology and Techniques in Cardiothoracic and Vascular Surgery. 2010;5(2):134-5.
19. Lewandrowski K-U, McLain RF, Lieberman I, Orr D. Cord and cauda equina injury complicating elective orthopedic surgery. Spine. 2006;31(9):1056-9.
20. Naja Z, Zeidan A, Maaliki H, Zoubeir S, El-Khatib R, Baraka A. Tetraplegia after coronary artery bypass grafting in a patient with undiagnosed cervical stenosis. Anesthesia & Analgesia. 2005;101(6):1883-4.
21. Chan PH. Role of oxidants in ischemic brain damage. Stroke. 1996;27(6):1124-9.
22. Shan L-q, Ma S, Qiu X-c, Zhou Y, Zhang Y, Zheng L-h, et al. Hydroxysafflor Yellow A protects spinal cords from ischemia/reperfusion injury in rabbits. BMC neuroscience. 2010;11(1):98.
23. Okajima K. Prevention of endothelial cell injury by activated protein C: the molecular mechanism (s) and therapeutic implications. Current Vascular Pharmacology. 2004;2(2):125-33.
24. Bazan NG, Marcheselli VL, COLE-EDWARDS K. Brain Response to Injury and Neurodegeneration. Annals of the New York Academy of Sciences. 2005;1053(1):137-47.
25. Pan W, Banks WA, Kastin AJ. Blood–brain barrier permeability to ebiratide and TNF in acute spinal cord injury. Experimental neurology. 1997;146(2):367-73.
26. Yavuz C, Demirtas S, Guclu O, Karahan O, Caliskan A, Yazici S, et al. Rosuvastatin may have neuroprotective effect on spinal cord ischemia reperfusion injury. CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders). 2013;12(7):1011-6.
27. Kurt G, Gokce EC, Cemil B, Yildirim Z, Kaplanoglu GT, Durdag E, et al. Neuroprotective Effects of Rosuvastatin in Spinal Cord Ischemia-Reperfusion Injury in

Rabbits. Neurosurgery Quarterly. 2015;25(2):189-96.
28. Zhu P, Li J-x, Fujino M, Zhuang J, Li X-K. Development and treatments of inflammatory cells and cytokines in spinal cord ischemia-reperfusion injury. Mediators of inflammation. 2013;2013.

FIGURE/VIDEO CAPTIONS ***figures should NOT be embedded in this document***

Figure 1 (a-b). MRI cervical spine pre procedure, in sagittal plane T 2 sequence (1a) and axial T 2 sequence (1b), demonstrating annular tear and acute disc prolapse at C 5/6 level with subtle hyperintense signal changes in the spinal cord representing edema and cord compression.

Figure 2. X-ray cervical spine lateral view, demonstrating bone graft and plate in place without any migration in the spinal canal.

Figure 3 (a-b). MRI cervical spine post procedure; T 2 (3a) and T 1 (3b) sequence in sagittal plane, demonstrating hyper intense signal changes in the spinal cord representing hemorrhage. One can appreciate adequate decompression, removal of the disc fragment, surgical implants in place with rest of the post-surgical changes.

Table 1. Summary of all the reported cases of quadriparesis.

PATIENT'S PERSPECTIVE ***Optional but strongly encouraged – this has to be written by the patient or next of kin***

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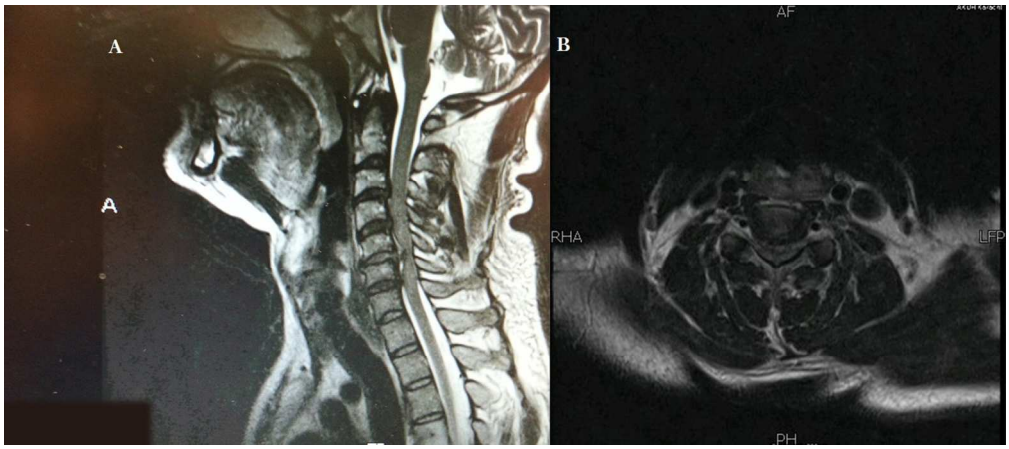

Figure 1 (a-b). MRI cervical spine pre procedure, in sagittal plane T 2 sequence (1a) and axial T 2 sequence (1b), demonstrating annular tear and acute disc prolapse at C 5/6 level with subtle hyperintense signal changes in the spinal cord representing edema and cord compression.

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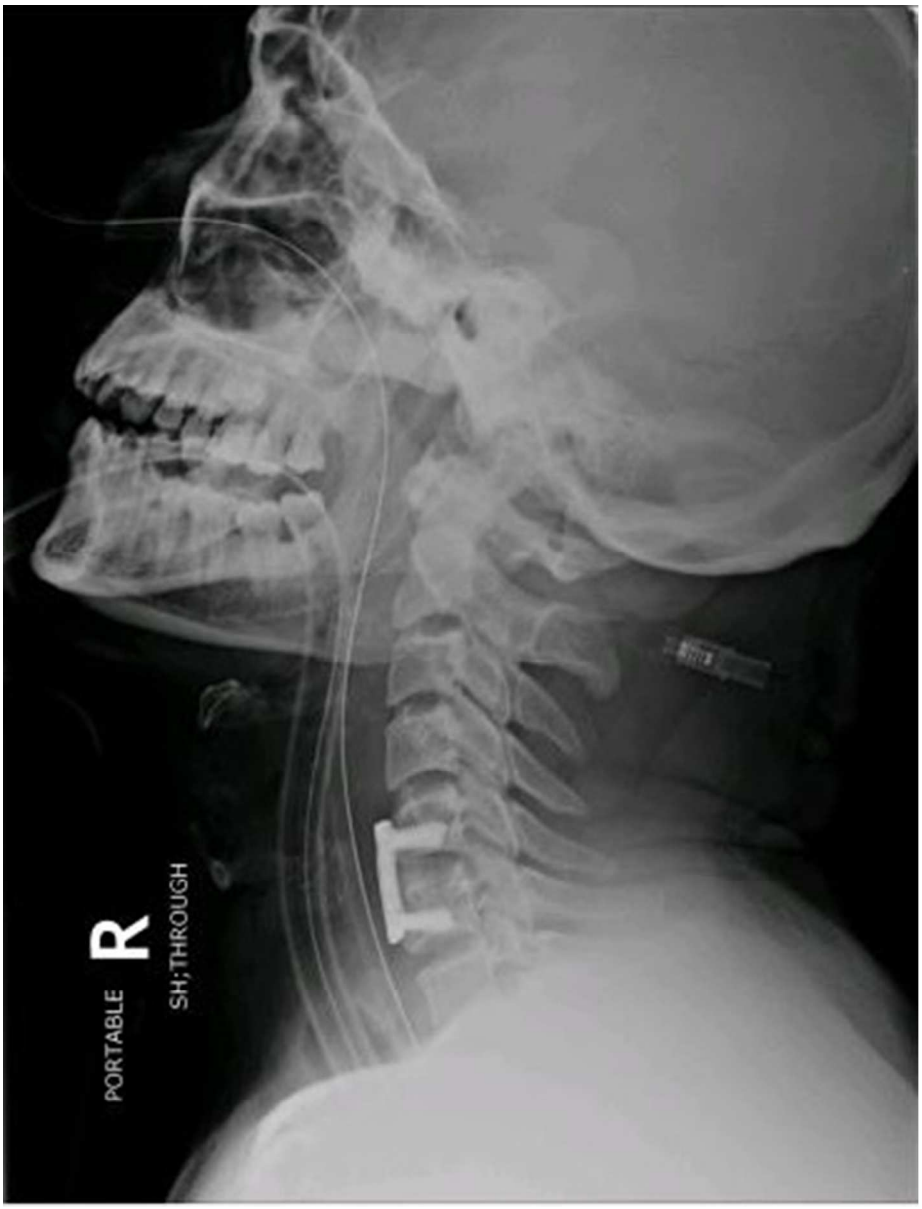

Figure 2. X-ray cervical spine lateral view, demonstrating bone graft and plate in place without any migration in the spinal canal.

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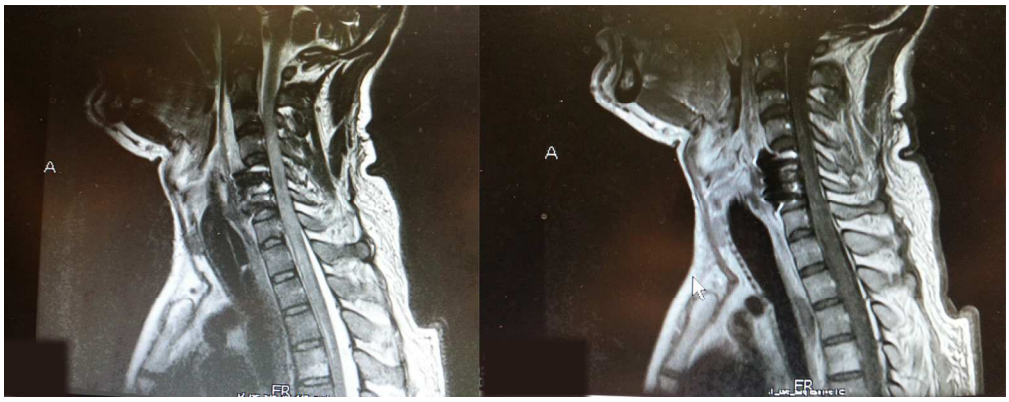

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