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ORIGINAL PAPER

Early presentation of traumatic cervical disc herniation with neurologic deficit and without an adjacent bone lesion

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Abstract

Aim of the study The purpose of this study was to explore clinical features and the operational opportunity of traumatic cervical disc herniation.

Method Patients with cervical spine injury (413) were retrospectively reviewed. Six patients with neurological deficits were identified to have disc herniation without adjacent bone lesion. The diagnosis was confirmed by MRI. The Japanese Orthopedic Association (JOA) score was used to assess the severity of clinical symptoms. Different grading systems have been used in analyzing various stages of herniated cervical discs. All patients underwent anterior cervical decompression, insertion of autologous iliac crest graft, and fixation with cervical plate.

Results The causes of injury were road traffic accidents in four patients and sport and domestic accidents in one patient each. There were five patients with single intervertebral disc herniation and one patient with double. Pre-operative JOA score was 14 for three patients, the remaining three patients scored 10, 6, and 3 respectively. At final follow-up, the score was 17 for four patients and 14 for two patients.

Discussion Traumatic cervical disc herniation with neurologic deficit and without adjacent bone lesion is a rare condition. MRI is the golden examination to confirm diagnosis. Early recognition is essential for appropriate therapy and to minimize the extent of neurological deficit.

Conclusion The MRI is mandatory in diagnosing different types of traumatic herniated cervical disc. Discectomy and anterior cervical interbody fusion using autologous iliac crest graft are the treatment options.

Keywords Traumatic cervical disc herniation · Neurological deficit · MRI · Discectomy

Introduction

Traumatic cervical disc herniation with neurologic deficit and without an adjacent bone lesion is a rare condition [1–3]. Almost all cervical spinal cord injuries are a result of severe traumatic accidents such as traffic accidents, labour accidents, or sport accidents. Most of them accompany fractures and/or dislocations [4]. Magnetic resonance imaging (MRI) is the golden modality to confirm diagnosis in view of the absence of both conventional radiographs and computed tomography (CT) bone lesions [5–7]. Early recognition is essential for appropriate therapy and to minimize the extent of neurological deficit [8, 9]. The retrospective multifactor study of six patients treated for symptomatic traumatic herniated cervical disc without bony injuries enabled us to analyze the clinical features and appreciate the results of the various treatments administered.

Materials and methods

The medical records of all patients with cervical spinal injuries treated in the Orthopaedic and Trauma Surgery Department over a period of ten years, from March 2008 to March 2018, were retrospectively reviewed. Of the 413 patients with acute cervical spinal injury admitted, 6 (1.45%) were found to have

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cervical disc herniation with neurologic deficit and without adjacent bone lesion. Only patients with MRI scans were included. We did not consider cervical disc herniation caused by cervical fractures, dislocations, and other pathologies including degenerative changes, malignancy, infection, or congenital anomalies.

There were five males and one female, with an average age of 34 years ranging from 16 to 60 years. The mean follow-up time was four years and three months (range 4 months–7 years and 3 months). All patients underwent discectomy and/or corporectomy, insertion of an autologous iliac crest graft, and fixation with cervical plate (Figs. 1d and 2e). All of the incisions were with primary healing. Rehabilitation was systematic thereafter.

We have investigated epidemiological characteristics such as the type of accident, the mechanism of injury, the age, and the past history of both axial and radicular cervical pain. The American Spinal Injury Association (ASIA) classification grading system was used to document sensory and motor impairments. The Japanese Orthopedic Association (JOA) score was used to assess the severity of clinical symptoms with normal function: 16–17; grade 1: 12–15; grade 2: 8–11, and grade 3: 0–7. The Decoulx (1986), Annette Kettler (2006), Ji Sook Yi (2015), and Lloydine J. Jacobs (2016) grading systems have been used in analyzing various stages of herniated cervical discs.

Results

The causes of injury were road traffic accidents in four patients including one by motorcycle accident and three by motor vehicle collision. Contact sport (wrestling) and domestic accidents by fall were involved in one patient each. The mechanism of injury associated hyperextension to forced flexion or vice versa ("whiplash" injury), whether it was vehicle passengers without a headrest, the motorcycle driver or the fall on the buttocks during a domestic accident (Table 1). The only female patient presented the cervical osteoarthritis with neither spinal canal stenosis nor history of both neck and shoulder pain (Fig. 1a, b).

Pre-operative X-rays (Figs. 1a and 2a) and CT (Fig. 2a, b) did not show any skeletal injury. Pre-operative sagittal (Figs. 1c, 2c, and 3a) and transversal (Figs. 2d and 3b) weighed MRI scans revealed herniated discs. In total, seven herniated discs were involved. There were five patients with single intervertebral disc herniation and one patient with double. The injury levels were at C3-C4 in three patients, C5-C6 in one patient, C6-C7 in one patient, and the one with double intervertebral disc involved C3-C4 and C4-C5. There was spinal contusion in four patients. Preoperative Decoulx grading revealed four discs grade B, two grade C, and one grade D (Table 1).

Four patients were operated within three days after their trauma (early operational group), and other two patients were operated upon after 15 and 18 days respectively (delayed operational group). Solid bone fusion was obtained in all patients. Complete neurological recovery was seen in four patients (early operational group), and it was incomplete in two patients (delayed operational group). At hospital admission, three patients were ASIA's grade D while grades A, B, and C counted one patient each. At final follow-up, four patients were ASIA's grade E and two patients ASIA's grade D. Preoperative JOA score was 14 for three patients, 10 for one patient, 6 for one patient, and 3 for one patient. At final follow-up, the score was 17 for four patients (early operational group) and 14 for two patients (delayed operational group).

Discussion

Cervical intervertebral disc herniation is generally regarded as a consequence of a long-term degenerative process in the disc tissue [2]. The contribution of traumatic events as potential causes in the absence of adjacent fracture and/or dislocation is debatable. Only in a few cases of symptomatic disc herniation without adjacent bone lesion has a preceding traumatic episode been identified [1, 3, 4, 10–12]. In our study, cervical disc herniation has a well-documented traumatic origin. Road traffic accidents were responsible of disc hernias in four patients, while contact sport (wrestling) and domestic accidents were involved in one patient each.

Cervical spine disc herniation is a disabling condition. The clinical features are those of spinal cord compression either complete (quadriplegia) or incomplete. The algesic and deficit element predominated in the upper extremities, the spinal cord damage being expressed essentially by sphincteral disorders and spastic quadriparesis. It may also present forms of specific cervical spinal nerve root compression. The symptomatology can be local (neck pain, stiff neck), cervicobrachialgic and laterocollis [13]. Jesica J. Wong et al. [14] showed that understanding the natural history, clinical course, and prognostic factors of symptomatic herniated cervical discs is necessary to guide patients' expectations and assist in their management. In our study, outcomes of interest included self-rated and functional recovery such as return to activities, work or school, limitations of activities of daily living, and clinical outcomes either pain or disability. All patients experienced substantial improvements within post-operative follow-up.

Plain X-rays and non-contrast CT scans are of little diagnostic value in isolated non-skeletal injuries of the cervical spine. Sagittal and transversal magnetic resonance imaging scans are mandatory for evaluation of cervical disc herniation. It is superior to CT because it does not expose patients to a radiation hazard, has excellent soft-tissue resolution, and can create multiplanar images. Additionally, contrast-enhanced

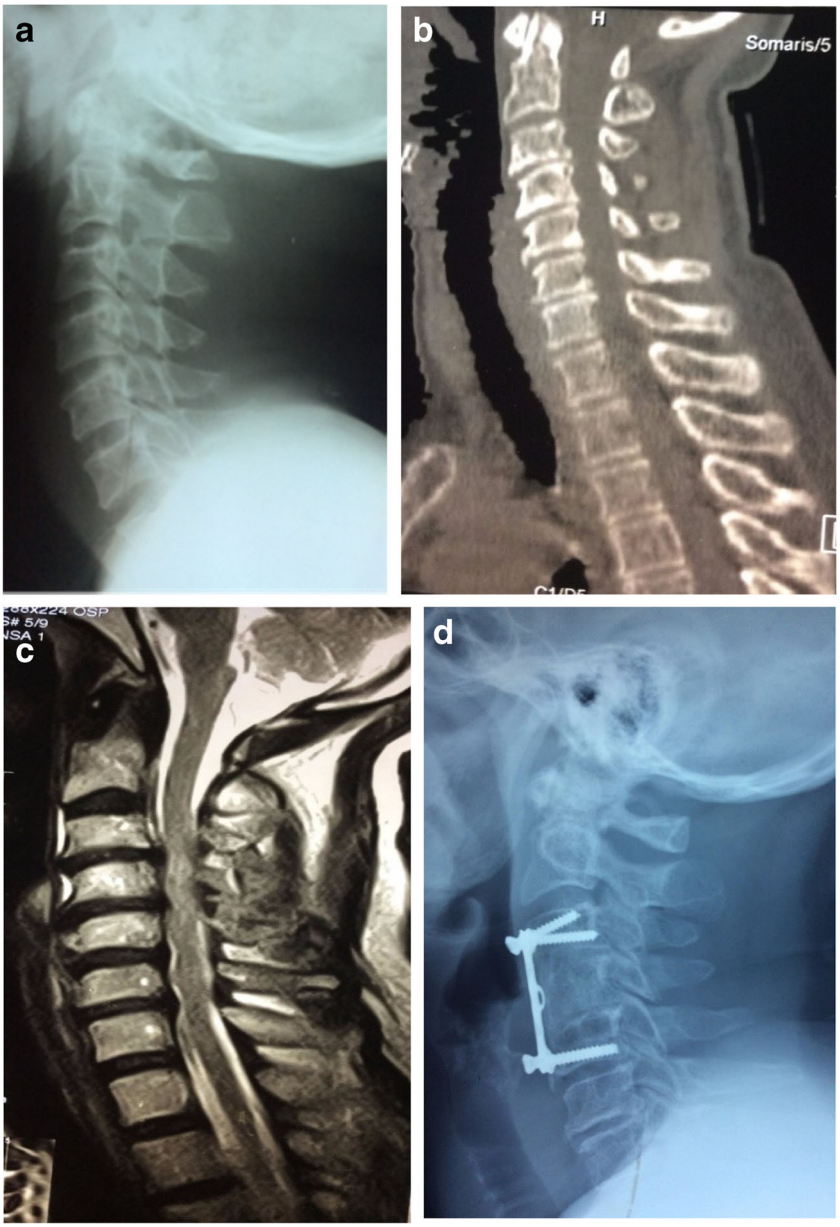

Fig. 1 A 60-year-old patient, after a road traffic accident, ASIA's grade A with arthritis of the cervical spine without spinal canal stenosis and no fracture dislocations on both lateral X-ray (**a**) and CT scan (**b**) of the cervical spine. MRI scan showing a multilevel cervical disc herniation from C3 to C7 DECOULX grade B associated with spinal cord contusion (**c**) and a lateral X-ray taken 2 years postoperatively showing anterior fixation with C3-C5 bone fusion and slightly pulled out screws. This happened after fixation because screws subsided in the weak osteoporotic bone (**d**)

CT carries the risk of anaphylactic reactions and nephrotoxicity with the use of iodinated contrast material [5–7]. In accordance with these findings, the value of MRI proved most useful in our cases in diagnosing traumatic cervical disc herniation with neurologic deficit and without adjacent bone lesion.

The classification drawn up by Decoulx should facilitate anatomico-clinical correlations as computed tomography coupled with subarachnoid injection of contrast medium ought to enable the identification of various stages of cervical disc herniation and promote a better therapeutic approach. This classification distinguishes between four anatomical types. The grade A is the disc prominence with a permanent bulging. The grade B is the non-exteriorized herniated disc which is compressing the nerve elements through the intact common posterior vertebral ligament (CPVL). The grade C is the exteriorized herniated disc. It is said to be of the "shirt button" type as a disc pedicle remains in the intervertebral space and the CPVL is torn. The grade D is the free herniated disc into the cervical canal directly compressing the cervical spinal cord [15].

Based on MRI findings, Lloydine J. Jacobs et al. [16] have introduced the grading system based on the biological progression of disc degeneration. Ji Sook Yi et al. [17] have assessed intermodality variability when evaluating cervical intervertebral disc herniation using 64-slice multidetector row computed tomography (MDCT) and magnetic resonance imaging. They described a four-grade system: normal, bulging, protrusion, and extrusion. Annette Kettler et al. [18] have proposed a new radiographic grading system based on lateral

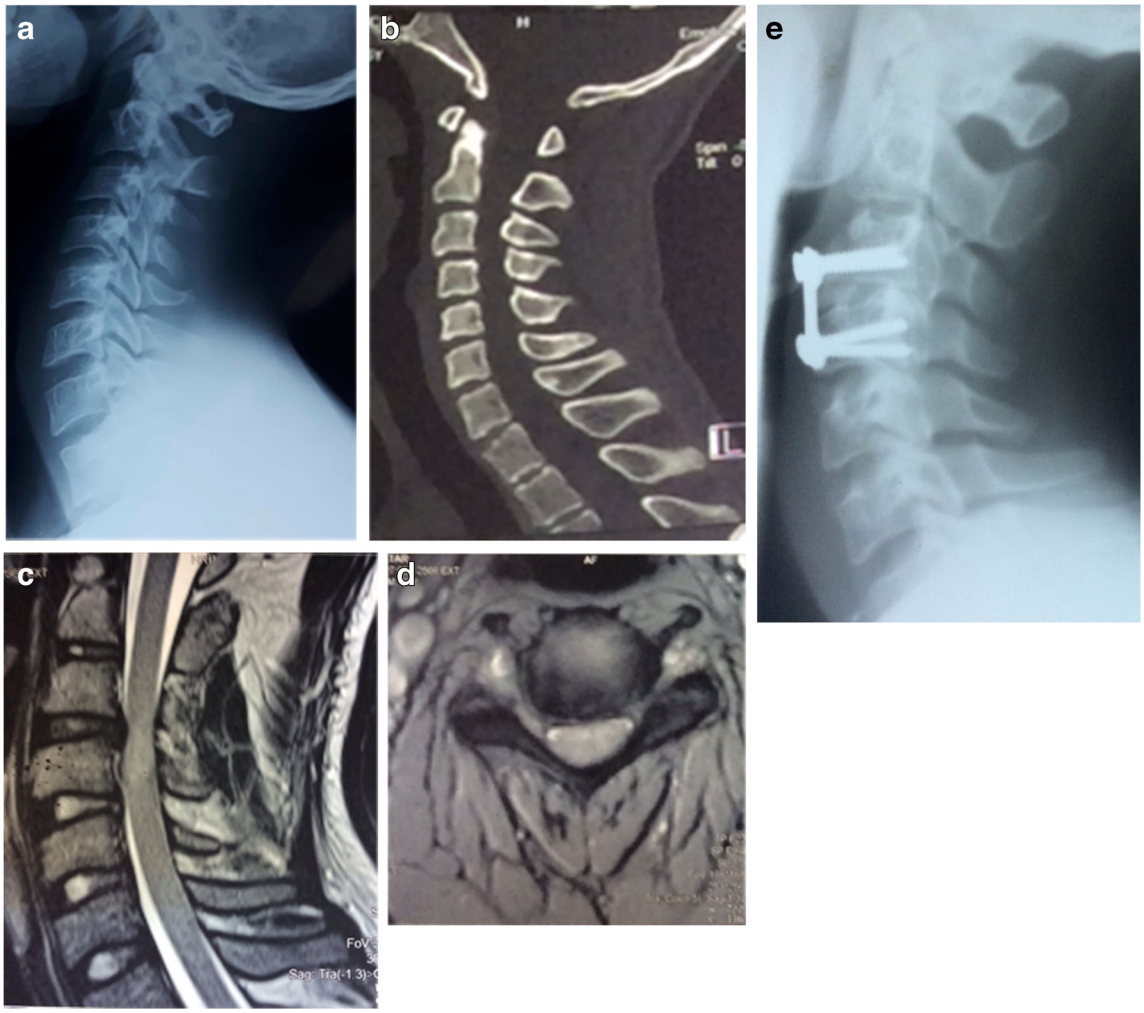

Fig. 2 Images of a 23-year-old patient, victim of contact sport (wrestling) accident, ASIA's grade C without bony injuries on both lateral X-ray (**a**) and CT scan (**b**). Pre-operative MRI images. Left: sagittal T2-weighted MRI image (**c**) showing severely compressed spinal cord at C3-C4 level. Right: axial T2-weighted MRI image (**d**) showing cervical disc herniation at C3-C4 level compressing from central. This figure shows the post-operative lateral X-ray taken 4 months after surgery with C3-C4 intervertebral fusion not fully evident, but this was due to the short follow-up time between surgery and this post-operative X-ray (**e**)

radiographs for cervical intervertebral disc degeneration. Pre-operative MRI findings enabled us to distinguish four non-exteriorized discs (Decoulx grade B or Ji Sook Yi grade 3), two exteriorized discs (Decoulx grade C or Ji Sook Yi grade 4), and one free disc (Decoulx grade D).

Anterior cervical discectomy and interbody fusion (ACDF) have been proven to be a safe and effective procedure for the treatment of herniated cervical discs. However, the choice of fusion materials remains controversial. Some authors [19–21] suggest discectomy, insertion of an intersomatic polyetheretherketone (PEEK) cage filled with synthetic bone, and placement of a cervical plate. Others prefer to use the minimally invasive procedure (full-endoscopic anterior cervical discectomy) rather than the classic anterior cervical decompression and fusion with autologous iliac crest grafts [22]. Cheng-Wei Chu et al. [23] have demonstrated that interbody cage fusion without plate fixation has a good fusion rate and neurological outcome. Bjarne Lied et al. [24] evaluated the clinical outcome of ACDF, with respect to both patient selection and choice of surgical procedure: fusion with an autologous iliac crest graft (AICG) versus fusion with an artificial cage made of PEEK. Because of similar clinical outcomes, the advantage of simplifying the surgery with a shorter duration of the procedure and lack of donor site morbidity when using PEEK, they suggested to prefer fusion with PEEK cage to AICG. As we did not dispose artificial cage made of PEEK, we have performed ACDF with AICG and stabilization with cervical plate.

Early operation is favourable to the recovery of neurological function in patients with spinal cord compression [8, 9]. There were significant differences between early and delayed operational groups during the follow-up time. We have a complete recovery in four patients (early operational group) and

Table 1 Details of patients presenting traumatic herniated cervical disc with neurologic deficit and without adjacent bone lesion

Patient/age/sex	Cause of injury	Mechanism of injury	Past history	ASIA grade on admission	MRI lesion level/ DECOULX grading	Treatment	Mean follow-up time/ASIA's score
ND/22 years/male	Road traffic accident (motorcycle)	Fall on head	None	ASIA D	C3-C4 disc/Decoulx grade C	Discectomy C3-C4 + graft + anterior plate	4 months/ASIA E
SAT/39 years/male	Domestic accident (fall)	Fall on buttocks	None	ASIA D	C5-C6 disc/Decoulx grade B	Discectomy C5-C6 + graft + anterior plate	1 year and 7 months/ ASIA E
MT/16 years/male	Road traffic accident (car)	Unbelted front passenger involved in traffic collision	None	ASIA D	C3-C4 disc + spinal contusion/ Decoulx grade C	Discectomy C3-C4 + graft + anterior plate	4 years and 4 months/ ASIA E
FD/60 years/female	Road traffic accident (car)	Rear passenger involved in traffic collision	Arthritis of the cervical spine	ASIA A	C3-C4 and C4-C5 discs + spinal contusion/Decoulx grade B	Corporectomy C4 + discectomy C3-C4 and C4-C5 + graft + anterior plate C3-C5	6 years/ASIA E
AMK/23 years/male	Contact sport accident (wrestling)	Fall on head	None	ASIA C	C3-C4 disc + spinal contusion/ Decoulx grade B	Discectomy C3-C4 + graft + anterior plate	7 years/ASIA D
MD/45 years/male	Road traffic accident (car)	Rear passenger involved in traffic collision	None	ASIA B	C6-C7 disc + spinal contusion/ Decoulx grade D	Corporectomy C6 + discectomy C5-C6 and C6-C7 + graft + anterior plate C5-C7	6 years/ASIA D

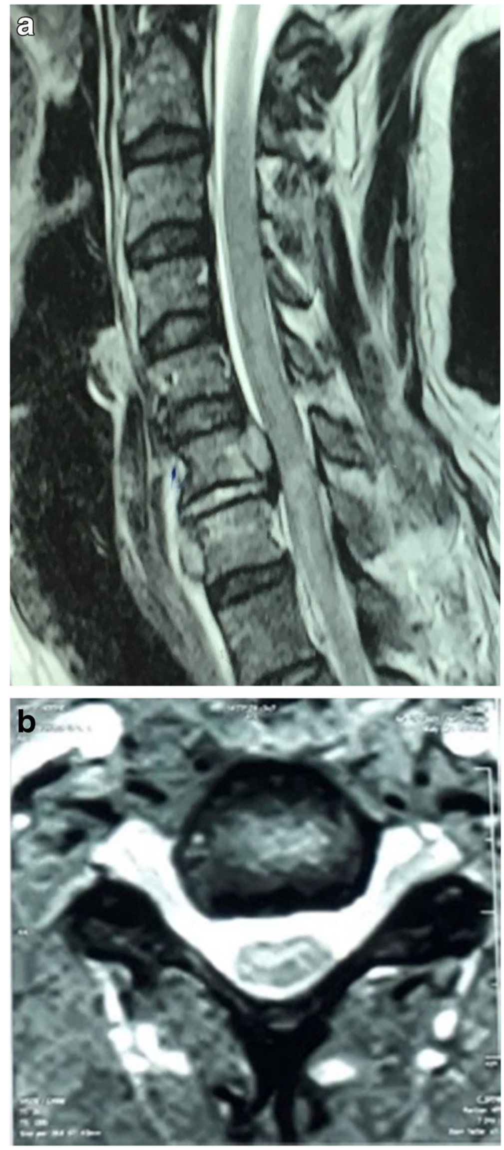

Fig. 3 This figure shows T2 weighted sagittal (**a**) and transversal (**b**) MRI images of a 45-year-old patient ASIA's grade B. The scan revealed a free herniated C6-C7 disc into the spinal canal directly compressing the cervical spinal cord DECOULX grade D

incomplete recovery in delayed operational group (two patients cored ASIA D from ASIA B and C respectively). The operation was delayed due to patients' luck of financial supports to timely do IRM or pay hospital fees. In one osteoporotic patient, we have slightly pulled out screws two years post-operatively. This sometimes happens after fixation when screws subside in the weak osteoporotic bone [25]. However, the most important thing is the clinical improvement observed after four months (Table 1).

The primary limitation of our study is that it was conducted on a small population. Therefore, further large-scale studies are needed to make strong recommendations. This study has been conducted in low-income country, and fixation materials (cervical plate) were not MRI compatible;

therefore, no patient has a post-operative MRI. We could not compare pre- and post-operative spinal cord. However, the good thing is that the neurologic deficit has recovered.

Conclusion

The MRI is mandatory in diagnosing different types of traumatic herniated cervical disc. Early operation is essential to minimize the extent of neurological deficit and favourable to the recovery of neurological functions. Hence, the importance of emergency of surgical option in patients with spinal cord compression was due to cervical disc herniation. As well as the global good results, and given the local and general surgical environment, one can agree for taken option of discectomy and bone graft fusion.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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