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Traumatic total axial reversal of the thoracic vertebral body

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Abstract Numerous vertebral fracture patterns have been reported in the literature. We present the case of a patient who sustained severe trauma to the back that resulted in a very unusual and not previously reported rotational injury consisting in complete 180° rotation of the T6 vertebral body along a vertical axis, with only limited anteroposterior and lateral displacement. An unsuspected aortic tear resulted in severe evolu-

tion with fatal outcome following surgical attempt. The aetiology of such displacement is unknown. The possibility of late vascular complications should be kept in mind while treating thoracic spine fractures with rotational displacement.

Key words Thoracic vertebrae · Fractures · Paraplegia · Aortic rupture · Intraoperative complications

Introduction

Numerous vertebral fracture patterns have been reported in the literature in the thoracic and thoracolumbar spine. These have been classified in different systems that take into account involvement of bone and soft tissue [1, 9], injuries in different compartments such as the “three-column concept” of Denis [3], and displacement in the three dimensions [5, 12]. The occurrence of some degree of rotation in the overall fracture pattern is a well-recognized factor of complications such as instability and neurological involvement. However, some fracture patterns still do not fit into any classification scheme [12]. We present the case of a patient who sustained severe trauma to the back that resulted in a very unusual and not previously reported pattern of injury. Unsuspected vascular complication resulted in severe evolution with fatal outcome.

Case report

The patient was a 52-year-old man who suffered a work-related accident in which he was struck from behind by a concrete tank that fell from a construction crane. He was admitted to the hospital as an emergency, with T7 complete paraplegia and in subacute respi-

ratory distress. Chest radiographs showed bilateral haemothorax and anterolateral flail chest. Emergency lateral thoracic spine radiograph showed a 6-mm retrolisthesis of the T5 vertebral body over the T6 vertebra and an 11-mm retrolisthesis of T6 over T7 (Fig. 1). The anteroposterior (AP) view was rated normal with good alignment (Fig. 2). Only CT examination provided the basis for the diagnosis. CT scans revealed fractures of the T4, T5 and T6 pedicles, and showed that the T6 vertebral body was in a completely rotated position, with the posterior wall and broken pedicles being actually anterior, whereas the anterior aspect of the vertebral body was posterior, close to the dura (Figs. 3, 4). This suggested that the T6 vertebral body had undergone a complete 180° rotation around a vertical axis at the time of injury (Figs. 5, 6). Significant widening of the gap between the T6 and T7 facet joint was also present, with T6 posterior elements markedly displaced posteriorly, but the whole segment remained in gross alignment.

In the intensive care unit, the patient remained a complete paraplegic. The clinical course was characterised by marked respiratory distress, Gram-negative pulmonary infection and severe urinary infection. A tracheostomy was needed on the 6th day, and all other surgery had to be delayed. The general status improved slowly in the intensive care unit, with chest drainage and antibiotics. MR imaging could be performed only after 1 month. It showed severe injury to the spinal cord and abnormal signal of the T6 and anterior part of T5 vertebral bodies (Fig. 7). No vascular abnormalities concerning the great vessels were suspected on the MR or CT studies. The segmental arteries at the level of the fractured vertebra could not be seen on these examinations.

Instability due to rotation and the disruption of soft tissues was considered an indication for anterior surgery. The operation was

scheduled after general problems had been resolved and was performed 2 months after the initial accident. A right thoracotomy was performed in the bed of the seventh rib and the fractured vertebra was approached. It was found in the same rotated position as

shown by the CT scan, with the axis of rotation being vertical along the thoracic spine. The fractured vertebra was also free from any remaining vascular or disc connection and was completely mobile between the disrupted discs and soft tissues. Exposure of

◀ **Fig. 1** Emergency lateral radiograph showing only limited displacement with 11-mm retrolisthesis of T6 over T7 and 6-mm retrolisthesis of the T5 over the T7 vertebral body

Fig. 2 Anteroposterior (AP) emergency radiograph showing no displacement. The view could be mistaken as normal

Fig. 3 **A** Emergency CT scan at the level of the T6 pedicles. Both pedicles are fractured close to their insertion into the body, and the vertebral body is turned 180° with the concave posterior wall pointing anteriorly, whereas the convex anterior aspect is posterior close to the dura. **B** Emergency CT scan at the level of the facet joints showing extensive widening of the joints and anterior position of the pedicular remains on the rotated vertebral body

Fig. 4 Global chest CT scan showing bilateral haemothorax, left anterolateral flail chest and the displaced vertebral body with the pedicular remains pointing anteriorly to the mediastinum

Fig. 5 CT scan with 2D sagittal reconstruction showing the broken T6 pedicles, significant widening of the gap between the T6 over the T7 facet joint, and pedicular remains on the now anterosuperior aspect of the T6 vertebral body

Fig. 6 CT scan with 3D reconstruction: right anterolateral view showing 180° rotation of the T6 vertebral body. Both pedicles can be visualized. The general shape of the spine remains, with minimal anteroposterior and lateral displacement

Fig. 7 Sagittal MR image showing injury to the spinal cord and abnormal signal of T6 and the anterior part of the T5 vertebral body

the left vertebral aspect was conducted using gentle dissection with a swab on a clamp. As soon as the vertebra had been approached on this side, severe bleeding started from the left aspect of the vertebral body. This was thought to arise from a disrupted segmental artery. Removal of the vertebral body was done with the idea of controlling the bleeding. The vertebral body was found completely free and could be removed gently in one piece. Once the vertebral body had been removed, increased bleeding emanated from the medial aspect of the aorta, which was immediately controlled with packing alone. An experienced vascular surgeon was immediately summoned. The arterial bleeding originated from a hemi-circumferential tear to the aorta. The left aspect of the posterior mediastinum was released, the aorta was exposed from the isthmus to the lower thoracic portion, and appropriate haemostasis was completely achieved only by using a transluminal Foley catheter. No real false aneurysm wall was found for dissection, but release of the aorta was rendered extremely difficult due to extreme frailty of the tissue. The arterial wall was very soft, and attempts at arterial repair failed. After clamping the extremities of the vessel, an extra-anatomic shunt was performed between the ascending portion and the lower thoracic portion of the aorta. The shape of the transplant appeared satisfactory. Unfortunately, ventricular fibrillation occurred at removal of the clamps. Cardiac arrest followed and led to the death of the patient in spite of prolonged cardiac resuscitation. His relatives refused consent for an autopsy. The removed vertebral fragment was kept for examination.

Discussion

Rotation is a common finding in spine fractures in the thoracic and thoracolumbar segments. The presence of rotation is a recognized risk factor for spinal cord injury [18] and spine instability [7, 16, 17]. The clues for a rotational mechanism in vertebral injuries are fractures of the lateral

elements such as transverse processes, and lateral displacement on the AP view [12].

The injury we describe in our patient is very unusual and to our knowledge has never been described in the literature. It comprised the maximum amount of rotation that can be seen in a vertebral body, but no residual rotatory displacement in the spinal segments below and above the injury. The complete pattern included fractures of the T4, T5 and T6 pedicles, significant widening of the gap between the T6 over the T7 facet joint, and complete 180° rotation of the T6 vertebral body along a vertical axis. Although there were no remaining connections with bone or soft tissue, the T6 vertebral body remained in good alignment with T5 and T7 and the AP views could be mistaken for normal. MR imaging performed after 1 month showed that the T6 vertebral body appeared as isosignal on T1 and hypersignal on T2 sequences. This is consistent with bone oedema due to trauma. MRI provided little information concerning the discs below and above T6, but the magnitude of the rotational displacement was consistent with total disruption, which was proved at operation.

We provide no physiopathological explanation for the occurrence of a 180° rotational displacement in our patient. One would expect that in a patient with complete dislocation of the spine and immediate reduction at the time of trauma, the vertebral body would sustain rotation along a horizontal axis in either direction. In such an occurrence, the posterior aspect of the vertebra would become anterior and the broken surfaces of the pedicles would point anteriorly. However, if the axis of rotation had been horizontal, the superior vertebral end-plate would have become inferior and the pedicles would be located on the lower part of the anterior aspect of the rotated vertebral body. This was not the case in our patient: the pedicles remained on the upper part of the now anterior aspect of the vertebral body, indicating that the result of the displacement was actually 180° rotation over a vertical axis. Also, we provide no explanation for the occurrence of a three-level pedicular fracture, with complete loss of T6-T7 articular contact. However, the actual movement of the body at the time of injury may have been more complex, such as a combination of different rotational movements over multiple axes with a resulting position in a fixed 180° vertical rotation. We suspect that a differential rotational movement superimposed on the upper and lower spinal segments could produce such a displacement, but this is pure assumption and the issue will not be discussed further here.

Due to the three-column disruption through bone and soft tissue and the concern for bone necrosis, the injury was considered highly unstable. Moreover, the expected outcome for the T6 vertebral body was similar to that of an anterior bone graft performed with the vertebral end plates and intervertebral disc remnants still in place. In spite of the absence of further displacement during the clinical course over 2 months, those concerns were considered an indication for anterior surgery.

Concomitant vascular injury following injuries to the thoracic spine are a well-recognized occurrence [15, 21, 23]. In a retrospective hospital study concerning severely injured patients, the occurrence of traumatic aortic rupture (TAR) was 5.5% in patients with upper thoracic spine fractures, and the mortality rate was 100% among them (five patients) [22]. However, the possible occurrence of delayed late ruptures is not emphasized [10].

It is our opinion that the involvement of the arterial wall of the aorta in our patient was due to a blind tear following traction on the segmental arteries at the time of the trauma, and the rupture was due to the reopening of the tear under aortic pressure during dissection and removal of the vertebral body. However, there is no doubt that aortic rupture occurred during the operative procedure, and no evidence that it would have happened at all if no operation had been done. Emergency radiographs showed mild mediastinal enlargement, but this is a common finding in patients with thoracic spine fractures, and the sensitivity for TAR is low [2, 8, 11]. The preoperative explorations (MRI, CT scan with 3D reconstruction) failed to

show any degree of vascular involvement. The accuracy of CT scan in screening patients with blunt chest trauma for TAR is expected to be high, but still remains controversial [6, 13, 14, 19]. The occurrence of severe perioperative bleeding in our case is thought to be caused by the arterial pressure reopening the vascular tear at the time of vertebral body removal. The question of whether this would have been recognized by aortography is pending. The sensitivity of aortography in acute TAR is thought to be close to 100% [20], although false-negatives have been reported [4].

Had the occurrence of vascular involvement been recognized or suspected prior to the operation, we would have considered operating in a facility with extra-corporal circulation capabilities, which would have made the occurrence of arterial bleeding less desperate. We still think that, considering the complete loss of vascular connections in the injured vertebra, surgery is desirable in such an occurrence as long as all the possible complications are taken into account.

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