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CASE REPORT

Occult thoracic disco-ligamentous Chance fracture in computed tomography: a case report

Daniel García-Pérez[1] · Irene Panero[1] · Alfonso Lagares[1] · José A. Alén[1] · Igor Paredes[1]

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Abstract

We report on a 46-year-old woman who was involved in a road traffic accident. Neurological examination demonstrated paraplegia, while initial CT showed bilateral pneumothorax and hemothorax, rib fractures, a C2 vertebral body fracture with C2–C3 dislocation and active arterial bleeding at the sacral level. Given the fact that her neurological status did not particularly correspond with what we observed on CT scan, MRI was obtained due to the suspicion that a much more severe occult injury could be present. MRI showed a complete rupture of the posterior ligamentous complex along with the intervertebral disk and the posterior longitudinal ligament at T8–T9 level. The patient underwent minimally invasive posterior fixation with pedicle screws. Chance fractures of the thoracic spine are uncommon. To our knowledge, this is the first report of a pure soft-tissue Chance fracture located in the thoracic spine. Given that the initial CT showed no fracture evidence or vertebral malalignment, a high index of suspicion, based on the mechanism of injury, clinical examination and/or concomitant lesions, is necessary to identify such extremely unstable injury. Early recognition is crucial for appropriate therapy and to minimize the extent of neurological deficit.

Keywords Motor vehicle collision · Chance-type fracture · Spinal cord injury · Occult computer tomography injury · Trauma · Thoracic

Introduction

Chance-type fractures are flexion–distraction injuries in the thoracolumbar vertebral column [1]. Chance fractures are usually associated with automobile accidents when the occupant is restrained with a lap seat belt, which acts as an anterior fulcrum. Consequently, the spinal column splits transversely in the posteroanterior direction involving bone structures, the disco-ligamentous components or a combination of both. Thus, bony Chance fractures consist of disruption of the posterior elements of the vertebra, with the fracture extending throughout the pedicles and into the vertebral body. In contrast, soft-tissue Chance fractures involve the rupture of the posterior ligamentous complex (PLC), consisting of the supraspinous ligament, the interspinous ligament, the ligamentum flavum and the facet joint capsules, and the posterior longitudinal ligament and intervertebral disk anteriorly [2]. Usually, the bone elements fail before the disco-ligamentous components because the tensile strength of the ligaments is greater, mostly leading to osseous Chance fractures [3]. For instance, Groves and colleagues [4] performed a retrospective study where they studied 24 patients who displayed Chance-type injuries, with just one patient having purely soft-tissue flexion–distraction injury at T12–L1 level.

The vast majority of Chance fractures occur in thoracolumbar junction [4, 5]. In contrast, Chance fractures of the thoracic spine represent an unusual location, since there is an inherent limitation to the degree of flexion in this region of the vertebral column, due to the rib cage. As a consequence, both bony and soft-tissue Chance fractures of the lumbar spine have been widely described, whereas scarce reports of Chance fractures of the thoracic spine are found after careful review of the current body of literature [3, 6–8]. Moreover, only bony or combined bony and soft-tissue thoracic Chance fractures have been reported to date.

Here, we present a rare case of pure soft-tissue Chance fracture in the thoracic spine. In addition to the unusual Chance-subtype fracture and uncommon location, image

✉ Daniel García-Pérez
dgp.neurosurgery@gmail.com

1 Department of Neurosurgery, University Hospital 12 de Octubre, Avda de Córdoba s/n, 28041 Madrid, Spain

findings also were unexpected, given that occult disco-ligamentous injury was only detected by MRI with no abnormalities previously revealed by CT scanning. To the authors' knowledge, this is the first such report in the literature.

Case report

A 46-year-old woman was involved in a high-speed car accident. She was a passenger restrained with a three-point seat belt. The patient got trapped in flexion by crushing of the car roof. After a difficult and prolonged extraction, the patient was transferred to our emergency department.

On the primary assessment at intensive care unit (ICU), the patient showed GCS 12 (E3, V4, M5) with a tendency to sleep. Motor examination revealed equal strength of the upper extremities but no movement of the lower extremities. Due to decrease in the level of consciousness, it was decided to proceed with intubation and invasive mechanical ventilation. Likewise, she exhibited hemodynamic instability that required vasoactive drugs and blood products transfusion. The initial radiograph showed bilateral pneumothorax and hemothorax, which was treated by insertion of a chest drain.

After adequate stabilization, the patient was further treated according our advanced trauma life support (ATLS)-based trauma algorithm, including body multislice computed tomography (skull, spine, thorax, abdomen, pelvis). CT of the cervical spine demonstrated a C2 vertebral body fracture, together with antero-lateral dislocation of the intervertebral C2–C3 joint. C2–C3 interfacet dislocation on the right side was also observed (Fig. 1). CT of the thoracolumbar spine failed to show any other traumatic injury. We also employed the soft-tissue window in the initial CT scan to search for any sign of ligamentous injury or hematoma (Fig. 1). Unfortunately, not even with that window, we could detect any injury at this spine level. Further imaging of the thorax also revealed serial rib fractures on the left side. The MSCT trauma scan also revealed an extensive soft-tissue hematoma in the lumbosacral region, with active arterial bleeding at the sacral level. Given these findings, arteriography and subsequent selective embolization were performed.

After the initial study, immobilization was maintained by cervical collar. However, the cervical fracture could not explain the clinical signs of the patient, who presented a motor deficit restricted to the lower limbs. So, given the clinical–radiological dissociation, an MRI was performed the following day, after adequate hemodynamic stabilization.

Cervical MRI showed important reduction of the antero-lateral C2–C3 dislocation. C2–C3 interfacet no longer showed dislocation, but only distraction. MRI also revealed soft-tissue damage. We detected that C2–C3 right facet joint capsule was broken, as well as focal disruption of the anterior longitudinal ligament in C2–C3 region (Fig. 2).

Dorsal MRI bony fracture was not identified. However, we detected a minimum anterolisthesis T8–T9 not present in the previous CT. Importantly, we noticed a complete rupture of the PLC at T8–T9 level, consisting of the supraspinous ligament, the interspinous ligament, the ligamentum flavum and the facet joint capsules. The posterior longitudinal ligament and intervertebral disk were also damaged. The spinal cord was almost completely interrupted except in the left side. In the T2-weighted sequence, signal hyperintensity of the spinal cord spanned one to two vertebral bodies caudally and cranially from the T8–T9 level (Fig. 3).

Once we achieved clinical stability and after sedation removal, it was possible to perform neurological assessment through ASIA. The patient exhibited ASIA grade A. While normal active movement was observed in both arms, no motor function was preserved in both legs. The sensory level was T9 level.

Given MRI findings, we decided to perform surgical fixation, which was accomplished 2 weeks after the traffic accident. First, discectomy and anterior cervical interbody fusion with C2–C3 PEEK cage and screws to C2 and C3 vertebral bodies were performed. Second, bilateral percutaneous transpedicular screws were placed in T8 and T9 vertebral bodies. There were no intraoperative or postoperative complications. Postsurgery CT showed preserved height and alignment of the vertebral bodies without postsurgical complications (Fig. 4).

One week after the spinal surgery, the patient was discharged to a rehabilitation center. The patient did not show any neurological worsening or improvement during the hospital stay. At 1-year follow-up, our patient exhibits no cervical pain, no kyphosis or neurological worsening. CT and MRI studies 1 year later show no complications. We observed cervical interbody fusion through the cage. There were bridging trabeculae across T8 and T9 thoracic vertebral bodies and articular processes, which suggests sufficient stabilization through the percutaneous transpedicular screws (Fig. 5).

Discussion

Spinal flexion–distraction injuries (FDI) include traditional Chance fractures (proceeding ventrally from the spinous process throughout the vertebral body) and non-osseous disruptions of the PLC [1, 2]. This type of fracture most frequently occurs at the thoracolumbar junction because of its relative increased mobility [2]. In contrast, the rib cage provides evident support to the thoracic spine and much less motion is present in these segments than in the lumbar spine. Importantly, as happened in our case, all the cases of thoracic Chance spinal injury that have been reported are associated with multiple rib fractures [3, 6–8]. So, it might

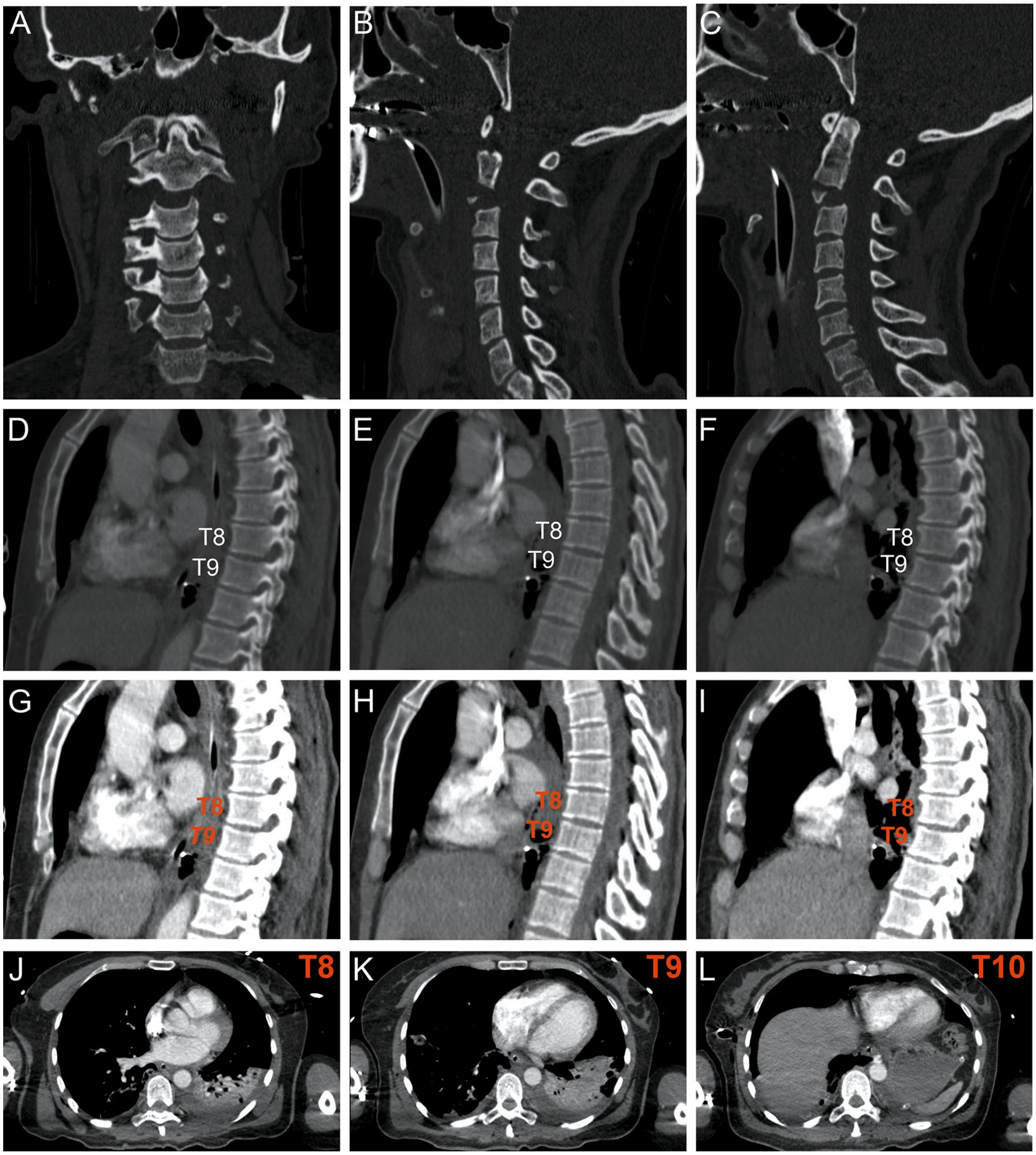

Fig. 1 Posttraumatic CT scan showing C2–C3 fracture. Coronal (**a**) and parasagittal (**b**, **c**) CT cervical scan showed antero-lateral dislocation of the intervertebral C2–C3 joint and C2 antero-inferior tear-like vertebral body fracture, together with C2–C3 interfacet dislocation. **d**–**f** Thoracolumbar spine CT failed to show any fracture evidence, vertebral malalignment or diastasis of the facet joints. Retrospectively, we can detect that the distance between T8 and T9 spinous process is slightly bigger than in the surrounding levels. Parasagittal (**g**–**i**) and axial (**j**–**l**) soft-tissue window in CT scan also failed to detect any injury at the thoracolumbar spine level

be postulated that previous rib cage fracture is a mandatory condition to generate a flexion–distraction injury pattern in the thoracic spine.

Compared to other spinal injuries, Chance-type injuries carry a higher risk of associated visceral damage, spinal cord trauma, and concomitant spinal injury [9]. The rate of intra-abdominal injuries in flexion–distraction fractures has been reported as 44–67% [10]. In fact, it has been described that the most frequent injury mechanism in patients with a combined spine and abdominal trauma is high-energy flexion–distraction trauma [11]. However, our patient and previous reports describing Chance thoracic fractures after a road traffic accident did not depict any abdominal injury [6–8]. On the other hand, literature confirms that thoracic Chance fractures are persistently associated with several thoracic injuries, such as lung contusion,

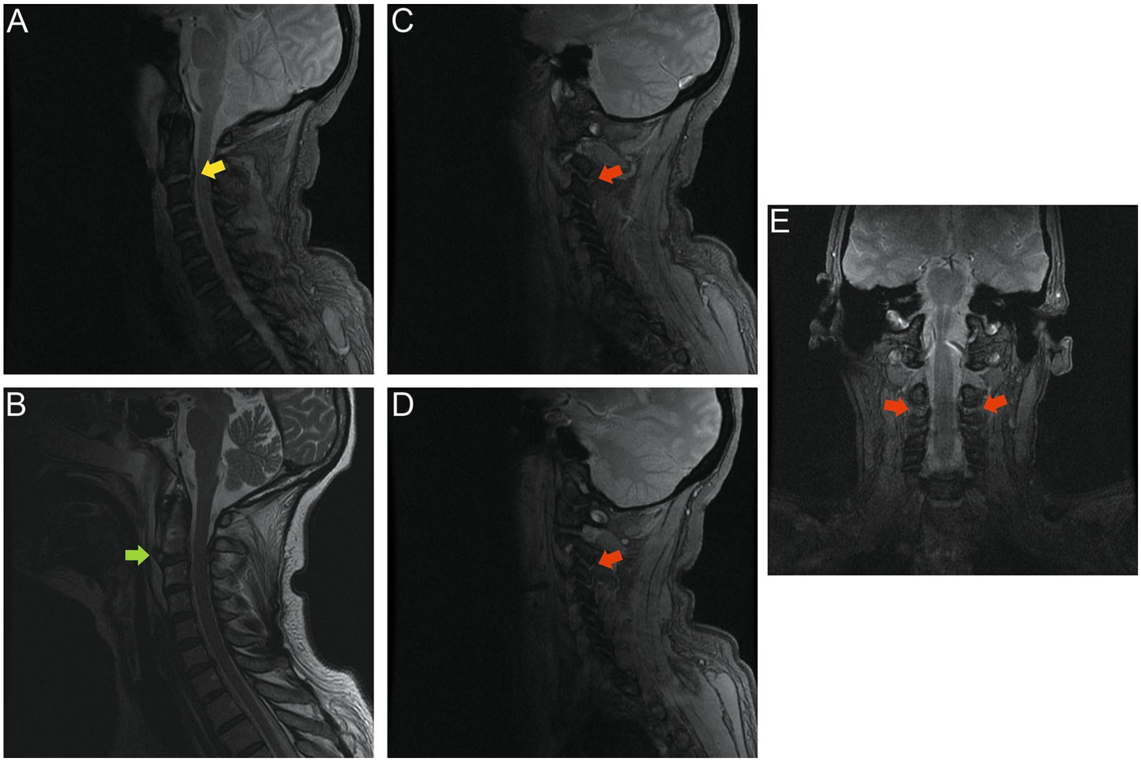

Fig. 2 MRI of the cervical spine. **a** Coronal MERGE image demonstrated epidural hematoma. **b** T2-weighted sagittal image revealed focal disruption of the anterior longitudinal ligament in C2–C3 region. Right (**c**), left (**d**) and coronal (**e**) MERGE images showed important reduction of the antero-lateral C2–C3 dislocation

hemothorax and/or pneumothorax [3, 6–8]. Likewise, our patient presented with pneumothorax and hemothorax, injuries nearby the injured spinal segment that required further consideration in the patient's treatment. From these data, we can conclude that Chance thoracic fractures have a different group of associated injuries which may have a greater degree of morbidity and mortality.

MR imaging is helpful in showing the site and extent of spinal cord injury, since it can be located proximal to the level of osteo-ligamentous trauma. Our patient presented with motor deficit restricted to the lower limbs that was correlated with sustained damage to the spinal cord at the level of the Chance-type injury. Chance spine fractures are frequently associated with spinal cord injury [12]. Another report described spinal cord disruption in up to 33% of patients having Chance-type injuries [4], including the only case that presented with purely soft-tissue injury. In that work, most cases of cord injury were associated with either bilateral facet dislocation or bilateral pedicular fractures and disk injury, or even rupture of the anterior longitudinal ligament. These findings prompt us to suggest that spinal cord harm occurs in some Chance fractures characterized by deep hyperflexion under huge distractive forces in which all three columns are affected.

CT plays an essential role in the initial diagnostic of traumatic spinal injuries, since osseous injuries, as well as misalignment, can be reliably evaluated with CT [13]. However, ligamentous lesions or soft-tissue damage is detected with a higher sensitivity by MRI [14]. Some reports have demonstrated high diagnostic accuracy of MRI for PLC injury [15, 16], although indirect signs on CT can also suggest the presence of a PLC injury. Among them, we can detect diastasis of the facet joints, avulsion fracture of the superior or inferior aspect of contiguous spinous processes, vertebral translation or an interspinous spacing greater than that of the level above or below [17, 18]. In our case, initial CT failed to show increased space between the posterior osseous structures or other indirect signs of disco-ligamentous injury. The inconsistency of the clinical and initial CT findings in our case raised the suspicion of a thoracic spinal cord injury. Although Chance-type injuries are characterized by longitudinal separation of the disrupted posterior elements, injury is seldom caused by a single vector [2]. So, rotational and deceleration forces occur in addition to the primary flexion–distraction insult, rendering a wide spectrum of injury patterns. As suggested by previous authors [4], a possible explanation for our CT findings is that the primary hyperflexion injury which split T8 and T9 vertebral bodies was

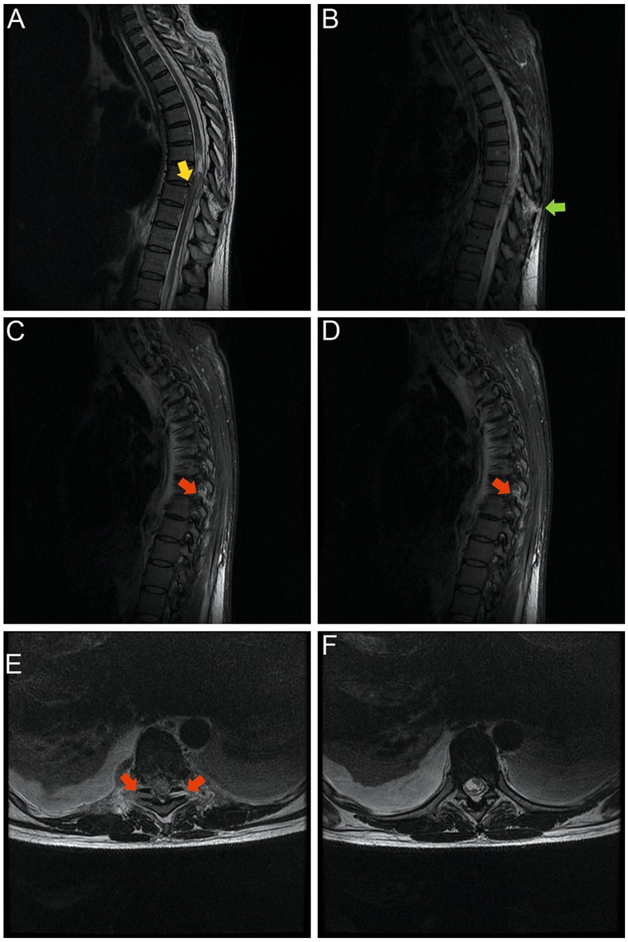

Fig. 3 MRI of the thoracic spine. Sagittal T2-weighted (**a**) and sagittal STIR (**b**) images noticed rupture of the posterior longitudinal ligament and the posterior ligamentous complex (PLC), respectively. T8–T9 anterolisthesis not present in the previous CT was also described. Left sagittal (**c**), right sagittal (**d**) and axial (**e**) STIR images depicted bilateral facet joint capsules damage. **f** Axial T2-weighted images confirmed that the spinal cord was almost completely interrupted except in the left side. In **a** signal hyperintensity suggested edema in the upper and lower spinal cord

then followed by a low-velocity recoil injury, producing a complete reduction of the fracture to an anatomic position with no further bone or ligamentous disruption. MRI findings, showing complete destruction of the disco-ligamentous components, were surprising. A previous work evaluated the influence of additional MRI compared with CT alone on traumatic spinal injuries classification using the AO system and the Thoraco-Lumbar Injury Classification and Severity (TLICS) scale [19]. They found that MRI increased fracture classification in a third of the patients. Importantly, management recommendations changed in favor of surgery due to new MRI findings in about a quarter of the patients [19].

According to Denis classification, flexion–distraction injuries belong to three-column injuries, which are biomechanically unstable [20]. However, Chance fractures have sometimes been treated conservatively. For example, a thoracic brace was used in a case of combined bony and soft-tissue Chance fracture at the same thoracic level that the patient presented here [8]. Unfortunately, it turned out to be unsuccessful, given that the patient presented with spondylolisthesis 10 weeks after injury [8]. Another report described a patient who developed late complications following initial conservative management [21]. Specifically in soft-tissue injuries, the likelihood of ligamentous injury to heal is low and one would expect progressive deterioration in the spine alignment. After MRI, our TLICS score turned out to be 9, suggesting surgical management. Moreover, the anterolisthesis T8–T9 that we observed on the MRI made it easy to assess the instability of the fracture, and so to advise the patient about the necessity of operative management. Previous data support that flexion–distraction injuries are best treated with percutaneous pedicle screws with the goal of restoring the disrupted posterior tension band formed by the PLC [22–24]. However, the available evidence cannot conclude about the necessity of bone fusion [5].

Tear drop fracture of the axis represents a very small percentage of injuries of the cervical spine, but there exists controversy about the best treatment method, especially when a large avulsed fragment is significantly displaced. Recent studies suggest that anterior surgical procedures would be an effective treatment of massive tear drop fracture of axis since complete reduction, sufficient stabilization and normal physiological lordosis can be achieved postoperatively [25, 26]. In agreement, at 1-year follow-up, our patient exhibits no cervical pain, no kyphosis or neurological worsening.

Conclusion

This case describes a rare pure soft-tissue Chance fracture at the thoracic spine. Although indirect signs of PLC have been described, our report demonstrates that severe occult disco-ligamentous injuries might not be detected by initial CT scanning. Both neurological status and/or additional injuries in the immediate vicinity could help to identify patients at special risk, and MRI emerges as an essential imaging modality for systematically assessing the whole extent of spine injury. This must be considered when treating trauma victims, especially those suffering motor vehicle accident with a flexion mechanism, in order to recognize this unusual fracture and prevent deterioration.

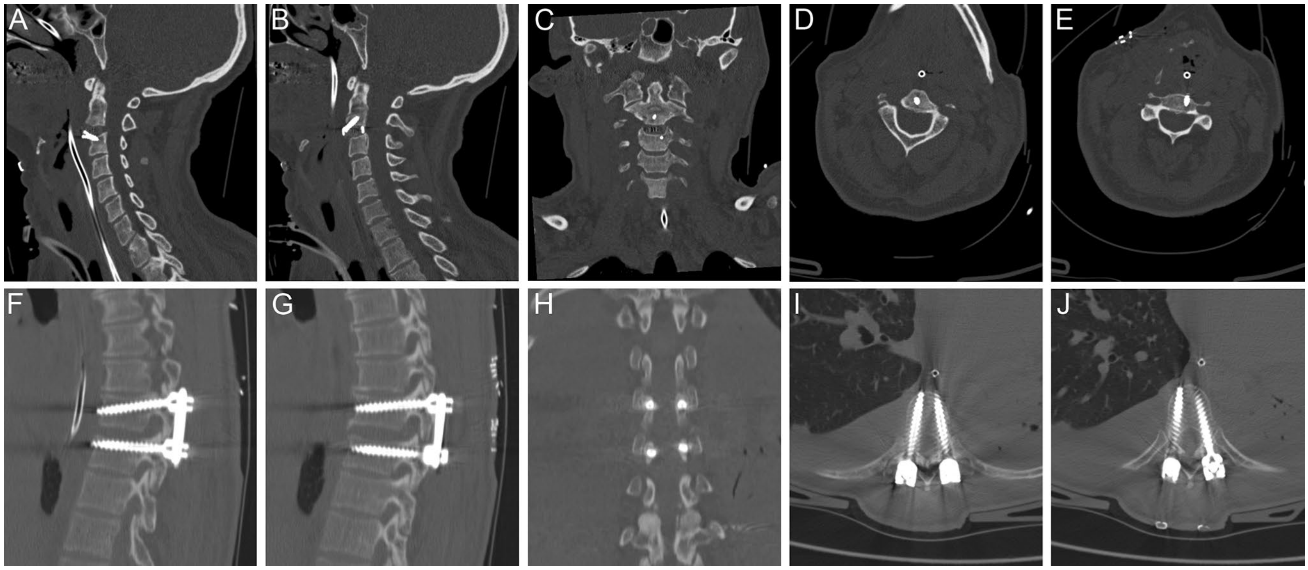

Fig. 4 Postoperative CT scan. Sagittal (**a**, **b**), coronal (**c**) and axial (**d**, **e**) cervical CT scan showed C2–C3 cervical interbody fusion with interbody PEEK cage and screws to C2 and C3 vertebral bodies. Sagittal (**f**, **g**), coronal (**h**) and axial (**i**, **j**) thoracic CT scan depicted that bilateral percutaneous transpedicular screws were correctly placed

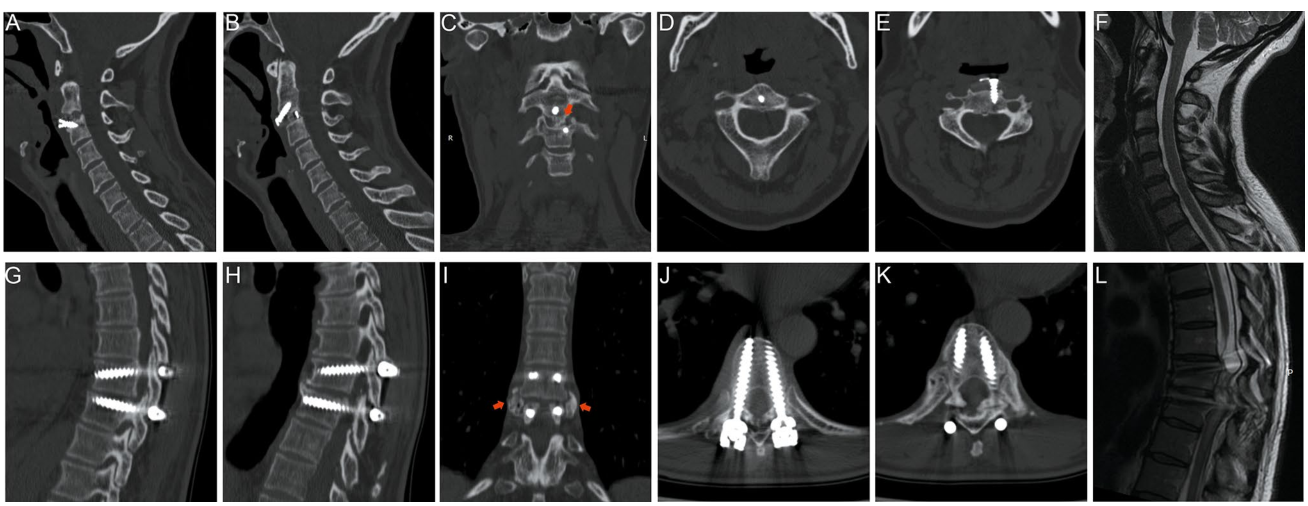

Fig. 5 CT and MRI at 1-year follow-up. Sagittal (**a**, **b**), coronal (**c**) and axial (**d**, **e**) cervical CT scan. Sagittal (**g**, **h**), coronal (**i**) and axial (**j**, **k**) thoracic CT scan. **f**, **l** Cervical and thoracic MRI studies, respectively. Cervical interbody fusion through the cage (**c**) and bridging trabeculae across thoracic vertebral bodies and articular processes (**i**) were detected (red arrows)

Compliance with ethical standards

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

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