Cervical spine fracture-dislocations in children: literature review and clinical case report

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ABSTRACT
Fracture-dislocations are a rare presentation, but their knowledge is critical in terms of diagnosis, treatment and potential sequelae. We report a literature review on cervical spine fracture-dislocations in children and a case of a 10-year-old girl who sustained a C3-C4 fracture-dislocation. Patient underwent open reduction and internal fixation at C3-C4, and a 2-year follow-up.
Key words: Cervical fracture-dislocations; children, arthrodesis; cervical reduction.
Level of Evidence: IV

Luxofractura cervical en niños: revisión bibliográfica y caso clínico

RESUMEN
Las luxofracturas son poco frecuentes, pero revisten mucha importancia a la hora de considerar el diagnóstico, el tratamiento y las posibles secuelas. Presentamos una revisión bibliográfica sobre luxofracturas cervicales en niños y el caso de una niña de 10 años que sufrió una luxofractura de C3-C4. La paciente fue sometida a una reducción abierta y una artrodesis de C3-C4, y controlada durante 2 años.
Palabras clave: Luxofractura cervical; niños; artrodesis; reducción cervical.
Nivel de Evidencia: IV

INTRODUCTION

Serious traumatic injuries to the cervical spine are rare presentations in children and they include cervical spine fractures, dislocations and fracture-dislocations. Their etiology in children is similar to adults, including motor-vehicle and sports accidents, but their location, pathology, evolutionary potential, and treatment commonly are rarely the same.

These lesions have an impact on the immature skeleton with spine cartilage not yet ossified, i. e., weak areas in children which may prove challenging to radiographically assess. In addition, due to children's greater ligament elasticity, trauma results in greater vertebral slippage and a potential neurological condition. Among these conditions, we call attention to the Spinal Cord Injury Without Radiographic Abnormality (SCIWORA), a clinical entity that involves neurological lesions without bone alterations and is characteristic of the immature skeleton. These features disappear as the skeleton matures and during adolescence lesions become comparable to those in adults.

Knowledge of these lesions radiographic characteristics, especially those of the upper cervical spine, as well as being aware that their diagnosis may commonly not be straightforward is vital. Challenging diagnostic cases warrant the several radiographic criteria for assessing the cervical spine anatomy described by Swischuk *et al*. to complement the data provided by radiographs by using imaging studies, such as dynamic radiography to confirm ligament instability, magnetic resonance imaging (MRI) to assess soft tissue lesions (ligamentous apparatus, intervertebral discs, and spinal canal material) and computerized tomography (CT) to study vertebral bodies and articular processes. These studies are the most effective in conducting the correct evaluation for lesions involving bone, cartilage, and spine material.

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Surgical treatment has specific indications, such as ligament lesion, facet joint dislocation, SCIWORA or an alteration in the relation between the atlanto-dental interval and the posterior atlanto-dental interval, which would result in a lesion of the C1-C2 complex. These entities constitute what could be referred to as serious cervical spine lesions.

Identifying these lesions is paramount to minimize growth disorder risk associated with surgery (laminectomy, periosteal stripping, growth plate lesion, etc.). These lesions require long follow-ups because they are associated with a long-term growth disorder risk.

Most cases evidence post-traumatic deformities when the severity of the initial injury was not noticed or when conservative of surgical management proved to be inadequate. Therefore, prevention of these deformities requires being familiar with the anatomical elements responsible for spine stability and growth.

METHODOLOGY

We conducted a literature review for articles on cervical fracture-dislocation in children, published between 2008 and 2018, using Pubmed and Google Scholar with the following key words: luxofractures, children cervical fractures, arthrodesis, cervical reduction. We found and reviewed 15 studies. Their revision produced no single unified criteria regarding treatment in terms of age and type of lesion in the pediatric population. For many years, the limited materials and knowledge available cause many lesions to be treated conservatively or using in situ arthrodesis techniques or sublaminar cerclage fixation, which requires complementary techniques, such as external fixation. However, these approaches are not without consequences, including a high pseudarthrosis rate, reduction loss associated with subsequent deformity, and higher morbidity associated with the cervical halo and revision surgeries.

According to the reviewed studies, surgical treatment by open reduction and screw fixation is being increasingly used in unstable lesions and lesions with spinal cord involvement, and, despite the lack of dedicated pediatric instrumentation, has become deemed a safe approach provided child-adult anatomical differences are taken into consideration and preoperative planning is performed thoroughly, for which imaging is most helpful (X-rays, CT and MRI). We found no information addressing the need or the benefits of removing hardware after fracture consolidation or arthrodesis.

We report the clinical case of a 10-year old girl who sustained a C3-C4 fracture-dislocation and underwent open reduction and internal fixation at C3-C4.

We were authorized to perform the surgical procedure and to take pictures by her parents through a signed informed consent form, which was given freely and fully informed.

This study was approved by the Institutional Ethics Committee.

CLINICAL CASE REPORT

Ten-year old girl, from a rural area, product a full-term delivery, with no hereditary conditions and adequate development and growth.

In July 2017, she was admitted for neck pain secondary to a direct blunt/sharp skull trauma in the occipital region caused by a metal swing. The patient was lucid, able to move her arms and legs, and had normal stretch reflexes. C4-C5 paresthesia was identified in the left upper limb. There were no signs of paresis or sensory deficits in arms or legs. She complained of pain when moving her neck, and presented with a blunt/sharp injury in her scalp, on her nape, in the occipital region.

She was brought into the Department on a spinal board, with a Philadelphia collar and analgesia through a peripheral intravenous line. No intravenous corticosteroids had been administered.

Plain X-rays, CT and MRI evidence C3-C4 fracture-dislocation, with a fracture in the left inferior C3 articular process and an anterior slippage of almost 90%. MRI allowed the assessment of the posterior ligament complex and the visualization of an undamaged intervertebral disc, which was contained by the posterior longitudinal ligament with no slippage through the spinal canal (Figures 1-5).

The patient underwent emergency surgery by a team of orthopedic surgeons specialized in spinal surgery.

The patient was placed in ventral decubitus on a radiolucent fracture table and electrophysiologic monitoring of the spinal cord was performed with motor potentials before surgery, during the whole procedure and, afterwards, during when turning the patient from dorsal to ventral decubitus and vice versa. It must be said that no traction was applied through the Mayfield head holder. To minimize the risks associated with orotracheal intubation, intubation was performed by an endoscopist.

Figure 1. Initial X-rays, July 2017. **A.** Anteroposterior view. **B.** Lateral view, evidencing C3 forward slippage, of approximately 90%. **C.** Intraoperative cervical spine lateral view.

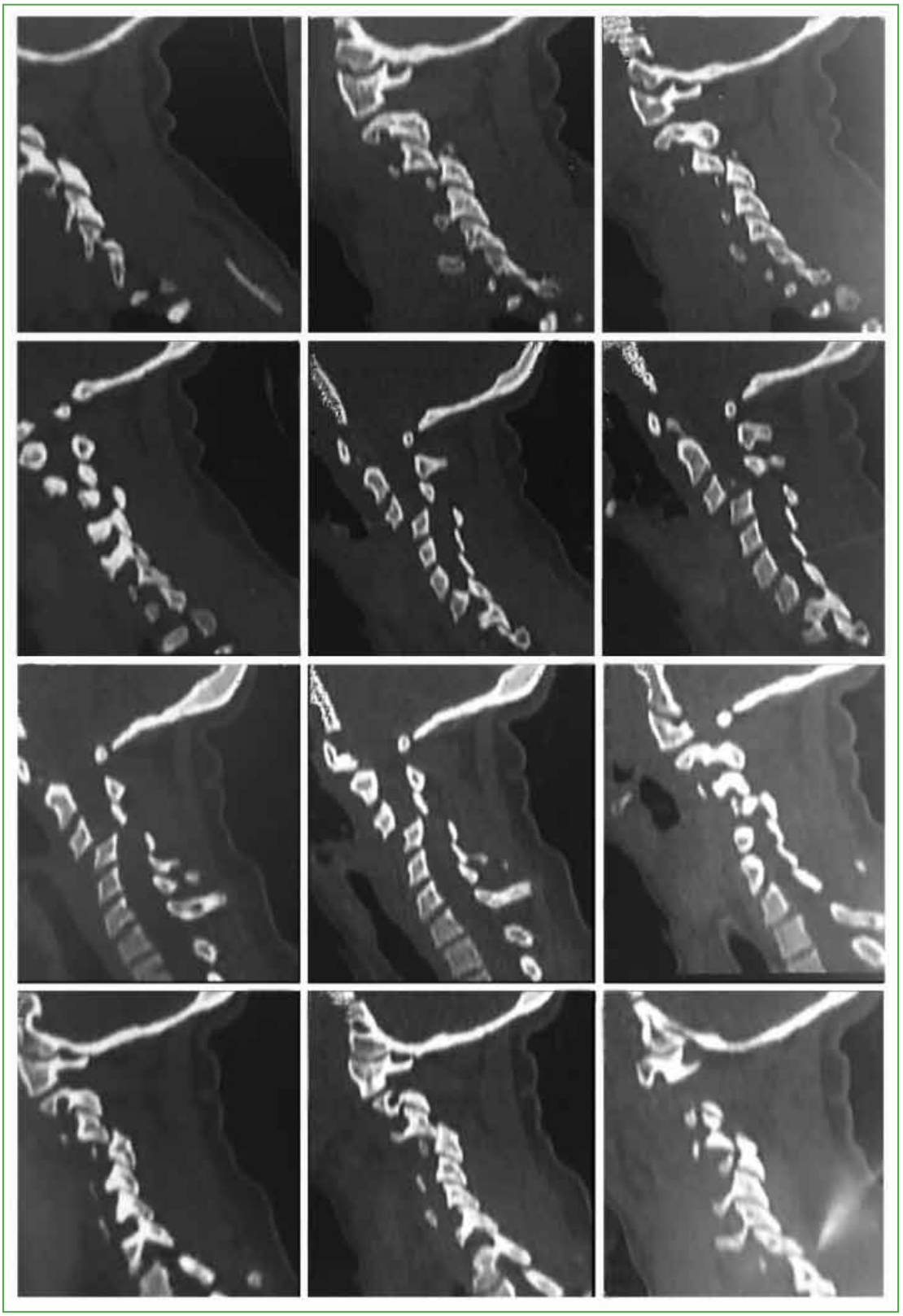

Figure 2. One-hour postsurgery CT evidencing a bilateral facet fracture-dislocation and slippage of almost 100%.

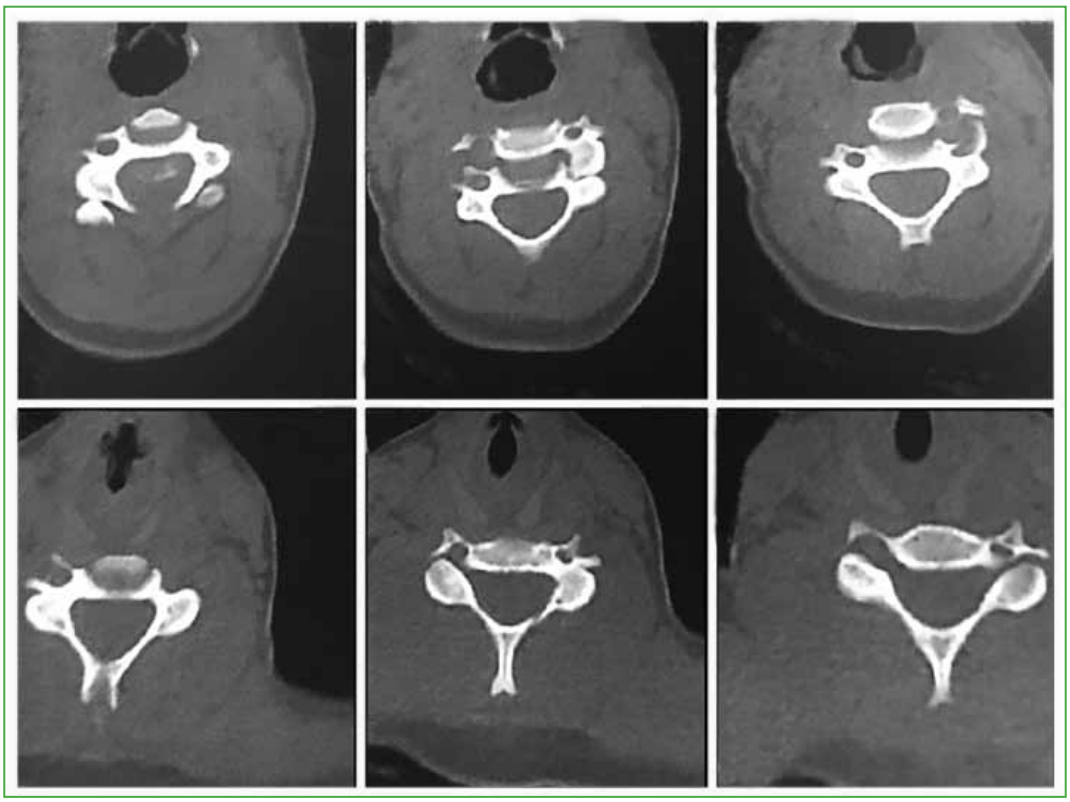

Figure 3. CT transverse section evidencing a bilateral facet fracture-dislocation.

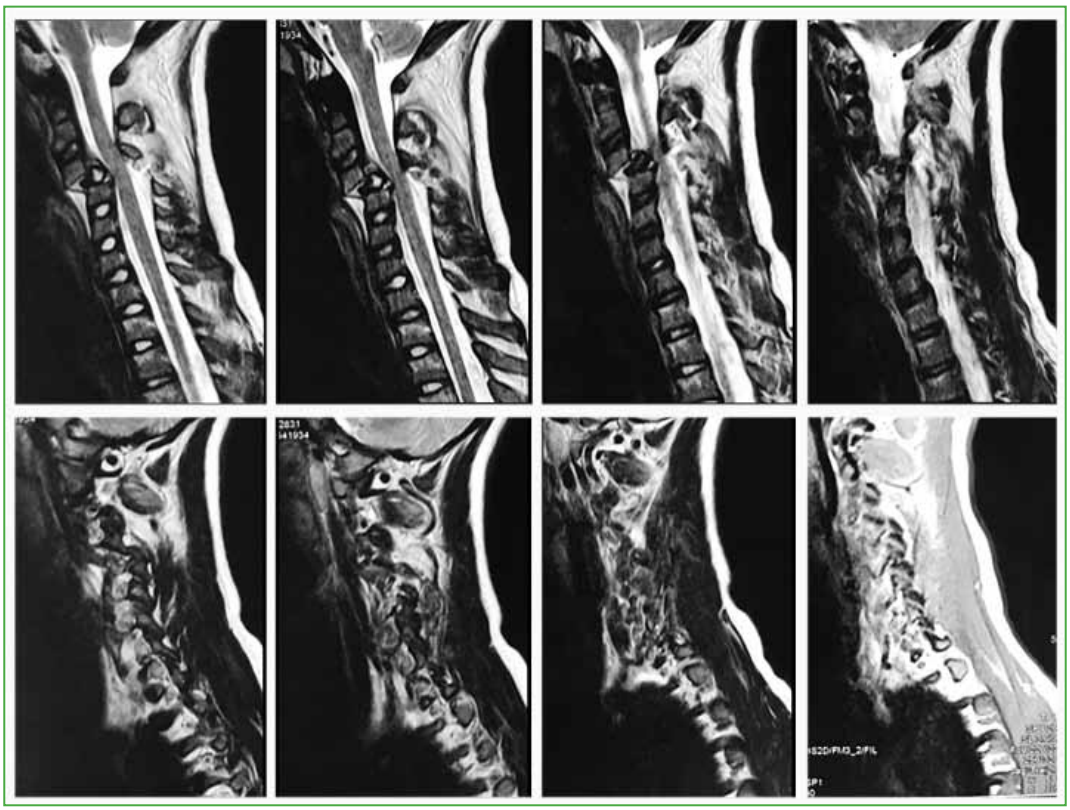

Figure 4. T2 MRI sequence. Image evidences cervical dislocation, signal hyperintensity in the posterior ligament complex, undamaged posterior longitudinal ligament, and contained intervertebral disc.

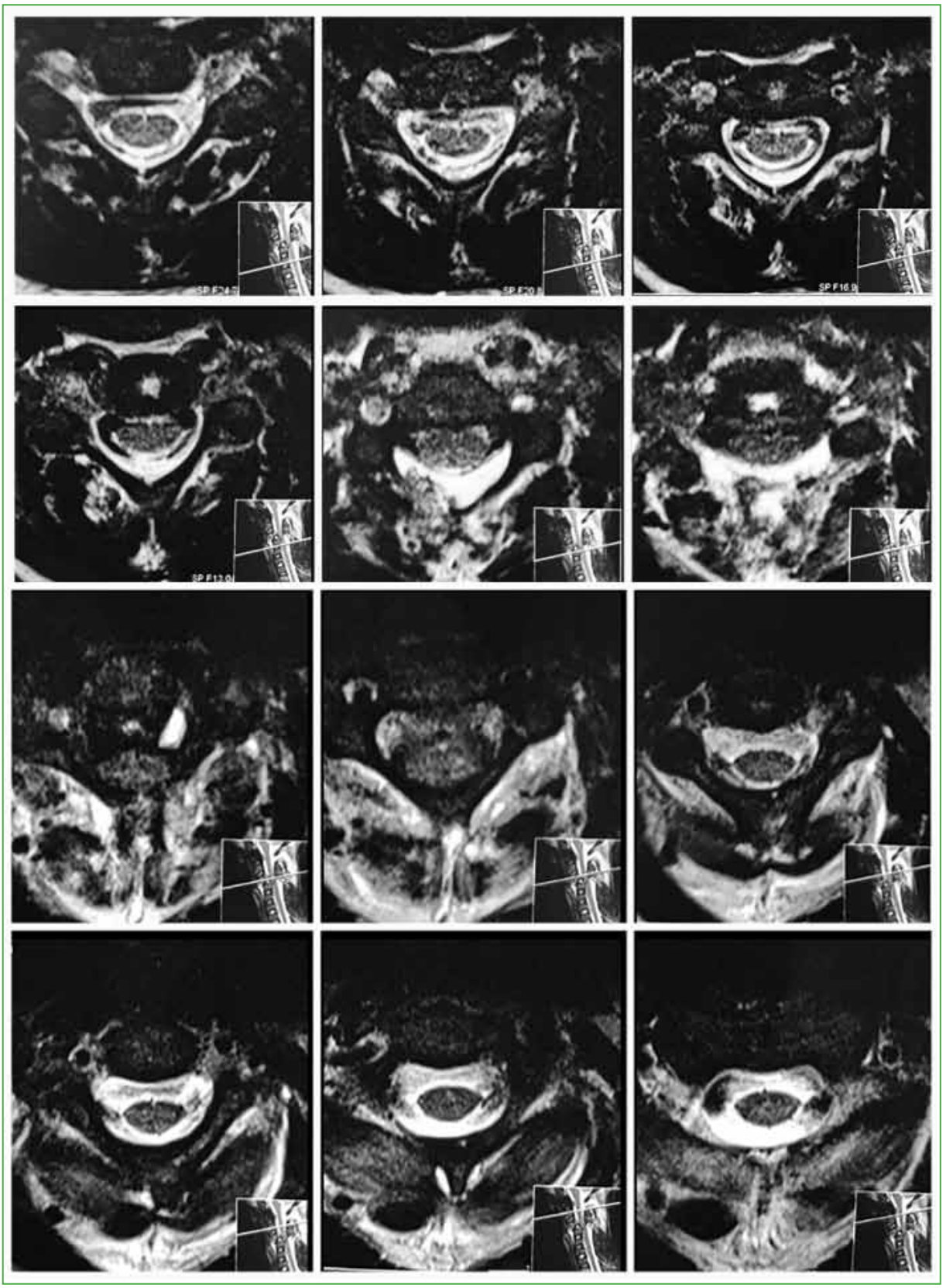

Figure 5. T2 MRI sequence. Images show signal hyperintensity in the posterior ligament complex and at C3 spinous process level.

Surgery was performed through a posterior longitudinal approach centered on C3. Release of the muscles exposing laminae was performed up to the articular processes. Inspection of the ligamentum flavum, supraspinous, and interspinous ligaments showed all were torn. A fracture was identified in the left inferior C3 articular process, while the right articular processes were only dislocated. Reduction was performed through gentle traction following a slight resection of the superior C4 articular process. Intraoperative X-ray was used to assess adequate reduction and then bilateral transarticular screws and two titanium rods were placed at C3-C4 level.

A new radiographic control was then performed, which was followed by the placement of a posterior iliac crest autograft. The surgical site was closed with a layered technique and postoperative suction drainage was applied for 24 hours.

A cervical spine MRI was performed in the immediate postoperative period, and the patient was then transferred to the pediatric intensive care unit for monitoring and control. The main reason behind this MRI was to assess the cervical canal and the potential intervertebral disc spinal canal invasion. MRI showed an excellent reduction with no spinal canal compromise or invasion, the intervertebral disc in its place, and undamaged anterior and posterior intervertebral ligaments. Therefore, we chose not to perform an anterior approach for stabilization (Figure 6).

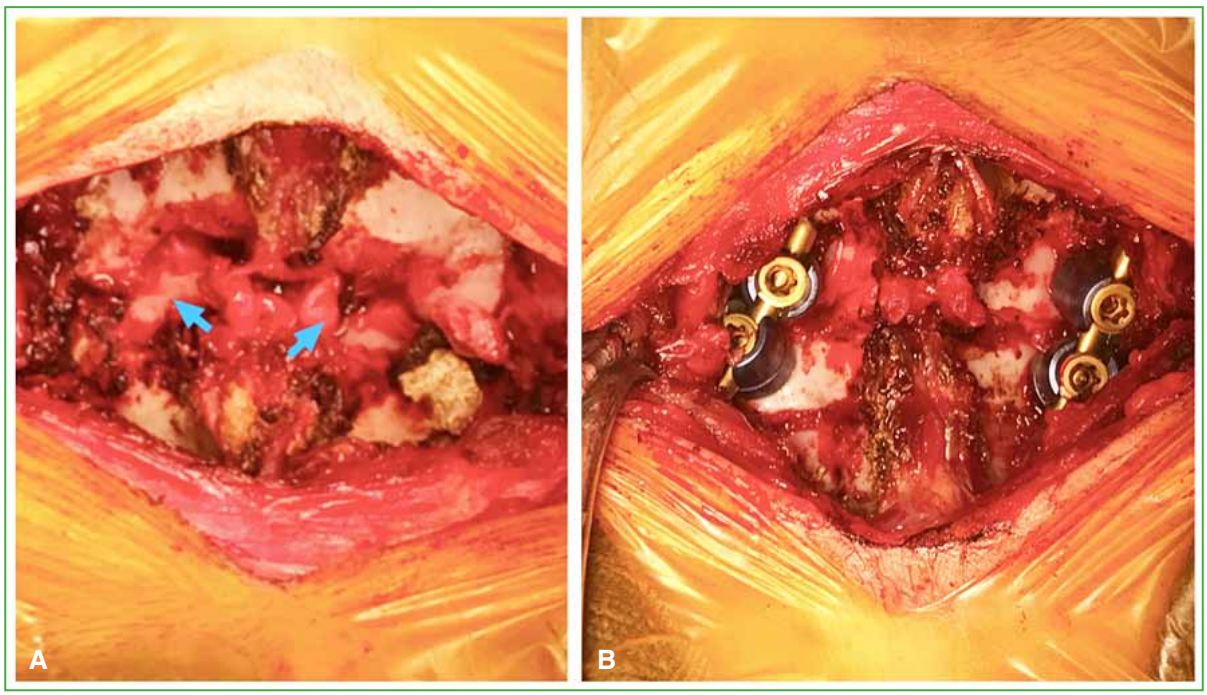

Figure 6. A. Vertebral fracture-dislocation, visible articular processes, **B.** Fracture-dislocation, articular screws.

After surgery, the patient had to wear a cervical collar for 4 weeks. Clinical and radiological controls show an adequate course. The patient returned to her daily routine 3 months after her accident (Figure 7-10).

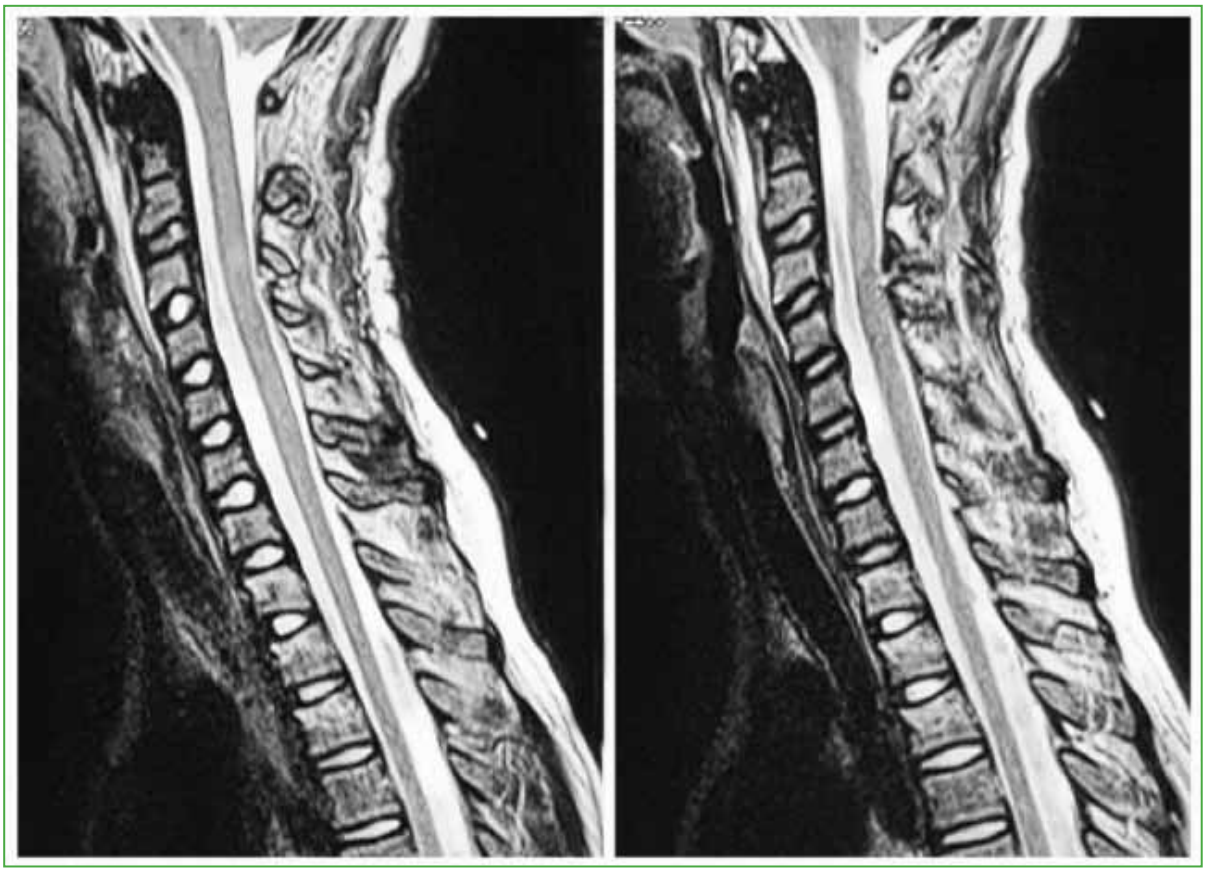

Figure 7. Immediate postoperative MRI. Image evidences adequate reduction, a intervertebral disc contained by the posterior longitudinal ligament, and a wide cervical canal.

Figure 8. X-rays taken a month after surgery.

Figure 9. Functional X-rays at 3-month follow-up control. There are no signs of instability.

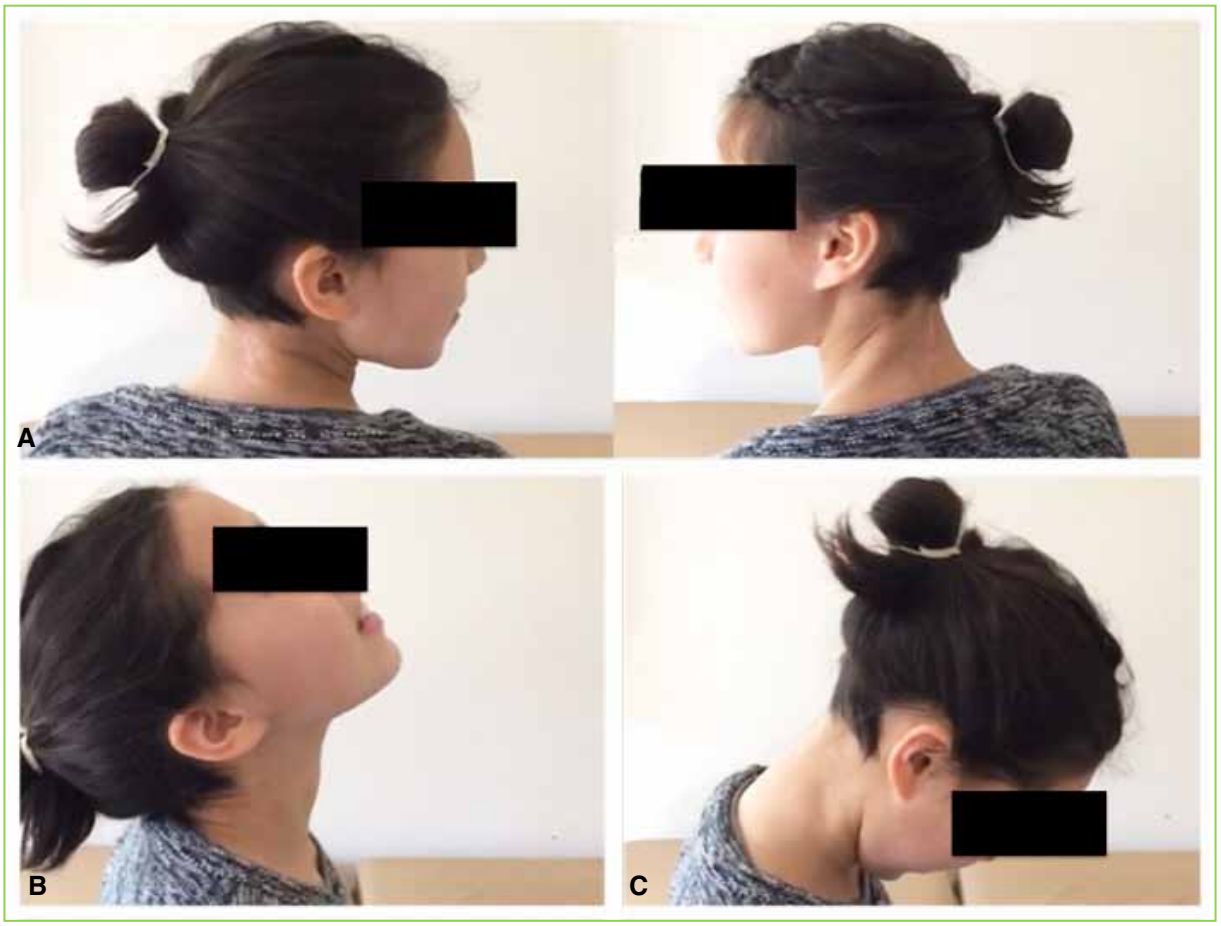

Figure 10. Pictures taken 3 months after surgery. **A.** Unrestricted rotation. **B.** Full extension. C. Painless full flexion.

DISCUSSION

Trauma accidents in children under 14 years of age commonly affect the cervical region, most of them being unstable lesions. In children under 8, the most common trauma site is the upper cervical[1] region due to the particular anatomic and physiologic characteristics of the area and to the head being heavier in relation to the rest of the body. At this age range, they are less frequently associated with neurological defects. In children aged 10 and onwards, the lesion characteristics are no different from those in the adult population.[2-7]

Injured infants and small children commonly present with lesions involving the atlas, the axis, and the upper cervical spine, which may be attributable to their relatively heavier head, ligamentous laxity and different articular process angulation; moreover, muscles provide no relevant support until puberty. C1, C2 and C3 have horizontally oriented articular facets that will never become obliquely oriented as in the rest of the cervical spine. Young children have immature flat uncinate processes, which fail to help against flexion-rotation mechanisms. In addition, young children point of support for cervical movement is at a superior level than that of a teenager or an adult.[7-11]

Due to the immature spine in children under 2 years of age and to its progressive ossification, their lesions commonly are epiphyseal separations, dislocations and growth plate fractures rather than actual fractures. This mechanism holds true for the entire spine, but more so for odontoid fractures.[12-17]

CONCLUSIONS

We report the clinical case of a 10-year old girl who sustained a C3 fracture-dislocation with an anterior slippage of almost 90% and an ASIA-E score at admission. Within 24 hours after the accident, she underwent a posterior approach surgery with open reduction and internal fixation using transarticular screws. The patient suffered from no postoperative neurological complications and had a favorable course without pain or mobility limitations. We consider that the patient benefited from the early diagnosis and referral, and surgical treatment within 24 hours of the accident, which achieved adequate reduction and stabilization. On the basis of a new post-traumatic neck score (pain, mobility, neurological status), the patient had an excellent outcome.

We raise two issues for further research: whether a 10-year old patient presenting with this type of lesion requires arthrodesis, and whether hardware removal is necessary during postoperative evolution.

Conflict of interests: Authors claim they do not have any conflict of interests.

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