Non-accidental Trauma to the Thoracolumbar Spine in a 10-month-old Child

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ABSTRACT
We present the case of a 10-month-old boy with a chronic thoracolumbar spine fracture-subluxation without neurological damage caused by an unknown mechanism of non-accidental trauma. To assess stability, we used the scoring system for thoracolumbar injuries according to Vaccaro et al. We performed a segmental pedicle osteosynthesis. We analyzed and compared our case with others in the available literature. We updated UNICEF data on child violence in Argentina, but not before clearly defining the subject, and the legal framework, and providing a brief historical review.
Keywords: Children; non-accidental trauma; thoracolumbar spine.
Level of Evidence: IV

Trauma no accidental de columna toracolumbar en un niño de 10 meses

RESUMEN
Presentamos el caso de un niño de 10 meses con fractura-subluxación inveterada de la columna toracolumbar, sin daño neurológico, a causa de un trauma no accidental por mecanismo desconocido. Para evaluar la estabilidad espinal se utilizó el sistema de clasificación de la gravedad de las lesiones toracolumbares de Vaccaro. Se realizó una osteosíntesis pedicular segmentaria. Se analizó y comparó el caso presentado con otros publicados. Se actualizaron los datos registrados por Unicef sobre violencia infantil en la República Argentina, no sin antes definir claramente el tema, el marco legal y realizar una sucinta reseña histórica.
Palabras clave: Niños; trauma no accidental; columna toracolumbar.
Nivel de Evidencia: IV

INTRODUCTION

Child abuse is a complex socio-cultural problem that affects various social groups, cultures, and ethnicities in the world. According to the World Health Organization, it encompasses any form of abuse or neglect affecting a child under the age of 18. It encompasses physical injury, emotional harm, sexual abuse, neglect, and economic or other exploitation that undermines or is likely to impair the child's health, development, or dignity or endangers the child's survival in the context of a relationship of responsibility, trust, or power.[1] In other words, a clear violation of human rights. A more subtle and complex form is Münchausen syndrome by proxy or factitious disorder imposed on another.[2] The common denominator of this violence is the asymmetry between the one who exercises power and the victim. In recent years, the term child abuse has been replaced by the euphemism non-accidental trauma (NAT).

Childhood violence has existed from the dawn of civilization. Children thrown into the Nile River in Ancient Egypt as tribute to the fertility of the land; those offered to the red-hot arms of Moloch (Leviticus 18:2, King James Version); the slaughter of the Innocents ordered by Herod the Great (Matthew 2:16-18 King James Version); the silk belt used by some sultans and viziers in the Ottoman Empire to hang, according to Muhammad's interdiction, minors with the right of succession; in Greece, the sexual subjugation exercised by teachers to the detriment of ephebes; the sacrifice of children in the pre-Hispanic societies executed by the Mexica priests in

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Tenochtitlan and the Mayans at Chichen Itza; the death and burial of infants from Inca royalty or *capacocha* (in the Quechua language, royal obligation).[3] In the Modern Age, and particularly in the Contemporary Age, examples abound, notoriously after the Industrial Revolution and the overcrowding in the big cities, the genesis of the proletariat, the imposition of biopower and the exploitation of child labor. In the United States, public interest in child abuse began with the case of Mary Ellen Wilson, an abused child who had to be defended by the American Society for the Prevention of Cruelty to Animals in the absence of ad hoc legislation. Many hidden secrets of the European disciplinary society of the 19th and 20th centuries were uncovered by Sigmund Freud's psychoanalysis.

In 1989, the Convention on the Rights of the Child recognized the rights of all persons under the age of 18. These include protection from all forms of violence or negligent treatment. Our country ratified the Convention with constitutional status in 1990 and 1994, the last year of the enactment of the National Act on Protection against Family Violence No. 24,417, which regulates the obligation of health personnel to report the abuse, both at the state and private levels. In 2005, National Act No. 26,061 on the Comprehensive Protection of the Rights of Children and Adolescents (NNyA, in Spanish) was approved.

UNICEF, in collaboration with the Ministry of Justice and Human Rights of the Nation, presented data on child and adolescent violence reports from October 2021 to September 2022. Out of a total of 9,970 cases, 6,770 (45%) occurred in the family environment. In 90% of the cases, the aggressors were, in descending order, the father, mother or stepfather. 63% of the complaints came from the Buenos Aires Metropolitan Area. Violence camouflaged as domestic discipline culture is very significant between the ages of two and four (72.9%). Seven out of 10 children suffer from these methods in Argentina.[4] Ironically, while 95% of individuals polled oppose corporal punishment, more than 70% use it.[4] With the onset of puberty comes an upsurge in sexual and psychological abuse of girls. The types of violence are often interrelated. NAT accounted for 33% of the total.[4] According to the REUNA database of the province of Buenos Aires (Unified Statistical Registry of Children and Adolescents [in Spanish: *Registro Estadístico Unificado de Niñez y Adolescencia*]), 43.7% of the 5,341 allegations of violence in 2010 were related to physical abuse, primarily in males, while sexual abuse happened primarily in females.[5] In both databases, the prevalence of lesions by anatomical areas or topographic discrimination is not detailed.

According to the literature, the prevalence of spinal trauma in childhood is 2%. Its causes, in order of frequency, are: traffic accidents, high-energy sports injuries, and NAT. About 50 cases of pediatric thoracolumbar fractures have been published, 38% of them attributed to NAT in children under two years of age.[6,7] Unfortunately, omission or late diagnosis affects more than one-third of victims. In this regard, long bone fractures have been reported in 77% and head trauma in 50% of cases.[2,8]

The purpose of this research is to present a 10-month-old child with NAT of the thoracolumbar spine in the context of the previously indicated social problem. The traumatic pathophysiology of the region is described in depth, and the treatment is analyzed and discussed in relation to relevant specialty publications. This is an observational, retrospective study.

CLINICAL CASE

In December 2015, the paternal grandparents of a 10-month-old child consulted because they had noticed a lump in the thoracolumbar region of their grandson, a premature child of a 19-year-old; gestational age of 28 weeks, birth by cesarean section due to the possibility of preterm labor, APGAR 3/6, and birth weight 1,125 g. He spent 75 days in an intensive care unit and was on mechanical ventilation for 14 days. The mother suffered from a complex postpartum psychiatric condition that resulted in aggressive behavior towards the people around her. The grandparents suspected that their grandson had been shaken, as they never noticed external stigmata, such as bruises or other surface lesions. It was a family from the middle socioeconomic class. The corresponding report was made.

The child's overall examination revealed normal maturation patterns for his age, weight 7,800 g, and height 68 cm. Clinically structured thoracolumbar kyphosis with Frankel E neurological status was observed. No other musculoskeletal involvement, extraskeletal injuries, or congenital pathologies were detected (Figure 1).

Radiography revealed a T12-L1 subluxation, an L2 flexion fracture, a thoracolumbar hinge kyphosis of 25°, and a <20° inversion of physiological kyphosis or thoracic lordosis, indicating the inveterate nature of the lesion (Figure 2).

Figure 1. Clinical aspect. Note the thoracolumbar hump.

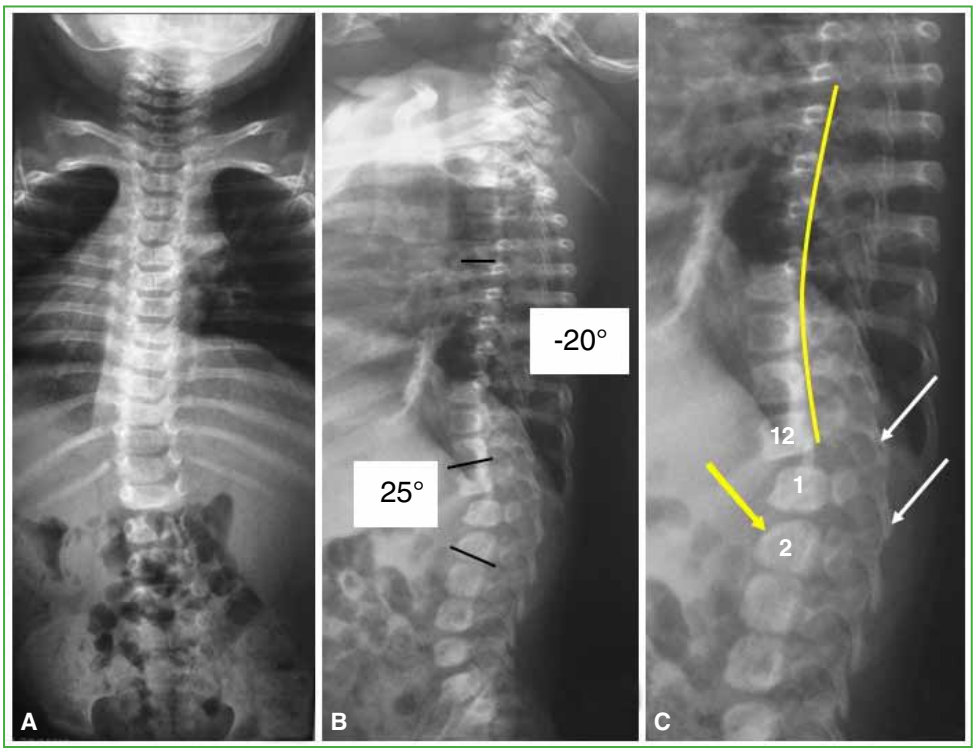

Figure 2. Initial radiographs. **A.** Anteroposterior. **B and C.** Lateral (standard and extended). Fracture of the body of LII (yellow arrow), decreased facet contact (white arrows). T12-L1 subluxation. 25° hinge kyphosis, -20° thoracic lordosis.

Magnetic resonance imaging did not provide data of interest and computed tomography was essential to verify a left facet denudation of T12-L1-L2 and to detail the anatomical aspects of the pedicles (Figure 3).

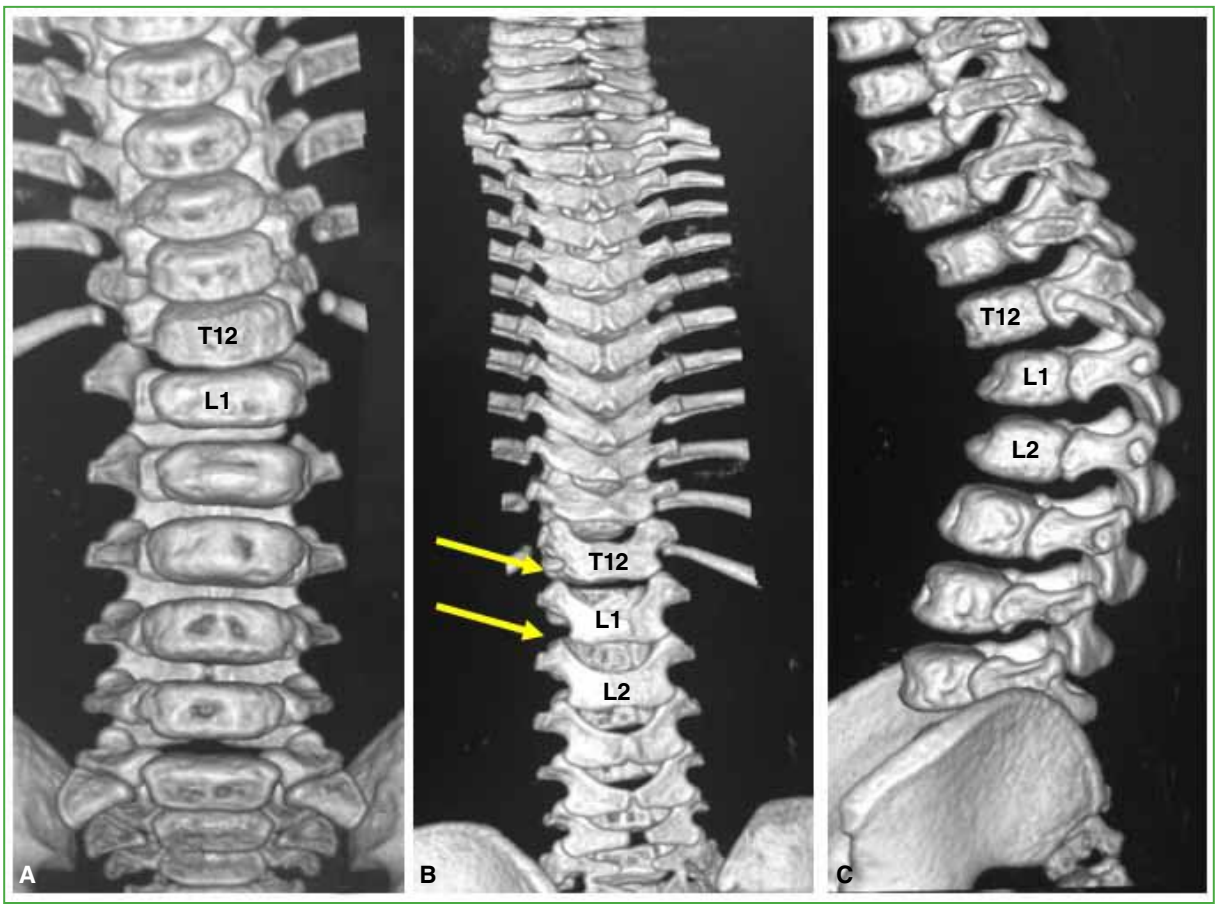

Figure 3. 3D reconstruction by computed tomography. A. Note that compression fractures of the L1 and L2 vertebral bodies are asymmetrical. B. Right facet denudation (yellow arrows). C. Sagittal plane. Subluxation of T12-L1 and very low contact of T12-L1-L2 facets.

This was a child with NAT sequelae of the thoracolumbar spine as a result of flexion-distraction. The Vaccaro classification system, validated for the pediatric population by Daniels et al. and Savage et al., was used to assess spinal stability, and the sum of the scores defined instability (Table).[9-11] Therefore, osteosynthesis from T12 to L2 was performed with titanium polyaxial pedicle screws, 3.5 mm in diameter by 14 mm in length, and 4 mm diameter rods. Intraosseous palpation and an image intensifier in the coronal-sagittal-oblique planes were used to control placement. An autologous iliac graft was added (Figure 4).

A neurophysiologist carried out multimodal neurological monitoring. The immediate and late postoperative evolution was satisfactory. Because of the child's restless personality, a thermoplastic spinal orthosis was prescribed to be worn during the day for one year. The current follow-up is seven years and the child's neurological status is normal (Figure 5).

Table. Classification of thoracolumbar Injuries and severity score

Parameter	Score
Morphology	
Compression	1
Burst	2
Translation-rotation	3
Distraction	4
Neurological status	
Intact	0
Nerve root injury	2
Complete spinal cord or conus medullaris injury	2
Incomplete spinal cord or conus medullaris injury	3
Cauda equina	3
Posterior ligamentous complex integrity	
Intact	0
Indeterminate	2
Disrupted	3

Therapeutic recommendations: <3, orthopedic treatment, 4, debatable, ≥5, surgery.

Figure 4. Clinical and radiographic appearance 2 months after surgery.

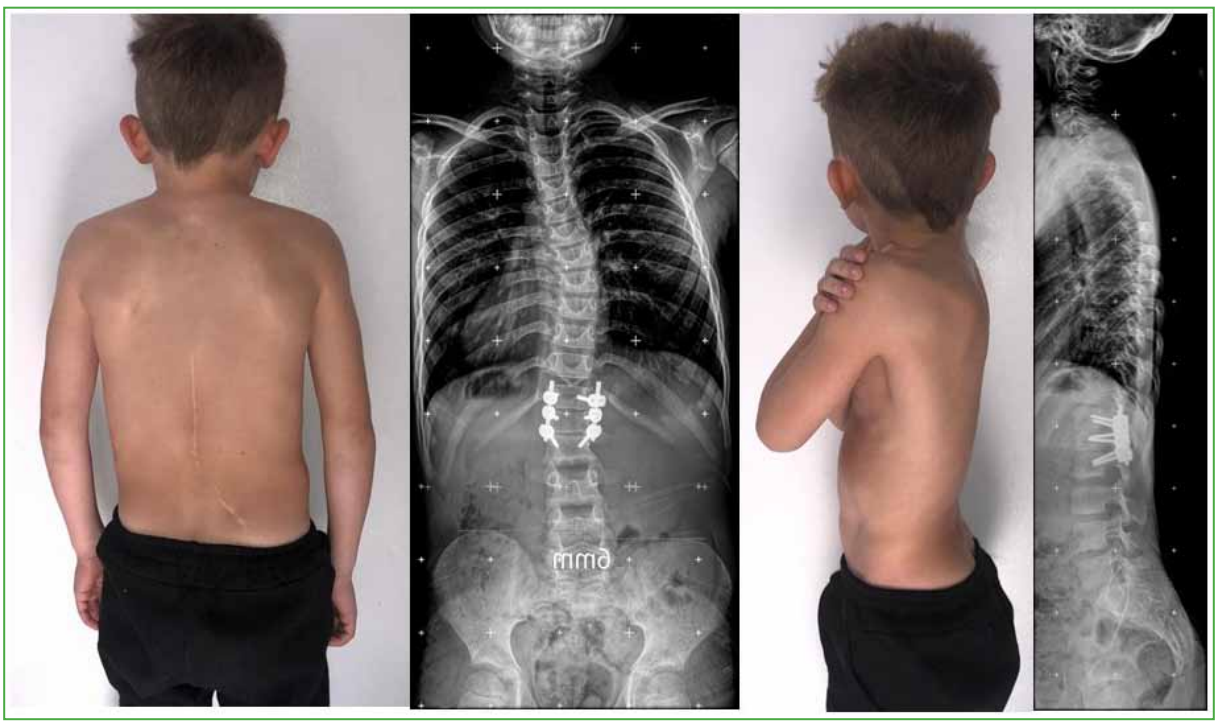

Figure 5. Clinical and radiographic appearance after 7 years of follow-up.

DISCUSSION

The most common etiologic kinetic mechanisms of thoracolumbar spine NAT in children are flexion and flexion-distraction caused by shaking or tossing the child. There are few published cases of hypertension NAT. The increased viscoelastic component of the tissues, and hence the better capacity to dissipate energy, explains several anatomical aspects of the injuries. The spinal cord, which lacks this characteristic, is more vulnerable to intrinsic injury.

Some postmortem investigations describe the penetration of chondrocytes and epiphyseal epiphyseal ground substance into the bone marrow stroma as a result of compressive forces, while the addition of a flexion-distraction vector is the cause of dilaceration and hemorrhages of the posterior capsuloligamentous complex and a variety of epiphysiolyses of the vertebral body similar to those described by Salter-Harris for long bones.12,13 SCIWORA (Spinal Cord Injury Without Radiologic Abnormality) is exceptional in the thoracolumbar spine.[14]

In addition to neurological damage, these injuries can be associated with chylothorax or hemothorax, retroperitoneal hematoma, dilaceration of the superior mesenteric artery or aorta, injuries to the pancreas, spleen or liver, among others.[6,10] In a prospective study of 50 children with neurological thoracolumbar fractures, 58% reported suffocation due to respiratory distress, regardless of the radiographic finding, despite the fact that magnetic resonance imaging was very eloquent in detecting the lesion and with a very high statistical sensitivity in all of them.[15] One-third of traumatic spinal injuries often coexist with others in adjacent or distant segments. The association or history of traumatic brain injury is very significant. As a result, it is critical in early children to compare sagittal and coronal sutures measured by computed tomography to the standardized ones available in the literature; any increase is significantly predictive of NAT.[16]

A thorough evaluation of the child in accordance with institutional practice, hospitalization, and reporting of suspicion to the appropriate committee are all required.

In terms of treatment, the common denominator in the literature is the lack of consensus. Sieradzki et al. obtained an excellent result with reduction and hyperextension casting in a 14-month-old child without neurological damage.[17] Other authors do not recommend orthopedic treatment if kyphosis is >20°, since severe ligament

damage would condition the reproduction of the deformity.[18] Other publications refer to surgical reduction as a standalone procedure or with the addition of sublaminar wiring.[6] Bode et al. performed pedicle osteosynthesis in an 8-month-old infant and based this indication on the greater stability of screws compared to hooks.[19] From an anatomical point of view, the use of pedicle screws is absolutely possible and they have scientific support in young children.[20,21] Thornley et al. recently performed pedicle screw fixation on an unstable flexion-rotation injury in a 2-year-old child with neurologic compromise and respiratory failure due to severe chylothorax. The evolution was excellent. After 18 months of follow-up, when they considered that the injury was healed, they removed the implant.[6] Crossing the neurocentral synchondrosis in young children could, theoretically, induce a deformity, spinal stenosis, or alter the growth of the vertebral body or pedicles; however, several scientifically rigorous publications have refuted this concept.[23-25] Although some animal research has suggested this, others have rejected these hypotheses.[23] In other words, there is no concrete academic support that justifies the withdrawal of osteosynthesis.

Radiographic and magnetic resonance imaging measurements of the spinal canal and the size of the instrumented pedicles were taken from our patient, which were compared with published data, and no anomalous effects were found.[21,22,25]

The ideal therapeutic option is supported by scientific evidence. Our indication was based on the analysis of the injury according to the TLICS (Thoracolumbar Injury Classification System) which takes into account the following items: morphology or type of injury, appearance of the posterior ligament complex, and neurological status.[9-11] A value equal to or greater than four implies instability and, consequently, the need for fixation. Our patient had a score of six. We also consider the recommendations already referred to by Arkader et al.

In conclusion, NAT can include only the spine, other bones or organs, and be coupled with psychological or sexual trauma. Even in the absence of neurological damage, the sensation of suffocation while breathing is predictive of thoracolumbar injury. It is vital to consider potential associations, as some pose a high risk of death. Pedicular osteosynthesis in young children is feasible and safe; a detrimental effect on growth has not been demonstrated. The TLICS is useful for analysis and therapeutic indication. In addition to the trauma, the doctor will be immersed in a social tragedy, his or her inescapable duty is to report the incident and protect the child.

Civilization aspires to be synonymous with evolution, and today's humanity coexists with a marvelous technological-scientific revolution, but the atrocious drama of child abuse persists, as do its potentially harmful consequences: cognitive deficit, psychiatric diseases, endocrine alterations, and a proclivity to drug use in adolescence, delinquency, and the perpetuation of the violence spiral.

Conflict of interest: The authors declare no conflicts of interest.

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