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CASE REPORT

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Coronal Cleft Vertebra Initially Suspected as an Abusive Fracture in an Infant*

ABSTRACT: A case of a four-month-old male infant is described who was found unresponsive at home and brought to the emergency room. He lived for four days. During his hospital admission he was diagnosed by radiography with a fracture of the third lumbar vertebra that was presumed abusive in nature.

Autopsy examination failed to confirm a fracture. However, a defect in the development of the vertebral bodies was discovered. He was diagnosed with possible failure of the notochord to regress, a condition with no significant sequelae. The cause of death was certified as sudden infant death syndrome after full investigation, and all autopsy studies were negative.

KEYWORDS: forensic science, notochord regression failure, fracture, child abuse

Evaluation of any infant death must include a full skeletal survey in order to detect any possible trauma, including both anteroposterior and lateral radiographs. Findings of suspicious trauma would eliminate the diagnosis of sudden infant death syndrome as a cause of death and may suggest abusive treatment by the caregivers. Fractures of the spine in children are uncommon but may be manifestations of child abuse (1–3). Many vertebral injuries resulting from child abuse are often misdiagnosed because they are asymptomatic and therefore may be overlooked unless neurologic deficit or kyphosis are associated (4,5). However, caution must be used in that congenital and developmental anomalies of the vertebrae and vertebral bodies can be mistaken for abusive trauma (6).

The most commonly observed radiographic abnormalities in child abuse-related spinal injuries include: 1) compression fractures of the vertebral body, 2) anterior notching of the vertebral body, and 3) fracture/dislocation of the posterior elements (1,2,7,8). Of these, compression fractures of the anterior vertebral bodies and end plates are the most commonly observed spinal injury in child abuse cases (1,2). These frequently occur in the lower thoracic and upper lumbar spine and may involve more than one vertebra and/or posterior element disruptions. Bruises, other fractures, and injuries often accompany spinal trauma in reported child abuse (1,4,9). Given this background in spinal trauma associated with child abuse, we will discuss a case of suspected spinal injury due to child abuse.

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Background

Case History

The decedent was a four-month-old male infant. According to reports, he was found unresponsive in a crib under a blanket in the early morning hours by his father. He was brought to the emergency room with a poor respiratory effort and unresponsive. He was intubated but continued to decline and never regained consciousness. He was pronounced dead approximately four days after admission to the hospital. Evaluation in the hospital included an antemortem skeletal survey and ophthalmologic examination. The eye exam was unremarkable. However, a defect of the 3rd lumbar vertebra, which was interpreted as a possible fracture, was identified (Fig. 1). Follow-up radiological studies of the lumbar vertebrae failed to reveal a definite fracture. There was no history of trauma or abuse.

Pathological/Anthropological Assessment

Initial examination of the antemortem radiographs taken of the infant revealed a clear coronal defect of the vertebral body of L3, with a slight defect in L5 (Fig. 1). However, autopsy examination failed to reveal any fractures or hemorrhages in the lumbar area. In order to accurately determine if the defects were due to developmental abnormalities or trauma, the lower lumbar vertebrae were removed, dissected, and macerated for evaluation. After dissection and separation, the defects were still noted in the postmortem radiological examination (Fig. 2 and Fig. 3).

Following maceration, visual examination of the vertebrae revealed a complete coronal cleft of the centrum of L3, while the centrum of L5 possessed only slight indentations of the lateral aspects (Fig. 3). No residual defects were noted on L4. Linearly transecting the two portions of the centrum of L3 were residual cartilaginous tissue and the remnants of the notochord (Fig. 4A). The coro-

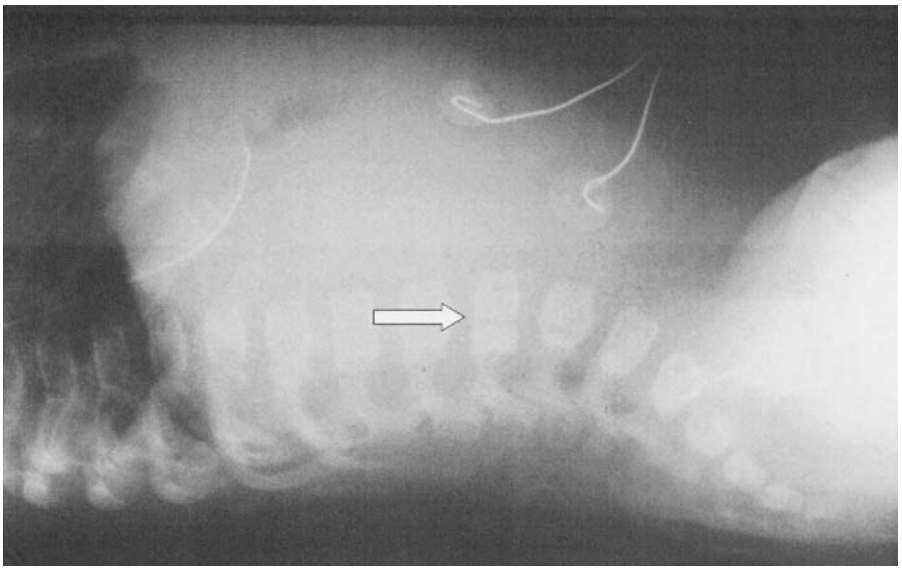

FIG. 1—*Antemortem lateral view X-ray of the lumbar spine revealing a vertically oriented lucency through the vertebral body of L3 that was thought to represent a fracture (arrow).*

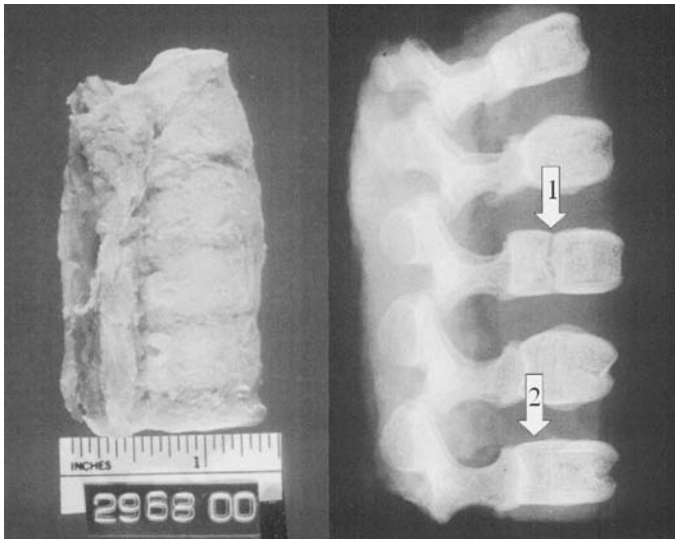

FIG. 2—*Lumbar vertebrae removed en bloc prior to maceration (left) and corresponding postmortem X-ray revealing a clear defect of the vertebral body of L3 (Arrow 1) and a slight defect in L5 (Arrow 2) (right).*

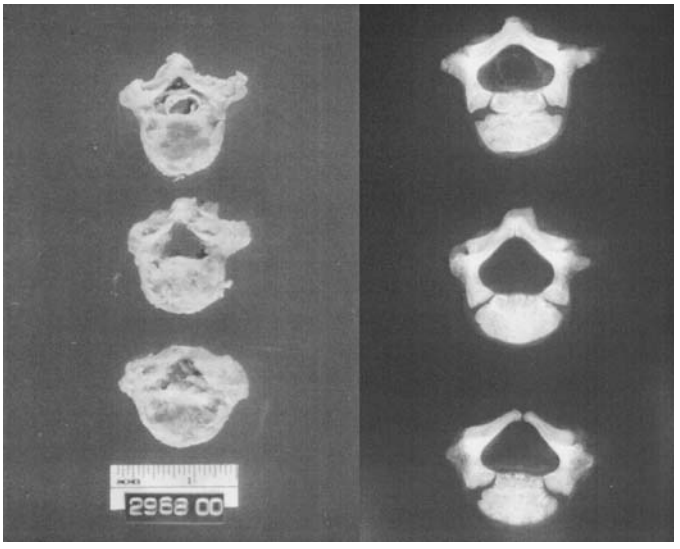

FIG. 3—*Gross examination of L3 through L5 with corresponding X-rays revealing a complete coronal cleft of the centrum of L3 and slight indentations of the lateral aspects of the centrum of L5.*

nal cleft is consistent with the delayed union of the anterior and posterior ossification centers of the vertebral body (10–12). The coronal cleft and the cartilaginous tissues are also consistent with the failure of the notochord to regress appropriately during the development of the vertebral body (13,14)(Fig. 4B). This would interfere with the normal unification of the anterior and posterior portions of the centrum and give the false appearance of being fractured. Microscopic examination supports the diagnosis of notochord regression failure (Fig. 4C). This type of vertebral body cleft defect, regardless of etiology, is more commonly seen in the lumbar region and predominantly in male neonates (11,14,15). Coronal cleft vertebra have been documented with other physiological abnormalities such as imperforate anus, spinal meningocele, and chondrodystrophia calcificans, none of which were noted on this infant (11).

Conclusions

The pathologic correlation to the radiological findings of this defect in the spine was failure of the notochord to regress, a developmental defect and not the result of trauma. However, an etiology of delayed fusion of the anterior and posterior ossification centers of the vertebral body cannot be ruled out as the cause of the coronal cleft developmental defect. No other developmental

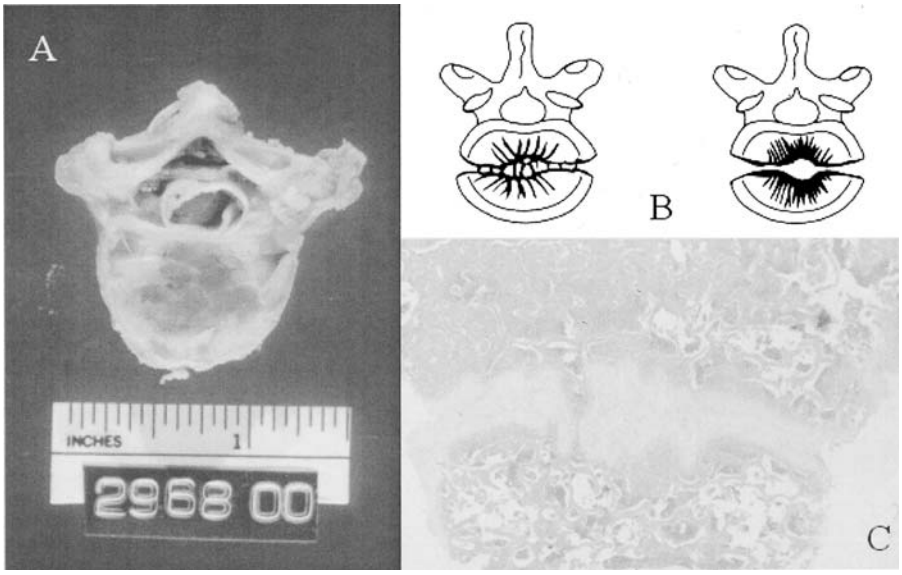

FIG. 4—(A) *L3 with residual cartilaginous tissue and notochord remnants.* (B) *Failure of the notochord to regress—coronal cleft centrum. Left:* connecting bony *strands; right: complete cleft.* (C) *Microscopic section of L3 revealing retention of cartilage within the bone marrow, dissecting the marrow space of the vertebral body.*

or congenital anomalies were identified. No other significant trauma or anatomic cause of death was identified and the cause of death was classified as sudden infant death syndrome. The classification of this infant's death as "sudden infant death syndrome" versus "sudden unexpected death in infancy" was due to two factors: first, the blanket used to cover the infant was lightweight, and second, the blanket was not covering the head at the time of discovery.

Although coronal cleft vertebra are well known and a common finding in certain radiological circles, delayed fusion of vertebral body ossification centers and failure of the notochord to regress are important entities not regularly encountered or known by forensic scientists in a position to encounter this developmental defect. Many coronal cleft vertebra are discovered as an incidental finding during other medical procedures or investigations. Additionally, coronal cleft vertebra are frequently seen in normal, healthy infants without any of the physical abnormalities noted. As evident from this case report, those unfamiliar with the anomaly can readily confuse coronal cleft developmental defects with an abusive traumatic fracture.

Though it is important in any infant death to include a full skeletal survey in order to evaluate and identify any possible trauma that could be associated with child abuse, caution must be used to prevent the overzealous identification of any spinal anomaly as resulting from child abuse.

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