Case Report

Traumatic Sternal Segment Dislocation in a 3-year-old Girl: Sonographic Findings

Nicolas Murray, MD,[1] Françoise Rypens, MD,[2] Jean-Sébastien Trudel, MD,[3] Marie-Andrée Cantin, MD,[4] Marie-Claude Miron, MD[2]

[1] Department of Medical Imaging, CHU de Quebec, 10 Rue de l'Espinay, Quebec City, Canada, G1L 3L5
[2] Department of Medical Imaging, CHU Sainte-Justine, University of Montreal, 3175 Cote Sainte-Catherine, Montreal, Canada, H3T 1C5
[3] Department of Medical Imaging, Hopital du Haut Richelieu, 920 Boul. Du Seminaire Nord, Saint-Jean-sur-Richelieu, Canada, J3A 1B7
[4] Department of Orthopedic Surgery, CHU Sainte-Justine, University of Montreal, 3175 Cote Sainte-Catherine, Montreal, Canada, H3T 1C5

Received 23 December 2015; accepted 14 May 2016

ABSTRACT: Sternal fractures are uncommon in the pediatric population, and sternal segment dislocations are even rarer with only a few cases reported in the literature. Most cases are secondary to direct trauma to the chest, but nontraumatic dislocations have been reported. The diagnosis can be difficult to establish with standard radiographs, while CT is not desirable in the pediatric population due to the associated irradiation. Ultrasound (US) can be used as the first-line modality to evaluate the sternum. We report the US findings associated with a case of traumatic sternal segment dislocation in a 3-year-old girl. © 2016 Wiley Periodicals, Inc. *J Clin Ultrasound* **45**:45–49, 2017; Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/jcu.22378

Keywords: pediatrics; ultrasonography; musculoskeletal system; bones; sternal segment dislocation and fracture

INTRODUCTION

Traumatic lesions to the sternum are uncommon, especially in the pediatric population. Sternal fractures require significant force to occur due to the greater thorax elasticity in children compared with adults.[1] Sternal segment dislocation is extremely rare, with only 14 cases reported in the literature.[2–13] We report a case of traumatic sternal segment dislocation in a 3-year-old girl that was initially diagnosed with ultrasound (US) and confirmed by CT.

CASE REPORT

A previously healthy 3-year-old girl presented to the emergency department with chest pain increased by Valsalva maneuver and low-grade fever after she fell on a pole while playing at the park with her father. The patient was hospitalized for observation for 3 days; blood tests and abdominal US examination were all normal, and she was discharged. The following day, the patient experienced a painful thoracic crisis with the development of a new presternal lump. Blood tests were again normal, and frontal view chest radiograph was unremarkable (not shown).

US examination was ordered to assess the anterior chest lump. The examination was performed with an Aplio XG scanner and a 12-MHz linear-array transducer (Toshiba Medical Systems, Tokyo, Japan). Midline sagittal sonograms showed a calcified mass with acoustic shadowing and swelling of the overlying soft tissues (Figure 1). The mass was located between the manubrium and the second sternal segment, tilted at almost 90° in relation to the sternal plane (Figure 1), with an associated anterior cortical irregularity. The diagnosis of a

Correspondence to: M.-C. Miron

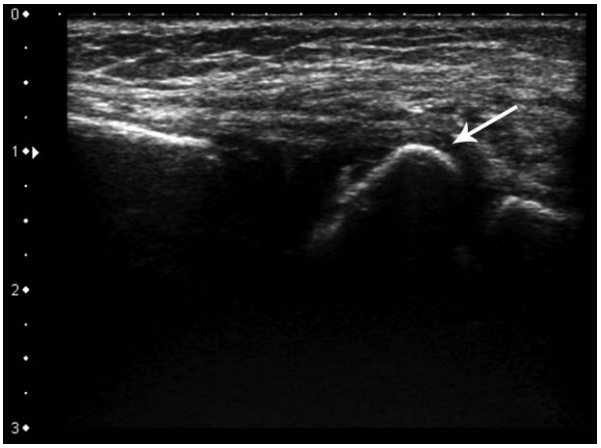

FIGURE 1. Midline sagittal sonogram of the sternum shows the dislocated and rotated first sternal segment (arrow) with associated swelling of the overlying soft tissues.

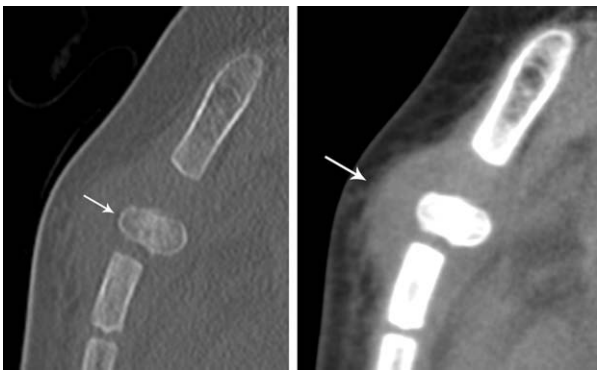

FIGURE 2. Sagittal CT reconstruction of the sternum in bone **(A)** and soft tissue windows **(B)** shows dislocation with 90° rotation of the first sternal segment (arrow). There is also a nondisplaced fracture line with cortical irregularity in the middle portion of the first sternal segment.

dislocated first sternal segment with an associated fracture was made.

The dislocation and possible associated mediastinal injury were then evaluated by CT scan of the chest. It confirmed the dislocation with 90° rotation of the first sternal segment and an undisplaced fracture line in the middle of this segment (Figure 2). There was soft tissue swelling anterior to the dislocated segment but no significant impact on mediastinal structures.

Since the patient was almost asymptomatic, the orthopedic team selected a conservative management. The clinical follow-up at 2 weeks was unremarkable. Ten months after the initial trauma, the patient remained asymptomatic. Lateral sternal radiograph showed partial remodeling of the first sternal segment (Figure 3). The subsequent CT scan demonstrated partial osteolysis of

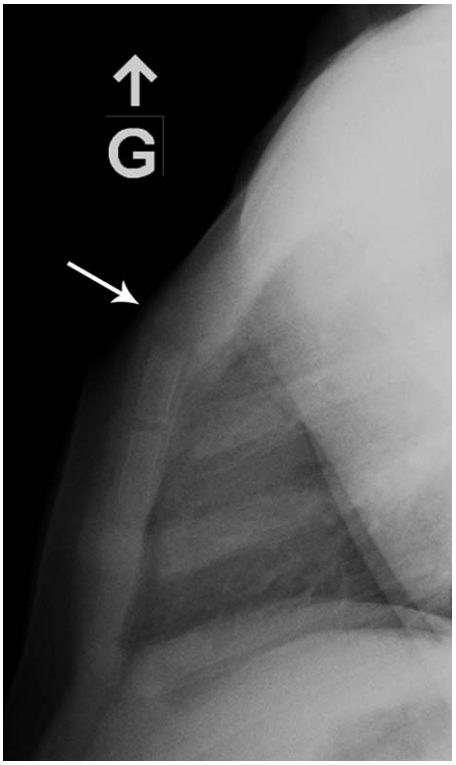

FIGURE 3. Follow-up sternal radiograph 10 months after initial presentation shows partial remodeling of the first sternal segment (arrow).

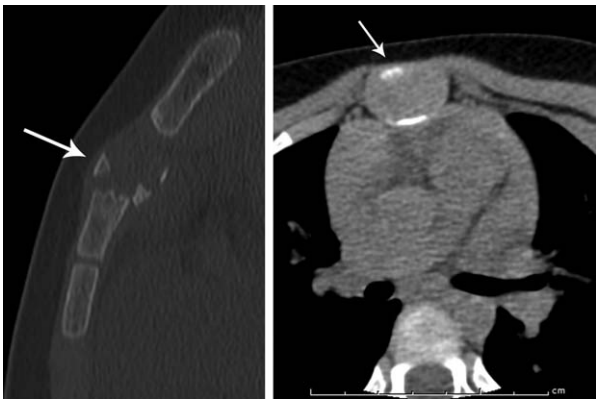

FIGURE 4. Follow-up CT scan 10 months after initial presentation: **(A)** Sagittal CT reconstruction of the sternum in bone window shows fragmentation and bone resorption of the first sternal segment (arrow) suggesting osteonecrosis. There is also remodeling of the proximal portion of the second sternal segment. **(B)** Axial CT scan of the first sternal segment in soft tissue window shows persistent horizontal alignment (arrow) without soft tissue swelling.

the first sternal segment consistent with osteonecrosis, without soft tissue modification (Figure 4). Two years after the initial trauma, follow-up US examination demonstrated the dislocated and partially ossified rotated first sternal segment (Figure 5).

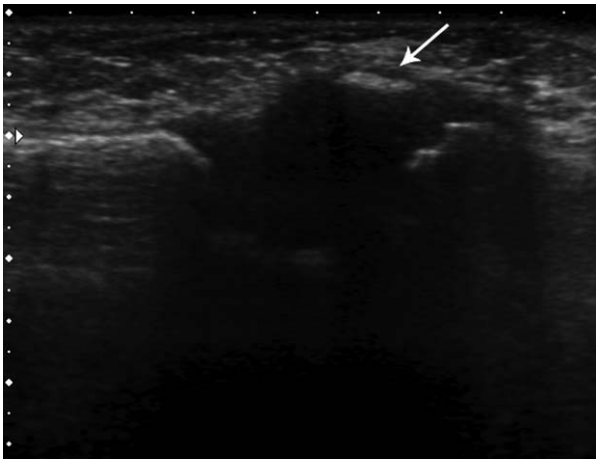

FIGURE 5. Follow-up US examination 2 years after initial presentation. Midline sagittal sonogram of the sternum shows the dislocated and partially ossified first sternal segment (arrow).

DISCUSSION

Traumatic lesions of the sternum are rare in children due to the greater thoracic elasticity compared with that of adults.[1] The sternal body is normally composed of 4 segments, which begin to ossify early in childhood.[8] Synostosis connection between each segment starts in the seventh year of life and proceeds from caudal to cranial.[8] Although the manubrium is rigidly attached to both the first ribs and the clavicles, there is relative elasticity of the other sternal segments.

The diagnosis of sternal fractures can be made using conventional radiography or CT scans. Sonography has also been used, and studies have shown a sensitivity and specificity as high as 100% in the diagnosis of sternal fractures.[14] The main advantage of US is the lack

TABLE 1
Review of the Sternal Segment Dislocation Cases Reported in the Literature

Authors (year of publication)	Age	Gender	Mechanism	Dislocation	Treatment	Outcome
Scudamore et al, 1982	5	M	Avascular necrosis	1st sternal segment	Surgical excision	No deformity at 6 months
Honma et al, 1988	4	M	Indirect forces	1st sternal segment	Open reduction and fixation (plate and screws)	?
Suzuki et al, 1989	5	M	Indirect forces Pain during rope jumping	1st sternal segment	Open reduction and fixation (K-wires)	?
Watanabe et al, 1989	3	F	Direct forces Forward bending after been caught in iron fence	1st sternal segment	Open reduction and fixation (bioabsorbable pin)	Remodeling at 2 years
Watanabe et al, 1993	5	F	Direct forces Forward fall, chest struck a stone	1st sternal segment	Observation	Remodeling at 1 year, completed at 4.5 years
Norotte et al, 1997	14	M	Indirect forces Anterior chest pain during an exercise in parallel bars without any fall	Traumatic manubriosternal dislocation	Open reduction and fixation (plate) Stabilization removed after 2 months	Not mentioned
Wada et al, 2002	4	M	Direct forces Fall onto chest while playing soccer	1st sternal segment	Observation	Complete remodeling at 3 years
Wada et al, 2002	4	M	Indirect forces Occasional coughing before onset of chest pain. No history of chest trauma	1st sternal segment	Observation	Remodeling at 11 months
Wada et al, 2002	10	M	Dislocation after 1 week of IV antibiotics for biopsy-confirmed osteomyelitis of the sternum (*S aureus*)	Junction 1st and 2nd sternal segment	Observation	Complete remodeling at 2 years
Kusaba et al, 2003	4	M	Direct forces Struck his chest against the side fence at the bottom of a slide	2nd sternal segment	Open reduction and fixation (plate to bridge 1st and 3rd segments)	Normal alignment at 5 years

TABLE 1. *Continued*

Authors (year of publication)	Age	Gender	Mechanism	Dislocation	Treatment	Outcome
Nijs et al, 2005	9	M	Indirect forces Sudden pain and click while stopping backward swing and initiating forward movement on parallel bars	1st sternal segment	Failure of conservative Open reduction and fixation (plate and screws, removed after 4 months)	Normal alignment at 4 months
Pawar et al, 2007	19 months	M	Direct forces Found on the floor crying, presumably after falling from bed	1st sternal segment	Observation	Not mentioned
Soysal et al, 2012	10	M	Direct forces	Junction 2nd and 3rd sternal segments	Closed reduction	Normal alignment at 9 months
Nakagawa et al, 2015	10	M	Indirect forces Felt pain when bending backward while playing dodgeball	3rd sternal segment	Observation	Complete remodeling at 7 months No abnormality radiographically at 4.5 years

of irradiation, especially important in the pediatric population. Moreover, the high reflectivity of sound at the bone surface can demonstrate fine details related to fracture such as a step-off deformity and cortical disruption.[15]

Sternal segment dislocation is extremely rare in the pediatric population, with only 14 cases reported with the first sternal segment being the most common dislocated segment.[2–13] Usually, the cause of dislocation is direct trauma with chest wall, but it has also been associated to nontraumatic causes such as osteomyelitis[10] and osteonecrosis.[8] Indirect forces can also cause sternal segment dislocation, such as forces transmitted when coughing[10] or using parallel bars in gymnastics.[5,6]

The patient usually presents with focal chest pain and anterior chest wall deformation. Infrequently, the patient may have dyspnea, dysphagia, or severe chest pain.[5]

The diagnosis of sternal segment dislocation can be suspected based on history and physical examination. Diagnosis can be confirmed with imaging studies such as lateral chest radiograph and CT. As demonstrated in our case, US findings are characteristic and can be used as the first-line diagnostic modality in children to avoid irradiation.

As described by Wada et al,[10] the sternal segment may be minimally dislocated initially, but can continue its rotation for about 2 weeks and gain stability at 90° rotation. No significant internal injury has been described in association with sternal segment dislocation. In the presence of a stable and almost asymptomatic patient, US may therefore represent the only imaging modality needed to diagnose and follow-up this injury.

Conservative and operative managements have been used in cases of sternal segment dislocation (Table 1). In the case of conservative management, follow-up radiographs demonstrate the remodeling of the dislocated sternal segment within few months.[7,10,11,13] Soysal et al[9] described one case of closed reduction in a 10-year-old boy using hyperextension of the chest. The maneuver had good results with immediate and complete resolution of the pain and deformity. One case underwent surgical excision of the dislocated segment because of osteonecrosis with no residual thoracic deformity at 6 months.[8] Six other cases have been treated with open reduction and fixation and demonstrated good outcome at follow-up.[2–6,12] Some authors used K-wire,[3] plate and screws,[2,4–6] or bioabsorbable pins.[12]

In conclusion, sternal segment dislocation in childhood is rare. Most cases are secondary to direct trauma to the chest. US may be used as initial and follow-up imaging modality to avoid unnecessary irradiation. Conservative management is a valid alternative to surgical treatment.

REFERENCES

1. Gledhill RB. Fractures of the sternum, scapula, and ribs. In: Letts RM, editor. Management of pediatric fractures. New York: Churchill Livingston; 1994, p 93.

2. Honma T, Hamano Y, Shiraishi T, et al. A case report of spontaneous sternal segment dislocation [in Japanese]. Kanto J Orthop Traumatol 1988;19:628.
3. Suzuki H, Kaneko F, Gomibuchi F, et al. Sternal segment dislocation: a case report [in Japanese]. Seikeigeka 1989;40:727.
4. Kusaba A, Saito S. Apophyseal dislocation of the body of the sternum in a child: a case report. J Orthop Trauma 2003;17:126.
5. Nijs S, Broos PL. Sterno-manubrial dislocation in a 9-year-old gymnast. Acta Chir Belg 2005;105:422.
6. Norotte G, Peres E, Vanderweyen A, et al. Segmental sternal dislocation in children. Apropos of a surgically treated case [in French]. Rev Chir Orthop Reparatrice Appar Mot 1997;83:283.
7. Pawar RV, Blacksin MF. Traumatic sternal segment dislocation in a 19-month-old. Emerg Radiol 2007;14:435.
8. Scudamore CH, Ashmore PG. Spontaneous sternal segment dislocation: a case report. J Pediatr Surg 1982;17:61.
9. Soysal O, Akdemir OC, Ziyade S, et al. Management of sternal segment dislocation in a child with closed reduction. Case Rep Med 2012;2012:676873.
10. Wada A, Fujii T, Takamura K, et al. Sternal segment dislocation in children. J Pediatr Orthop 2002;22:729.
11. Watanabe H, Chigira M, Shimizu T, et al. Completely remodeled dislocated sternal segment in a child. Arch Orthop Trauma Surg 1993;112:88.
12. Watanabe S, Nakamura T, Shimizu Y, et al. Traumatic sternal segment dislocation in a child. Chest 1989;96:684.
13. Nakagawa T, Tsuboi T, Wada A, et al. Sternal segment dislocation in a child treated by conservative observation. Tokai J Exp Clin Med 2015;40:27.
14. You JS, Chung YE, Kim D, et al. Role of sonography in the emergency room to diagnose sternal fractures. J Clin Ultrasound 2010;38:135.
15. Cho KH, Lee YH, Lee SM, et al. Sonography of bone and bone-related disease of the extremities. J Clin Ultrasound 2004;32:511.