



# Atlantoaxial rotatory subluxation in children: A review

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**Abstract**

Torticollis is a common complaint of childhood. Trauma should always be considered and carefully excluded. All children with torticollis should be examined with plain radiographs to rule out a fracture or bony abnormality. Atlantoaxial rotatory subluxation has been defined as a cause of temporary, self-resolving torticollis in children. However, on occasion it may be a potentially severe rotational deformity of the cervical spine. Early diagnosis of the lesion, proper evaluation and prompt treatment leads to a permanent resolution of the deformity, while misdiagnosis may lead to chronic deformity. In addition, fracture of the clavicle is one of the commonest injuries in childhood. However, torticollis associated with clavicular fracture is extremely rare. This co-existence in children should always be considered as a potential atlantoaxial rotatory subluxation. Two new cases as well as an extensive review of the literature are presented in this report.

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**Review**

Torticollis is seen at all ages, from newborns to adults, and refers to rotational deformity of the cervical spine with secondary tilting of the head. In children, it may be congenital or post-natally acquired. Acquired torticollis in children is a symptom that is usually due to a number of benign underlying lesions. However, severe and life threatening causes have also been encountered. The latter include musculoskeletal, ophthalmologic, infectious, neurologic, and neoplastic diseases that may exhibit an early presentation, with only torticollis [1-6].

Torticollis secondary to trauma is most commonly due to muscle spasm or injury. Physical examination is essential in the diagnostic investigation of patients with acquired torticollis resulting from trauma. Rare post-traumatic causes of acquired painful torticollis may include fracture or dislocation of the od-

ontoid, fracture of the first or second cervical vertebra, fracture of the first rib, atlantoaxial rotatory subluxation (or displacement) and a clavicular fracture [7-13].

Diagnosis of atlantoaxial rotatory subluxation is difficult and often delayed. The onset is spontaneous and usually occurs following minor trauma, or may follow an upper respiratory tract infection (Grisel syndrome) [14-18]. The child presents with torticollis and resists any attempt to move the head because of pain. The head is tilted to one side and rotated to the opposite side with the neck slightly flexed (a typical 'cock robin' position of the head). The associated muscle spasm is noted on the side of the 'long' sternocleidomastoid muscle because the muscle is attempting to correct the deformity, unlike congenital muscular torticollis, in which the spasmodic muscle causes the torticollis.



In acute cases attempts to move the head cause pain. Patients are able to increase the deformity but cannot correct it past the midline [19-26]. If the deformity becomes fixed (atlantoaxial rotatory fixation), the pain subsides but the torticollis persists along with diminished range of neck motion. In long-standing cases, plagiocephaly and facial asymmetry with flattening may develop on the side of the tilt [27-29]. Neurologic evaluation should carefully determine any neurologic compression or vertebral artery compromise [30].

Conventional radiography, including anteroposterior, lateral and odontoid views, should be the first-line imaging modality. Congenital anomalies and normal variants of the immature anatomy of the cervical spine should also be carefully defined in children suffering from torticollis after trauma [31]. The radiologist plays a key role in confirming the diagnosis [32].

Interpretation of radiographs is difficult. On the open mouth view there is loss of symmetry between the lateral masses of the atlas and the odontoid process. The lateral mass of the atlas that is rotated anteriorly appears wider and closer to the midline (medial offset), whereas the opposite lateral mass is narrower and away from the midline (lateral offset). The facet joints may be obscured because of apparent overlapping. The lateral view shows the wedge-shaped lateral mass of the atlas lying anteriorly, than the oval arch of the atlas normally lies, and the posterior arches fail to superimpose because of the head tilt. The normal relationship between the occiput and atlas is preserved. A lateral radiograph of the skull may show the relative position of cervical vertebrae 1 (C1) and cervical vertebrae 2 (C2) more clearly than a lateral radiograph of the cervical spine. Lateral flexion and extension views should be obtained to document any atlantoaxial instability [33]. In some children, the anterior physiological displacement of axis on the third cervical vertebra is so pronounced that it appears pathological (pseudosubluxation) [34, 35]. Swischuk has used the posterior cervical line, drawn from the anterior cortex of the posterior arch of atlas to the anterior cortex of the posterior arch of the third cervical vertebra, to differentiate it from pathological subluxation [36].

Acute post-traumatic torticollis is not necessarily the sign of a pathologic condition of the atlantoaxial joint. It is also not necessary to obtain computed tomography scans (static or dynamic) in this group of patients at the time of presentation. However, children presenting with resistant, unresolving torticollis may suffer from atlantoaxial rotatory subluxation.

Post-traumatic atlantoaxial rotatory subluxation is a rare, but potentially severe, cause of acquired torticollis in children. Atlantoaxial rotatory subluxation represents a wide spectrum of injuries. Atlantoaxial rotatory fixation may occur within the normal range of rotation of the atlantoaxial joint. In these cases, the joint is neither subluxed nor dislocated. The obstruction is probably due to capsular or synovial interposition. It may also be due to anterior shift of the atlas on the axis following fractures or ligamentous deficiency leading to atlantoaxial instability [37].

The increased incidence of atlantoaxial rotatory subluxation in children, compared to adults, may be related to certain anatomical differences. The dens-facet angle of the axis is steeper in children than in adults. Meniscus-like synovial folds are found in the first two cervical vertebrae facet joints of the spines in children, but not in those of adults [38].

The atlantoaxial rotatory displacement, as defined initially

by Fielding and Hawkins in 1977, is classified into four types: Type 1 is the most common form in children. It is a simple rotatory displacement without an anterior shift. Type 2 is potentially more dangerous. It is a rotatory displacement with an anterior shift of 5 mm or less. Type 3 is rotatory displacement with an anterior shift greater than 5 mm. Finally, type 4 is rotatory displacement with a posterior shift. Type 3 and 4 deformities are rare, but neurological involvement or even instant death may follow [39,40].

Diagnosis of the condition is largely clinical but may be aided by various imaging studies, including radiographs, static or dynamic Computed Tomography (CT) scanning, three-dimensional CT reconstructions, or magnetic resonance imaging. The radiological technique of choice for this condition is CT. Consideration should always be given to infection or other inflammatory disease as an underlying, precipitating cause [41-50].

Treatment includes observation if the complaints are mild and have been present for less than a week, short bed rest, a simple soft collar and analgesics. Most cases prove transitory and spontaneously resolving. Whenever the stiff neck and the slightly twisted head do not resolve in a few days, more aggressive treatment should be instituted. The most important factor for success of conservative treatment is the time from the onset of symptoms to recognition and initiation of treatment. In cases that reduction does not occur spontaneously or the rotatory subluxation is present for longer than 1 week, but less than 1 month, hospitalization and cervical traction are indicated. Head-halter traction is used, but halo traction may be required when torticollis persists for longer than 1 month [51-57].

Indications for operative treatment include neurologic involvement, anterior displacement, failure to achieve and maintain correction if the deformity exists for longer than 3 months, and recurrence of the deformity after an adequate trial of conservative management consisting of at least 6 weeks of immobilization [58-61]. If left untreated, persistent deformity due to the development of secondary changes in the bony anatomy of the atlantoaxial joint may be evident [62].

Pediatric emergency physicians should have a high clinical suspicion for atlantoaxial rotator subluxation, particularly when a child presents with neck pain and an abnormal head posture without the ability to return to a neutral position [63].

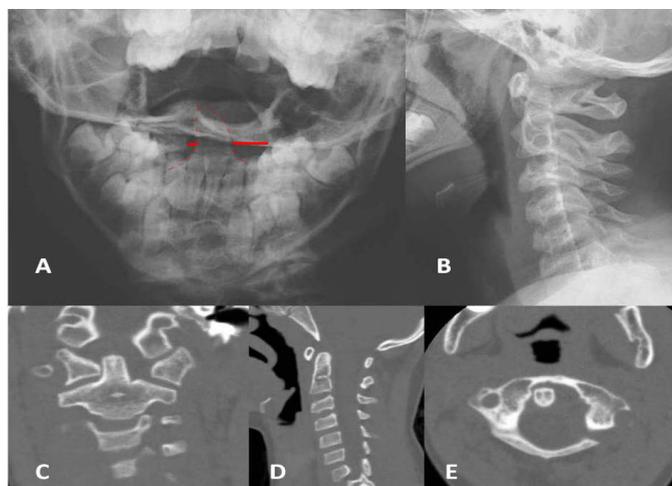
The diagnosis of atlantoaxial subluxation should always be considered in children presenting with a clavicular fracture associated with acute torticollis. It has been postulated that the rotary displacement is a direct result of the traumatic injury that produces the fracture. The head is most often laterally bent toward and rotated away from the fractured clavicle. Treatment of the clavicle fracture is straightforward, but failure to recognize and treat the atlantoaxial rotatory subluxation promptly may lead to a fixed deformity [64-70].

Cases with a diagnosed atlantoaxial rotatory subluxation associated with a fractured clavicle, although very rare, have sufficiently been discussed in the world literature. However, reports on missed cases and their final outcome are not evident.

We were able to identify, from the hospital database, two cases with atlantoaxial rotatory subluxation.

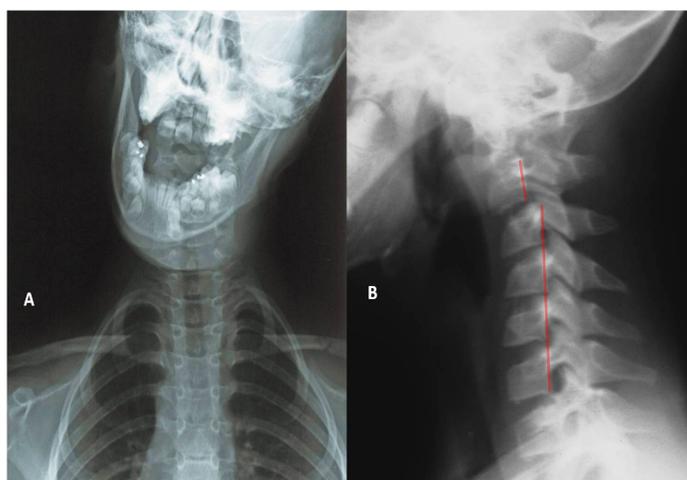
The former was a 10-year-old boy that presented with acute torticollis and neck stiffness after falling on backwards a day ago. The frontal and open mouth odontoid views demonstrated

atlantoaxial rotatory subluxation (Figure 1A). On the lateral radiograph loss of the normal lordosis was only diagnosed (Figure 1B). Diagnosis was clearly secured with the CT scan findings. Coronal (Figure 1C), sagittal (Figure 1D) and axial (Figure 1E) views showed that the odontoid was lying eccentrically between the lateral masses of the atlas. A type I simple atlantoaxial rotatory displacement was diagnosed. The neck symptoms were considerably relieved immediately after gentle manipulative axial traction.



**Figure 1:** Initial anteroposterior radiograph of the cervical spine indicated loss of symmetry between lateral masses of the atlas and odontoid process (A). Lateral cervical spine radiograph showed loss of the normal lordosis (B). Coronal CT images demonstrated narrowing of the right lateral atlantodental interval and a wider left lateral atlantodental interval (C). Sagittal CT views of the cervical spine indicated no abnormal findings (D). Axial CT views confirmed that the odontoid was lying eccentrically between the lateral masses of the atlas (E).

The latter was an 8-year old boy that presented with torticollis associated with an injury of the left shoulder. Plain anteroposterior (Figure 2A) radiograph showed a midshaft fracture of the left clavicle, while the lateral view was indicative of a reversed cervical lordosis (Figure 2B). The potential severity of the cervical spine injury was overlooked. No CT scanning evaluation was recommended. Bed rest and analgesics was the offered treatment. The patient reported an uneventful recovery of the torticollis within a few days.



**Figure 2:** Typical torticollis position of atlantoaxial rotatory displacement. The head is tilted to the side of the fractured clavicle and rotated to the opposite side, with slight flexion. Associated muscle spasm, unlike muscular torticollis, is predominantly on the side of the 'long' sternocleidomastoid, because the muscle is attempting to correct the deformity. Initial anteroposterior radiograph of the cervical spine, demonstrating left lateral cervical tilt due to the midshaft clavicular fracture (A). On the lateral projection no abnormal alignment of the atlas and the axis was evident but there was a reversed cervical lordosis. The anterior displacement of the axis on the third cervical vertebra was not considered pathological (B).

#### Conflict of interest statement

The author certifies that he has no commercial associations (such as consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

#### References

- White AA 3rd, Panjabi MM. The clinical biomechanics of the occipitoatlantoaxial complex. *Orthop Clin North Am.* 1978; 9: 867-878.
- Kahn ML, Davidson R, Drummond DS. Acquired torticollis in children. *Orthop Rev.* 1991; 20: 667-674.
- Ballock RT, Song KM. The prevalence of non muscular causes of torticollis in children. *J Pediatr Orthop.* 1996; 16: 500-504.
- Nigrovic LE, Rogers AJ, Adelgais KM, Olsen CS, Leonard JR, Jaffe DM, Leonard JC; Pediatric Emergency Care Applied Research Network (PECARN) Cervical Spine Study Group. Utility of plain radiographs in detecting traumatic injuries of the cervical spine in children. *Pediatr Emerg Care.* 2012; 28(5): 426-432.
- Tomczak KK, Rosman NP. Torticollis. *J Child Neurol.* 2013; 28: 365-378.
- Per H, Canpolat M, Tümtürk A, Gumuş H, Gokoglu A, Yikilmaz A, et al. Different etiologies of acquired torticollis in childhood. *Childs Nerv Syst.* 2014; 30(3): 431-440.
- Routt ML Jr, Green NE. Jefferson fracture in a 2-year-old child. *J Trauma.* 1989; 29: 1710-1712.
- de Beer JD, Hoffman EB, Kieck CF. Traumatic atlantoaxial subluxation in children. *J Pediatr Orthop.* 1990; 10: 397-400.
- Mazur JM, Loveless EA, Cummings RJ. Combined odontoid and Jefferson fracture in a child: A case report. *Spine.* 2002; 27: E197-199.
- Papadimitriou NG, Christophoridis J, Papadimitriou A, Beslikas TA. Acute torticollis after isolated stress fracture of the first rib in a child. A case report. *J Bone Joint Surg Am.* 2005; 87: 2537-2540.
- AuYong N, Piatt J Jr. Jefferson fractures of the immature spine. Report of 3 cases. *J Neurosurg Pediatr.* 2009; 3: 15-19.
- Ottink KD, van Middendorp JJ, Kleinveld S, Breemans E. Traumatic atlas fracture in a child following fall on head. *Ned Tijdschr Geneesk.* 2009; 153: 1084-1089.
- Burkhardt M, Garcia P, Fries P, Heinzmann J, Pohlemann T, et al. Post-traumatic torticollis in a schoolchild: Fracture, congenital anomaly or age-appropriate radiological findings of the atlas? *Unfallchirurg.* 2010; 113: 230-234.
- Maranich AM, Hamele M, Fairchok M. Atlanto-axial subluxation: A newly reported trampolining injury. *Clin Pediatr (Phila).* 2006;

- 45: 468-470.
15. Sobolewski BA, Mittiga MR, Reed JL. Atlantoaxial rotary subluxation after minor trauma. *Pediatr Emerg Care.* 2008; 24: 852-856.
  16. Benson M, Fixsen J, Macnicol M, Parsch K. *Children's Orthopaedics and Fractures*, Springer-Verlag. 2010.
  17. Warner WC Jr. Pediatric cervical spine (Chapter 43). In *Campbell's Operative Orthopaedics E-Book*. Azar FM, Beaty JH, Canale ST, eds. Elsevier, Philadelphia. 2017.
  18. Spiegel D, Shrestha S, Sitoula P, Rendon N, Dormans J. Atlantoaxial rotatory displacement in children. *World J Orthop* 2017; 8: 836-845.
  19. Muñiz AE, Belfer RA. Atlantoaxial rotary subluxation in children. *Pediatr Emerg Care.* 1999; 15: 25-29.
  20. Lee SC, Lui TN, Lee ST. Atlantoaxial rotatory subluxation in skeletally immature patients. *Br J Neurosurg.* 2002; 16: 154-157.
  21. Beier AD, Vachhrajani S, Bayerl SH, Aguilar CY, Lamberti-Pasculli M, Drake JM. Rotatory subluxation: Experience from the Hospital for Sick Children. *J Neurosurg Pediatr.* 2012; 9: 144-148.
  22. Hussain K, Abdo MM, AlNajjar FJ, Abbo M. Not your typical torticollis: A case of atlantoaxial rotatory subluxation. *BMJ Case Rep.* 2014; 2014.
  23. Bagouri E, Deshmukh S, Lakshmanan P. Atlantoaxial rotatory subluxation as a cause of torticollis in a 5-year-old girl. *BMJ Case Rep.* 2014; 2014.
  24. Missori P, Marruzzo D, Peschillo S, Domenicucci M. Clinical remarks on acute post-traumatic atlanto-axial rotatory subluxation in pediatric-aged patients. *World Neurosurg.* 2014; 82: e645-648.
  25. Neal KM, Mohamed AS. Atlantoaxial rotatory subluxation in children. *J Am Acad Orthop Surg.* 2015; 23: 382-392.
  26. Powell EC, Leonard JR, Olsen CS, Jaffe DM, Anders J, et al. Atlantoaxial rotatory subluxation in children. *Pediatr Emerg Care.* 2017; 33: 86-91.
  27. Wortzman G, Dewar FP. Rotary fixation of the atlantoaxial joint: Rotational atlantoaxial subluxation. *Radiology.* 1968; 90: 479-487.
  28. Fielding JW, Hawkins RJ, Hensinger RN, Francis WR. Atlantoaxial rotatory deformities. *Orthop Clin North Am.* 1978; 9: 955-967.
  29. Sundseth J, Berg-Johnsen J, Skaar-Holme S, Züchner M, Kolstad F. Atlantoaxial rotatory fixation-a cause of torticollis. *Tidsskr Nor Lægeforen.* 2013; 133: 519-523.
  30. Roach JW, Duncan D, Wenger DR, Maravilla A, Maravilla K. Atlanto-axial instability and spinal cord compression in children-diagnosis by computerized tomography. *J Bone Joint Surg Am.* 1984; 66: 708-714.
  31. Samartzis D, Shen FH, Herman J, Mardjetko SM. Atlantoaxial rotatory fixation in the setting of associated congenital malformations: a modified classification system. *Spine (Phila Pa 1976).* 2010; 35: E119-127.
  32. Roche CJ, O'Malley M, Dorgan JC, Carty HM. A pictorial review of atlanto-axial rotatory fixation: key points for the radiologist. *Clin Radiol.* 2001; 56: 947-958.
  33. Ghanem I, El Hage S, Rachkidi R, Kharrat K, Dagher F, et al. Pediatric cervical spine instability. *J Child Orthop.* 2008; 2: 71-84.
  34. Cattell HS, Filtzer DL. Pseudosubluxation and other normal variations in the cervical spine in children. A study of one hundred and sixty children. *J Bone Joint Surg Am.* 1965; 47: 1295-1309.
  35. Schwarz N, Lenz M, Berzlanovich A, Smetka W. Atlanto-axial rotation and distance in small children. A postmortem study. *Unfallchirurg.* 2000; 103: 656-661.
  36. Swischuk LE. Anterior displacement of C2 in children: Physiologic or pathologic. *Radiology.* 1977; 122: 759-763.
  37. Pang D. Atlantoaxial rotatory fixation. *Neurosurgery.* 2010; 66: 161-183.
  38. Kawabe N, Hirotani H, Tanaka O. Pathomechanism of atlanto-axial rotator fixation in children. *J Pediatr Orthop.* 1989; 9: 569-574.
  39. Fielding JW, Hawkins RJ. Atlanto-axial rotatory fixation. (Fixed rotatory subluxation of the atlanto-axial joint). *J Bone Joint Surg Am.* 1977; 59: 37-44.
  40. Waegeneers S, Voet V, De Boeck H, Opdecam P. Atlantoaxial rotatory fixation. A case report and proposal of a new classification system. *Acta Orthop Belg.* 1997; 63: 35-39.
  41. Fielding JW, Stillwell WT, Chynn KY, Spyropoulos EC. Use of computed tomography for the diagnosis of atlanto-axial rotatory fixation. A case report. *J Bone Joint Surg Am.* 1978; 60: 1102-1104.
  42. Kowalski HM, Cohen WA, Cooper P, Wisoff JH. Pitfalls in the CT diagnosis of atlantoaxial rotary subluxation. *AJR Am J Roentgenol.* 1987; 149: 595-600.
  43. Murray JB, Ziervogel M. The value of computed tomography in the diagnosis of atlanto-axial rotatory fixation. *Br J Radiol.* 1990; 63: 894-897.
  44. Scapinelli R. Three-dimensional computed tomography in infantile atlantoaxial rotatory fixation. *J Bone Joint Surg Br.* 1994; 76: 367-370.
  45. Ludwig K, Reisberg S. Computerized tomography in atlanto-axial rotatory fixation in childhood. *Rofo.* 1998; 168: 534-536.
  46. Hicazi A, Acaroglu E, Alanay A, Yazici M, Surat A. Atlantoaxial rotatory fixation-subluxation revisited: A computed tomographic analysis of acute torticollis in pediatric patients. *Spine (Phila Pa 1976).* 2002; 27(24): 2771-2775.
  47. McGuire KJ, Silber J, Flynn JM, Levine M, Dormans JP. Torticollis in children: Can dynamic computed tomography help determine severity and treatment. *J Pediatr Orthop.* 2002; 22: 766-770.
  48. Alanay A, Hicazi A, Acaroglu E, Yazici M, Aksoy C, et al. Reliability and necessity of dynamic computerized tomography in diagnosis of atlantoaxialrotatory subluxation. *J Pediatr Orthop.* 2002; 22: 763-765.
  49. Been HD, Kerkhoffs GM, Maas M. Suspected atlantoaxial rotatory fixation-subluxation: the value of multi detector computed tomography scanning under general anesthesia. *Spine (Phila Pa 1976).* 2007; 32: E163-167.
  50. Haque S, Bilal Shafi BB, Kaleem M. Imaging of torticollis in children. *Radiographics.* 2012; 32: 557-571.
  51. Burkus JK, Deponte RJ. Chronic atlantoaxial rotatory fixation correction by cervical traction, manipulation, and bracing. *J Pediatr Orthop.* 1986; 6: 631-635.
  52. Phillips WA, Hensinger RN. The management of rotatory atlanto-axial subluxation in children. *J Bone Joint Surg Am.* 1989; 7: 664-668.
  53. Subach BR, McLaughlin MR, Albright AL, Pollack IF. Current management of pediatric atlantoaxial rotatory subluxation. *Spine*

- (Phila Pa 1976). 1998; 23: 2174-2179.
54. Mihara H, Onari K, Hachiya M, Toguchi A, Yamada K. Follow-up study of conservative treatment for atlantoaxial rotatory displacement. *J Spinal Disord*. 2001; 14: 494-499.
  55. Martinez-Lage JF, Martinez Perez M, Fernandez Cornejo V, Poza M. Atlanto-axial rotatory subluxation in children: early management. *Acta Neurochir (Wien)*. 2001; 143: 1223-1228.
  56. Govender S, Kumar KP. Staged reduction and stabilisation in chronic atlantoaxial rotatory fixation. *J Bone Joint Surg Br*. 2002; 84: 727-731.
  57. Weisskopf M, Naeve D, Ruf M, Harms J, Jeszenszky D. Therapeutic options and results following fixed atlantoaxial rotatory dislocations. *Eur Spine J*. 2005; 14: 61-68.
  58. Crossman JE, Thompson D, Hayward RD, Ransford AO, Crockard HA. Recurrent atlantoaxial rotatory fixation in children: a rare complication of a rare condition. Report of four cases. *J Neurosurg*. 2004; 100: 307-311.
  59. Crossman JE, David K, Hayward R, Crockard HA. Open reduction of pediatric atlantoaxial rotatory fixation: long-term outcome study with functional measurements. *J Neurosurg*. 2004; 100: 235-240.
  60. Park SW, Cho KH, Shin YS, Kim SH, Ahn YH, et al. Successful reduction for a pediatric chronic atlantoaxial rotatory fixation (Grisel syndrome) with long-term halter traction: case report. *Spine (Phila Pa 1976)*. 2005; 30: E444-449.
  61. Lavelle WF, Palomino K, Badve SA, Albanese SA. Chronic C1-C2 rotatory subluxation reduced by C1 lateral mass screws and C2 translaminar screws: A case report. *J Pediatr Orthop*. 2017; 37: e174-177.
  62. Schwarz N. The fate of missed atlanto-axial rotatory subluxation in children. *Arch Orthop Trauma Surg*. 1998; 117: 288-289.
  63. Kinon MD, Nasser R, Nakhla J, Desai R, Moreno JR, et al. Atlanto-axial rotatory subluxation: A review for the pediatric emergency physician. *Pediatr Emerg Care*. 2016; 32: 710-716.
  64. Kato T, Kanbara H, Sato S, Tanaka I. 5 cases of clavicular fractures misdiagnosed as congenital myogenic torticollis. *Seikei Geka*. 1968; 19: 729-732.
  65. Goddard NJ, Stabler J, Albert JS. Atlanto-axial rotatory fixation and fracture of the clavicle. An association and a classification. *J Bone Joint Surg Br*. 1990; 72: 72-75.
  66. Al-Etani H, D'Astous J, Letts M, Hahn M, Yeadon A. Masked rotatory subluxation of the atlas associated with fracture of the clavicle: A clinical and biomechanical analysis. *Am J Orthop (Belle Mead NJ)*. 1998; 27: 375-380.
  67. Nannapaneni R, Nath FP, Papastefanou SL. Fracture of the clavicle associated with a rotator atlantoaxial subluxation. *Injury*. 2001; 32: 71-73.
  68. Bowen RE, Mah JY, Otsuka NY. Midshaft clavicle fractures associated with atlantoaxial rotatory displacement: a report of two cases. *J Orthop Trauma*. 2003; 17: 444-447.
  69. Kanik A, Sutcuoglu S, Aydinlioglu H, Erdemir A, Arun Ozer E. Bilateral clavicle fracture in two newborn infants. *Iran J Pediatr*. 2011; 21: 553-555.
  70. Karski J, Matuszewski L, Jakubowski P, Karska K, Kandzierski G. Clavicle fracture associated with atlantoaxial rotator displacement, type II in an 8-year-old girl: A case report. *Medicine (Baltimore)*. 2017; 96: e8781.