Case Report

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# Traumatic Odontoid Epiphysiolysis in a Young Child, Case Report and Literature Review

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## Abstract

**Background Data:** Traumatic Odontoid Epiphysiolysis fractures, although rare in the overall incidence of spinal trauma, these fractures are one of the common fractures in young children. The appropriate treatment of this type of odontoid fractures remains controversial. The rarity of literature reports on these fractures and limited number of cases prevented the consensus on the optimal line of treatment.

**Purpose:** To clarify the role of non-operative treatment in this type of fracture and ascertain its beneficial role in reaching sound fusion.

**Study Design:** Prospective assessment of Traumatic Odontoid Epiphysiolysis in young child with literature review.

**Patients and Methods:** A 4 years female child developed Traumatic Odontoid Epiphysiolysis after falling downstairs. The child was neurologically intact with severe neck pain and spasm. On examination apparent neck spasm and limitation of movement was noticed. The patient was managed by non-operative treatment. External immobilization using Minerva orthosis for 12 weeks was conducted under fluoroscopy to ascertain optimum position. The patient was followed up clinically and radiologically for 3 months. Literature review of series reporting children with Traumatic Odontoid Epiphysiolysis fractures was also conducted.

**Results:** Realignment and sound fusion was obtained after 12 weeks. The patient remained neurologically intact. Neck pain and limitation of movement improved after removal of the external fixation. As regard literature review, 105 cases were reported with Traumatic Odontoid Epiphysiolysis fractures, external immobilization was done successfully in 87%, and surgical intervention using wiring or screws was done only in 13% of cases.

**Conclusion:** Closed reduction and external fixation can be the primary treatment option for Traumati Odontoid Epiphysiolysis with high rate of fusion. (2018ESJ154)

**Key words: Traumatic; odontoid; epiphysiolysis; external immobilization; cervical trauma**

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## Introduction

Fractures of the odontoid process in children are rare but account for the majority of all the cervical spine injuries in the young juvenile groups.[6,8] Below the age of 9 years, it is not a true fracture resembling the adult type but it is exclusive separation of the subdental synchondrosis ie. Traumatic Odontoid Epiphysiolysis (TOE). After the age of 9 years, odontoid fracture resemble the adult type.[3] Clinically, the symptoms of odontoid fracture, such as neck pain

or neck stiffness, may be vague and unspecific.[11] The diagnosis of TOE is based on radiographic screening of traumatized cervical spines with a standard three-view program (anteroposterior, lateral from the occiput on Th1, transoral dens view). Computed tomography (CT) and Magnetic Resonance Imaging (MRI) are done in cases of difficulties with plain radiography and confirmation of the diagnosis.[4] Acute odontoid fracture is treated either conservatively, with a Minerva cast or internal fixation with preservation of C1/C2 mobility.[6,8,11,13,21]

**Case Report:**

A 4 years-old girl suffered head and spinal trauma after falling down stairs. The patient was transferred to Alexandria Main University Hospital. Her neck was immobilized in a rigid cervical collar during transfer. She was fully conscious and neurologically intact with severe neck pain and cervical muscle spasm.

Initial images from the referring facility demonstrated that the odontoid process was displaced and angulated anteriorly (Figure 1). The patient underwent further imaging at our facility, including an MRI study and CT scan. The MRI study demonstrated the absence of neural compression. The CT scan showed the anterior angulation of the odontoid process (Figure 1).

The patient underwent external immobilization using Lerman MINERVA™ (Truelife USA) under guide of C-arm fluoroscopy (Figure 2,3). The orthosis continued for 12 weeks during which clinical and radiological follow up was done. Her images after 12 weeks showed anatomical reduction of the deformity (Figure 4). She was at full activity and was neurologically intact.

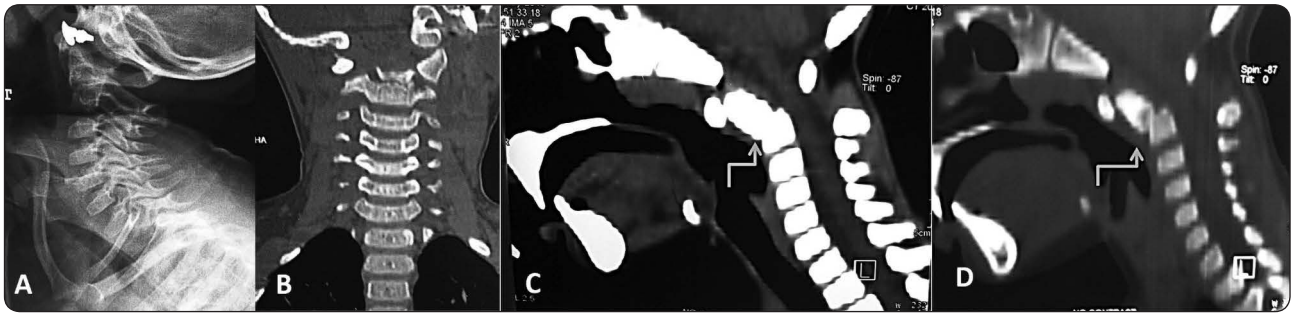


***Figure 1.*** (A) Plain radiograph of the cervical spine, lateral view showing angulation and forward displacement of the odontoid process. (B) CT scan of the cervical spine, coronal view showing line of separation of the dens. (C,D) CT scan of the cervical spine with sagittal reconstruction showing same finding.

***Figure 2.*** Photography of the patient taken with permission showing Minerva orthosis.

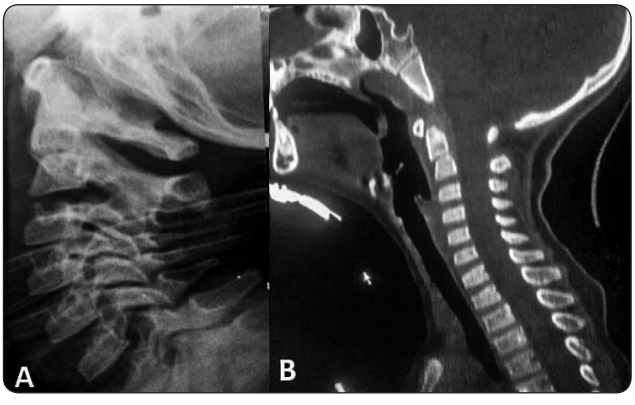


***Figure 3.*** (A,B) Plain radiograph and sagittal CT scan immediately after application of the Minerva showing realignment of the dens.

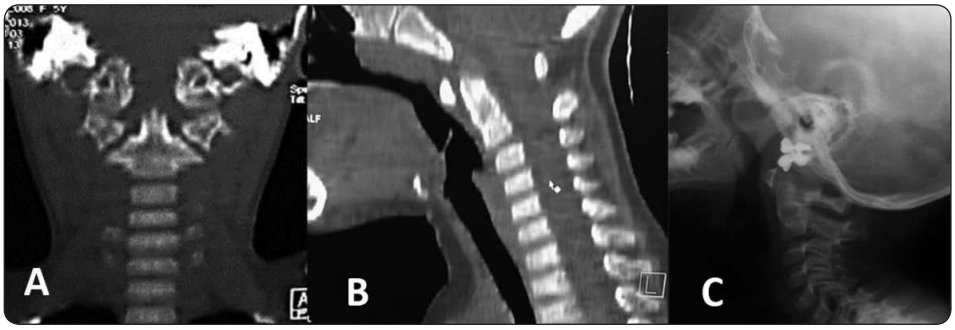


***Figure 4.*** Follow up imaging after 12 weeks. (A,B) coronal and sagittal CT scan of the cervical spine showing sound fusion of the odontoid process. (C) Plain radiography showing same finding.

***Table 1.*** Literature Review of Series Reporting Children with Traumatic Odontoid Synchondrosis Fractures

| Authors | Year | Cases | Treatment | Morbidity |
|---|---|---|---|---|
| Willard[26] | 1941 | 2 | Reduced by traction, immobilization in a cast and Thomas collar | None |
| Hamilton[15] | 1951 | 1 | Reduced with Glisson sling, immobilization with Minerva cast | None |
| Amyes[1] | 1956 | 2 | 1 case: traction in a head-halter, followed by a cervical brace<br>1 case: no treatment, non-united fracture revealed after 2 years | None |
| Blockey[7] | 1956 | 2 | Traction & plaster casts and collar | None |
| Tuell[25] | 1957 | 2 | Reduced using dependent head traction & immobilization with Minerva cast, followed by Forrester collar | None |
| Price[20] | 1960 | 1 | Primary wiring & fusion after recurrent odontoid dislocation following removal of an initial plaster cast | None |
| Ewald[10] | 1971 | 1 | Reduced using Crutchfield tongs & immobilization with halo device | None |
| Griffiths[14] | 1972 | 4 | 3 cases: traction with Crutchfield tongs<br>1 case: Minerva cast after manipulation | None |
| Anderson[3] | 1974 | 5 | 3 cases: traction followed by a Minerva cast<br>1 case: primary wiring & fusion<br>1 case: died during 1st week post-injury due to associated severe head injury | None |
| Bhattacharyya[4] | 1974 | 1 | Reduced by manipulation & immobilization in a cast | None |
| Hubbard[17] | I974 | 1 | Fusion | None |
| Seimon[23] | 1977 | 2 | Normal initial X-ray films; traction followed by a cervical collar | None |
| Sherk[24] | 1978 | 11 | All reduced by passive manipulation or by “hanging-head” technique,” supported in a Minerva jacket or halo cast | None |
| Anderson[2] | 1983 | 11 | All reduced in traction or by split-mattress technique, followed by casts or braces | None |
| Diekema[9] | 1988 | 1 | Initially reduced by traction but later required atlantoaxial fusion | None |
| Fujii[12] | 1988 | 6 | Plaster cast or brace | None |
| Mandabach[18] | 1993 | 13 | 10 cases: had fusion with the halo alone<br>3 cases: went on to fuse after surgery | 46% (N=6) Minor Complications |
| Blauth[5] | 1996 | 3 | 1 case: fused with halo and plaster vest for 12 weeks<br>2 cases: required internal fixation (posterior wiring in one and 2 odontoid screws in another) | Non-union in one case |
| Schippers[21] | 1996 | 2 | 1 case: conservative<br>1 case: surgery | None |
| Odent[19] | 1999 | 15 | 12 cases: conservative<br>3 cases: surgery | None |
| Fulkerson[13] | 2012 | 2 | Surgery for both cases | None |
| Hosalkar[16] | 2009 | 17 | 15 cases fused with external fixation<br>1 case required internal fixation<br>1 case died before treatment due to associated injury | N=9 |
| Total | 2018 | 105 | 92 (87%): External immobilization<br>13 (13%): Internal fixation | 14% (N=15) |

## Discussion

Upper cervical injuries are common in young children.[22] Odontoid fractures in young children are different in mechanism and pathology than an odontoid fracture in the same anatomical location in a patient with a skeletally fused synchondrosis. They are not true fractures but separations of the subdental synchondrosis i.e. TOE. In young children, the axis is formed from four primary ossification centers: the body, the two neural arches, and the dens. These ossification centers are separated by a cartilaginous plate called a synchondrosis. The synchondrosis between the dens and the body of C-2 is a potential source of bio-mechanical weakness it does not ossify until a child is 5 to 7 years old. The weak synchondrosis, in combination with the relatively large size of a child's head, which can act as a pendulum in high-speed trauma, makes the odontoid synchondrosis prone to traumatic injury. The clinical presentation of odontoid synchondrosis fractures can range from neck pain to neurological deficits with spinal cord injury (SCI). Most of cases present without neurological deficits, therefore, clinicians must maintain a high index of suspicion for children who have neck stiffness, neck pain, or have other concurrent/distracting injuries.[13,22]

The rarity of pediatric synchondrosis fractures limits the consensus on the optimal treatment. The management algorithms are extrapolated from similar pathological conditions. The reported cases in the literature since 1941 according to our literature search were about 105 cases. Conservative management using different forms of external immobilization was conducted successfully in 87% of cases. Internal fixation was performed in 13 (13%) patients. Minor complications were reported in 14% of patients (Table 1).

Hosalkar et al,[16] proposed a classification system to describe these fractures based on the extent of displacement of the odontoid process from the vertebral body. Type-I injuries were defined as fractures through the odontoid synchondrosis and were further subdivided into 3 different groups: subtypes A (0%–10% displacement), B (11%–100% displacement), and C (> 100% displacement). Based on this classification system, they recommended halo immobilization for Type-IA, closed reduction and halo fixation for Type-IB, and surgical stabilization for Type-IC. Type-II fractures were above the level of the synchondrosis. They did not include the degree of angulation in their classification. Despite the usefulness of this classification for this rare type of injury, there no strong conclusion regarding the choice of appropriate method of management as most of the cases were managed conservatively. Fulkerson et al,[13] in their report recommended open reduction and internal fixation for fractures with marked angulation. They suggested that these fractures are associated with ligamentous injury in the presence of this marked angulation.[13] The degree of angulation is a factor in other types of upper cervical fractures as well. The normal functional anatomy at C1–2 allows 20–30°of excursion in flexion-extension. An angular subluxation of >30°, which is definitively outside the normal physiological range of movement at the atlantoaxial complex, should be considered when deciding management options concurrently with severity of ligamentous injury.[13] Despite the strong suggestion of considering marked angulation for internal fixation, external orthosis still a primary option to treat this fracture in a such young skeleton.

Conservative therapy of closed reduction and external fixation for TOE in children include Minerva orthosis, cervical collar, and Halo fixation. Minerva carries less risk of infection, discomfort, and tissue injuries than Halo system. However, there are insufficient data available to determine if these methods are rigid enough to immobilize the atlantoaxial complex. But there is a high rate of fusion with external orthosis in previous reports; a meta-analysis of Fassett et al,[11] reported a 93% fusion rate with a treatment duration of 3–6 months in TOE. The fusion rate with external orthosis in the study of Hosalkar et al,[16] was 16 out of 16 cases i.e. 100%.

Open reduction and internal fixation for TOE in children can be used in cases of failure of conservative treatment. Previous reports on surgical treatment carried high rate of complications. Fulkerson et al,[13] suggested that many of these previously reported surgical cases were limited by the technology of the time. In these studies, fusion was performed with

non-rigid fixation or on lay grafts. The availability of improved spinal hardware now allows for rigid screw fixation, which has a higher rate of fusion and minimal complications. However, a rigid internal fixation for a growing skeleton is still questionable and it is often difficult to find a suitable hardware for those young children. Further studies are needed to evaluate long-term effects of this type of treatment as rigid fixation may limit the normal skeletal growth. Some authors suggest that there is limited growth potential in the upper cervical spine, especially after a child is 10 years old. Also some remodeling may prevent further deformity during growth.[13,24] Currently, there are multiple surgical options, including odontoid screw fixation, transarticular screws, translaminar screws, and lateral mass instrumentation, the advantage of surgical fixation is rapid return to full activity and avoid complications of Halo fixation.

In our case, we used Minerva orthosis successfully for 12 weeks. In spite of marked angulation, closed reduction and external fixation was enough to obtain fusion. We suggest that external fixation should be the first option in TOE in children based on the high rate of fusion obtained in the literature.[11]

## Conclusion

Closed reduction and external fixation can be the primary treatment option for Traumatic Odontoid Epiphysiolysis with high rate of fusion despite the lack of randomized controlled trials.

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The authors report no conflict of interest

## العنوان العربي

**انفصال عظمة المحور من الفقرة العنقية الثانية للأطفال الصغار، تقرير حالة ومراجعة الابحاث السابقة**

**البيانات الخلفية:** انفصال عظمة المحور من الفقرة العنقية الثانية، على الرغم من انه نادر في المعدل العام لكسور العمود الفقري، هي واحدة من الكسور الاكثر شيوعا عند الأطفال الصغار. العلاج المناسب لهذا النوع من الكسور لا تزال موضع جدل نظرا لندرتها في الابحاث السابقة. والهدف من هذا التقرير هو لتوضيح دور العلاج غير الجراحي في هذا النوع من الكسر وللتأكد من دور مفيد في الوصول إلى الانصهار السليم.

**الغرض:** لتوضيح دور العلاج غير الجراحي في هذا النوع من الكسور والتأكد من دورها المفيد في الوصول إلى الانصهار العظمي

**تصميم الدراسه:** تقييم مستقبلي لاصابه سن الفقره العنقيه الثانيه في الأطفال الصغار مع مراجعة الدوريات

**المرضي و الطرق:** تعرضت طفلة 4 سنوات لانفصال عظمة المحور من الفقرة العنقية الثانية بعد سقوطه علي درجات سلم. كان الطفل سليما عصبيا مع آلام بالرقبة شديدة . وقد خضعت المريضة للعلاج الغير الجراحي. وقد أجريت تثبيت خارجي باستخدام جبيرة المينرفا لمدة 12 أسبوعا. وتم متابعة المريض سريريا وبالاشعة لمدة 3 أشهر. وأجريت أيضا مراجعة للابحاث السابقة للأطفال الذين اصيبوا بانفصال عظمة المحور من الفقرة العنقية الثانية.

**النتائج:** تم الحصول على التحام سليم بعد 12 أسبوعا. بقيت المريض سليمة عصبيا. مراجعة للابحاث السابقة اظهرت وجود 105 حالة انفصال عظمة المحور من الفقرة العنقية الثانية للأطفال الصغار ، وقد تم العلاج غير الجراحي بنجاح في ٪87، باستخدام التثبيت الخارجي وتم التدخل الجراحي باستخدام الأسلاك أو مسامير فقط في ٪13.

**الاستنتاج:** العلاج غير الجراحي بواسطة التثبيت الخارجي يمكن أن يكون خيار العلاج الرئيسي انفصال عظمة المحور من الفقرة العنقية الثانية للأطفال الصغار.