Isolated traumatic retroclival hematoma: case report and review of literature

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Abstract

Background Retroclival hematomas are a rare entity. The pathology can be categorized into epidural hematoma or subdural hematoma based on the anatomy of the tectorial membrane. Frequently, the etiology is related to accidental trauma, though other mechanisms have been observed, including coagulopathy, non-accidental trauma, and pituitary apoplexy. There have been only 2 prior cases where both epidural and subdural hematoma co-present.

Case presentation An 8-year-old male was involved in a high-speed motor vehicle accident. He presented with a Glasgow Coma Score (GCS) of 14 with bilateral abducens nerve palsies. Computed tomography (CT) revealed a hemorrhage along the dorsum sella, clivus, and dens. Magnetic resonance imaging (MRI) demonstrated the retroclival hematoma in both the subdural and epidural space. At discharge, 19 days after the accident, the abducens nerve palsies had resolved without medical or operative intervention.

Conclusion Retroclival hematoma may present after trauma. Although most cases exhibit a benign clinical course with conservative management, significant and profound morbidity and mortality have been reported. Prompt diagnosis with close observation is prudent. Surgical management is indicated in the presence of hydrocephalus, symptomatic brainstem compression, and occipito-cervical instability.

Keywords Retroclival hematoma · Abducens nerve palsy

Introduction

Retroclival hematomas are rare and only represent a small subset of posterior fossa extra-axial hematomas, which as a whole constitute approximately 0.3 % of acute extra-axial hematomas [1, 2]. The pathology can be categorized into epidural hematoma (rcEDH) or subdural hematoma (rcSDH) based on the anatomy of the tectorial membrane. Most cases in the literature involve the pediatric population, though few cases have been reported in the adult population as well. Frequently, the etiology is related to accidental trauma, though other mechanisms have been observed, including coagulopathy, non-accidental trauma, pituitary apoplexy, and ruptured aneurysm. Still, some remain spontaneous without an identifiable cause [3–8]. We report a pediatric patient who sustained a retroclival hematoma (with both subdural and epidural components) after a motor vehicle crash and provide a review of the available English literature, emphasizing the pathophysiology of injury and the appropriate clinical management. There have been only 2 prior cases where both epidural and subdural hematoma co-present [9].

Case presentation

An 8-year-old male was involved in a motor vehicle crash. He was sitting on the back seat along the driver side; his seat belt status was unknown. The vehicle was “T-boned” by another vehicle traveling 60 miles per hour. At the scene, patient exhibited a GCS 14. On presentation, his eyes were crossed, but he did not complain of diplopia until the following day. Because he was lethargic and confused, he was admitted to the ICU for close monitoring. He denied significant headaches, blurred vision, eye pain, or light sensitivity. Physical examination was significant for bilateral 6th nerve palsies.
CT of the head revealed a hemorrhage along the dorsum sella, clivus, and dens (Fig. 1a, 1b). MRI brain and cervical spine were obtained to evaluate the hematoma and the craniocervical junction for signs of instability; the retroclival hematoma appeared in the subdural space and epidural space; there was T2 hyperintensity in atlanto-occipital joints and blood along the tectorial membrane (Fig. 2a, 2b). Subsequently, cervical spine flexion/extension x-rays were obtained, which demonstrated no instability and the cervical collar was discontinued. The patient had a prolonged hospitalization due to a duodenal hematoma and associated feeding issues. At discharge, 19 days after the accident, he exhibited intact eye movements.

Discussion

Retroclival subdural hematoma (rcSDH) has been reported less often than epidural hematoma (rcEDH). However, both can co-present, particularly in violent injuries [10]. Tables 1, 2, 3, and 4 summarize the available English literature. In the pediatric population, there have been 30 cases of rcEDH and 16 cases of rcSDH; in the adult population, there have been 8 cases of rcEDH and 21 cases of rcSDH. The tectorial membrane helps define the distinction between the epidural space and the subdural space, where the former is ventral to the membrane and the latter is dorsal to the membrane [11]. The tectorial membrane is the rostral continuation of the posterior longitudinal ligament, attached inferiorly to the posterior body of the axis and superiorly to the occipital bone along the clivus [11]. RcEDH are restricted by the boundaries of the membrane (that is, from the mid-portion of the clivus to the middle of the body of the axis); rcSDH are not restricted and can disseminate from the intracranial to the spinal subdural space [11]. The MRI (Fig. 2a, 2b) from our patient demonstrated stripping of the tectorial membrane, with focal areas of disruption; the ventral fluid collection tracking down to the mid body of the odontoid is consistent with an epidural hematoma; however, there is also a collection that exists posterior to the tectorial membrane and tracks more inferiorly to the posterior of the C3 body; this collection is consistent with a subdural collection.

![Fig. 1 a](image1.png) Axial CT head demonstrates retroclival hematoma. ![Fig. 1 b](image2.png) Mid-sagittal CT head demonstrates retroclival hematoma

![Fig. 2 a](image3.png) Sagittal T2 and T1 MR demonstrate rupture of tectorial membrane, with hematoma both ventral and dorsal to the membrane. Epidural hematoma tracks to mid-body of the dens, while subdural hematoma tracks to inferior C3 body

The most common etiology is a traumatic event that induces hypermobility of the neck. Either hyperflexion or hyperextension can lead to soft tissue injury or fractures, causing a retroclival hematoma. The preponderance of reported pediatric cases relative to adult cases may be attributed to the anatomical differences at the craniocervical junction. Compared to adults, children possess certain features (large head-to-body proportion, small occipital condyles, shallow facet joints, and weak cervical muscles) that increase the mobility of the spine and augment the risk for injury [12, 13]. Disruption of the tectorial membrane (i.e., from its insertion into the clivus) can cause venous bleeding from the surrounding basilar venous plexus and dorsal meningeal branch of the meningohypophyseal trunk, leading to an epidural collection [11]. In children, the dura can be more easily detached from the bone, which makes them more vulnerable to forceful traction [14]. Clival fractures have been associated with rcEDH, likely due to bone bleeding as well as injury to the tectorial membrane [15, 16]. Similarly, odontoid fractures have been reported; dislocation of the dens can cause damage to the transverse ligament and traction to the tectorial membrane, prompting hemorrhage [17, 18]. Shearing forces may lead to rcSDH via rupture of the bridging petrosal and small veins near the foramen magnum; the tectorial membrane is usually unharmed, remaining attached to the clivus; this feature is an important characteristic which differs from rcEDH [11]. Other traumatic injuries associated with retroclival hematoma include atlanto-occipital dislocation [19, 20], atlanto-axial dislocation, rupture of the transverse ligament [17], fractures of the occipital condyles [21], spheno-occipital synchondrosis diastasis [22], brain stem contusion [17], and intraventricular hemorrhage [17].

There are a variety of non-traumatic causes of retroclival hematoma. A common etiology is pituitary apoplexy. Hemorrhage can spread through the diaphragm sella into the subdural space, constrained by the posterior arachnoid membrane of the preopticine cistern [1, 23]; on the other hand, a defect in the dorsum can permit blood flow into the epidural space [24]. Rare cases of rcSDH have been associated with aneurysmal
| Literature      | Year | Age  | Gender | Mechanism                  | Exam                          | Surgery?                  | Long-term deficits                                           | Other features                                                                 |
|-----------------|------|------|--------|----------------------------|-------------------------------|---------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------|
| Orrison         | 1986 | 8    | M      | MVA while riding bike      | GCS 3, polytrauma, blown pupils and no brain stem reflexes | Evacuation of parietal hematoma (not for RCH) | Died Odontoid fracture, rupture of transverse ligament, brain stem contusion, pontine hemorrhage, 4th ventricle hemorrhage |
| Kurosu          | 1990 | 11   | F      | MVA while crossing street  | GCS 7, quadriparesis         | No                         | Slight right arm paresis                                      | Spheno-occipital synchondrosis diastasis                                      |
| Papadopoulos    | 1991 | 10   | M      | MVA while crossing street on bicycle | GCS 4, bilateral 6th, quadraparesis, shallow respirations | Evacuation of hematoma via posterolateral approach, then posterior fusion | None AOD                                                              |
| Marks           | 1997 | 8    | F      | MVA                         | GCS 6, quadriplegia, apneic   | No                         | Mild left hemiparesis, able to walk unaided                  | AAD                                                                           |
| Mizushima       | 1998 | 8    | M      | MVA while crossing street  | GCS 7, bilateral 6th, mild bilateral arm paresis | No                         | None AAD                                                   |
| Suliman         | 2001 | 16   | M      | MVA versus a tree           | GCS 8, paresis of 9, 12th cranial nerves, right hemiparesis | No                         | None Left occipital condyle fracture                        |
| Yang            | 2003 | 5    | M      | MVA while crossing street  | GCS 7, poor spontaneous respiration, right side hemiparesis/ poor fine motor control | No                         | None ***                                                   |
| Agrawal         | 2006 | 8    | F      | MVA                         | GCS 7, bilateral 6th, left 12th palsy | No                         | None ***                                                   |
| Patenakis       | 2005 | 10   | M      | MVA                         | GCS 13, right 6th, right 9th cranial nerve, partial 7th | No                         | Minimal 6th palsy Clival fracture                            |
| Guillaume       | 2006 | 5    | F      | MVA versus tractor trailer  | GCS 8, right gaze preference, right hemiparesis | No                         | Mild spastic quadriparesis                                  |
| Guillaume       | 2006 | 8    | M      | MVA                         | Confused but alert, following commands | No                         | None ***                                                   |
| Meo              | 2006 | 10   | M      | MVA                         | GCS 14, right 6th palsy      | No                         | Minimal 6th palsy                                           |
| Guillaume       | 2007 | 5    | F      | MVA                         | GCS 3, fixed/dilated pupils/ cardiorespiratory arrest/polytrauma/ obstructive hydrocephalus | No                         | Minimal 6th palsy                                           |
| Kwon            | 2008 | 11   | F      | MVA                         | GCS 15, bilateral 6th palsy, uvula deviation to left, weak tongue | No                         | None ***                                                   |
| Tubbs           | 2010 | Mean 12 years | 5 male and 3 female patients | MVA-related | Mean GCS 8 | 2 patients with stabilization | 2 died, 4 patients are neurologically intact, 1 patient had a complete upper cervical spinal cord injury, 1 patient had mild bilateral abducens nerve palsy | 2 AOD                                                                         |
| Becco de Souza  | 2011 | 8    | F      | MVA                         | GCS 15, bilateral 6th        | No                         | None ***                                                   |
| McDougall       | 2011 | 10   | F      | MVA                         | GCS 14, right 6th palsy      | No                         | Minimal 6th palsy                                           |
| Tahir           | 2011 | 12   | F      | MVA                         | GCS 11, right hemiparesis    | No                         | Improving right hemiparesi                                  |
| Silvera         | 2014 | 2 months | F | Abuse                  | ***                          | ***                         | ***                                                        |
| Silvera         | 2014 | 1 months | M | Abuse                  | ***                          | ***                         | ***                                                        |
| Silvera         | 2014 | 13 months | M | Abuse                  | ***                          | ***                         | ***                                                        |
rupture [25, 26]. Moreover, pressure changes (spontaneous intracranial hypotension [7] and posterior fossa decompressive craniectomy [27]), thrombocytopenia [28], and hemophilia [29] have been linked with rcSDH. Several cases have occurred spontaneously with negative work-up and no history of trauma [3–8].

| Literature | Year | Age (years) | Gender | Mechanism | Exam | Surgery? | Long-term deficits | Other features |
|------------|------|-------------|--------|-----------|------|----------|-------------------|---------------|
| Silvera⁹   | 2014 | 30 months F | Abuse (both SDH and EDH) | *** | *** | *** | *** |
| Silvera⁹   | 2014 | 1 months F | Abuse (both SDH and EDH) | *** | *** | *** | *** |
| Dal Bo³    | 2015 | 2 years M  | Spontaneous, neck pain | NF | No | None | *** |

**Table 2**  
Literature Review of Adult rcEDH

| Literature | Year | Age (years) | Gender | Mechanism | Exam | Surgery? | Long-term deficits | Other features |
|------------|------|-------------|--------|-----------|------|----------|-------------------|---------------|
| Tomaras⁸   | 1995 | 36 M        | Spontaneous | GCS 15, left 7th nerve palsy | No | None |
| Goodman²⁴  | 1997 | 62 M        | Pituitary apoplexy | Chiasmal syndrome | Pituitary resection | Improvement of chiasmal syndrome | Resection of hemorrhagic pituitary adenoma |
| Calli²⁷    | 1998 | 42 M        | Status post posterior fossa decompressive surgery for cerebellar infarct | *** | Posterior fossa decompressive surgery, not for RCH | *** | *** |
| Khan¹⁵     | 2000 | 19 M        | MVA | GCS 12, right 3rd palsy, dilated nonreactive right pupil failing, bilateral 6th palsy, right 7th palsy, bilateral conductive hearing deficit | No | Partial improvement right 6th and 3rd, recovery of left 6th, stable 7th paresis, no hearing deficits | Fracture of the posterior clinoid and clivus extending into the sphenoid sinus |
| Ratilal³¹  | 2006 | 26 F        | MVA | GCS 13, bilateral 6th, bilateral V3 numbness, left 12th palsy | No | Mild diplopia on extreme lateral eye movements and left tongue deviation | *** |
| Cho⁷       | 2009 | 36 M        | Spontaneous (dilated cervical epidural veins) | NF | No | None | Bilateral supratentorial SDH, epidural venous engorgement |
| Datar³⁷    | 2013 | 75 M        | Tripped on rug, head trauma | NF | Posterior fusion | Died | Oumadin coagulopathy |
| Perez¹⁸    | 2013 | 68 M        | MVA | GCS 15 | No | Died | Odontoid fracture, cardiorespiratory arrest |

**Table 1** (continued)

| Literature | Year | Age | Gender | Mechanism | Exam | Surgery? | Long-term deficits | Other features |
|------------|------|-----|--------|-----------|------|----------|-------------------|---------------|
| Silvera⁹   | 2014 | 30 months F | Abuse (both SDH and EDH) | *** | *** | *** | *** |
| Silvera⁹   | 2014 | 1 months F | Abuse (both SDH and EDH) | *** | *** | *** | *** |
| Dal Bo³    | 2015 | 2 years M  | Spontaneous, neck pain | NF | No | None | *** |

GCS Glasgow Coma Scale, MVA motor vehicle accident, *** no data, RCH retroclival hematoma, SDH subdural hematoma, EDH epidural hematoma, M male, F females, NF non-focal
### Table 3  Literature review of adult rSDH

| Literature | Year | Age (years) | Gender | Mechanism | Exam | Surgery? | Long-term deficits | Other features |
|------------|------|-------------|--------|-----------|------|----------|-------------------|---------------|
| Narvid⁴    | 2015 | 58          | M      | Spontaneous | NF   | None     | None              | IVH           |
|            |      | 64          | F      | Spontaneous | NF   | None     | None              | ***           |
|            |      | 64          | M      | Spontaneous | Diplopia | None     | None              | IVH           |
|            |      | 67          | M      | Spontaneous | Unresponsive in the Emergency Department | None | None | IVH |
| Azizyan²³  | 2015 | Mean 55     | 8 M, 2 F | Pituitary apoplexy | 9 of 10 exhibited ophthalmoplegia | 8 of 10 surgery for pituitary, did not address RCH | *** | *** |
| Mohamed¹   | 2013 | 37          | M      | Pituitary apoplexy | Left 3rd, left temporal field cut, decreased visual acuity bilaterally | None | Surgery for pituitary | *** |
| Krishnan²⁸ | 2013 | 59          | F      | Thrombocytopenia | Flexing both upper limbs to pain, Both plantars were extensor | None | Died | Left convexity SDH |
| Schievink⁵ | 2001 | 49          | F      | Spontaneous | NF | None | None | *** |
| Sridhar³⁵  | 2010 | 19          | M      | Fall from moving bus | Spontaneous | Bilateral 6th, bilateral leg paresis | *** | *** |
| van Rijn⁶  | 2003 | 72          | M      | Spontaneous | None | *** | *** | *** |
| Kim²⁵      | 2012 | 83          | F      | Pcomm aneurysmal rupture | Confusion | Coil embo for aneurysm | None | *** |
| Brock²⁶    | 2010 | 42          | F      | Infraclinoid aneurysm | 3rd, 4th right paresis | Aneursym clipping | None | *** |

GCS Glasgow Coma Scale, *** no data, IVH intraventricular hemorrhage, RCH retroclival hematoma, SDH subdural hematoma, M male, F females, NF non-focal

### Table 4  Literature review of pediatric rSDH

| Literature | Year | Age | Gender | Mechanism | Exam | Surgery? | Long-term deficits |
|------------|------|-----|--------|-----------|------|----------|-------------------|
| Ahn⁴⁰      | 2005 | 4 years | M | Fall, four-story window | Left side hemiparesis | None | None |
| Myers²⁹    | 1995 | 17 years | M | Hemophilia, slipped on ice and hit head | Comatose, fixed dilated pupils, no brain stem reflexes | None | Died |
| Casey²     | 2009 | 18 years | M | Trivial head injury | GCS 13 | None | None |
| Sridhar³⁵  | 2010 | 18 years | M | Fall from two-wheeler | Bilateral 6th | Yes, evacuation of RCH | None |
| Silvera⁹   | 2014 | 3 months | M | Abusive | *** | *** | *** |
|            |      | 1 months | F | Abusive | *** | *** | *** |
|            |      | 3 months | M | Abusive | *** | *** | *** |
|            |      | 1 months | M | Abusive | *** | *** | *** |
|            |      | 36 months | M | Abusive | *** | *** | *** |
|            |      | 30 months | M | Abusive | *** | *** | *** |
|            |      | 7 months | F | Abusive | *** | *** | *** |
|            |      | 7 months | F | Abusive | *** | *** | *** |
|            |      | 3 months | M | Abusive | *** | *** | *** |
|            |      | 4 months | F | Abusive | *** | *** | *** |
|            |      | 4 months | M | Abusive | *** | *** | *** |
|            |      | 30 months | F | Abusive | *** | *** | *** |

GCS Glasgow Coma Scale, *** no data, RCH retroclival hematoma, M male, F females, NF non-focal
Clinical presentation can be variable. Neurological impairment may be related to stretching, direct compression, or contusion of surrounding nerves and brain parenchyma. The most frequently injured cranial nerve is the sixth cranial nerve (unilateral [16, 30] or bilateral [6, 14, 15, 19, 31–35]). Other affected nerves include the optic, oculomotor, trigeminal, facial, glossopharyngeal, and hypoglossal nerves. Patients may also exhibit hemiparesis or quadriplegia. The rare extreme cases include brain stem contusion with cardiorespiratory compromise [17–20, 36] and progressive hydrocephalus [19].

These hematomas may be overlooked on axial CT due to beam hardening artifacts in the posterior fossa [16], requiring reformatted CT images or MRI to elucidate the diagnosis and assess for ligamentous damage. Common etiologies can typically be inferred based on clinical presentation (history of trauma or presence of pituitary adenoma). Work-up for concurrent blunt traumatic vascular injury may be warranted. With no obvious mechanism, work-up for vascular pathology or coagulopathy should ensue [28]. The presence of ligamentous instability and brain injury or spinal cord injury will determine the appropriate management [11]. The possibility of brainstem compression or instability mandates initial close observation, reasonably within an ICU setting [30]. Although rare, the extra-axial hematoma can cause mass effect on the brainstem and cranial nerves, necessitating surgical evacuation [19, 35, 37, 38]. Of the 33 traumatic cases of rEDH, twelve patients exhibited a cranial nerve palsy, five patients required surgical stabilization of the craniocervical junction [19, 35, 37, 38], one patient required an external ventricular drain for progressive hydrocephalus [20], and six patients died. Of the 17 traumatic cases of rSDH, no patient required surgical stabilization; one patient died. Of the 12 cases of pituitary apoplexy, all but 1 patient exhibited cranial nerve palsies; overall, surgical resection of the hemorrhagic pituitary adenoma has led to good outcomes [1, 24].

Except for the rare cases that lead to death [17, 18, 20, 28, 29, 37, 39], the majority of patients exhibit good outcomes with minimal long-term neurological deficits with conservative management. Tubbs et al. [39] noted no relationship between hematoma size and presenting symptoms; moreover, initial GCS did not correlate with outcomes. Hematoma appears to resolve within 2–11 weeks [14, 36, 39]. On admission, our patient exhibited bilateral 6th nerve palsies, consistent with prior reports. At discharge, 19 days after the accident, he exhibited intact eye movements. Flexion and extension films demonstrated no cervical instability, and his cervical spine was cleared.

**Conclusion**

Retroclival hematoma may present after trauma. Most cases exhibit a benign clinical course with conservative management, but significant and profound morbidity and mortality have been reported. Prompt diagnosis with close observation is prudent. Surgical management is dictated based on the presence of hydrocephalus, brainstem compression, and occipitocervical instability.

**Compliance with ethical standards**

**Conflict of interest** The authors have no conflict of interest.

**Sources of supports** None was provided in this study.

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