

Isolated traumatic retroclival interdural hematoma causing craniocervical instability: A case report of pathology in a rare location and literature review

By Praveen K Sharma



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AUTHORS: Praveen K Sharma,¹ Govindarajan BR,² Karthik Krishna Ramakrishnan,³
*Sakthi Ganesh Subramonian,⁴ Sharmeela S⁵

AFFILIATIONS:

¹ Professor, Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India. **Email ID:** kpraveensharma.kps@gmail.com

² Post-graduate Resident, Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India. **Email ID:** govindarajand09@gmail.com

³ Associate Professor, Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India. **Email ID:** kkdrkr@gmail.com

⁴ Post-graduate Resident, Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India. **Email ID:** sakthi23ganesh@gmail.com

⁵ Post-graduate Resident, Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India. **Email ID:** sharmeelarajsantan@gmail.com



Corresponding Author:

Dr. Sakthi Ganesh Subramonian*

PG Resident

3

Department of Radio-Diagnosis

Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical

Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu - 602105, India.

18

Email: sakthi23ganesh@gmail.com

ORCID: <https://orcid.org/0009-0006-3184-1496>

Short Running Title: Traumatic Retroclival Hematoma & Instability



**TITLE: Isolated Traumatic Retroclival Interdural Hematoma causing
Cranio cervical Instability: A case report of pathology in a rare location
and literature review**

ABSTRACT

Introduction: Retroclival hematomas (RCH) are a rare entity primarily as a post-traumatic phenomenon in the pediatric population. We present a case of Retroclival interdural hematoma in a 12 y/o female with a previous record of cranio cervical trauma. A RCH is identified initially by CT and easily overlooked. MRI cervical spine to evaluate the Tectorial membrane and other cranio cervical ligaments integrity.

Case report: A 12-year-old female presented with bilateral abducens nerve palsies and a Glasgow Coma Score (GCS) of 13 following a high-speed motor vehicle accident.

Initial CT brain revealed an infra-tentorial extra-axial focal hyperdense collection (hemorrhage) along the retroclival region in the interdural space measuring approximately 9 x 29 x 58 mm. Subsequent imaging and evaluations suggested cranio-cervical instability, leading to surgical intervention.

Conclusions: Prompt diagnosis of RCH with conservative or surgical management is essential to avoid neurological deficits and mortality. Despite the significant potential for morbidity and mortality, the majority of patients show a benign clinical course with conservative care, underscoring the importance of quick diagnosis and close observation.

Keywords: tectorial membrane, cervical vertebrae, ligaments, computed tomography, magnetic resonance imaging



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INTRODUCTION

Retroclival hematomas, or RCHs, are extremely uncommon; they account for only 0.3% of posterior fossa hematomas.^[1] Considering the tectorial membrane's structure (TM), RCH is classified as an epidural, subdural, or interdural hematoma. Most cases involve the pediatric than the adult population. Usually, the hematoma's compression of the brainstem and increased intracranial pressure cause death. RCH is treated conservatively or with neurosurgical interventions.^[1] Coleman and Thompson reported the first case of a posterior fossa epidural hemorrhage in 1941, while Orrison et al. reported the first case of a clival epidural hematoma in 1986.^[2] The tectorial membrane's disruption was mentioned by Koshy et al. as a potential mechanism for the development of retroclival epidural hematomas.^[3]

7 Case presentation

A 12-year-old female presented with bilateral abducens nerve palsies and a Glasgow Coma Score (GCS) of 13 following a high-speed motor vehicle accident. She experienced pain on flexion of both upper limbs and had plantar extensors. Laboratory values were within normal limits.

Initial CT brain revealed an infra-tentorial, extra-axial, focal hyperdense collection (hemorrhage) along the retroclival region in the interdural space, measuring approximately 9 x 29 x 58 mm (Figure 1). The hematoma caused partial effacement of the prepontine cistern and bilateral cerebellopontine and cerebellomedullary angles/cisterns, with mild mass effect and compression of the pons and medulla oblongata. No fracture was identified. A traumatic retroclival extradural hematoma (RC-EDH) was suspected.

Placeholder for figure 1:

Subsequent cervical spine radiographs, taken during a three-day follow-up, showed changes in the Wiesel-Rothman interval (WR), with measurements of 3.6 mm and 5.4 mm indicating a decrease, and in the Basion-axial interval (BAI), which changed to -5.0 mm



and 1 mm, respectively, marking an increase. These alterations suggested a potential cranio-cervical instability.

Ten days after the accident, an MRI of the cervical spine revealed an infra-tentorial and extra-axial focal hyperintense collection (hemorrhage) along the retroclival region within the interdural space, measuring approximately 8 x 24 x 26 mm (anteroposterior x transverse x craniocaudal). The hematoma led to a partial obliteration of the prepontine cistern and the bilateral cerebellopontine and cerebellomedullary angles/cisterns. It was bounded posteriorly by the tectorial membrane and inferiorly by the apical and cruciform ligaments. The STIR sequence showed a mild heterogeneous hypo-hyperintense signal, indicating a slight reduction in the hematoma collection. A traumatic retroclival interdural hematoma (RC-IDH) in its late-acute phase was considered (Figure 2).

Placeholder for figure 2:

Immediate pre-operative cervical spine radiographs demonstrated changes in the Wiesel-Rothman interval (WR), with measures of 2.0 mm and 6.8 mm respectively, indicating a decrease, and in the Basion-axial interval (BAI), showing measures of -12.0 mm and 1.5 mm respectively, indicating an increase. These findings suggested the persistence of cranio-cervical instability.

The immediate post-operative cervical spine radiograph showed a return to normal with the Wiesel-Rothman interval (WR) at 4.5 mm and the Basion-axial interval (BAI) at -2.8 mm, indicating the resolution of cranio-cervical instability.

At the 1-year post-operative follow-up, cervical spine radiographs (Figure 6) displayed normal flexion and extension with the Wiesel-Rothman interval (WR) at 6.7 mm and 7.2 mm, respectively, and the Basion-axial interval (BAI) slightly increased at -1.2 mm and -1.0 mm, respectively, with no signs of cranio-cervical instability (Figure 3).

Placeholder for figure 3:

DISCUSSION

A traumatic event causes RCH resulting from neck flexion-extension injury (whiplash) and increases the spine's mobility.^[5,6] Odontoid bone fracture is not a frequent finding.^[7] Also leads to soft tissue injury, dislocations, ligamentous injuries, and focal neurological deficits. The anatomical variations at the craniocervical junction— weak cervical muscle tone, shallow facet joints, small occipital condyles, and more laxity in the ligaments—are the cause of RCH. MRI is the most effective imaging modality for figuring out the relationship between hematomas and craniocervical structures.



The extensive venous network among the 2 dural leaves covering the clivus is part of the retroclival venous anatomy. The clivus's diploic veins, which puncture the external dura, and the cisternal veins, which puncture the internal dura, are connected to the venous network. A complex basilar venous plexus (BVP) is found in the dorsal side of the clivus's bilayered dura. The BVP joins the clival diploic veins anteriorly and inferior petrosal sinuses laterally. BVP joins superior petrosal sinuses, cavernous sinuses superiorly, and internal vertebral venous plexus inferiorly. BVP connects anterior condylar veins, and the posterior intercavernous sinus is connected to the clival diploic veins. The anterior pontomesencephalic vein and the posterior intercavernous sinus are connected by bridging veins.

RCHs are characterized as epidural, subdural, or interdural depending on the morphology of the clival veins and the causes of bleeding. Krishnan *et al.* stated that the majority of RCH are epidural. However, some are interdural. The Tectorial membrane (TM) defines the boundary between the subdural and epidural compartments. The epidural space is ventral to the TM, and the subdural space is dorsal to the TM. The posterior longitudinal ligament's rostral extension is called TM. TM is connected superiorly to the occipital bone along the clivus as well as inferiorly to the posterior body of the C2 vertebra.^[3]

Retroclival extradural hematoma (RC-EDH) is due to stripping of the TM. It may result in venous hemorrhage from the dorsal meningeal branch of the meningo-hypophyseal trunk and the basilar venous plexus nearby, which could induce an EDH. It is located between the midpoint of the clivus and the axis's body.^[3] Children are especially susceptible to forceful traction because the dura could detached from the bone more readily in these cases.^[8] There is a connection between RC-EDH and ciliary fractures.^[9] Similarly, odontoid fractures and dislocation of the dens may result in traction on the TM and injury to the transverse ligament, which may cause bleeding.^[2]

Retroclival subdural hematomas (RC-SDH) can spread from the spinal subdural area to the intracranial area and are not restricted. RC-SDH tracks more inferiorly to the posterior of the C3 body and is located posterior to the TM. Shearing forces can cause RC-SDH by rupturing the bridging petrosal and tiny veins close to the foramen magnum; in contrast to RC-EDH, the TM is typically unaltered and stays attached to the clivus.^[3]

There are two layers in the cerebral dura mater. An 'interdural hematoma' (RC-IDH) is a hematoma that occurs between the inner 'meningeal' layer and the outer 'periosteal' layer in the retroclival area.^[10]

RCH is associated with an atlantooccipital and atlantoaxial dislocation and occipital condyles fractures.^[11] Other include transverse ligament rupture, brain stem contusion and intraventricular bleeding.^[2] The ligamentum flavum, apical ligament, interspinous



ligaments, and anterior atlantooccipital membrane injuries cause RC-EDH. The transverse band of the cruciform ligament, the anterior as well as the posterior longitudinal ligaments, and the alar ligaments are additional important stabilizing CCJ components. Unlike EDH, which is brought on by arterial bleeding, IDH is characterized by blood being trapped between the two dura leaves.

Non-traumatic causes of RCH include pituitary apoplexy. Prepontine cistern posterior arachnoid membrane prevents bleeding from passing via the diaphragm sella and into the subdural region;^[12] blood flow into the epidural space is allowed by a dorsum defect.^[13] Rare cases of RC-SDH are linked with aneurysmal rupture,^[14] Posterior fossa decompressive craniectomy,^[15] thrombocytopenia,^[16] hemophilia,^[17] and spontaneous intracranial hypotension.^[18]

Variations can occur in clinical presentation. Neurological deficit is due to the brain parenchyma, stretching, or contusion of surrounding nerves and direct compression. Sixth cranial nerve injury can be unilateral or bilateral.^[19] Additionally impacted nerves include the glossopharyngeal, trigeminal, oculomotor, optic, and hypoglossal. Additionally, patients may have quadriparesis or hemiparesis. Rarely comprise **brain stem contusion with cardiorespiratory compromise**^[20] and **progressive hydrocephalus**.^[11] The clinical presentation (trauma history or pituitary adenoma) usually indicates common etiologies. Axial CT **beam hardening artifacts in the posterior fossa** may cause RCH to be overlooked and needs an MRI or CT that has been reformatted in order to explain the diagnosis and check for ligamentous injury. A work-up is necessary if there is coagulopathy, vascular disease, or blunt traumatic vascular injury concurrently.^[16] The appropriate management will depend on the **ligamentous instability, brain injury, or spinal cord injury**.^[3] Initial attentive observation is essential to rule out any chance of compression or instability of the brainstem.^[19] EDH may require surgical excision due to **its mass effect on the brainstem as well as** cranial nerves. Tubbs et al.^[5] noted hematoma size and presenting symptoms were unrelated, and there was no correlation between the initial GCS and the results. Within 2–11 weeks, the hematoma appears to resolve.^[20]

Existing literature reviews provide valuable insights into the etiology, clinical presentation, diagnostic modalities, and management strategies for isolated traumatic retroclival interdural hematoma (ITRIH). They highlight the role of high-energy trauma, the challenges of prompt recognition, the importance of advanced imaging, and the need for individualized treatment plans. However, the rarity of ITRIH cases and potential selection bias in case reports limit the generalizability of findings and the ability to draw



robust conclusions. Despite these limitations, literature reviews remain crucial in guiding clinicians in the diagnosis, prognostication, and treatment decision-making for this rare condition.

Core Learning points in Isolated traumatic retroclival interdural hematoma (ITRIH) are that, it is a rare condition that presents diagnostic challenges due to its variable clinical presentation and nonspecific symptoms. CT and MRI are crucial for diagnosis and determining the extent of the hematoma. Managing ITRIH requires a multidisciplinary approach, with surgical intervention potentially necessary for progressive neurological deterioration or craniocervical instability. Long-term follow-up is essential to monitor patient outcomes and detect complications. Case reports and literature reviews serve as valuable educational resources, enhancing awareness of this uncommon pathology and informing clinical decision-making. Understanding these key points can help healthcare professionals effectively diagnose and manage ITRIH, ultimately improving patient outcomes.

CONCLUSION

RCH could appear following trauma. Although considerable and profound morbidity and mortality are described, the majority of patients show a benign clinical course along with conservative care. It is prudent to diagnose quickly while closely observing. The existence of occipito-cervical instability hydrocephalus, and brainstem compression determines the course of surgical care.

¹ PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

CONFLICT OF INTEREST

None declared

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FIGURES

21

Figure 1: (a) Sagittal, (b) axial, and (c) coronal CT images demonstrating an infra-tentorial, extra-axial, focal hyperdense collection (hemorrhage) along the retroclival region in the interdural space (short black arrow). Clivus (black asterisk). The hematoma causes partial effacement of the prepontine cistern, bilateral cerebellopontine, and cerebellomedullary angles/cisterns, with mild mass effect and compression of the pons and medulla oblongata. No fracture is evident.

6

Figure 2: (a) AP and (b, c) lateral flexion and extension radiographs of the cervical spine at 3 days post-injury, demonstrating craniocervical instability. (d) T1, (e) T2, (f) STIR sagittal, and (g) T2 axial MRI images of the cervical spine at 10 days post-injury, showing an infra-tentorial, extra-axial, T1 and T2 hyperintense collection (hemorrhage) along the retroclival region in the interdural space (short white arrow). Clivus (white asterisk). The hematoma causes partial obliteration of the prepontine cistern, bilateral cerebellopontine, and cerebellomedullary angles/cisterns. The hematoma is posteriorly limited by the tectorial membrane (long white arrow) and inferiorly by the apical and cruciform ligaments (white arrowhead). STIR images demonstrate mild heterogeneous hypo-hyperintensity, indicating a mild decrease in hematoma collection.

6

Figure 3: (a, b) Immediate pre-operative lateral flexion and extension radiographs of the cervical spine, showing persistent craniocervical instability. (c, d) Immediate post-operative AP and lateral radiographs of the cervical spine, demonstrating no craniocervical instability following surgical management with occipitocervical alignment and rod contouring. (e) AP, (f) lateral extension, and (g) lateral flexion radiographs of the cervical spine at one-year post-operative follow-up, showing no craniocervical instability.

16