Osteogenesis Imperfecta and Extra-/Intradural Hematomas: A Case Report and Review of the Literature

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Abstract

Osteogenesis imperfecta, also named as brittle bone disease, is characterized by fragile bones and short stature caused by mutations in the collagen gene. Subdural and intraparenchymal hematomas are defined and associated with trauma, vascular causes, and systemic bleeding diathesis. Skull fragility may lead to epidural hematoma, which is a life-threatening situation. Vascular fragility and intrinsic platelet defects are the causes of bleeding in patients with osteogenesis imperfecta, which is a major management challenge for neurosurgeons. Here, we reported on a 5-year-old boy with osteogenesis imperfecta with epidural hematoma and skull fracture following a trivial trauma, and made a literature review of 28 cases with extra-/intradural hematoma.

Keywords
- osteogenesis imperfecta
- extradural hematoma
- bleeding diathesis

Introduction

Osteogenesis imperfecta (OI) is an inherited connective tissue disorder.[1,2] The incidence of OI is 1 per 20,000 live births.[3] Recurrent bone fractures often occurred because of minimal traumas[2] and the prognosis is variable.[1] The disease, also known as brittle bone disease, is an autosomal dominant genetic disorder of type I collagen,[4] caused by mutations of the *COL1A1* and *COL1A2* genes in 85 to 90% of cases.[5] The lack of collagen affects multiple organs including bones, joints, ears, eyes, skin, and other tissues that are composed of a substantial amount of type 1 collagen.[4] Vascular fragility and intrinsic platelet defects are the major causes for intracranial bleeding in patients with OI.[6] Five types of OI were classified by Bonafe et al:[7] (1) nondeforming form (type I), (2) perinatally lethal (type II), (3) severe, progressively deforming (type III), (4) moderate (type IV), and (5) calcification of the interosseous membranes and/or hypertrophic callus (type V).

For pediatric patients with OI, traumas often occur and head traumas could happen. This article presents a patient with OI and epidural hematoma (EDH) following a trivial trauma and a comprehensive literature review of extra-/intradural hematomas in patients with OI.

Case Report

A 5-year-old boy was admitted to the hospital with a soft swelling on the head. Patient was diagnosed as OI since 2 years of age. The boy had a crash with his little brother a week ago. His Glasgow Coma Scale was 15/15 at admission. Physical examination revealed a palpable, soft swelling lesion on the left frontoparietal area with a triangular face shape (►**Fig. 1**) and multiple deformities of lower extremities (►**Fig. 2**). He had no blue sclera or hearing loss. Neurologic deficit was not identified. The patient was evaluated as type III OI based on the clinical and radiological findings. The cranial computed tomography revealed left frontoparietal EDH without midline shift

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Fig. 1 Patient with a triangular face.

that is associated with soft tissue swelling (►**Fig. 3**) and linear nondisplaced skull fracture (►**Fig. 4**). The complete blood count did not reveal a significant deviation from normal: hemoglobin 10.6 mg/dL; hematocrit 31.8 mg/dL; platelets 301/mm^3; activated partial thromboplastin time ratio 1.22; and protrombin time ratio 1. The treatment was conservative and the hospital stay was uneventful. The patient was discharged neurologically intact and no swelling on the head was found in the 1-month follow-up.

Discussion

Intracranial hemorrhages could be caused by arterial damage, vascular fragility, spontaneous intracranial hypotension, bone fractures,[8] or hematological abnormalities such as intrinsic platelet defects.[9] When evaluating the bleeding risk, platelet counts and coagulation tests are not always reliable. If platelet dysfunction is suspected, other studies such as platelet function analyzer-100 or a platelet aggregation study is recommended.[9] For patients with OI, nontraumatic hematoma has been reported in the literature.[6] The study of 58 patients with OI by Evensen et al revealed that the most common abnormalities were increased capillary fragility (35%), decreased platelet retention (33%), and reduced factor VIII-related antigen (23%).[10] Others included reduced ristocetin cofactor, deficient platelet aggregation induced by collagen, and prolonged bleeding time. Treatment with bisphosphonates reduces bone resorption, increase in bone density, and reduction in fracture incidence.[11] Bisphosphonates are usually well tolerated in pediatric patients.[11] Thrombocytopenia is a rare adverse effect of bisphosphonates.[12] Persiani et al[13] mentioned that the intake of bisphosphonates may influence coagulation. Bleeding diathesis that is caused by disease or medication may be an obstacle to surgical approaches. Keegan et al[14]

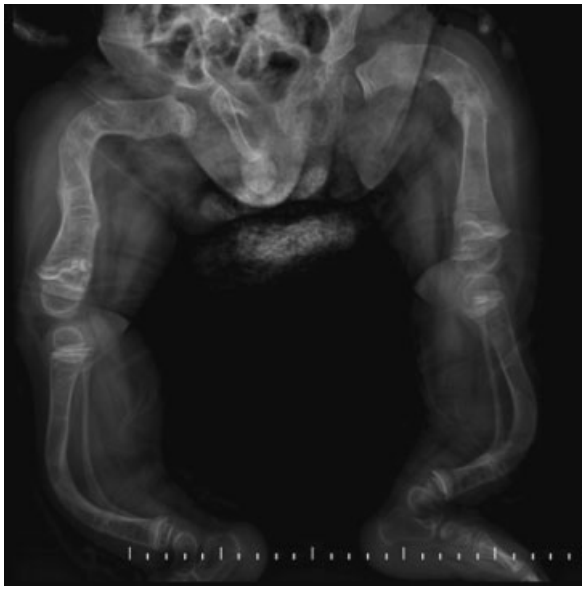


Fig. 2 Multiple deformities on lower extremities on X-ray.

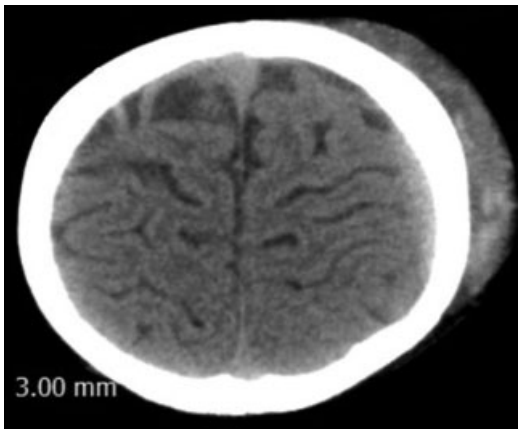


Fig. 3 Computed tomography (CT) revealed the left frontoparietal epidural hematoma and associated with soft tissue swelling. There was no midline shift.

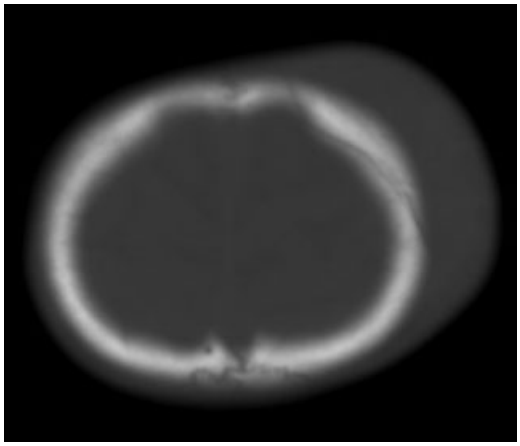


Fig. 4 Linear nondisplaced skull fracture on cranial computed tomography (CT).

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suggested treatment using desmopressin, plasma concentrations of factor VIII, von Willebrand factor, and tissue plasminogen activator.

We searched the literature with the terms of "osteogenesis imperfecta," "extradural hematoma," "subdural hematoma," "intraparenchymal hemorrhage," and "subarachnoid hemorrhage," and a total of 28 cases with intra-/extradural hematoma were found (►**Table 1**). Epidural (extradural) hematoma was identified in 6 patients and 4 of them were pediatric patients. One of the cases with EDH was bilateral. Among the 11 cases with subdural hematoma (SDH), the ratio of pediatric and adult patients was 2.7 (8/3). Six cases were bilateral (one case was adult and others were pediatric). A bilateral SDH case was complicated with EDH at older age. Two intraparenchymal hemorrhage case were identified and both of them had systemic bleeding diathesis because of mutations. One of the intraparenchymal hemorrhage case also had SDH in the posterior fossa. Nine cases with

Table 1 All extra-/intradural hematoma cases with OI patients till date

Authors	Sex (F, M), Age (y, mo)	Clinical presentation	Platelet count and coagulation profile	Cause	Outcome
Eddeine et al,[15] 2009	60 y, F	Bilateral SDH	N/A	Intracranial hypotension	Epidural blood patch (two times) and patient was improved
Sasaki-Adams et al,[16] 2008	–11 y, M + 2 y, F &3 mo, N/A *3 y, N/A	–Bilateral SDH and EDH +Bilateral subdural collections &SDH	–Intraoperative coagulopathy but not proved + N/A &N/A *N/A	–Macrocephaly evaluation + Trivial trauma &Macrocephaly evaluation *Trivial trauma	–Subdural peritoneal shunt at 8 mo Craniotomy and epidural hematoma evacuation was performed on 11-y-old. Patient recovered + conservative treatment and subdural shunt, *Craniotomy and epidural hematoma evacuation was performed
Erdogan et al,[17] 2013	7 y, M	EDH	Normal	N/A	N/A (only told that patient was taken to ICU with spontaneous respiration)
Parmar et al,[2] 2007	14 mo, M	EDH	N/A	Trivial fall	Craniotomy and hematoma evacuation. Patient was improved
Diaz and Lippe,[18] 1985	22 y, M	EDH	N/A	Trivial fall	Somnolence and rapidly progressive hemiparesis Craniotomy and hematoma evacuation. Patient was improved
Groninger et al,[19] 2005	11 mo, F	Bilateral SDH	Normal	Nontraumatic	Seizure 1 wk later, clinical condition deteriorated and bilateral hematoma was drained. Patient was improved
Cole and Lam,[20] 1996	3 mo, M	Bilateral SDH and right arachnoid cyst	N/A	Nontraumatic	A right temporal craniotomy and subdural hematoma drainage were performed and a catheter was placed to cyst. No surgical intervention was performed for left subdural hematoma. Hydrocephalus occurred and ventriculoperitoneal shunt was placed
Tokoro et al,[21] 1988	At birth, F	SDH	Normal	N/A	Decreased tone and movement. Operated on 17th day and neurologically intact

(*Continued*)

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Table 1 (*Continued*)

Authors	Sex (F, M), Age (y, mo)	Clinical presentation	Platelet count and coagulation profile	Cause	Outcome
Sayre et al,[6] 1987	29 y, M	SDH	Prolonged protrombin time	During hemodialysis (with heparin)	Unresponsive to painful stimuli. Craniotomy and hematoma evacuation. Patient died
Pozzati et al,[22] 1983	18 y, M	Bilateral EDH	N/A	Trivial trauma	Loss of consciousness. Craniotomy and hematoma evacuation. Patient died
Cavalcante et al,[23] 2015	6 y, F	EDH	Normal	Trivial trauma	GCS was 6, urgency craniotomy and hematoma evacuation were performed. She was discharged after 2 wks with left oculomotor paresis and right spastic hypertonic hemiparesis
Rezazadeh et al,[9] 2006	42 y, M	SDH	Normal for first two times. Last episode was under ASA and alcohol	Under ASA and alcohol	Three subdural hematoma episodes: first two were treated conservatively. The last time, hematoma was evacuated surgically following platelet transfusion
Faqeih et al,[24] 2009	–15 y, M + 17 y, F &7 y, F	–SDH +Bilateral SDH &EDH	Glycine mutations affecting exon 49 of the COL1A2 gene (all of the cases)	–Nontraumatic + Arachnoid cyst and bilateral SDH and Trauma	–Hematoma was evacuated and the patient recovered without neurological impairment +Surgical evacuation and shunting. Patient was improved &Urgent craniotomy and evacuation of the blood collection. Patient was improved
Kim and Hahn,[25] 2015	Neonate, M	Subcortical hemorrhage and subdural hemorrhage in posterior fossa	Heterozygous c.1036–2A > C (IVS19) in COL1A2 gene	N/A	N/A
Goddeau et al,[26] 2010	36 y, F	Intraparenchymal hemorrhage (mesencephalic hemorrhage)	Only plasminogen activator inhibitor-1 activity level was abnormally low	Emotional trauma	Patient had quadriparesis and somnolence at first. No surgical intervention was performed. Patient was improved on the second day
Hirohata et al,[27] 2014	37 y, F	SAH (middle cerebral artery aneurysm)	A single nucleotide G/C polymorphism (SNP) of exon 28 of the COL1A2 gene	N/A	Surgical clipping and the patient was asymptomatic after 1 wk
Okamura et al,[28] 1995	33 y, F	SAH (Acom A)	N/A	N/A	Surgical clipping and discharged with no neurological deficits
Narváez et al,[29] 1996	22 y, F	SAH (Acom A)	Normal	N/A	

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Table 1 (*Continued*)

Authors	Sex (F, M), Age (y, mo)	Clinical presentation	Platelet count and coagulation profile	Cause	Outcome
					Surgical clipping and discharged with no neurological deficits
Havlik and Nashelsky,[30] 2006	38 y, M	SAH (Acom A)	N/A	N/A	Death at bed. Autopsy was performed
Petruzzellis et al,[31] 2007	44, M	SAH (ruptured aneurysm at the fenestrated basilar artery)	N/A	N/A	Coiling was performed
Matouk et al,[32] 2011	49, M	SAH (SCA)	N/A	N/A	First EVD was performed when GCS 7. Repetitive angiograms demonstrated a ruptured dissecting-type right SCA pseudoaneurysm. Coiling was performed and patient was intact
Kaliaperumal et al,[33] 2011	53, M	SAH (V4 segment fusiform aneurysm)	N/A	N/A	Coiling was performed and ventriculoperitoneal shunt was placed following hydrocephalus. Patient was recovered
Alamri et al,[34] 2016	35, F	SAH (basilar artery aneurysm)	N/A	N/A	EVD was installed and coiling was performed at the next day. Vasospasm was treated successfully
Sardana et al,[35] 2017	50, F	Right frontal hemorrhage (ruptured middle cerebral artery mirror aneurysm)	N/A	N/A	N/A

Abbreviations: Acom A, anterior communicating artery; ASA, acetylsalicylic acid; EDH, epidural hematoma; EVD, external ventricular drainage; F, female; GCS, Glasgow Coma Scale; ICU, intensive care unit; M, male; N/A, no answer; OI, osteogenesis imperfecta; SAH, subarachnoid hemorrhage; SCA, superior cerebellar artery; SDH, subdural hematoma.

subarachnoid hemorrhage were detected. All of the patients were adult and had an aneurysm. Sasaki-Adams et al presented coagulopathy during operation and patient was resuscitated with packed red cells, fresh frozen plasma, platelets, and cryoprecipitate intraoperatively.[16] Blood loss was $>$ 1,500 mL. A cardiac arrest came true and chest compression was required during operation. The patient was improved after surgical intervention and no coagulopathy reason was detected. Parmar et al noticed that hematoma was diagnosed several months after a trivial trauma.[2] Our case had a 1-week delay in diagnosis.

Conclusion

Head traumas are frequently encountered in daily neurosurgery practice, especially for pediatric patients. Patient with OI and intra-/extradural hematoma is a challenge for physicians. Intra-/extracranial hemorrhages are life-threatening situations. Neurological deficits that are caused by intracranial hematomas are indications for surgery. If the amount of bleeding is low or does not lead to a neurological deficit in the patient, conservative treatment will be appropriate. Surgical approaches are complicated due to bleeding diathesis.

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