Review Article

Pediatric vitreous hemorrhage: A narrative review

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Vitreous hemorrhage is one of the most common causes of sudden, painless loss of vision in adults. This is probably one of the reasons why it has been extensively studied and reported in literature. However, the same cannot be said when it comes to vitreous hemorrhage in the pediatric age group. The causes of vitreous hemorrhage in children tend to differ from those of adults. Not much data exist regarding their presentation and management. In addition to trauma, certain spontaneous causes such as pediatric tumors and congenital conditions assume importance while considering the differential diagnosis of vitreous hemorrhage in the pediatric age group. However, it is natural that the treating ophthalmologist is faced with challenges when a child presents with vitreous hemorrhage. In this narrative review, we have attempted to analyze the retrospective observational studies regarding pediatric vitreous hemorrhage reported in English literature till date. The article sheds some light on the prevailing epidemiology, management strategies employed and the visual outcome among different regions of the world.

Key words: Children, pediatric, vitreous hemorrhage

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Vitreous hemorrhage is defined as the presence of extravasated blood within the space outlined by the internal limiting membrane of the retina posteriorly and laterally, the non-pigmented epithelium of the ciliary body laterally, and the lens zonular fibers and posterior lens capsule anteriorly.[1] The etiologies, clinical features, and management strategies of vitreous hemorrhage have been well described in adults.[1-5] However, vitreous hemorrhage is rare in children and adolescents and is not well-described. Pediatric vitreous hemorrhage is a challenging entity in terms of diagnosis and management. The challenges in evaluation include difficulty in eliciting reliable history, poor patient cooperation and difficulty in assessing visual acuity.[6] Unlike adults, presence of co-morbidities, risks of anesthesia and post-operative management in terms of positioning (in case of tamponade) and refractive rehabilitation pose a challenge to comprehensively manage this entity.

There is paucity of literature regarding the epidemiology and management of vitreous hemorrhage in children. The causes of vitreous hemorrhage in the pediatric age group are different from the principal causes of vitreous hemorrhage such as posterior vitreous detachment and diabetic retinopathy in adults.[7] On reviewing the literature, different causes of pediatric vitreous hemorrhage have been published, most of these either being case reports or case series that have focused on different modalities of treatment.[8-28] There is lack of evidence comprehensively reviewing the etiologies or giving definite guidelines regarding the management of vitreous hemorrhage in the pediatric age group. We attempt to present a narrative review on the demographic profile, etiology, clinical manifestations, treatment modalities, and outcomes of vitreous hemorrhage in children from the major studies available in literature till date.

Methods

PubMed database was searched using the keywords "pediatric," "children," "vitreous," and "hemorrhage" in the title. The search retrieved 19 results of which six manuscripts in English[6,29-33] dealt with epidemiology and outcomes of vitreous hemorrhage in children. Three of these studies[6,29,30] dealt with pediatric vitreous hemorrhage irrespective of laterality or cause. One each dealt with exclusively bilateral vitreous hemorrhage,[31] traumatic vitreous hemorrhage[32], and spontaneous causes of vitreous hemorrhage.[33] These six manuscripts were included for the purpose of this review. Non-English manuscripts and isolated case reports were excluded from this review.

The study design and main parameters of the articles reviewed are presented in Table 1. All six studies were hospital-based, had a retrospective design and were reported from three different geographical regions (United States,[29] India,[6,31-33] and Saudi Arabia[30]). The studies on bilateral, traumatic, and spontaneous vitreous hemorrhage were reported from a single institute in India. Five studies[6,29,31-33] included patients less than 18 years of age in their sample, while Al Harkan *et al*. limited[30] their sample age to less than or equal to 16 years. The criteria of recruiting

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study subjects by various studies are comprehensively illustrated in Table 2. There was no uniformity in the criteria employed by different authors. While some used the International Classification of Diseases code,[6,29] others stuck to their hospital database with diagnosis of vitreous hemorrhage with complete records and without any coding errors.[30-33]

The demographic profile of study subjects of all the studies has been illustrated in Table 3. The age range for most of the studies was between 7–12 years. The mean age at diagnosis reported by Rishi *et al*.[6] was greater than that reported by Spirn *et al*.[29] and Al Harkan *et al*.[30] In studies conducted by Sudhalkar *et al*.,[31-33] the mean/median age was higher than the studies reported from outside India. It is evident that the mean age at presentation was greater in the studies reported from the Indian scenario than other regions. Rishi *et al*.[6] mention that this might be because of the greater proportion of subjects with Eales' disease in the Indian sub-continent. Eales' disease is endemic to South Asia and seen predominantly in the Indian subcontinent although rarely in the West.[34] Male children outnumbered female children in terms of proportion of cases presenting with vitreous hemorrhage in all the studies except in the study reporting spontaneous vitreous hemorrhage cases.[33] This gender difference was statistically significant as noted by Spirn *et al*.[29] in their study. Sudhalkar *et al*.[32] attribute this to the fact that male children are probably involved in aggressive indoor and outdoor activities more than their female counterparts. Most of the studies reported a higher proportion of unilateral cases except in case of spontaneous vitreous hemorrhage[33], where majority of the cases were bilateral. There was no predisposition to the eye that was involved, as reported in three studies.[6,29,30]

Decreased vision was the most common presenting symptom in most studies [Table 4]. An exception to this is the subset of children less than 3 years, where nystagmus and behavioral changes were the most common presenting complaints as reported by Spirn *et al*.[29] and Sudhalkar *et al*.,[32] respectively. This subset includes the pre-verbal children and it is natural that decreased visual acuity is not realized till the consequences of it such as strabismus/nystagmus (amblyopic sequelae) or behavioral changes set in.

Unilateral traumatic pediatric vitreous hemorrhage

A comparative description of the incidence of traumatic vitreous hemorrhage in the pediatric group along with mode

Table 1: Study parameters

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[31]	Sudhalkar *et al*.[32]	Sudhalkar *et al*.[33]
Year in which published	2006	2013	2014	2015	2014	2013
Region	United States	India	Saudi Arabia	India	India	India
Study design	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective
Sample cohort	Pediatric vitreous hemorrhage	Pediatric vitreous hemorrhage	Pediatric vitreous hemorrhage	Bilateral pediatric vitreous hemorrhage	Traumatic pediatric vitreous hemorrhage	Spontaneous pediatric vitreous hemorrhage
Age	<18 years	<18 years	<16 years	<18 years	<18 years	<18 years
Duration studied	8 years	10 years	5 years	11 years	12 years 4 months	11 years
Sample size - number of eyes (patients)	186 (168)	261 (246)	240 (230)	190 (85)	501 (464)	124 (76)
Follow - up duration (months)	16	26.52	24.65	34.2±11.2	CGI - 47±12.47 OGI - 36.24±9.72	28±18.38

CGI: Closed globe injuries, OGI: Open globe injuries

Table 2: Inclusion and exclusion criteria

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[31]	Sudhalkar *et al*.[32]	Sudhalkar *et al*.[33]
Inclusion criteria	All patients with vitreous hemorrhage identified by computerized search of hospital database with ICD (9) diagnostic code for vitreous hemorrhage	Vitreous hemorrhage of all causes, retrieved through hospital medical record database using the ICD diagnostic code for vitreous hemorrhage	Any patient diagnosed with vitreous hemorrhage either in the outpatient clinic or in the operative notes	Computer assisted hospital database search and chart review of patients with vitreous hemorrhage in the pediatric age group		
Exclusion criteria	Infants with active ROP	Patients with follow-up of <3 months duration	Follow-up duration of <1 month Development of endophthalmitis at presentation or during follow-up	Active ROP Those with incorrect diagnosis or coding errors	Non-traumatic cases Those with incomplete records	Traumatic cases ROP cases <1 month follow-up duration Those with incomplete records/diagnosis

ICD: International Classification of Diseases, ROP: Retinopathy of prematurity

of injury and etiologic agents is given in Table 5. An age-group wise distribution of the etiology within the pediatric patients was attempted by Rishi *et al*.[6] and Sudhalkar *et al*.[33] Rishi *et al*. divided the 0–18 years age groups into four sub-groups: <4 years (pre-school), >4 and <8 years (primary school), >8 and <12 years, and >12 and <18 years (adolescent). Sudhalkar *et al*.[33] divided the age range into three groups: <1 year, >1 to 10 years, and >10 years. Both studies found that the proportion of traumatic cases showed an upward trend with advancing age, i.e., as the age increased, the proportion of traumatic cases also increased [Table 6]. Trauma was the most common cause of pediatric vitreous hemorrhage in all studies. However, the proportion of cases because of the blunt versus penetrating trauma varied. All authors except Al Harkan *et al*.[30] reported blunt trauma to constitute a major proportion of the cases responsible for vitreous hemorrhage. This could possibly correlate with most common type of agents that were responsible for the trauma in the first place. For example, cricket ball or fist injuries are more likely to cause blunt trauma, while sticks, sharp objects such as needles are more likely to cause penetrating trauma.

Of the traumatic cases, a variety of concomitant posterior segment findings were noted in addition to vitreous hemorrhage. These include lens dislocation/subluxation, posterior vitreous detachment, retinal detachment, choroidal detachment, intra-ocular foreign body (IOFB), and optic nerve trauma/avulsion. In penetrating trauma cases, the presence of IOFB ranged from as low as 6.4% to as high as 21.7%.[6,29,30,33] The local epidemiology seems to be responsible for variation in the type of trauma causing vitreous hemorrhage. Rishi *et al*.[6] observed that in the Indian sub-continent, children tend to be involved more in popular trauma-prone outdoor sports such as cricket, *gilli-danda* (a local sport in which a spindle-shaped smaller stick and a larger wooden stick are used) and bow-arrow. This could also be responsible for males occupying a major proportion of traumatic vitreous hemorrhage cases as mostly male children engage in most of these sports activities. Rishi *et al*.[6] stated that the differences in the nature of trauma accounting for vitreous hemorrhage could be attributed to regional preference to outdoor versus indoor sports and socio-economic factors including the practice of child labor in the developing world. Elsewhere, Rostomian *et al*.[35] reported that indoor items such knives, toys, etc. were common causes for open globe injuries in children, making it evident that the etiological agents, the local circumstances in which trauma occurs varies between populations and hence, the associated findings vary.

Unilateral spontaneous pediatric vitreous hemorrhage

Spontaneous vitreous hemorrhage can be purely due to underlying ocular causes or due to a sinister systemic pathology. The list of disorders/conditions described in literature that lead to spontaneous vitreous hemorrhage in children is long and exhaustive. Excluding isolated case reports, a comparison of five studies under the purview of

Table 3: Demographics

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[31]	Sudhalkar *et al*.[32]	Sudhalkar *et al*.[33]
Mean age±SD (years)	7.5	10.7	7.5±4.6	Spontaneous: 14.48±2.03 Traumatic: 13.47±5.31	12.27*±4.51	12.78*±4.68 (months)
Gender						
Male	73.80	81.70	71.30	72.97	77.80	48.68
Female	26.20	18.30	28.70		22.20	51.31
Laterality						
Unilateral	90.50	94	95.65	-	92.03	36.85
Bilateral	9.5	6	4.35	100	7.97	63.15
Eye involved						
OD	49.5	49	49.17	-	-	-
OS	50.5	51	50.83			

All figures in percentage; *median age mentioned. SD: Standard deviation, OD: Right eye, OS: Left eye

Table 4: Clinical presentation

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[31]	Sudhalkar *et al*.[32]	Sudhalkar *et al*.[33]
Most common presenting symptom	0-3 years - nystagmus 4-8 years - diminished vision 9-18 years - diminished vision	Diminished vision	Diminished vision	Diminished vision	Diminished vision (96.45%)	>3 years - diminished vision (95.96%) <3 years - behavioral changes
Mean BCVA (logMAR±SD)	1.92	-	-	Traumatic cases - 2.34±1.31 Spontaneous cases - 1.97±1.13	2.64±1.11	2.25±1.11
Mean final visual acuity (logMAR±SD)	1.14	-	-	Traumatic cases - 1.08±0.23 Spontaneous cases - 0.82±0.24	1.01±0.58	0.76±0.58

SD: Standard deviation, logMAR: Logarithm minimum angle of resolution, BCVA: Best corrected visual acuity

this review is illustrated in Table 7. While Eales' disease and vasculitis-related vitreous hemorrhage were common in Indian studies,[6,31,33] regressed retinopathy of prematurity (ROP) and tumors dominated the share of spontaneous vitreous hemorrhage elsewhere.[29,30] Sudhalkar *et al*.[33] attribute this to the fact that immunologic reactions to infectious agents such as tuberculosis were more likely to occur in a developing country such as India. In an age-wise analysis attempted by Sudhalkar *et al*.,[33] vasculitic and hematological disorders were more likely to cause vitreous hemorrhage after infancy. In infants, idiopathic causes were more compared to children over 1 year of age.[14] This was also noted by Al Harkan *et al*.[30] This also corroborates with a previous study[28] which stated that in many cases, the exact cause was unknown in infants. Sudhalkar *et al*.[33] state that this has more to do with the practical difficulty in eliciting appropriate history and clinical signs and symptoms in young children. Pars planitis is a well-known cause of vitreous hemorrhage in children.[18] It was noted in numerous studies[6,29,30,33] irrespective of the geographical regions where they were conducted. Sudhalkar *et al*.[35] in their study dealing exclusively with spontaneous vitreous hemorrhage, divided the study sample into three age groups: <1 year, >1–10 years, and <10 years. In the first group, tumors, familial exudative vitreoretinopathy, and idiopathic

Table 5: Traumatic pediatric vitreous hemorrhage

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[31]	Sudhalkar *et al*.[32]
Trauma	73.10	68.5	82.5	43.52	100 (exclusively trauma cases studied)
Blunt	29.60	43.67	26.30	36.47	69.06
Penetrating	24.70	24.90	51.70	7.05	30.94
Postoperative	5.4	-	4.60	-	-
Birth trauma	4.8%	-	Included in blunt trauma - 0.8%	-	-
Etiologic agents					
Most common	-	Cricket ball (29.8%)	Sharp object (56.9%)	Firecracker (43.24%)	Wood/iron sticks (43.43%)
Cricket ball	-	29.8	-	-	
Wooden stick	-	40	-	18.91	43.43
Iron rod	-	13.1	-	-	
Firecracker	-	26.7	-	43.24	9.12
Stone	-	17.7	-	13.51	12
Iron particle	-	9.2	-	-	-
Glass	-	4.6	-	-	1.05
Knife	-	4.6	-	-	-
Needle	-	4.6	-	-	3.34
Wire	-	5.4	-	-	2.02 (wire, bicycle handles)
Bicycle	-	6.5	-	-	
Scissors	-	3.8	-	-	-
Bomb blast	-	3	-	-	-
RTA	-	4.1	-	24.3	1.01 (accidents/falls)
Fall	-	2.6	-	-	
Belt	-	1.7	-	-	
Arrows	-	-	-	-	5.12
Fists	-	-	-	-	7
Thorns	-	-	-	-	2.12
Miscellaneous	-	20.5	-	-	-

All figures in percentages. RTA: Road traffic accident

Table 6: Age-wise distribution of blunt versus penetrating trauma

Rishi *et al*.[6]			Sudhalkar *et al*.[32]		
Age group (years)	Blunt (%)	Penetrating (%)	Age group (years)	Blunt (%)	Penetrating (%)
0-4	7.9	9.2	<1	4.59	1.59
>4-<8	19.3	26.2	1-10	18.69	6.28
>8-<12	31.6	33.8	>10	43.91	23.15
>12-<18	41.2	30.8			
Total (eyes)	114/246	65/246		346/501	155/501

causes occupied a major share. Vasculitis and hematological disorders accounted for the majority of cases (70%, 77/110 eyes) in the other two groups. Thus, the etiology is extremely varied, even within different regions of a particular country, and further variation is possible as the children grow older. It is important to note that spontaneous vitreous hemorrhage in children is a condition with a diverse etiology that mandates a thorough systemic examination and investigations to reach an appropriate diagnosis. As Sudhalkar *et al*.[33] have mentioned, vitreous hemorrhage in such cases can be a pointer to malignancy, both ocular and systemic. From their observations, they formulated an algorithm to approach a child presenting with vitreous hemorrhage,[33] which could be quite helpful.

Bilateral vitreous hemorrhage

The proportion of patients presenting with bilateral vitreous hemorrhage and the most common cause differs between different studies. In the Western literature,[29] non-accidental trauma or the battered baby syndrome appears to be the most common cause. However, no cases of battered baby syndrome were recorded by any of the Indian studies[6,31,32] or by Al Harkan *et al*.[30] Shaken baby syndrome apparently occurs with less frequency in the developing countries.[36,37] Al Harkan *et al*.[30] attributed this to the fact that their study was conducted in a specialized eye hospital where only patients with medically stable condition were referred. Within the same country too, the common causes of bilateral vitreous hemorrhage seem to vary among different regions. While Rishi *et al*.[6] noted all cases of bilateral vitreous hemorrhage to be spontaneous in their study, trauma due to firecracker injuries was the most common cause noted by Sudhalkar *et al*. in two separate studies.[31,32] IOFB was reported in 16.6% of the bilateral cases by Sudhalkar *et al*.[31] Firecracker injuries have particular spike in incidence during the time of festivals such as Diwali in India, as noted by Sudhalkar *et al*.[31] Among spontaneous causes for bilateral vitreous hemorrhage, data available from the Indian sub-continent points to Eales' disease and vasculitic pathologies to be the most common cause. Etiologies such as firecracker injuries are modifiable factors through increased awareness programs at the target population. This calls for not only awareness and counseling at the health-care center level but also at the administrative level in the form of efficient legislative measures.

Management and outcomes

Globally, there is no specific consensus on the approach to and management of a pediatric patient with vitreous hemorrhage. Majority of the studies have divided management strategies into three categories: observation/medical therapy, non-incisional therapy (laser/cryotherapy), and surgery. A review into the existing literature is shown in Table 8. Half of the cases were observed by Spirn *et al*.[29] However, Rishi *et al*.[6] and AlHarkan *et al*.[30] reported surgical intervention in a majority of their cases. As far as bilateral vitreous hemorrhage is considered, 40.5% cases were managed by observation or topical/systemic medical therapy in the traumatic group. Surgical intervention was required in more than two-thirds of the bilateral traumatic group versus approximately one-fifth of the bilateral spontaneous cases. The proportion of traumatic cases that required surgical intervention was in the range of 55–90% cases, while that for blunt trauma cases was in the range of 25–96%.[6,29,30,32] In certain studies, the proportion of penetrating trauma cases requiring surgical attention was higher,[6,29,30] while in others blunt trauma cases required surgery in a major proportion compared to penetrating trauma.[32] Therefore, a thorough primary evaluation is necessary to determine whether to plan observation, medical management, or proceed for surgery depending on the etiology, mechanism of trauma, age of the patient and associated risks for surgery including those of general anesthesia.

Factors affecting visual outcome

No uniformity was observed in the factors that positively or negatively affected visual outcome among available studies. Spirn *et al*.[29] observed that etiology of the vitreous hemorrhage had a major effect on the final visual outcome. While cases such as ROP fared well, those due to penetrating trauma had poor visual outcome. However, the limitation in their study was that visual acuity was not recorded in a standardized manner. Approximately, 39% of the patients had severe visual loss, defined by the authors as one of the following: final visual acuity of less than 20/800 (1.6 logMAR), no fixation behavior and no blink to light. Penetrating trauma was the most common cause responsible for severe visual loss, amounting to 40% of the cases. They also reported that younger children had a higher proportion of severe visual loss than elder ones, although this difference was not statistically significant. Rishi *et al*.[6] defined severe visual loss as visual acuity of ≤ 3/60 (1.3 logMAR) and found that risk factors for severe visual loss were male sex, age greater than 8 years, unilateral presentation and surgical treatment. They also observed that eyes sustaining blunt trauma had a higher risk of severe visual loss among children with vitreous hemorrhage than eyes sustaining penetrating trauma. Of the 223 (of 261) eyes in which visual outcome could be determined, improvement was noted in 118 (52.9%), stabilization was achieved in 92 (41.3%), and the remaining 13 (5.8%) worsened despite treatment. Al Harkan *et al*.[30] analyzed the outcomes of traumatic and non-traumatic vitreous hemorrhage separately. They observed that in traumatic cases, the density of vitreous hemorrhage had a significant impact on the eventual visual outcome. However, performance of surgery had no significant correlation with the prediction of visual outcome. Visual acuity of ≥ 20/200 (1.0 logMAR) at presentation had a favorable visual outcome. However, poor initial visual acuity (≤ hand movements), age ≤ 3 years, and severe vitreous hemorrhage at presentation were significantly associated with a poor visual outcome. Contrary to traumatic cases, they observed that density of vitreous hemorrhage at presentation had no significant bearing on the eventual visual outcome in non-traumatic cases. In addition, retinal (detached versus attached) and lens (clear lens/pseudophakia versus cataract/aphakia) status at presentation had a correlation with the final visual outcome. Spontaneous causes, younger age, presence of retinal detachment, cataract, and aphakia at presentation had poor visual outcome. Al Harkan also observed that the rates of surgery (55.6% versus 28.6%) and enucleation/evisceration (11.9% versus 1.6%) were significantly higher in the non-traumatic group. One peculiar finding was that the incidence of retinal detachment at last follow-up (42.9% versus 2.1%) was significantly higher in the non-traumatic cases. They explained this by the fact that many of the non-traumatic causes such as hereditary diseases or retinoblastoma tend to occur in younger age group, which are usually associated with retinal detachment, while trauma tends to occur in a

Table 7: Spontaneous causes of vitreous hemorrhage

	Spirn *et al*.[29]	Rishi *et al*.[6]	AlHarkan *et al*.[30]	Sudhalkar *et al*.[33]	Sudhalkar *et al*.[31]
Congenital					
FEVR	4 (2.2)	3 (3.6)	3 (1.3)	13 (10.48)	4 (8.33)
PFV/PHPV	4 (2.2)		4 (1.7)		
Norrie's disease	1 (0.5)				
X-linked juvenile retinoschisis/ congenital retinoschisis	1 (0.5)	1 (1.2)			
VHL		1 (1.2)			
Congenital retinal dysplasia		1 (1.2)			
Familial retinal artery macroaneurysm			2 (0.8)		
Nanophthalmos			2 (0.8)		
Vascular					
Regressed ROP	9 (4.8)		3 (1.3)		
Coats' disease	1 (0.5)	2 (2.4)	1 (0.4)		
Arteriovenous malformation			1 (0.4)		
Ocular inflammation/infection					
Pars planitis/intermediate uveitis	4 (2.2)	5 (6)	3 (1.3)	2 (1.61)	
Congenital cytomegalovirus	1 (0.5)				
Eales' disease	1 (0.5)	33 (40.2)			
Posterior uveitis	1 (0.5)				
Panuveitis		1 (1.2)	1 (0.4)		
Vasculitis		3 (3.6)		43 (34.67)	21 (50)
Toxocara chorioretinitis		1 (1.2)			
Tumor					
Retinoblastoma	2 (1.1)		5 (2.1)		
Astrocytoma	1 (0.5)				
Cavernous hemangioma	1 (0.5)				
Choroidal hemangioma	1 (0.5)				
Retinal capillary hemangioma		1 (1.2)			
Acute lymphoblastic leukemia			2 (0.8)		
Ocular tumors/vascular malformations				8 (6.45)	
Systemic condition/association					
Thrombocytopenia	1 (0.5)				
Neonatal meningitis			2 (0.8)		
Stickler disease with RRD			1 (0.4)		
Hematologic disorders				34 (27.41)	18 (37.5)
Diaetic retinopathy				4 (3.22)	4 (8.33)
Hepatorenal dysfunction				1 (0.80)	
Sepsis				1 (0.80)	
SLE related retinal vasculitis		2 (2.4)			
Miscellaneous					
Terson syndrome	2 (1.1)	4 (4.8)	3 (2.1)		
Valsalva	2 (1.1)				
Ciliary body neovascularization	1 (0.5)				
NVG s/p retinoblastoma		1 (1.2)			
Radiation retinopathy	1 (0.5)				
Retinal detachment/breaks	1 (0.5)			13 (10.48)	1 (2.08)
NVD after papillophlebitis		1 (1.2)			
RP with Coats like disease			2 (0.8)		
Nanophthalmos			2 (0.8)		
Idiopathic	9 (4.8)	5 (6)	4 (1.7)	8 (6.45)	

All figures expressed as - *n* (%). FEVR: Familial exudative vitreoretinopathy, PFV: Persistent fetal vasculature, PHPV: Persistent hyperplastic primary vitreous, VHL: Von Hippel-Lindau, ROP: Retinopathy of prematurity, RRD: Rhegmatogenous retinal detachment, NVG: Neovascular glaucoma, NVD: Neovascularization of the disc, RP: Retinitis pigmentosa

Table 8: Management strategies and outcomes

	Observation/medical therapy (%)	Non-incisional therapy (%)	Surgery (%)
Spirn *et al.*[29]	50	4.3	45.7
Rishi *et al.*[6]	24.1	9.7	66.2
AlHarkan *et al.*[30]	36.2	-	54.1
Sudhalkar *et al.*[32]	15.9	-	77.2
	Improvement	**Stabilization**	**Worsening**
Rishi *et al.*[6]	52.9	41.3	5.8
AlHarkan *et al.*[30]			
Traumatic	45.9	51.1	3
Spontaneous	35.7	57.1	7.2
	Mean BCVA at presentation (logMAR)	**Mean BCVA at final follow-up (logMAR)**	
Spirn *et al.*[29]	1.92	1.54	
Rishi *et al.*[6]	-	-	
AlHarkan *et al.*[30]	-	-	
Sudhalkar *et al.*[31]	Traumatic cases - 2.34±1.31 Spontaneous cases - 1.97±1.13	Traumatic cases - 1.08±0.23 Spontaneous cases - 0.82	
Sudhalkar *et al.*[32]	2.25±1.11	0.76±0.58	
Sudhalkar *et al.*[33]	2.64±1.11	1.01±0.58	

logMAR: Logarithm minimum angle of resolution, BCVA: Best corrected visual acuity

physically active child (sic). In studies where comparison of mean final best corrected visual acuity (BCVA) to the mean BCVA at presentation was available, all of them reported improvement in the mean final BCVA,[29,31-33] some being statistically significant.[31-33] [Table 4]. The mean BCVA at final follow-up for closed globe injuries/non-penetrating trauma was significantly better in certain studies,[31,33] while no such significant difference was noted in others.[30]

Conclusion

Vitreous hemorrhage in the pediatric age group poses unique challenges for the ophthalmologist. These challenges range all along the management course right from lack of a reliable history, challenges in objective evaluation, to treatment approaches and post-operative rehabilitation. As evident from this review, the etiology for both traumatic and spontaneous cases can be highly varied. One should not hesitate in subjecting the child to examination under general anesthesia if it is essential. However, the risks of general anesthesia and systemic co-morbidities need to be duly considered during such an examination and also during surgical intervention. There is no straightforward consensus regarding the timing of intervention and the mode of management. One needs to decide the same from experience, available evidence, and tailor it according the individual case, considering the age of the patient, laterality of the hemorrhage, risk of amblyopia, and compliance of the patient with treatment protocol and follow-up. Certain cases may need a multi-pronged approach involving not only the ophthalmologist but also the pediatrician and the anesthetist. However, available literature does suggest that improvement in visual acuity is possible with the optimal management strategy. All studies available in the literature are from retrospective review of institutional records and suffer from limitations such as non-standardized inclusion and exclusion criteria and visual acuity evaluation. This calls for large scale prospective studies to be undertaken, as vitreous hemorrhage in children can be quite debilitating in not only visual but also in psychosocial development of the patient.

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Conflicts of interest

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References

1. Spraul CW, Grossniklaus HE. Vitreous hemorrhage. Surv Ophthalmol 1997;42:3-9.
2. Butner RW, McPherson AR. Spontaneous vitreous hemorrhage. Ann Ophthalmol 1982;14:268-70.
3. Lindgren G, Sjödell L, Lindblom B. A prospective study of dense spontaneous vitreous hemorrhage. Am J Ophthalmol 1995;119:458-65.
4. Rotimi-Samuel A, Aribaba OT, Odeyemi MG, Sonuga AT, Mbadugha CA, Ilo OT, *et al.* Aetiology of vitreous haemorrhage in Guinness Eye Centre, Lagos University Teaching Hospital over a two year period (June 2007-May 2009). Nig Q J Hosp Med 2010;20:162-4.
5. Sharma R, Joshi SN, Shrestha JK. Etiology of vitreous hemorrhage in a tertiary eye care center in Nepal. Nepal J Ophthalmol 2010;2:121-6.
6. Rishi P, Rishi E, Gupta A, Swaminathan M, Chhablani J. Vitreous hemorrhage in children and adolescents in India. J AAPOS 2013;17:64-9.
7. Lindgren G, Lindblom B. Causes of vitreous hemorrhage. Curr Opin Ophthalmol 1996;7:13-9.
8. Augsten R, Königsdörffer E, Strobel J. Surgical approach in terson syndrome: Vitreous and retinal findings. Eur J Ophthalmol 2000;10:293-6.
9. Barry GP, Shields CL, Binenbaum G. Leukocoria and vitreous hemorrhage as the initial manifestation of sickle retinopathy in a 3-year, 6-month-old child with sickle trait (AS). J Pediatr Ophthalmol Strabismus 2011;48:e58-60.

10. Berrocal AM, Davis JL. Chorioretinal involvement and vitreous hemorrhage in a patient with juvenile xanthogranuloma. J Pediatr Ophthalmol Strabismus 2005;42:241-2.
11. Bhardwaj G, Jacobs MB, Moran KT, Tan K. Terson syndrome with ipsilateral severe hemorrhagic retinopathy in a 7-month-old child. J AAPOS 2010;14:441-3.
12. Brown SM, Bradley JC. Hemorrhagic posterior vitreous detachment without intraretinal hemorrhage in a shaken infant. Arch Ophthalmol 2007;125:1301.
13. Christiansen SP, Muñoz M, Capó H. Retinal hemorrhage following lensectomy and anterior vitrectomy in children. J Pediatr Ophthalmol Strabismus 1993;30:24-7.
14. Dana MR, Werner MS, Viana MA, Shapiro MJ. Spontaneous and traumatic vitreous hemorrhage. Ophthalmology 1993;100:1377-83.
15. Ganesh A, Jenny C, Geyer J, Shouldice M, Levin AV. Retinal hemorrhages in type I osteogenesis imperfecta after minor trauma. Ophthalmology 2004;111:1428-31.
16. Hutcheson KA, Nguyen AT, Preslan MW, Ellish NJ, Steidl SM. Vitreous hemorrhage in patients with high-risk retinopathy of prematurity. Am J Ophthalmol 2003;136:258-63.
17. Kuhn F, Morris R, Witherspoon CD, Mester V. Terson syndrome. Results of vitrectomy and the significance of vitreous hemorrhage in patients with subarachnoid hemorrhage. Ophthalmology 1998;105:472-7.
18. Lauer AK, Smith JR, Robertson JE, Rosenbaum JT. Vitreous hemorrhage is a common complication of pediatric pars planitis. Ophthalmology 2002;109:95-8.
19. Lopez JP, Roque J, Torres J, Levin AV. Severe retinal hemorrhages in infants with aggressive, fatal streptococcus pneumoniae meningitis. J AAPOS 2010;14:97-8.
20. Marshman WE, Adams GG, Ohri R. Bilateral vitreous hemorrhages in an infant with low fibrinogen levels. J AAPOS 1999;3:255-6.
21. Matthews GP, Das A. Dense vitreous hemorrhages predict poor visual and neurological prognosis in infants with shaken baby syndrome. J Pediatr Ophthalmol Strabismus 1996;33:260-5.
22. Naithani P, Mehrotra A, Venkatesh P, Wadhwa N, Garg S. Bilateral vitreous hemorrhage in a child due to isolated platelet factor 3 availability defect. J AAPOS 2008;12:203-4.
23. Nazari H, Modarres M, Parvaresh MM, Ghasemi Falavarjani K. Intravitreal bevacizumab in combination with laser therapy for the treatment of severe retinopathy of prematurity (ROP) associated with vitreous or retinal hemorrhage. Graefes Arch Clin Exp Ophthalmol 2010;248:1713-8.
24. Potter MJ, Myckatyn SO, Maberley AL, Lee AS. Vitrectomy for pars planitis complicated by vitreous hemorrhage: Visual outcome and long-term follow-up. Am J Ophthalmol 2001;131:514-5.
25. Reddy SC, Menon BS. A prospective study of ocular manifestations in childhood acute leukaemia. Acta Ophthalmol Scand 1998;76:700-3.
26. Ruth A, Hutchinson AK, Baker Hubbard G. Late vitreous hemorrhage in patients with regressed retinopathy of prematurity. J AAPOS 2008;12:181-5.
27. Shaw HE Jr., Landers MB 3rd. Vitreous hemorrhage after intracranial hemorrhage. Am J Ophthalmol 1975;80:207-13.
28. Simon J, Sood S, Yoon MK, Kaw P, Zobal-Ratner J, Archer S, *et al.* Vitrectomy for dense vitreous hemorrhage in infancy. J Pediatr Ophthalmol Strabismus 2005;42:18-22.
29. Spirn MJ, Lynn MJ, Hubbard GB 3rd. Vitreous hemorrhage in children. Ophthalmology 2006;113:848-52.
30. AlHarkan DH, Kahtani ES, Gikandi PW, Abu El-Asrar AM. Vitreous hemorrhage in pediatric age group. J Ophthalmol 2014;2014:497083.
31. Sudhalkar A, Chhablani J, Rani PK, Jalali S, Balakrishnan D, Tyagi M, *et al.* Bilateral vitreous hemorrhage in children: Clinical features and outcomes. J Ophthalmic Vis Res 2015;10:139-43.
32. Sudhalkar A, Chhablani J, Jalali S, Narayanan R. Traumatic vitreous hemorrhage in children-clinical features and outcomes. Eye Sci 2014;29:63-9.
33. Sudhalkar A, Chhablani J, Jalali S, Mathai A, Pathengay A. Spontaneous vitreous hemorrhage in children. Am J Ophthalmol 2013;156:1267-7100.
34. Biswas J, Mukesh BN, Narain S, Roy S, Madhavan HN. Profiling of human leukocyte antigens in Eales' disease. Int Ophthalmol 1997;21:277-81.
35. Rostomian K, Thach AB, Isfahani A, Pakkar A, Pakkar R, Borchert M, *et al.* Open globe injuries in children. J AAPOS 1998;2:234-8.
36. Arun Babu T, Venkatesh C, Mahadevan S. Shaken baby syndrome. Indian J Pediatr 2009;76:954-5.
37. Ray M, Ghosh D, Malhi P, Khandelwal N, Singhi PD. Shaken baby syndrome masquerading as apparent life threatening event. Indian J Pediatr 2005;72:85.