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Traumatic retrobulbar hematoma: a European multicenter study

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A R T I C L E I N F O

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Complications
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A B S T R A C T

Background: Retrobulbar hematoma/hemorrhage (RBH) is a vision-threatening condition requiring prompt diagnosis and timely medical or surgical intervention. Despite its clinical relevance, standardized treatment protocols and well-defined prognostic factors remain lacking.
Materials and methods: This retrospective multicenter study included patients treated for posttraumatic RBH between January 2015 and December 2024. Demographic data, comorbidities, antithrombotic therapy, trauma etiology, associated injuries, clinical signs, imaging findings, treatment modalities, and visual outcomes were recorded. Outcomes were classified as complete visual recovery, partial recovery, or blindness.
Results: In total, 77 patients (mean age 56 years) were included. Falls were the most common cause of injury, with concomitant body injuries present in 61% of patients and associated ocular injuries in 22%. Computed tomography was the primary imaging modality. RBH was extraconal in most cases, while intraconal involvement was less frequent. Most patients received combined medical and surgical treatment, with lateral canthotomy and cantholysis being the most common surgical approach. Complete visual recovery occurred in 51.9% of patients, partial recovery in 29.9%, and blindness in 10.4%. Intraconal RBH and associated ocular injury were significantly associated with poorer visual outcomes, whereas age, hematoma size, treatment type, timing of intervention, and antithrombotic therapy were not.
Conclusions: RBH is a rare maxillofacial trauma entity that often results in permanent disability. Intraconal localization and concomitant ocular injury are significant predictors of poor prognosis. Early recognition and individualized management are essential to optimize visual outcomes.

1. Introduction

Retrobulbar hemorrhage or hematoma (RBH) is a rare and potentially sight-threatening condition, most commonly associated with orbital trauma or surgery. Reported incidence of RBH varies in the literature, ranging from 1.3% to 3.6% depending on the study population (Aftab et al., 2024; Becker et al., 2025; Berg et al., 2019; Bourquard et al., 2026; Chen et al., 2012; Christie et al., 2018; Dos Santos et al.,

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2024; Fattahi et al., 2014; Ghorpade et al., 2025; Isa et al., 2025; Jamal et al., 2009; Jamali et al., 2023; Lubamba et al., 2023; Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Niño-Sandoval et al., 2025; Ochi et al., 2025; Papadiochos et al., 2023; Park et al., 2021; Tram et al., 2023; Ujam and Perry, 2016; Voss et al., 2016). RBH most frequently occurs following orbital trauma, but it may also develop as a complication of orbital or facial surgery and retrobulbar anesthesia, or spontaneously in patients with risk factors such as anticoagulation, vascular malformations, or hypertension. The reported rate of permanent visual impairment after RBH varies across studies, ranging from approximately 1% to around 22%, depending on the patient population and timing of treatment (Becker et al., 2025; Bourquard et al., 2026; Christie et al., 2018; Fattahi et al., 2014; Meltzer et al., 2019; Narjus-Sterba et al., 2025; Park et al., 2021; Ujam and Perry, 2016).

The clinical presentation typically includes sudden visual impairment or loss, severe orbital or periorbital pain, proptosis, restricted extraocular movements, relative afferent pupillary defect, and elevated intraocular pressure (Aftab et al., 2024; Becker et al., 2025; Ujam and Perry, 2016; Voss et al., 2016.).

Anatomically, the postseptal orbit can be divided into three compartments: the subperiosteal, intraconal, and extraconal spaces. In RBH, accumulation of blood within the orbital compartments increases intraorbital and/or intraocular pressure, potentially leading to orbital compartment syndrome. The resulting visual impairment is mediated by central retinal artery occlusion, direct compression of the optic nerve, and vascular compromise. When intraorbital or intraocular pressure exceeds arterial perfusion pressure, retinal and optic nerve ischemia may occur, leading to permanent damage if not rapidly reversed. In severe cases, mechanical stretching of the optic nerve due to proptosis may further contribute to nerve injury. Although the incidence of RBH is low, delayed or inadequate management may lead to significant morbidity, including permanent vision loss, with a profound impact on the patient's quality of life (Aftab et al., 2024; Becker et al., 2025; Berg et al., 2019; Bourquard et al., 2026; Meltzer et al., 2019; Ujam and Perry, 2016; Voss et al., 2016).

The use of anticoagulant and antiplatelet medications has been identified in the literature as a well-established risk factor for RBH, with increasing clinical relevance in ageing populations. Additional reported risk factors include hypertension and coagulopathies. Early recognition of RBH is essential, as delayed diagnosis may lead to irreversible visual loss. In this context, assessment of a relative afferent pupillary defect (RAPD) is particularly valuable for detecting optic nerve dysfunction, even in sedated or unconscious patients (Bourquard et al., 2026; Chen et al., 2012; Christie et al., 2018; Dos Santos et al., 2024; Fattahi et al., 2014; Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Voss et al., 2016).

The management of RBH requires prompt diagnosis followed by medical or surgical intervention. However, a universally accepted treatment protocol and clearly defined prognostic factors have not yet been established (Bourquard et al., 2026; Chen et al., 2012; Fattahi et al., 2014; Ghorpade et al., 2025; Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Voss et al., 2016).

Therefore, the aim of our study was to evaluate the demographic and clinical characteristics, diagnostic pathways, management strategies, and outcomes of patients with RBH across several European oral and maxillofacial surgery centers. This multicenter approach was designed to reduce selection bias and to provide further insight into the epidemiology, etiopathogenesis, current treatment trends, and clinical outcomes of RBH in Europe.

2. Materials and methods

This study utilized a systematic computer-assisted database that allowed the recording of data on all hospitalized and treated cases of RBH at participating surgical units across Europe between January 1st, 2015 and December 31st, 2024.

Helsinki Declaration guidelines were followed, according to local laws, in addition to STROBE criteria for observational studies. Ethical approval was obtained by each center if needed, according to local laws.

Patients with posttraumatic RBH who received surgical and/or medical treatment requiring hospitalization were included. Inclusion criteria were as follows: (i) patients with a posttraumatic RBH; and (ii) patients who received surgical and/or medical treatment for RBH. The intended outcome was the collection of uniform data on the epidemiology and management of posttraumatic RBH.

The following data were recorded for each patient: gender, age, substance use (alcohol, smoking, drug use), comorbidities, use of antiplatelet (e.g. aspirin) or anticoagulant (e.g. warfarin, rivaroxaban) treatment, etiology of trauma, facial fracture types, concomitant body injuries, clinical signs and symptoms of RBH, imaging findings, location and dimensions of RBH, timing of intervention, treatment, complications, and outcome.

The following categories of the etiology of RBH were considered: motor vehicle accident, falls on stairs or from height, ground-level falls, assault, sport injury, work injury, and other causes.

The associated facial fractures were determined from computed tomography scans on admission to the hospital and classified as fractures of the mandible, orbital-zygomatic-maxillary complex (MZO), orbit, nose, Le Fort, frontal sinus, and naso-orbital-ethmoid (NOE) complex. Frontal sinus and orbital fractures were subclassified according to the involved walls.

The associated concomitant body injuries were classified as orthopedic, encephalic, spinal, ocular, thoracic, and abdominal.

The primary outcome variable was the visual outcome, which was classified as either: complete visual recovery without visual deficits, partial visual recovery with some visual deficits, or blindness. Analyses were performed at the patient level. In bilateral cases, the eye with the more severe clinical involvement was considered for analysis to avoid within-patient correlation.

Data were recorded in Microsoft Excel (Microsoft Inc., Redmond, WA, USA). Statistical analysis was performed using SPSS software (IBM Corp., Armonk, New York, US). Categorical variables were analyzed using standard statistical methods, such as counts, frequency tables, and proportion analyses. Statistical significance for categorical variables was determined using the chi-square test or, if the sample was too small, the Fisher exact test. The Mann–Whitney U test was used to compare continuous variables, and $p < 0.05$ was considered statistically significant.

3. Results

In total, 77 patients (52 males, 25 females) diagnosed with posttraumatic RBH and who met the inclusion criteria were included. The mean age of the study population was 56 years (median 61 years; SD 21.67 years; range 14–92 years). Patients were most frequently distributed into the 60–69 years (20.8%) and 80–89 years (18.2%) age groups (Fig. 1).

In total, 27 patients (35.1%) reported substance use (Table 1). Specifically, 11 patients reported smoking or having smoked, 13 reported consuming alcohol, and three reported both smoking (or having smoked) and consuming alcohol. In all, 52 patients (67.5%) reported having one or more comorbidities, including the most frequently observed conditions of hypertension (28 patients), diabetes (11 patients), dyslipidemia (seven patients), atrial fibrillation (seven patients), cardiovascular ischemic disease (seven patients), depression (six patients), and dementia (five patients).

In total, 27 patients (35.1%) reported current use of antithrombotic medication: 11 patients were taking antiplatelet drugs (in nine cases acetylsalicylic acid, in one case clopidogrel, and in one case acetylsalicylic acid and clopidogrel), whereas 16 patients were taking anticoagulant drugs (in six cases warfarin, in four cases rivaroxaban, and in two cases fluindione). The mean age of the 27 included patients who took

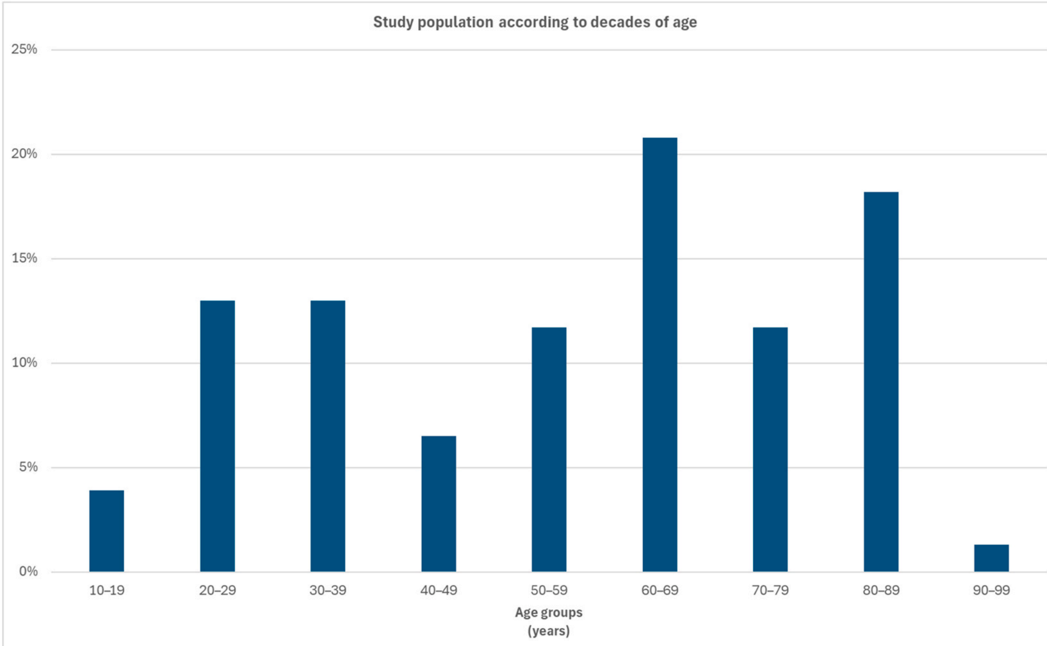

Fig. 1. Study population by age group.

Table 1
Descriptive statistics of 77 patients with retrobulbar hematoma.

Age (years)		
Mean	56 (SD 21.67)	
Median	61	
Range	14–92	
	n, total	% of 77
Sex		
Male	52	67.5
Female	25	32.5
Etiology		
Falls on stairs or from height	21	27.3
Ground-level falls	19	24.7
Assaults	12	15.6
Motor vehicle accidents	10	13.0
Sports	3	3.9
Result of surgical manipulations — orbital reconstruction	3	3.9
Work	2	2.6
Bicycle	1	1.3
E-scooter	1	1.3
Other	5	6.5
Substance use		
Yes	27	35.1
Comorbidities		
Yes	52	67.5
Antithrombotic medication		
Yes	27	35.1
Concomitant body injury		
Yes	47	61.0
Associated ocular injury		
Yes	17	22.1

antiplatelet (e.g. aspirin) or anticoagulant (e.g. warfarin, rivaroxaban) drugs was 74 years (range 55–92 years). The mean age of included patients not taking antiplatelet or anticoagulant drugs was 46 years (range 14–82 years).

Regarding the etiology of trauma, the most frequent cause of injury was fall on stairs or from height, with 21 patients (27.3%), followed by ground-level falls (19 patients, 24.7%), and assaults (12 patients, 15.6%) (Table 1).

Concomitant body injuries were observed in 47 patients (61.0%). Most frequently observed concomitant injuries were encephalic injuries (23 patients), orthopedic injuries (16 patients), spinal injuries (10 patients), thoracic injuries (nine patients), and abdominal injuries (four patients). Altogether, 17 patients had associated ocular injuries (22.1%).

Among the encephalic injuries, 11 patients presented with subdural hematoma, 11 with subarachnoid hemorrhage, 10 with intracerebral hemorrhage, and seven with skull fracture.

In 73 patients, one or more associated facial fractures were diagnosed together with RBH, whereas in four patients no associated facial fractures could be identified.

Isolated orbital floor and/or medial wall fractures were the most frequently observed fracture type, with 30 cases, followed by orbital roof/upper rim (24 fractures) and zygomaticomaxillary complex (23 fractures). Four patients developed RBH following orbital fracture surgery (Fig. 2).

Clinically, the most frequently observed signs and reported symptoms were proptosis (45 patients, 58.4%), ocular motility restriction (33 patients, 42.9%), high eye pressure (28 patients, 36.4%), lost pupillary light reflex (26 patients, 33.8%), decreased visual acuity (22 patients, 28.6%), uneven pupils (22 patients, 28.6%), and diplopia/double vision (17 patients, 22.1%) (Table 2).

The most frequently adopted imaging method was CT scan (70 cases, 90.9%), while in seven cases both CT and MRI imaging were performed.

The location of RBH was identified as extraconal in 59 cases (76.6%), intraconal in six patients (7.8%), and both intraconal and extraconal in 12 patients (15.6%).

In 52 patients (67.5%) a single hematoma area was identified, whereas in 25 patients (32.5%) multiple hematoma areas could be observed. The tenting/tulip sign was found in 22 patients (28.6%): of these, 16 patients presented a single hematoma area, with six showing

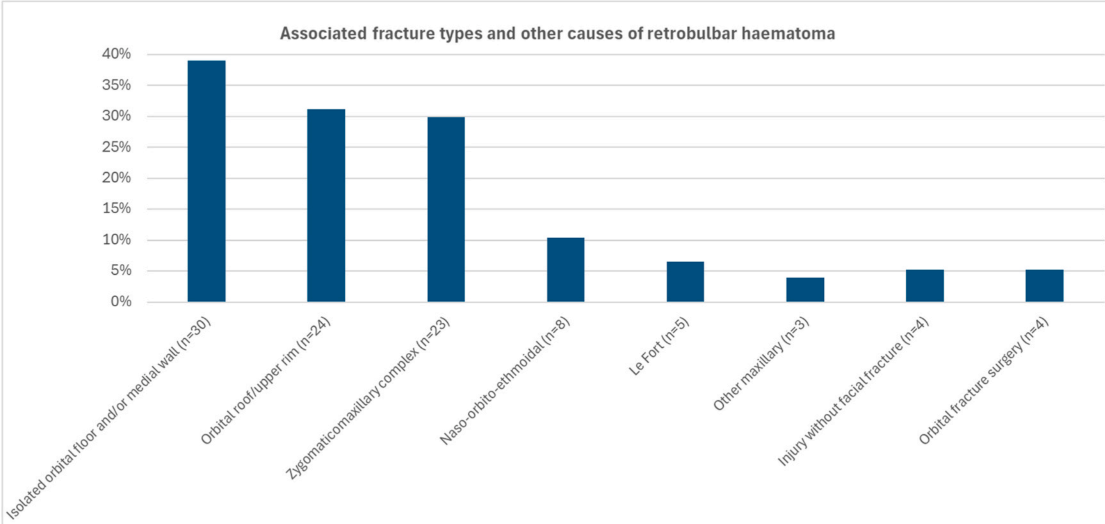

Fig. 2. Associated fracture types and other causes of retrobulbar hematoma.

Table 2
Observed clinical and radiological signs and reported symptoms at diagnosis of retrobulbar hematoma in the study population.

Clinical signs and symptoms	No. of patients	% of 77
Proptosis	45	58.4
Ocular motility restriction	33	42.9
High eye pressure	28	36.4
Abnormal pupillary light response	26	33.8
Decreased visual acuity	22	28.6
Uneven pupils	22	28.6
Diplopia (double vision)	17	22.1
Suggillation	10	13.1
Complete visual loss	6	7.8
Infraorbital nerve paresthesia	5	6.5
Eye pain	5	6.5
Chemosis	5	6.5
Enophthalmos	4	5.2
Relative afferent pupillary defect	4	5.2
Hyphema	1	1.3
Radiological signs		
Hematoma site		
Extraconal	59	76.6
Intraconal	6	7.8
Combined	12	15.6
Hematoma type		
Single	52	67.5
Multiple	25	32.5
Tenting sign		
Yes	22	28.6
Hematoma size (mm)		
Mean	10.5 (SD 7.94)	
Median	7	
Range	3–34	

multiple hematoma areas.

The mean calculated largest diameter of hematoma on CT was 10.5 mm (range 3–34 mm; SD 7.94; median 7 mm).

Regarding the timing of onset of symptoms after injury, a mean of 9 h was reported (range 0–120 h; median 2 h; SD 19.77).

Most patients (60 patients, 77.9%) were treated within 12 h after injury, eight patients between 12 and 24 h after injury, and nine patients beyond 24 h after injury (Fig. 3).

Several treatments were administered (Table 3), with most patients (38 patients, 49.3%) undergoing both medical and surgical treatment, whereas 18 patients (23.4%) underwent only medical treatment, and in 21 patients only surgery was performed (27.3%). Lateral canthotomy and cantholysis was the most preferred surgical treatment (50.6%).

Among the administered medical treatments, dorzolamide/timolol eye drops followed by oral acetazolamide was the most used. Mannitol and systemic glucocorticoids were used more rarely.

Regarding visual outcome, in 40 patients (51.9%) complete visual recovery without visual deficit was obtained, in 23 patients (29.9%) partial visual recovery with some visual deficits was observed, and in eight cases (10.4%) patients were blind at follow up (Tables 4 and 5). In six cases, visual outcome was not available.

Nine patients developed one or more complications, including the persistence of diplopia (five cases), ectropion (three cases), recurrence of RBH (one case), ptosis (one case), and dryness of the eye (one case).

Statistically, the age, the type of treatment, the timing of treatment, the hematoma diameter, imaging findings, or the assumption of anticoagulant/antiplatelet drugs was not associated with a poorer visual outcome ($p > 0.05$). In contrast, the finding of an intraconal retrobulbar hemorrhage or hematoma was significantly associated with a worse visual outcome ($p = 0.02$; 95% CI 1.197–18.144; RR = 4.42). The presence of ocular-associated injury was also significantly associated with a worse visual outcome ($p = 0.04$; 95% CI 1.190–17.166; RR = 4.28).

4. Discussion

The diagnosis and management of RBH remain clinically challenging, given its relatively low reported incidence, ranging from approximately 1.3% to 3.6%, depending on the study population (Becker et al., 2025; Bourquard et al., 2026; Dos Santos et al., 2024; Fattahi et al., 2014; Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Tram et al., 2023; Ujam and Perry, 2016; Voss et al., 2016). RBH requires prompt recognition and interdisciplinary collaboration between oral and maxillofacial surgeons and ophthalmologists, as well as other specialists treating trauma patients. Adequate knowledge of the epidemiology, pathophysiology, clinical presentation, and treatment strategies is essential to optimize patient outcomes.

In our study, the age distribution was notably wide, ranging from 14 to 92 years, reflecting the heterogeneous nature of RBH. A substantial proportion of patients were elderly (31%), which was consistent with previous studies reporting an increased incidence of orbital trauma related to ground-level falls in older populations. This finding also explains the high prevalence of comorbidities observed in our cohort

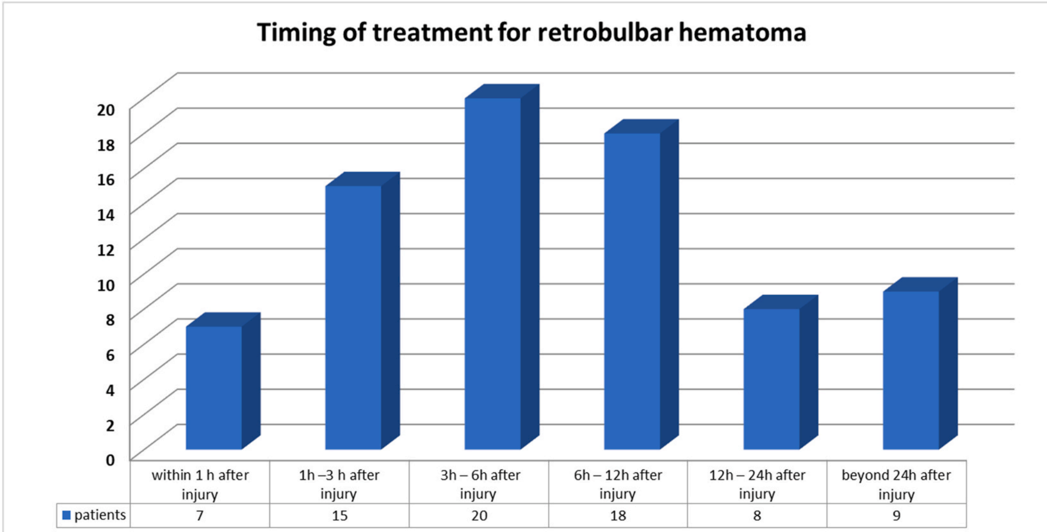

Fig. 3. Timing of treatment for retrobulbar hematoma.

Table 3
Treatment of retrobular hematomas in the study population.

	Number of patients	% of 77 patients
Combined surgical and medical	38	49.4%
Solely surgical	21	27.3%
Solely medical	18	23.4%
Surgical treatment methods		
Lateral canthotomy and cantholysis	39	50.6%
Transcutaneous/transconjunctival decompression	19	24.7%
Intentional opening of the orbital floor	10	13.0%
Medical treatment methods		
Dorzolamide/timolole eye drops	50	64.9%
Oral acetazolamide	10	13.0%
Systemic glucocorticoids	5	6.5%
Mannitole	4	5.2%

(Jamal et al., 2009; Jamali et al., 2023; Lubamba et al., 2023; Meltzer et al., 2019; Mohr et al., 2026; Park et al., 2021; Tram et al., 2023; Ujam and Perry, 2016; Voss et al., 2016).

The use of antithrombotic medications was frequent, with over one-third (35.1%) of patients receiving such therapy. This proportion is considerably higher than in the general population, and supports previous findings identifying anticoagulation as an important risk factor for RBH development (Aftab et al., 2024; Becker et al., 2025; Berg et al., 2019; Fattahi et al., 2014; Ghorpade et al., 2025; Isa et al., 2025; Jamal et al., 2009; Jamali et al., 2023; Narjus-Sterba et al., 2025; Voss et al., 2016). However, in line with prior reports, antithrombotic medication was not independently associated with worse visual outcomes, suggesting that while it may predispose to hemorrhage, it does not solely determine prognosis. Therefore, RBH should be regarded as a multifactorial condition in which medication-related risk represents only one contributing factor.

In previous literature (Aftab et al., 2024; Becker et al., 2025; Berg et al., 2019; Bourquard et al., 2026; Chen et al., 2012; Christie et al., 2018; Narjus-Sterba et al., 2025; Ujam and Perry, 2016; Voss et al., 2016), RBH was most commonly associated with direct orbital trauma, particularly falls and high-energy injuries, often accompanied with facial fractures. Our findings were in agreement with these reports, confirming trauma as the leading etiological factor. The strong association between RBH and maxillofacial fractures observed in our study further supports the concept that significant blunt force to the orbital region is a key mechanism underlying RBH development.

As confirmed by our study, several signs and symptoms may be suggestive of RBH, particularly proptosis, restricted ocular motility, elevated intraocular pressure, loss of the pupillary light reflex, and decreased visual acuity. However, it is important to note that RBH does not always present immediately after trauma. Symptoms may develop with a delay of several hours or even longer following the initial injury, which may complicate early diagnosis (Bourquard et al., 2026; Chen et al., 2012; Christie et al., 2018; Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Park et al., 2021; Tram et al., 2023; Ujam and Perry, 2016; Voss et al., 2016).

Computed tomography plays a crucial role not only in identifying associated fractures, but also in characterizing the anatomical location of the hematoma. In our cohort, extraconal hematomas were the most common (76.6%), which was in line with previous reports. However, intraconal RBH was significantly associated with worse visual outcomes ($p = 0.02$; 95% CI 1.197–18.144; RR = 4.42). This finding was consistent with prior studies, suggesting that deeper orbital involvement is associated with a higher risk of optic nerve compromise and ischemic damage.

Visual outcomes in RBH remain highly variable. In our study, only half (51.9%) of the patients achieved preservation or full recovery of vision, and one in 10 became blind. These findings were broadly consistent with previous literature, although some studies have reported even higher rates of permanent visual loss. Together, these findings highlight the potentially severe prognosis of RBH, despite treatment.

A variety of medical and surgical treatment options was employed, highlighting the need for individualized RBH management. Most patients (49.3%) underwent combined medical and surgical treatment, whereas 23.4% received medical therapy alone, and 27.3% underwent surgery alone. Similar variability in treatment strategies has been reported in previous studies (Meltzer et al., 2019; Mohr et al., 2026; Narjus-Sterba et al., 2025; Ujam and Perry, 2016; Voss et al., 2016), reflecting the absence of a universally accepted management protocol.

Regarding postoperative dressing, multiple options can be used, including sterile pads, rigid plastic shields, sterile gauze swabs, and hydrogel dressings.

No significant association was observed between visual outcome and treatment modality, timing of intervention, hematoma size, age, or use of antithrombotic drugs. Conversely, intraconal location and concomitant ocular injuries were the strongest predictors of poor outcome, in

Table 4
Treatment outcomes of retrobular hematomas in the study population.

	Number of patients	% of 77 patients
Complete visual recovery	40	51.9
Partial visual recovery	23	29.9
Blind	8	10.4
Not available	6	7.8

Outcomes of 71 patients with available information on visual recovery	Complete visual recovery	% of 40 patients	Incomplete visual recovery	% of 31 patients		
Age						$p > 0.05$
Mean	56		59			
Sex						$p > 0.05$
Male	26	65.0	21	67.8		
Female	14	35.0	10	32.2		
Substance use						$p > 0.05$
Yes	13	32.5	13	41.9		
Comorbidities						$p > 0.05$
Yes	27	67.5	22	71.0		
Antithrombotic medication						$p > 0.05$
Yes	14	35.0	11	35.5		
Concomitant body injury						$p > 0.05$
Yes	19	47.5	14	45.2		
Associated ocular injury						$p = 0.04$
Yes	6	15.0	10	32.2		
Treatment method					$p > 0.05$	
Combined surgical and medical	14	35.0	23	74.2		
Solely surgical	13	32.5	4	12.9		
Solely medical	13	32.5	4	12.9		
Hematoma site					$p = 0.02$	
Extraconal	35	87.5	19	61.3		
Intraconal	3	7.5	3	9.7		
Combined	2	5.0	9	29.0		
Hematoma type						$p > 0.05$
Single	27	67.5	19	61.3		
Multiple	13	32.5	10	32.2		
Tenting sign						$p > 0.05$
Yes	13	32.5	7	22.6		
Hematoma size						$p > 0.05$
mean	9.7		12.6			
Timing of treatment for retrobulbar hematoma after injury						$p > 0.05$
<1 h	4	10.0	3	9.7		
1–3 h	10	25.0	4	12.9		
3–6 h	11	27.5	7	22.6		
6–12 h	7	17.5	9	29.0		
12–24 h	2	5.0	6	19.3		
>24 h	6	15.0	2	6.4		

Table 5
Surgical and medical treatment outcomes.

Outcomes for 71 patients with available information on visual recovery	Complete visual recovery	Incomplete visual recovery
Surgical treatment methods		
Lateral canthotomy and cantholysis	15	12
Transcutaneous/transconjunctival decompression	2	7
Intentional opening of the orbital floor	7	1
Other combined surgical treatments	4	7
Medical treatment methods		
Dorzolamide/timolole eye drops	15	6
Systemic glucocorticoids + dorzolamide/ timolole eye drops	3	2
Oral acetazolamide + dorzolamide/ timolole eye drops	3	1
Systemic glucocorticoids + mannitole	1	8
Other combined medical treatments	5	10

line with prior evidence highlighting the dominant role of primary injury severity and secondary ischemia.

An additional noteworthy finding emerged from the analysis of concomitant and associated injuries, most commonly intracranial and ocular traumas. These findings emphasize the importance of broad awareness of RBH across different specialties; notably, the presence of associated ocular injuries was significantly correlated with worse visual outcomes ($p = 0.04$; 95% CI 1.190–17.166; RR = 4.28). These findings were consistent with previous reports indicating that associated ocular trauma is a major determinant of visual prognosis, and should be carefully distinguished from vision loss directly attributable to RBH.

Although early intervention is widely recommended and has been associated with improved outcomes in previous studies, our data did not demonstrate a statistically significant relationship between treatment timing and visual recovery. This discrepancy may be explained by the fact that most patients in our cohort received early treatment, with 77.9% managed within 12 h of injury, thereby limiting the ability to detect differences between early and delayed intervention. Since RBH can also develop hours after injury, close clinical surveillance is warranted.

This study had several limitations, including its retrospective design and the relatively small sample size, which reflects the rarity of RBH. Nevertheless, the multicenter nature of the study strengthens the generalizability of the findings.

5. Conclusions

Oral and maxillofacial surgeons should be familiar with the characteristics, risk factors, clinical signs and symptoms, and imaging findings of RBH to enable rapid and appropriate diagnosis. Clinical signs and symptoms, including proptosis, restriction of ocular motility, elevated intraocular pressure, loss of the pupillary light reflex, and decreased visual acuity, should be incorporated into routine examination protocols. Accurate diagnosis relies on early and appropriate assessment of both clinical and imaging findings. The presence of an intraconal RBH and associated ocular injury may be associated with a poorer outcome, and these increased risks may be anticipated and communicated to the patient. Several medical and/or surgical treatment options are safe and effective in the acute management of traumatic RBH, and should be individualized according to the clinical situation.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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