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Review article

Isolated tectal cavernomas: A comprehensive literature review with a case presentation

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HIGHLIGHTS

- We reviewed and statistically analyzed all reported cases of isolated tectal cavernoma in PubMed literature.
- Isolated tectal cavernoma is not associated with specific sex or a certain age.
- The most common complication associated with this condition is hemorrhage (64%).
- Parinaud's Syndrome has been associated with some cases, with its presence being male predominant.
- Lesion size is significantly associated with outcome as larger lesions (>11 mm) are more likely to induce persistent deficit.
- Surgical resection is the ultimate management modality as most surgically treated cases ended with complete recovery (79%).

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ABSTRACT

Intracranial cavernous angiomas or cavernomas (ICCs) are abnormal blood-filled vasculatures made of mono-endothelial layer and characterized by their bubble-like caverns. Brainstem cavernomas (BSCs) is a critical form of ICCs since slight changes in the lesion can result in devastating or life-threatening outcomes. We hereby present a rare case of BSC developed in the mesencephalic tectum with intraventricular bleeding and Parinaud's Syndrome. Our patient was managed by complete surgical resection of the lesion through an infra-tentorial supracerebellar approach. Additionally, we reviewed and analyzed the hitherto reported cases of isolated tectal cavernomas (TCs) in the literature, including our case, to elucidate the main factors associated with the management outcomes of TCs. There have been 25 cases of isolated TC reported until now. Most of the patients were adults between 18–77 y of age, except for two children (7 and 13 y). There was no sex predominance. Symptomatic patients presented with headache 56%, altered level of consciousness 24%, and/or double vision 20%. Most cases (64%) had hemorrhagic lesions at presentation, and 60% of all cases experienced recurrent hemorrhages. Parinaud's Syndrome was recorded in five cases, including the current one. All cases affected with Parinaud's were males. Lesion size was a determinant of the outcome as larger lesions were more likely to result in persistent deficits. Surgical resection of the lesion was an effective management modality with ~79% (15/19) of patients who underwent surgery ended up with complete recovery.

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1. Introduction

Cavernous angiomas or cavernomas are considered one of five major categories of benign vascular malformations in the central nervous system (CNS), which also include: *i*) telangiectasia (capillary angiomas), *ii*) varices, *iii*) venous angiomas, and *iv*) arteriovenous malformations [1]. Morphologically, cavernomas are raspberry-like clusters of low-flow sinusoidal channels, known as caverns, without intervening brain tissue. These caverns are lined by a single endothelial layer and, unlike normal blood vascular channels, lack smooth muscle and connective tissue layers [2]. This vulnerable architecture renders cavernomas to bleed easily and recurrently, resulting in a range of neurological symptoms like headaches, seizures, and neurological deficits, or even death. However, following the advent of magnetic resonance imaging (MRI), there has been a remarkable increase in the number of asymptomatic occult cavernomas detected incidentally, which could progress into symptomatic lesions in the future [3].

Intracranial cavernomas (ICCs) are found in up to 0.5% of the general population and tend to occur more often within the supra-tentorial cavity [4]. However, brainstem cavernomas (BSCs), which account for 4–35% of all ICCs, is a critical type of cavernomas, based on their location, since minimal changes of these lesions can result in life-threatening outcomes [5, 6]. Tectal cavernomas (TCs) comprise an extremely rare type of BSCs that develops within the tectal plate of the midbrain [7]. They constitute a special entity of BSCs due to their particular location on the dorsal aspect of the mesencephalon that interferes with both auditory and visual pathways and complicates any handling surgical approach [7]. The TCs can occur either concomitantly with other cavernomas elsewhere in the CNS or as solitary lesions [8]. To the best of our knowledge, there have been only twenty-five reported cases of solitary TC in the literature, including our case.

In this communication, we report a unique case of solitary TC with recurrent intraventricular hemorrhages and a reversible Parinaud's Syndrome after successful surgical resection of the lesion. Additionally, we review all cases of solitary TC available in the literature and statistically analyze their main epidemiologic and clinical features to reveal the main factors associated with TC management outcomes.

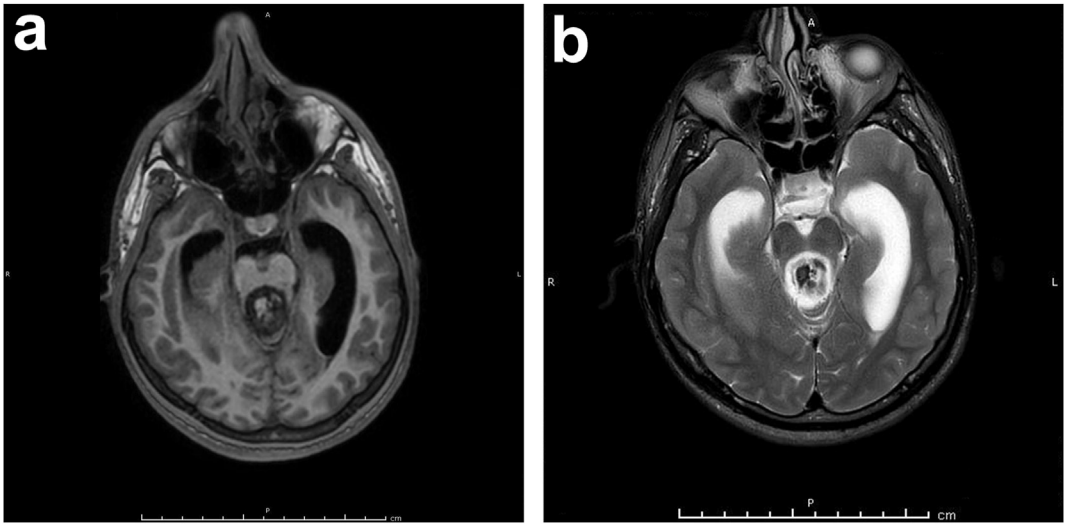

Figure 1. Preoperative axial MRI brain T1, showing a well-defined heterogeneous signal intensity mass lesion seen in the tectal region of the midbrain with low signal intensity measuring about 1,8 × 1,7 × 2,1 cm, causing obstructive hydrocephalus (A) and high T2 signal intensity containing multiple hypo intense foci representing hemorrhagic component (B).

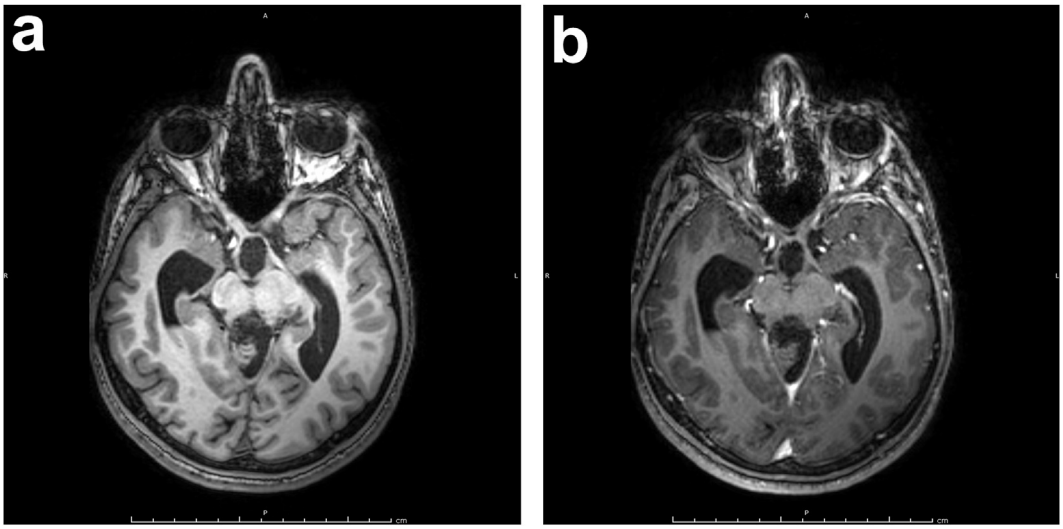

Figure 2. Postoperative T1 weighted axial MRI without (a) and with gadolinium contrast (b).

2. Case presentation

An 18-year-old male with no previous history of epilepsy or other health issues presented to our emergency department with severe headache and inability to produce comprehensible sounds. There was no associated fever, neck stiffness or photophobia; there was no history of recent infection or head trauma; the patient was not on any medication. Before he arrived at our hospital, his mother found him lying in his bed in a generalized tonic posture with no response; there were no clonic movements, up rolling of eyes, or tongue biting. By reaching our hospital, he had vomited three times each of a teacup volume. On examination, his vital signs were within normal range. He had a decreased level of consciousness with Glasgow Coma Scale (GCS) was 9/15. His GCS was recorded as follows: producing incomprehensible sounds, localizing the painful stimulus, and opening eyes in response to pain. The patient had small-sized pupils with sluggish reaction to light. He had mild squint and downward gazing while other cranial nerves were grossly intact. He was able to move all limbs in all directions (muscle power of 5/5); he had normal muscle tone and reflexes. A decision for intubation and ventilation was taken and urgent computed tomography (CT) scan of the brain was done which showed a lesion suggestive of a diffuse hemorrhagic or vascular lesion in the tectal plate of the midbrain with concurrent intraventricular hemorrhage (IVH) in the third and the fourth ventricles.

The patient underwent an urgent right frontal External Ventricular Drainage (EVD) after which he was admitted to the ICU. On day three, the patient was extubated since his vital signs were within normal range, GCS was back to 15/15, and he had no motor deficits. The pupils were mid-sized and reactive but there was overt bilateral abducent nerve palsy with convergent squint and limited upward eye gazing associated with eyelid retraction (Collier's sign) suggestive of Parinaud's Syndrome.

The patient continues to improve gradually, and –on day nine– the CSF from the EVD was clear, and a brain CT showed no remaining IVH. Therefore, the decision was made to remove the EVD. However, his level of consciousness deteriorated (GCS = 12/15) few hours after the EVD removal. Brain CT scan revealed IVH (grade 2), which was then managed by another right frontal EVD. Magnetic resonance imaging (MRI) without (Figure 1A) and with contrast (Figure 1B) revealed a well-defined heterogeneous signal intensity lesion measuring about 1.8 × 1.7 × 2.1 cm seen diffusely in the midbrain tectum causing moderate obstructive hydrocephalus and IVH. Moreover, the digital subtraction angiogram was negative in two occasions suggestive of TC. A decision for surgery was taken to be conducted after stabilization of the patient condition. We conducted a suboccipital craniectomy with image-guided supracerebellar infratentorial approach for gross microscopic resection of the TC. Intraoperatively, a tuft of abnormal tiny vessels was seen surrounded by yellowish soft tissue. Histopathological analysis reported cauterized tissue with areas of hemorrhage, fibrin deposition, gliosis, and hemosiderin-laden macrophages and clusters of vessels confirming the TC diagnosis.

Postoperatively, the patient had an uneventful course and returned to preoperative baseline cognition and activity. However, he had upward gaze palsy and bilateral limitation of lateral gaze. Follow-up MRI

Table 1. Review of PubMed reported cases for solitary tectal cavernoma.

Reference	Case #	Sex	Age (y)	Clinical Presentation	Hemorrhage	Hydrocephalus	Lesion size (cm)	Surgical resection	Outcome
Girard et al., 1969	1	F	NA	Coma	Yes	No	NA	No	Death
Sakai et al., 1991	2	F	7	Rt. hemiparesis, Abducent palsy, And altered consciousness	Yes	Yes	NA	Yes	Full recovery
Zimmerman et al., 1991	3	F	38	Headache, vertigo, tinnitus, and Lt. sided paresthesia	Yes	No	1.0	Yes	Full recovery
Bertalanffy et al., 1991	4	M	28	Headache, nausea, and vomiting	Yes	Yes	1.0	Yes	Full recovery
	5	M	13	Bilateral papilledema	NA	Yes	1.0	Yes	Full recovery
	6	F	38	Headache, nausea, and vomiting	NA	Yes	1.0	Yes	Full recovery
Mizoi et al., 1992	7	M	39	Headache and **Parinaud's syndrome**	Yes	No	1.5	Yes	Full recovery
Fritschi et al. 1994	8	F	66	Coma, hydrocephalus	Yes	Yes	1.0	No	Full recovery
	9	F	27	Headache and coma	No	Yes	2.0	No	Death
	10	M	62	Diplopia and hemiparesis	No	No	1.0	No	Full recovery
	11	F	45	Diplopia, ataxia, vertigo, and seizures	Yes	No	1.5	Yes	Persistent minimal neurological deficit
	12	F	38	Headache and tinnitus	Yes	No	1.0	Yes	Full recovery
	13	M	22	**Parinaud's syndrome**, coma	Yes	No	0.6	No	Death
Duffau and Sichez, 1998	14	M	63	headache and diplopia	Yes	No	0.3	Yes	Full recovery
Porter et al., 1999	15	M	22	NA	Yes	NA	NA	No	Death
Fujiwara et al., 2002	16	M	30	Headache and nausea	No	Yes	NA	Yes	Transient upward gaze palsy
Cristini et al., 2004	17	M	24	Headache, drowsiness, **Parinaud's syndrome**	No	Yes	2.0	Yes	Persistent Memory disorder
Lázaro and Landeiro, 2006	18	F	60	Headache	NA	Yes	NA	Yes	Full recovery
Nayak et al., 2015	19	F	39	Headache, diplopia, Rt side paresthesia	Yes	No	1.8	Yes	Partial recovery
Aboul-Enein et al., 2015	20	F	38	Diplopia	NA	Yes	NA	Yes	Transient upward gaze palsy
Januszewski et al., 2016	21	M	18	**Parinaud's syndrome**	Yes	No	0.8	Yes	Full recovery
	22	F	47	Headache	Yes	No	1.1	Yes	Full recovery
Carvalho et al., 2016	23	F	60	Headache, dizziness, and ataxia	NA	NA	NA	Yes	Persistent tremors
Negoto et al., 2017	24	M	77	Quadriplegia and coma	Yes	Yes	NA	Yes	Transient truncal ataxia
Al Barbarawi et al., 2022 (Current case)	25	M	18	Headache, convulsion, and **Parinaud's syndrome**	Yes	Yes	2.0	Yes	Full recovery

displayed a successful resection of the lesion (Figure 2). The patient demonstrated gradual improvement with regular postoperative follow-up visits, and after twelve weeks, he showed a significant improvement with better upward gazing and nearly no squint.

3. Methods

3.1. Literature review

A literature review of solitary TCs was conducted to study the epidemiologic and clinical features related to this condition, and to elucidate the main factors associated with the management outcomes in these patients. A PubMed search was performed to retrieve all cases of solitary tectal cavernoma reported over the last five decades. The following keywords and terms were used in the PubMed search: "tectal cavernoma," "tectal cavernous malformation," "tectal cavernous angioma," "tectal angioma," "tectal hemangioma." However, secondary causes as tectal metastasis and cases with multiple lesions were excluded.

3.2. Statistical analyses

The factors that were investigated in relation to TC were described using frequency distribution for categorical variables and mean ± standard deviation for continuous variables. Pearson's chi-square ($\chi 2$) tests were used to analyze the associations between categorical variables, and Student's *t*-tests were used for continuous variables. A $p < 0.05$ was considered statistically significant. If a substantial association was found between categorical variables, a *post-hoc* residual analysis was then conducted to determine the exact significance in the contingency table.

4. Results

There have been 25 cases of isolated TC reported in the literature, including the current case (Table 1). A detailed summary of the patients is presented in Table 2. There was an equal male to female ratio (12:13). Most of the patients were adults (aged 18–77 y), except for two children (aged 7 and 13 y). The mean age of the patients was 38.3 ± 18.6 y. The lesion size ranged from 6.0 to 20 mm. The most common presenting complaints were headache (14 cases, 56%), altered level of consciousness (6 cases, 24%), and double vision (5 cases, ~21%). The symptoms were mainly due to or at least associated with a concurrent hemorrhagic lesion at presentation (16 cases, 64%). Around 60% of cases experienced two or more hemorrhagic episodes of the lesion (15/25). Parinaud's Syndrome was present in five cases (20%) only (Table 2). Most of the cases ~79% (15/19) who underwent surgical resection demonstrated gradual improvement until full recovery following the surgery. Postoperative morbidities were minimal (16%), and no postoperative mortality case was ever documented. Six patients did not undergo surgical resection and four of them ended up with death.

There were no sex variations in the presented patient symptoms or lesion characteristics, except for the presence of Parinaud's Syndrome (Table 3). There was a significant association ($p < 0.05$) between the Parinaud's Syndrome and patients' sex since all patients who developed Parinaud's Syndrome were males.

Regarding the outcome, there were no significant associations between Parinaud's Syndrome, hemorrhage, or hydrocephalus from one side and the patients' outcome from the other side (Table 4). Additionally, Pearson's chi-square test of association revealed no significant association ($p = 0.059$) between the lesion size and the outcome; however, there was a significant ($p = 0.034$) likelihood ratio that the outcome could be expected from the lesion size. Furthermore, the *post hoc* residual analysis for the contingency table between the lesion size and the outcome showed that patients with lesion size between 1-10 mm have a higher-than-expected chance of full recovery ($p < 0.05$), while patients with lesion size between 11-20 mm have a higher-than-expected chance of developing a persistent deficit ($p < 0.05$) (Table 4).

Finally, there was a significant ($p < 0.05$) association between surgical resection and patient outcome, as patients who did not undergo surgical resection were more likely to end up with death.

Table 2. Summary for the PubMed reported cases of solitary tectal cavernoma.

Associated factors	Number	Percent (%)
	Mean ± SD	
Total Patients	25	100.0
Sex		
Male	12	48.0
Female	13	52.0
Age (y)	38.3 ± 18.6	
Patient Complaints		
Headache	14	56.0
Altered consciousness	6	24.0
Double vision	5	20.8
Dizziness/Vertigo	4	16.0
Nausea & vomiting	3	12.5
Seizure/Convulsion	2	8.0
Tinnitus	2	8.0
Hemiparesis	2	8.0
Parinauds Syndrome		
Yes	5	20.0
No	20	80.0
Hemorrhage		
Yes	16	64.0
No	4	16.0
Unidentified	5	20.0
Multiple Hemorrhagic Episodes		
Yes	15	60.0
No	10	40.0
Hydrocephalus		
Yes	12	48.0
No	11	44.0
Unidentified	2	8.0
Lesion Size		
1–10 mm	10	40.0
11–20 mm	7	28.0
Unidentified	8	32.0
Surgical Resection		
Yes	19	76.0
No	6	24.0
Outcome of patients who underwent surgery (Out of 19)		
Full recovery	12	63.2
Transient deficit	3	15.8
Persistent deficit	4	21.0
Death	0	0.0
Outcome of patients who did not undergo surgery (Out of 6)		
Full recovery	2	33.3
Transient deficit	0	0.0
Persistent deficit	0	0.0
Death	4	66.7
Total Outcome (Out of 25)		
Full recovery	14	56.0
Transient deficit	3	12.0
Persistent deficit	4	16.0
Death	4	16.0

Abbreviations: mm, millimeter; SD, standard deviation; y, years.

Table 3. Analysis of solitary tectal cavernoma cases with relation to sex.

	Male N (%)	Female N (%)	p-value
Age (y), mean ± SD	34.7 ± 21.1	41.9 ± 15.9	NS
Parinauds Syndrome			
Yes	5 (100.0)††	0 (0.0)	0.009
No	7 (35.0)	13 (65.0)	
Hemorrhage			
Yes	8 (50.0)	8 (50.0)	NS
No	3 (75.0)	1 (25.0)	
Hydrocephalus			
Yes	6 (50.0)	6 (50.0)	NS
No	5 (45.5)	6 (54.5)	
Lesion Size			
1–10 mm	6 (60.0)	4 (40.0)	NS
11–20 mm	3 (42.9)	4 (57.1)	
Surgical Resection			
Yes	9 (47.4)	10 (52.6)	NS
No	3 (50.0)	3 (50.0)	
Outcome			
Full recovery	7 (50.0)	7 (50.0)	NS
Transient deficit	2 (66.7)	1 (33.3)	
Persistent deficit	1 (25.0)	3 (75.0)	
Death	2 (50.0)	2 (50.0)	

Abbreviations: mm, millimeter; N, number; NS, not significant; p, probability; SD, standard deviation; y, years. ††($p < 0.01$): significantly higher than expected frequency.

5. Discussion

In this communication, we report a unique case of a rare condition of midbrain TC causing recurrent IVH and Parinaud's Syndrome. All the reported five cases of isolated TC with Parinaud's Syndrome in literature were males. Indeed, several studies showed that Parinaud's Syndrome, regardless of its cause, occurs in males more than females [9, 10, 11]. In all cases, MRI was the investigation of choice, and histopathology always confirmed the diagnosis.

Our patient sought emergency care after he had developed his first episode of symptomatic IVH as a result of a diffuse TC. Our patient then experienced the second episode of hemorrhage (rebleeding) after nine days of his first episode. Indeed, the annual risk of developing the first hemorrhagic episode of BSCs, including TCs, accounts for up to 6%, which is a relatively higher percentage than all ICCs [12]. The annual risk of developing the first hemorrhage in all ICCs accounts for up to 1.1% of all cases [13]. In addition, the annual risk of recurrent hemorrhages after the first episode in BSCs is remarkably very high (up to 60%) [12, 13]. Comparable to this fact, our review of the literature revealed that recurrent hemorrhage in TCs accounts for 60% of all reported cases.

The most common location for brainstem cavernoma is the pons, followed by the midbrain and medulla [14]. Brainstem cavernomas have a more aggressive course when compared with other central nervous system cavernomas due to either mass compression or hemorrhagic complications [15]. However, they are uncommon [16]. MRI scan is still the best imaging modality in the diagnosis of BSCs. It can also clearly demonstrate associated pathologies like perilesional edema, thrombus, or hemorrhage. Aggressive cavernoma can bleed from other causes like infection, hypertension, or coagulopathy, and all these causes can be affordable using MRI. The angiogram is usually negative [17].

The lesion size is considered a critical predictor of the outcome in different types of cancers [18, 19, 20]. The increase in tumor size has been associated with mass-related complications like compression and hemorrhage, and with higher invasion and metastasis rates in cases of malignancies [20, 21]. This will eventually result in more unfavorable management outcomes. Therefore, a large lesion size is considered a poor prognostic factor in the management of both benign and malignant types of cancers [22].

The management strategy of BSCs is controversial [23, 24]. Surgery may be considered in hemodynamically active cavernomas, recurrent bleeds, progressive neurologic deficits, significant mass effect, or progressive enlargement in the follow-up MRI. Due to the high rate of postoperative morbidity and mortality, surgical resection of brainstem cavernoma may be of great challenge for neurosurgeons. Postoperative complications could be reduced by appropriate surgical decision making, optimal surgical approach, careful surgical dissection, and the use of neuronavigation and electrophysiological monitoring [17]. Regarding TCs, specifically, our review showed that surgical resection was the ultimate management modality as 79% of all patients who underwent surgical removal ended up with full recovery, and two-thirds (66.7%) of the patients who did not perform surgery ended up with death. However, we believe that the management of BSCs must always be balanced by the risk-benefit profile of the patient and adapted to each case individually.

Table 4. Factors associated with the outcome in patients with solitary tectal cavernoma.

	Full Recovery N (%)	Transient Deficit N (%)	Persistent Deficit N (%)	Death N (%)	p-value (χ^2)
Age (y), mean ± SD	38.2 ± 19.7	48.3 ± 25.1	42.0 ± 14.9	23.7 ± 2.9	NS
Parinauds Syndrome					
Yes	3 (60.0)	0 (0.0)	1 (20.0)	1 (20.0)	NS
No	11 (55.0)	3 (15.0)	3 (15.0)	3 (15.0)	
Hemorrhage					
Yes	10 (62.5)	1 (6.3)	2 (12.5)	3 (18.8)	NS
No	1 (25.0)	1 (25.0)	1 (25.0)	1 (25.0)	
Hydrocephalus					
Yes	7 (58.3)	3 (25.0)	1 (8.3)	1 (8.3)	NS
No	7 (63.6)	0 (0.0)	2 (18.2)	2 (18.2)	
Lesion Size					
1–10 mm	9 (90.0)†	0 (0.0)	0 (0.0)	1 (10.0)	0.059
11–20 mm	3 (42.9)	0 (0.0)	3 (42.9)†	1 (14.3)	
Surgical Resection					
Yes	12 (63.2)	3 (15.8)	4 (21.1)	0 (0.0)	0.001
No	2 (33.3)	0 (0.0)	0 (0.0)	4 (66.7)††	

Abbreviations: mm, millimeter; N, number; NS, not significant; p, probability; SD, standard deviation; y, years. †($p < 0.05$), ††($p < 0.01$): significantly higher than expected frequency.

6. Conclusions

Solitary TC is a rare form of BSCs, with only few cases are reported in the literature. It is not associated with specific sex or a certain age. The most common complication associated with TC is hemorrhage (64%). Parinaud's Syndrome is found in some cases, with its presence being male predominant. The lesion size and surgical resection are the only factors associated with the outcome of TCs. Larger lesions are more likely to lead to persistent deficits. Surgical resection is the ultimate management modality since most surgically treated cases end up with the complete recovery.

Declaration

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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Ethical statement

This study was approved by the Institutional Review Board committee at Jordan University of Science and Technology (Approval # 18-136-2020). The study was conducted with the assurance of patient data confidentiality and in accordance with the Declaration of Helsinki and its later amendments for ethical research performance. The patient's signed consent was obtained for this study.

Data availability statement

All data related to this work are included in the article.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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