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Case Report

Brainstem intraparenchymal schwannoma: A case report and literature review

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ABSTRACT

Background: Intracranial intraparenchymal schwannomas (IS) are rare tumors that have mainly been described in case reports. Here, we report on a case of a brainstem IS and included a comprehensive literature review.

Case Description: A 74-year-old man presented with progressive gait disturbances. CT- and MRI-imaging revealed a contrast-enhancing mass accompanied by a cyst in the dorsolateral pons. Hemangioblastoma was suspected and surgery was advised. During surgery, gross total resection of a non-invasive tumor was performed. Postoperative recovery was uneventful. Based on histopathological examination, the intraparenchymal brainstem tumor was diagnosed as schwannoma.

Conclusion: Our extensive review illustrates that ISs are benign tumors that most often present in relatively young patients. Malignant cases have been described but form an extremely rare entity. Preoperative diagnosis based on radiological features is difficult but should be considered when peritumoral edema, calcifications, and cysts are noted. In benign cases, gross total resection of the lesion is curative. To adequately select this treatment and adjust the surgical strategy accordingly, it is important to include IS in the preoperative differential diagnosis when the abovementioned radiological features are present.

Keywords: Brainstem, Case report, Intraparenchymal, Review, Schwannoma, Tumor

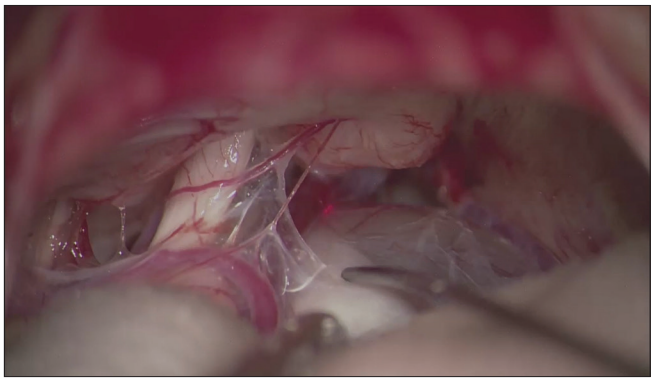
INTRODUCTION

Schwannomas are tumors that originate from Schwann cells, which form the myelin sheath of peripheral nerves.[15] Intracranial schwannomas comprise around 8% of all primary brain tumors, with the vast majority arising from the cranial nerves.[2,7] Less than 1% of intracranial schwannomas are located within the brain parenchyma.[1,11] The first case of intraparenchymal schwannoma (IS) was described by Gibson *et al.* in 1966.[5] Their histogenesis remains speculative, and radiological and histopathological diagnosis can be extremely difficult. Here, we present a case of a brainstem IS and included a comprehensive review on IS to shed light on the clinical, radiological, and histopathological characteristics.

CASE REPORT

A 74-year-old man with no reported prior medical condition presented with progressive gait disturbances and hearing loss that had developed over a few months. Neurological examination revealed sensory asymmetry in the left upper and middle trigeminal branch areas, broad-based gait, diplopia, dysphagia, and dysarthric speech. Imaging studies showed a cystic tumor in the left dorsolateral pons [Figure 1]. A pontine hemangioblastoma was suspected and surgery was recommended.

A left-sided suboccipital retrosigmoid craniotomy was performed [Video 1]. Intra-operative monitoring of trigeminal, facial, and vestibulocochlear nerve was used. An opaque aspect of the dorsolateral pons was noted and punctured, relieving a yellowish fluid. The solid mass consisted of flakey grey-yellowish tissue that was not invasive into the surrounding brain. Intraoperatively, the tumor resembled a pilocytic astrocytoma more than a hemangioblastoma. Gross total resection was performed. Postoperatively, all symptoms had alleviated and hearing had subjectively returned to normal. The direct postoperative MRI showed a small dorsomedial remnant. Radiological follow-up after 1 year was agreed upon.



Video 1: The most relevant intraoperative findings of the resection of an intraparenchymal schwannoma located in the dorsolateral pons displayed in a surgical video.

Histological assessment of the tumor sections showed clusters of spindle cells surrounded by fascicles and palisades in addition to thick-walled vessels [Figure 2a]. Some paucicellular areas were present, but no typical cystic spaces. Additional immunohistochemical examination exhibited positivity for S-100 protein, pericellular collagen IV basement membrane staining, and in some areas scattered few neurofilament (NF2F11) positive intratumoral axons [Figure 2b-d]. GFAP glial marker was negative, and MIB-1 proliferative activity was only 2%. The final histopathological diagnosis was IS Grade I. No clinical signs nor family history of neurofibromatosis (NF) was reported.

DISCUSSION

IS s are rare intracranial intra-axial tumors. We have found 150 cases reporting on histopathological confirmed IS [Table 1]. Intraventricular or schwannomas with dural attachment were excluded from our review as they form a different entity with an extra-axial origin. Based on our literature review, we will discuss characteristics of the clinical presentation, histogenesis, radiological features, histopathological findings, treatment, and prognosis of IS.

Clinical characteristics

ISs present at a relatively young age, with a majority occurring before the age of 30 and a slight male predominance [Table 2]. Around 65% of these tumors were located supratentorially and 35% infratentorially. The frontal lobe was most frequently affected [Table 3]. Only six cases of patients older than 70 years have been reported. Furthermore, we found only nine cases with pontine IS. This makes our case on a 74-year-old with a pontine IS unique.

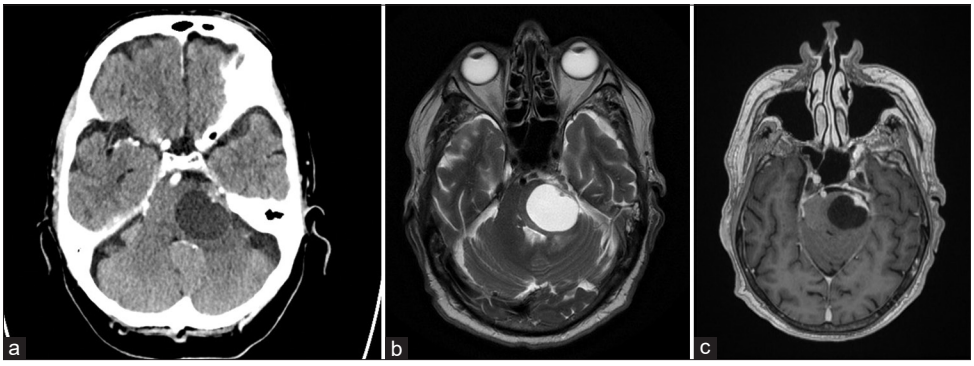


Figure 1: Preoperative radiological images. CT-scan of the brain without contrast showed a sharply delineated cystic lesion located in the left dorsolateral pons (a). There appear some calcifications located in the anterolateral solid mass of the lesions. Contrast-enhanced T2-weighed MRI images again showing the hyperintense aspect of the cystic fluid (b). Limited edema can be noted at the dorsal side of the tumor. On the contrast-enhanced T1-weighted images, the tumor mass and part of the cyst wall enhanced homogenously (c).

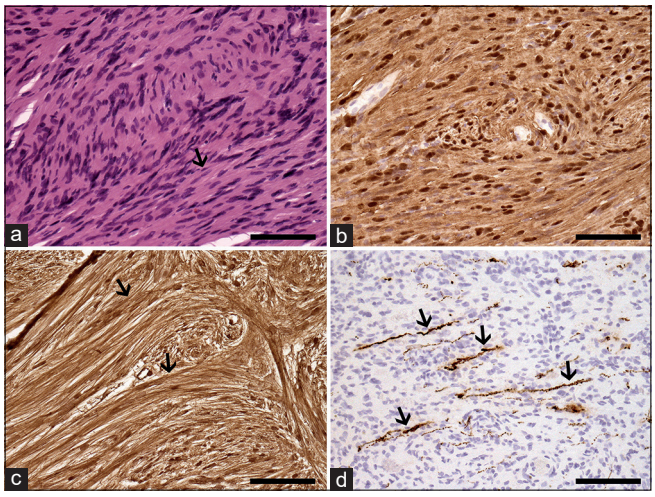


Figure 2: Histopathological images. Following HE-staining, elongated spindle cells (arrow) are noted in the biopsy sections (a). Additional immunohistochemical staining revealed a strong positivity for S-100 protein (b) and pericellular basement membranes (arrows) of tumor cells following collagen IV staining (c). In figure 2D, a scattered neurofilament-positive intratumoral axons (arrows) can be seen. Based on these findings, the tumor was diagnosed as of intraparenchymal schwannoma Grade I. Original magnification ×200 in all pictures, 100 mm scale bar.

Clinical presentation and clinical course are mostly dependent on tumor location and increased intracranial pressure. Tumors involving functional areas may be associated with a relatively short time between presentation and diagnosis.[4] According to our review, the occurrence of IS in a patient with NF was reported in 10% of the cases.

Histogenesis

Schwannomas originate from Schwann cells, which form the myelin sheath of peripheral nerves.[15] Since Schwann cells are usually not present within the brain parenchyma, the origin of IS has attracted much speculation.[8,13,22] Various theories have been proposed to explain the origin of IS. Menkü *et al*. differentiated these theories into developmental and non-developmental theories.[13] According to the developmental theory, a distorted embryogenesis forms the source of aberrant foci of Schwann cells in the brain parenchyma. These foci may originate from transformation of developed mesenchymal pial cells into Schwann cells, differentiation of multipotential mesenchymal elements into Schwann cells, ectopic migration of neural crest cells forming foci of Schwann cells, or misplaced myelinated nerve fibers.[11,13,15] The non-developmental theory suggests that the intraparenchymal Schwann cells originate from the perivascular nerve plexus of parenchymal arterioles.[11,13,15] The relative rarity of ISs is in this latter theory explained by considering the relative amounts of peripheral as opposed to parenchymal myelinated peripheral nerve plexus.

In our case, one could suggest a relation of the tumor with Schwann cells of the trigeminal nerve. However, the radiological findings suggested an intraparenchymal origin of the tumor as there was no border between the brainstem and the tumor. In addition, the tumor was located within the brainstem parenchyma as observed intraoperatively. If the tumor was related to trigeminal nerve Schwann cells, one would have expected a capsule between the Schwannoma and the brainstem which was not apparent in this case. Since the intraparenchymal myelin covering of the trigeminal nerve is dependent on astrocytes, and not Schwann cells, it is unlikely that the tumor is directly related to the trigeminal nerve.[16]

Radiological features

Diagnosis of IS based on preoperative radiological examinations is difficult. Our review revealed that a wide variety of differential diagnoses were suspected preoperatively and IS was not considered in any of these cases [Table 1]. CT-images of the brain may show a hypodense and sometimes hyperdense mass with occasional cysts, calcifications, and peritumoral edema.[7,14] The mass lesion and cyst wall may enhance following contrast administration. ISs usually appear hypointense and hyperintense on T1-weighted and T2-weighted MRI sequences, respectively.[11,14,20] The solid portion and cyst wall usually show homogeneous enhancement with gadolinium.[14] It is noteworthy that peritumoral edema, cyst formation and calcifications are commonly reported characteristics of IS, yet they lack specificity.[14,20,22]

In contrast, cranial nerve Schwannomas are radiologically characterized by a heterogeneous hyperintensity in T2-weighted images, with deformation of adjacent parenchyma, neural cisterns and bony foramina, and have a clear relation to a cranial nerve. Moreover, cranial nerve Schwannomas usually have a well delineated margin from the brainstem parenchyma and cause minimal peritumoral edema.[19]

Histopathological findings

Histological evaluation of IS shows a typical biphasic tissue pattern of Antoni type A and B areas.[12] It remains however difficult to differentiate IS from other tumors without immunohistochemical examination.[7] As there are no schwannoma-specific immunohistochemical markers to date, several markers should be included to differentiate schwannomas from other tumors. Schwannomas show a strong diffuse reactivity to S-100 protein and vimentin filament.[7] There is usually no reactivity for GFAP, EMA, CD34 on endothelial cells or α-SMA, excluding glial tumors, meningiomas, solitary fibrous tumors, and smooth muscle cell tumors, respectively.[1,7,12] The combination of histological analysis and immunohistochemical reactivity findings is required to make a definite diagnosis of IS. Malignant IS,

Table 1: Summary of 150 cases of intraparenchymal schwannomas.

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Gibson *et al.*, 1966	M, 6	Seizures	Temporal	N.A.	CR	Yes	No (EM: fibrillary basement membranes)	
New, 1972	M, 8	Seizures, headache, vomiting	Parietal	Glioma	CR	Yes	No	
Ghatak *et al.*, 1975 [abstract only]	F, 63	Seizures, hemiparesis	Parietal	N.A.	Resection	N.A.	N.A.	
Pialat *et al.*, 1975 [*abstract only*]	F, 24	Seizures	Frontal	N.A.	N.A.	N.A.	N.A.	
Van Rensburg *et al.*, 1975	M, 21	Seizures, headache	Temporal	Glioma or calcified hamartoma	CR	Yes	No	
Hahn and Netsky., 1977	M, 26	Headache, visual impairment	Frontal	N.A.	CR	Yes	No	NF1
Komminoth et al., 1977 [*abstract only*]	M, 15	Cerebellar signs, headache	Cerebellar	N.A.	CR	Yes	N.A.	
Russel and	M, 17	N.A.	Frontal	N.A.	N.A.	N.A.	N.A.	
Rubinstein, 1979 [*abstract only*]	F, 17	N.A.	Frontoparietal	N.A.	N.A.	N.A.	N.A.	
Prakash *et al.*, 1980	F, 14	Abducent and facial nerve palsy, tinnitus	Pons	N.A.	STR	Yes	No (GFAP -)	
Vassilouthis and Richardson, 1980	M, 17	Behavioral problems, headache, vomiting, confusion	Frontal	Meningioma	CR	Yes	No	
Kasantikul *et al.*, 1981	M, 23	Schizophrenia	Parietal	Metastasis	GTR	Yes	No (EM: fibrillary basement membranes)	
	M, 21	Seizures	Temporal		Temporal lobectomy	Yes	No (EM: fibrillary basement membranes)	
Auer *et al.*, 1982	M, 15	SAH	Frontal	N.A.	STR	Yes	No (EM: fibrillary basement membranes)	
Shalit *et al.*, 1982	F, 29	Headache, visual impairment, syncope	Parieto-occipital	Astrocytoma	Resection type	Yes	No	Additional remarks
Doi *et al.*, 1983 [*abstract only*]	M, 23	Headache, vomiting, vertigo	2 cerebellar and 4 cerebral lesions	N.A.	CR (cerebellar lesions)	Yes, malignant	N.A.	NF1
Bruner *et al.*, 1984	M, 18	Syncope	Frontal	N.A.	GTR	Yes	No	
Bruni *et al.*, 1984	M, 39	Seizures	Frontal	N.A.	CR	Yes	No	NF1
Gökay *et al.*, 1984	F, 16	Seizures, hemiparesis	Frontotemporal	N.A.	STR, later CR	Yes	No	Recurrence

(*Contd...*)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Rodriquez-Salazar *et al.*, 1984	F, 10	Seizures	Frontal	N.A.	Frontal lobectomy	Yes	No (EM: fibrillary basement membranes)	
Kuhn *et al.*, 1985 [*abstract only*]	F, 42	N.A.	Cerebellar	N.A.	N.A.	N.A.	N.A.	
Stefanko *et al.*, 1986	M, 15	Headache, vomiting	Parieto-occipital	N.A.	CR and RT, later re-resection	Yes, malignant	Yes (S-100 +)	Recurrence, died 9 months postop
Sarkar *et al.*, 1987	M, 24	Headache, vomiting, diplopia, visual impairment, gait disturbance	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
Solomon *et al.*, 1987	M, 69	Hemiparesis	Medulla oblongata and cervical medulla	N.A.	GTR	Yes	No (S-100 -)	
Aryanpur and Long., 1988	F, 50	Headache, vomiting, diplopia, facial numbness	Medulla oblongata	Cystic glioma	CR	Yes	Yes (S-100 +, GFAP -)	
Ben Rhouma *et al.*, 1988 [*abstract only*]	F, 13	ICP complaints	N.A.	N.A.	N.A.	Yes	N.A.	Recurrence
Cervoni *et al.*, 1988 [*abstract only*]	F, 61	Hemiparesis	Parieto-occipital	N.A.	CR	Yes	N.A.	NF1
Ng and South, 1988	F, 42	Headache	Temporal	N.A.	N.A.	N.A.	N.A.	
Schwartz and Sotrel, 1988	M, 48	Headache, sensory complaints	Cerebellar	N.A.	CR	Yes	No (EM: fibrillary basement membranes)	
Benazza *et al.*, 1989 [*abstract only*]	M, 8	N.A.	Cerebellar	N.A.	N.A.	N.A.	N.A.	
Ladouceur *et al.*, 1989	F, 46	Visual impairment, dysarthria, dysphagia	Pons	N.A.	STR	Yes	Yes (S-100 +, GFAP -)	
Wilberger, 1989	F, 62	Headache	Intrasellar	Pituitary tumor	Transsphenoidal STR followed by transcranial GTR	Yes	No	Second surgery for residual tumor
Redekop *et al.*, 1990	M, 7	Opthalmoplegia and facial nerve palsy	Pons / 4th ventricle	Glioma, ependymoma	STR	Yes	Yes (S-100 +, Vimentin +, GFAP -)	
Tran-Dinh *et al.*, 1991 [*abstract only*]	F, 64	N.A.	Cerebellar and brainstem	N.A.	Resection	N.A.	N.A.	

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Bando *et al.*, 1992	F, 55	Visual impairment, anosmia	Frontal	N.A.	CR	Yes	N.A.	Re-resection
Ezura *et al.*, 1992	F, 13	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +)	
Frim *et al.*, 1992	F, 11	Seizures	Temporal	N.A.	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA -)	
Ghosh and Chandy, 1992	M, 27	Seizures, hemiparesis	Frontal	N.A.	CR	Yes	Yes (S-100 +, Vimentin +)	
Casadei *et al.*, 1993	M, 16	Asymptomatic	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA-)	
	M, 17	Seizures	Temporal	N.A.	STR	Yes	Yes (S-100 +, GFAP -, EMA-)	
	M, 21	Seizures	Parietal	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA-)	
	F, 23	Headache	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA-)	
	F, 49	Headache	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA-)	
	F, 52	Headache, hemiparesis	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP +, EMA-)	
	M, 55	Headache	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP +, EMA-)	
	F, 79	Ataxia	Cerebellar	N.A.	STR	Yes	Yes (S-100 +, GFAP +, EMA-)	
	F, 84	Mental change, hemiparesis	Temporal	N.A.	STR	Yes	Yes (S-100 +, GFAP +, EMA-)	
Sharma and Newton, 1993	M, 18	Hemiparesis	Brainstem	Glioma	RT followed by STR	Yes	Yes (S-100 +)	No improvement after RT
Sharma *et al.*, 1993	F, 73	Gait disturbance, headache, vomiting	Brainstem	N.A.	GTR	Yes	Yes (S-100 +, GFAP -, EMA-)	
Singh *et al.*, 1993	F, 61	Headache, vomiting, gait disturbance	Cerebellar	N.A.	GTR	Yes, malignant	Yes (S-100 +, GFAP -)	Recurrence, died 18 months postop
Weiner *et al.*, 1993	M, 61	Facial nerve palsy and spasm, gait disturbance, headache	Brainstem	Glioma, epidermoid, arachnoid cyst	STR	Yes	No	
	F, 78	Facial nerve spasm, diplopia	Brainstem	Ependymoma, glioma, plexus papilloma	STR	Yes	Yes (S-100 +, GFAP -)	

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Deogaonkar *et al.*, 1994	F, 45	Visual impairment	Frontal	Meningioma	CR	Yes	No	
Di Biasi *et al.*, 1994 [abstract only]	M, 19	N.A.	N.A.	Glioma	N.A.	Yes	N.A.	
Ranjan *et al.*, 1995	F, 65	Vomiting, gait disturbance	Cerebellar	N.A.	CR	Yes	Yes (S-100 +)	Melanotic schwannoms
Blömer *et al.*, 1996	M, 8	Hemiparesis	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP +)	
Erongun *et al.*, 1996	F, 4	Headache, vomiting	Parieto-occipital	Plexus papilloma	STR followed by CR	Yes	No	2nd surgery for residual tumor
Sharma *et al.* 1996	F, 19	Hemiparesis	Occipital	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF1
	M, 8	Seizures	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 0.5	Seizures, hemiparesis, vomiting	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 21	Seizures, headache, vomiting	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF2
	M, 14	Visual impairment, gait disturbance	Brainstem	N.A.	STR	Yes	Yes (S-100 +, GFAP -)	
	M, 45	Headache, vomiting	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 24	Headache, vomiting, gait disturbance	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 14	Abducent and facial palsy	Pons	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
Tanabe *et al.*, 1996	F, 68	Hemiparesis, diplopia	Pons	HGG	CR	Yes	Yes (S-100 +, GFAP -, EMA -)	
Haga *et al.*, 1997	F, 15	Seizures	Parieto-occipital	HGG	CR	Yes	Yes (S-100 +, GFAP -)	
Tsuiki *et al.*, 1997	M, 17	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, Vimentin +, EMA-, GFAP +)	
	F, 64	Syncope	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, Vimentin +, EMA-, GFAP -)	
	M, 21	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, Vimentin +, EMA-, GFAP -)	

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Sharma *et al.*, 1998 [*abstract only*]	F, 8	N.A.	Temporal	N.A.	CR	Yes, malignant	Yes (S-100 +)	No recurrence
Zagardo *et al.* 1998	M, 15	Posttraumatic incidental finding	Parietal	N.A.	Biopsy followed by CR	Yes	Yes (S-100 +, GFAP -)	
Bhatjiwale and Gupta, 1999	M, 15	Headache, vomiting	Cerebellar	N.A.	CR	Yes	No	
Lee *et al.*, 1999	F, 29	Hearing loss, facial numbness, gait disturbance	Multiple lesion: cerebellar, brainstem, cervical medulla	N.A.	STR	Yes	Yes (S-100 +, GFAP -)	
Tanaka *et al.*, 2000	F, 4	Headache, vomiting	Parieto-occipital	N.A.	CR	Yes, malignant	Yes (S-100 +, Vimentin +, GFAP -, EMA -)	No recurrence
Andrade *et al.*, 2002	M, 17	Headache, vomiting, diplopia	Thalamus	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
Bhatoe *et al.*, 2003 [*abstract only*]	M, 50	Seizures, headache	Temporal	N.A.	CR	Yes	Yes (S-100 +, Vimentin +, EMA -)	
Bornstein-Quevedo *et al.*, 2003	M, 3	Headache, vomiting	Parieto-occipital	N.A.	STR	Yes, malignant triton tumor	Yes (S-100 +, GFAP -)	Patient died 10 days postop due to hemorrhage
Chng et al., 2003 [abstract only]	F, 13	Seizures	Frontal	N.A.	CR	Yes	Yes, not specified	
Lin et al., 2003	M, 48	Hemiparesis, ataxia, dysphagia, facial palsy and numbness	Medulla oblongata	Cystic glioma	RT followed by CR	Yes	Yes (Vimentin +, GFAP -)	No response to RT
Sarkar *et al.*, 2003 [*abstract only*]	M, 21	Seizure	N.A.	Pilocytic astrocytoma	N.A.	Yes	N.A.	
Beauchesne *et al.*, 2004	M, 35	Diplopia, headache, gait disturbance	Mesencephalon	Astrocytoma	Biopsy, chemotherapy	Yes, malignant	Yes (S-100 +, Vimentin +, GFAP -)	Died 29 months after biopsy
Maiuri *et al.*, 2004	F, 29	Headache, vomiting, visual impairment	Cerebellar	N.A.	GTR and RT	Yes, malignant	Yes (S-100 +, Vimentin +, GFAP -)	Recurrence at 6 months, died 8 months postop

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Vaishya and Sharma, 2004	M, 13	Seizures, headache, vomiting, diplopia	Frontal	TBC lesion	Tuberculostatics, CR	Yes	No / N.A.	TBC infection suspected
Takei *et al.*, 2005	F, 33	Headache, hemiparesis	Frontoparietal	Meningioma	CR	Yes	Yes (S-100 +, GFAP +, EMA -)	
Yako *et al.*, 2005	M, 14	Headache, vomiting, anosmia	Frontal	Neuroblastoma, glioma, meningioma, metastasis	CR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA -)	
Ahmad *et al.*, 2006	M, 21	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, EMA -)	
Bristol *et al.*, 2006	M, 8	Seizure	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA -)	
Bougrine *et al.*, 2007 [*abstract only*]	F, 20	Seizures, ICP symptoms	Parietal	N.A.	CR	Yes	N.A.	
De Cauwer *et al.*, 2007	M, 57	Seizures	Parietal	N.A.	CR	Yes, malignant triton tumor	Yes (S-100 +, Vimentin +)	NF1 Died 5 months postop because of recurrence
Celikoglu *et al.*, 2007	F, 23	Seizures	Parietal	N.A.	GTR	Yes	Yes (S-100 +)	
Kozic *et al.*, 2008	M, 39	Hemiparesis, ataxia, dysarthria	Pons	N.A.	Biopsy	Yes, malignant	Yes (S-100 +)	
Oztanir *et al.*, 2008	F, 1	Developmental delay, vomiting	Frontotemporal	N.A.	STR	Yes, malignant	Yes (S-100 +, Vimetin +)	NF1 Died of sepsis 6 weeks postop
Ambekar *et al.*, 2009	M, 32	Seizures, headache	Frontal	Tuberculoma, Lymphoma	GTR	Yes	Yes (S-100 +, GFAP -)	
Ishihara *et al.*, 2009	M, 5	Headache	Occipital	N.A.	CR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA-)	
Menkü *et al.*, 2009	M, 37	Headache, vomiting	Frontal	HGG, metastasis, lymphoma	CR	Yes	No / N.A.	
Consales *et al.*, 2010	M, 7	Seizures	Parieto-occipital	LGG	CR	Yes	Yes (S-100 +, Vimentin +, GFAP +)	
Muzzafar *et al.*, 2010	M, 68	Hemiparesis, vomiting, diplopia, gait disturbance, hiccups	Brainstem	N.A.	GTR	Yes	Yes (S-100 +, GFAP -)	Adherent

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Barnard *et al.*, 2011	F, 75	Personality changes and dysphasia	Frontal	N.A.	GTR + RT	Yes, malignant	Yes (S-100 +, GFAP -, EMA-, CD34 -, a-SMA -)	
Ellis *et al.*, 2011	F, 9	Headaches	Front otemporal	N.A.	STR	Yes, malignant	Yes (S-100 +)	NF1
Khursheed *et al.*, 2011	M, 16	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +)	
Luan et al., 2011 [*abstract only*]	F, 39	Seizures	Frontal	N.A.	CR	Yes	N.A.	
Srivastav *et al.*, 2011	M, 13	Hemiparesis, headache	Pons	N.A.	STR	Yes	Yes (S-100 +, Vimentin +, GFAP -)	NF
Umredkar *et al.*, 2011	F, 35	Headaches, vomiting, ataxia	Cerebellar	Pylocytic astrocytoma, hemangioblastoma, metastasis	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA -)	
Guha *et al.*, 2012	F, 51	Seizures	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
Kanakis *et al.*, 2012	M, 32	Death due to sepsis	Brainstem	N.A.	N.A.	Yes (S-100 +, Vimentin +)	Postmortem obduction: brainstem schwannoma	
Khoo and Taki, 2012	M, 60	Vertigo	Frontal	LGG	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA -, a-SMA -, CD-34 -)	
Paredes *et al.*, 2012	M, 19	Seizures	Occipital	SFT, Meningioma, PXA, DNET, Ganglioglioma	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 32	Dizziness	Occipital	HGG	CR	Yes	Yes (S-100 +, Vimentin +, EMA -)	
Sharma *et al.*, 2012	M, 25	Seizure, headache	Parieto-occipital	PAC or PXA	CR	Yes	Yes (S-100 +, GFAP +)	
Lee *et al.*, 2013	M, 25	Seizures	Frontal	PXA, ganglioglioma, DNET	CR	Yes	Yes (S-100 +)	
Li *et al.*, 2013	M, 19	Seizures	Frontal	Meningioma	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA -)	

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Luo *et al.*, 2013	M, 17	Asymptomatic	Parietal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF2
	F, 31	Headache	Brainstem	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 44	Headache, visual impairment, gait disturbance	Brainstem	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 51	Headache	Temporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 18	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 72	Hemiparesis, headache	Parieto-occipital	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 38	Headache, anosmia	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 24	Headache	Lateral ventricle	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 43	Headache	Occipitotemporal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 41	Headache	Intrasellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 10	Visual impairment	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 34	Asymptomatic	Occipital	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 55	Anosmia	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF2
	M, 64	Vomiting, gait disturbance	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 51	Gait disturbance	Cerebellar	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF2
	M, 13	Seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	F, 31	Seizures, anosmia	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
	M, 35	Visual impairment	Frontal	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	NF2

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Ma *et al.*, 2013	F, 24	Seizures	Frontal	Meningioma	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -, EMA-)	
Ramos *et al.,* 2013	F, 17	Headache, dizziness	Brainstem + CPA	N.A.	CR	Yes	Yes (S-100 +, GFAP -)	
Rotondo *et al.*, 2013	F, 45	Depression, headache, visual impairment	Frontal	Meningioma	GTR	Yes	No / N.A.	
Shweikeh *et al.*, 2013	M, 18	Headache, hemiparesis	Frontoparietal	Glioma	GTR and RT, followed by re-resection	Yes, malignant	Yes (S-100 1, Vimentin+, GFAP -)	NF1 Recurrence at 44 months, died 52 months postop
Srinivas *et al.*, 2013	F, 16	Seizures, headache	Frontoparietal	Glioma	GTR	Yes	No / N.A.	
Al Batly *et al.*, 2014	F, 49	Headache, gait disturbance	Temporal	Glioma	STR	Yes	Yes (S-100 +, GFAP -)	
Gupta *et al.,* 2016	M, 17	Headache, vomiting	Temporoparietal	HGG	GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -)	
Sharma *et al.*, 2016	F, 26	Headache, hemiparesis, facial palsy, gait disturbance	Pons and medulla oblongata	LGG	GTR	Yes	Yes (S-100 +)	
Wilson *et al.*, 2016	M, 34	N.A.	Temporal	Ganglioglioma, Oligodendro-glioma, post infectious	CR	Yes	Yes (S-100 +, EMA -, GFAP – CD34 +)	
Zhang *et al.,* 2016	F, 40	Paresis, numbness upper extremities, cervical pain	Medulla oblongata	Glioma	STR followed by GTR	Yes	Yes (S-100 +, Vimentin +, GFAP -)	Recurrence (STR due to adherence)
Pearson *et al.*, 2017	F, 22	Headache	Frontal	LGG, Pilocytic astrocytoma, ependymoma, neurocytoma	GTR	Yes	Yes (S-100 +, GFAP -)	
Gao *et al.*, 2018	F, 12	Headache, vomiting, gait disturbance	Brainstem	N.A.	CR	Yes	Yes (S-100 +, GFAP -, EMA-)	
Khaleghi *et al.,* 2018	F, 44	Headache, vomiting, diplopia	Frontal	Meningioma	GTR	Yes	Yes (S-100 +, GFAP -, EMA -)	
Ten *et al.*, 2018	M, 19	Visual impairment, headache	Occipital	N.A.	CR	Yes	No (EM: basement membrane attached to neoplastic cells	

(Contd...)

Table 1: *(Continued)*

Authors and year	Sex and Age	Symptoms	Site of lesion	Radiological diagnosis	Treatment	Histological diagnosis	IHC confirmed diagnosis	Additional findings
Chen *et al.*, 2019	M, 46	Seizures, headache	Temporal	Meningioma	GTR	Yes	Yes (S-100 +, GFAP -)	
Gulsuna *et al.*, 2019	M, 11	Seizures, neurogenic pulmonary edema	Frontotemporal	N.A.	GTR	Yes	No / N.A.	
Patankar *et al.*, 2019	M, 20	Headache, vomiting	Temporal	Meningioma	CR	Yes, malignant	Yes (S-100 +, Vimentin +, GFAP -)	No recurrence
Malhotra *et al.*, 2020	M, 18	Headache, seizures	Frontal	N.A.	CR	Yes	Yes (S-100 +, EMA-, GFAP -, CD34)	
Tokarev *et al.*, 2021	M, 27	Headache	Frontal	High-grade neuroepithelial tumor, metastasis or lymphoma	CR + RT	Yes	Yes (S-100 +, EMA-,	
Current case	M, 74	Gait disturbance	Pons	Hemangioblastoma	GTR	Yes	Yes (S-100+)	

CR: Complete resection, F: Female, GTR: Gross total resection, M: Male, NF1: Neurofibromatosis 1, NF2: Neurofibromatosis 2, N.A.: Not available, RT: Radiotherapy, STR: Subtotal resection, TBC: Tuberculosis

Table 2: Reported cases by age and sex.

Age group (years)	Male	Female	Total (%)
0–9	10	6	16 (10.7)
10–19	29	15	44 (29.3)
20–29	18	10	28 (18.7)
30–39	10	6	16 (10.7)
40–49	5	11	16 (10.7)
50–59	5	5	10 (6.7)
60–69	4	9	13 (8.7)
70 and older	2	4	6 (4.0)
Total	84 (56%)	66 (44%)	**150**

Table 3: Location of supratentorial and infratentorial intraparenchymal schwannomas.

Localization of supratentorial IS (*n*=99)		Localization of infratentorial IS (*n*=52)	
Frontal	42	Cerebellar	19
Temporal	20	Brainstem non-specified	11
Parieto-occipital	10	Pons	9
Parietal	9	Medulla	4
Occipital	6	Intrasellar	2
Frontotemporal	4	Mesencephalon	1
Frontoparietal	4	Lateral ventricle	1
Parieto-temporal	1	N.A.	3
Temporo-occipital	1	Multiple lesions	2
Thalamus	1		
Multiple lesions	1		

often called malignant intracerebral nerve sheath tumor (MINST), is extremely rare. Compared to benign IS, MINST are characterized by a high mitotic activity and Ki-labeling index.[9,18] A variant of MINST is a triton tumor, which is characterized additionally by rhabdomyoblastic components.[3]

Treatment and prognosis

Since IS are mostly benign lesions, gross total or complete resection of the tumor is usually curative. Therefore, surgical resection is the preferred treatment for symptomatic lesions.[7] We calculated a recurrence rate of 5.3% following gross total or complete resection [Table 1]. All recurrences were related to malignant histopathology. In cases with subtotal resection, only four patients required reoperation because of residual tumor or recurrence.[4,6,21,22] None of these recurrent cases were related to malignant pathology, suggesting that recurrence was the result of subtotal resection. Mortality rate among histopathological benign IS cases was 0% compared to 53% in malignant cases [Table 1].

Although rare, IS should be included in the differential diagnosis when typical radiological features are present. This is relevant as surgical approach and technique may be different in comparison to the many differential diagnoses that are included

in [Table 1]. For example, IS can be removed in a piecemeal intratumoral debulking fashion, whereas hemangioblastomas, being the preoperative suspected diagnosis in our case, requires an en bloc removal and entering the tumor could result in unnecessary blood loss. Similarly, in some cases, high grade glioma (of the brainstem) was the preoperative suspected diagnosis [Table 1] which may result in diagnostic biopsy surgery instead of surgical resection. Therefore, including IS in the differential diagnosis when typical radiological features are present is relevant for the surgical strategy.

The role of radiotherapy or chemotherapy as primary treatment of benign IS remains unknown. We found two cases in which radiotherapy was given as primary treatment.[10,17] In both cases, radiotherapy failed to reduce tumor size and tumor-related symptoms after which surgery was performed. Radiotherapy and chemotherapy may play a role as adjuvant treatment in malignant IS cases.[18]

CONCLUSION

ISs are rare benign tumors occurring mostly in young patients. Clinical presentation is usually related to tumor location or increased intracranial pressure. Gross total resection of the lesion is curative. To adjust the surgical strategy accordingly, ISs should be considered preoperatively when radiological features such as peritumoral edema, calcifications, and cysts are noted.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Casadei GP, Komori T, Scheithauer BW, Miller GM, Parisi JE, Kelly PJ. Intracranial parenchymal schwannoma. J Neurosurg 2009;79:217-22.
2. Chen F, Zhao S, Yu Y, Chen D. Intraparenchymal schwannoma with calcification of the temporal lobe: Case report and literature review. Medicine (Baltimore) 2019;98:e14263.
3. de Cauwer H, Bogers JP, Duwel V, van den Hauwe, Croese P, van Marck E. An intracerebral intraparenchymatous triton tumor in a man with neurofibromatosis. J Neurol 2007;254:1009-11.
4. Erongun U, Özkal E, Acar O, Uygun A, Kocaoğullar Y, Güngör S. Intracerebral schwannoma: Case report and review. Neurosurg Rev 1996;19:269-74.
5. Gibson AA, Hendrick EB, Conen PE. Intracerebral schwannoma. Report of a case. J Neurosurg 1966;24:552-7.
6. Gökay H, Izgi N, Barlas O, Erseven G. Supratentorial intracerebral schwannomas. Surg Neurol 1984;22:69-72.
7. Khoo HM, Taki T. Periventricular intraparenchymal schwannoma. Case report. Neurol Med Chir (Tokyo) 2012;52:603-7.
8. Khursheed N, Rumana M, Ramzan A, Furqan N, Abrar W, Salma B. Frontal intraparenchymal schwannoma. J Clin Neurosci 2011;18:411-3.
9. Kozić D, Nagulic M, Samardžić M, Ostojic J, Rasulić L, Cvetković-Dožić D. Intrapontine malignant nerve sheath tumor: MRI and MRS features. Acta Neurol Belg 2008;108:67- 71.
10. Lin J, Feng H, Li F, Zhao B, Guo Q. Intraparenchymal schwannoma of the medulla oblongata: Case report. J Neurosurg 2003;98:621-4.
11. Luo W, Ren X, Chen S, Liu H, Sui D, Lin S. Intracranial intraparenchymal and intraventricular schwannomas: Report of 18 cases. Clin Neurol Neurosurg 2013;115:1052-7.
12. Mahore A, Kansal R, Epari S, Kataria N, Sharma P. Supratentorial intraparenchymal schwannoma mimicking a glial tumor. Neurol India 2012;60:335-7.
13. Menkü A, Öktem IS, Kontaş O, Akdemir H. Atypical intracerebral schwannoma mimicking glial tumor: Case report. Turk Neurosurg 2009;19:82-5.
14. Muzzafar S, Ketonen L, Weinberg JS, Schellingerhout D. Imaging and clinical features of an intra-axial brain stem schwannoma. Am J Neuroradiol 2010;31:567-9.
15. Paredes I, Jimenez Roldán L, Ramos A, Lobato RD, Ricoy JR. Intraparenchymal schwannomas: Report of two new cases studied with MRI and review of the literature. Clin Neurol Neurosurg 2012;114:42-6.
16. Peker S, Kurtkaya O, Uzün I, Pamir MN. Microanatomy of the central myelin-peripheral myelin transition zone of the trigeminal nerve. Neurosurgery 2006;59:354-9.
17. Sharma V, Newton G. Schwannoma of the medulla oblongata. Br J Neurosurg 1993;7:427-9.
18. Shweikeh F, Drazin D, Bannykh SI. Malignant intracerebral nerve sheath tumors: A case report with review of the literature. Case Rep Surg 2013;2013:384076.
19. Skolnik AD, Loevner LA, Sampathu DM, Newman JG, Lee JY, Bagley LJ, *et al*. Cranial nerve schwannomas: Diagnostic imaging approach. Radiographics 2016;36:1463-77.
20. Tsuiki H, Kuratsu J, Ishimaru Y, Nakahara T, Kishida K, Takamura M, *et al*. Intracranial intraparenchymal schwannoma: Report of three cases. Acta Neurochir (Wien) 1997;139:756-60.
21. Wilberger JE. Primary intrasellar schwannoma: Case report. Surg Neurol 1989;32:156-8.
22. Zhang Q, Ni M, Liu WM, Jia W, Jia GJ, Zhang JT. Intra-and extramedullary dumbbell-shaped schwannoma of the medulla oblongata: A case report and review of the literature. World Neurosurg 2017;98:873.e1-7.

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