Intraparenchymal schwannoma with calcification of the temporal lobe
Case report and literature review
Fan Chen, MDa, Shuai Zhao, MDb, Ying Yu, MDa, Dawei Chen, MDa,∗

Abstract
Rationale: Intracranial schwannomas most frequently arise from the trigeminal nerve and the vestibular nerve. Schwannomas within the cerebral parenchyma are exceedingly rare. Additionally, calcification is an uncommon histopathological and radiological characteristic in schwannomas.

Patient concerns: A 46-year-old man presented to us with sudden onset epileptic seizure and a 3-month history of intermittent headache. After admission, the physical and neurological examinations were all normal. Brain CT revealed an irregular, well-defined, hyperdense mass in the right temporal lobe. MRI showed a solid mass appearing iso- to hypointensity on T1-weighted imaging and heterogeneous intensity on T2-weighted imaging in the right temporal lobe; after Gd-DTPA administration, the lesion showed heterogeneous enhancement.

Diagnosis: Histopathological examination revealed hyperchromatic nuclei and loose intercellular matrix with calcification. Immunohistochemical analysis demonstrated that the tumor was strongly positive for S100 protein but negative for GFAP and CK, which was consistent with a schwannoma.

Interventions and outcomes: A surgical resection via the right temporal approach was performed. Intraoperatively, we noticed that the tumor was grayish yellow, capsuleless, and located entirely within the temporal parenchyma. A gross total resection was achieved. The postoperative course was uneventful, and there was no epileptic seizure.

Lessons: Intraparenchymal schwannoma with calcification is an uncommon histopathological and radiological characteristic in schwannomas. Intraparenchymal schwannoma with calcification is extremely rare. The early identification and appropriate surgical treatment should be highlighted.

Abbreviations: CK = cytokeratin, CT = computed tomography, CUSA = cavitron ultrasonic surgical aspirator, CYT = cytochrome, EMA = epithelial membrane antigen, Gd-DTPA = gadolinium-diethylene triamine pentaacetic acid, GFAP = glial fibrillary acidic protein, MRI = magnetic resonance imaging.

Keywords: calcification, case report, intraparenchymal, schwannoma, surgical resection

1. Introduction
Intracranial schwannomas account for 8% of all primary cerebral neoplasms.[1] The tumors most frequently involve the trigeminal nerve and the vestibular nerve, and those arising from other cranial nerves are rare. Especially, schwannomas occurring within the cerebral parenchyma are exceedingly rare.[1,2] According to literatures, approximately 70 cases of schwannomas unrelated to the cranial nerves have been reported.[1] The pathogenesis of intraparenchymal schwannomas remains unknown, as there are no Schwann cells in the cerebral parenchyma.[3] Additionally, calcification is an uncommon histopathological and radiological characteristic in schwannomas; only 16 cases of intracranial schwannomas with calcification were identified in previous reports.

Herein, we reported a case diagnosed as intraparenchymal schwannoma with calcification in the temporal lobe. Moreover, we reviewed the literatures regarding schwannomas with calcification, and the clinicoradiological features were analyzed.

2. Case presentation
A 46-year-old man presented to us with sudden onset epileptic seizure and a 3-month history of intermittent headache. After admission, the physical and neurological examinations were all normal. Brain computed tomography (CT) revealed an irregular,
well-defined, hyperdense mass in the right temporal lobe (Fig. 1A). Magnetic resonance imaging (MRI) showed a solid mass appearing iso- to hypointensity on T1-weighted imaging and heterogeneous intensity on T2-weighted imaging in the right temporal lobe; after gadolinium-diethylene triamine pentaacetic acid (Gd-DTPA) administration, the lesion showed heterogeneous enhancement; the tumor did not involve the cerebellopontine angle region (Fig. 1B–F). The operative preliminary diagnosis was meningioma with calcification, and a surgical resection via the right temporal approach was performed. Intraoperatively, we noticed that the tumor was grayish-yellow, capsuled, and located entirely within the temporal parenchyma; there was parenchymal tissue between the tumor and the dura mater, and no significant adhesion with the surrounding tissue was noted. Microscopically, the tumor was resected in piecemeal fashion and the calcified part was removed using cavitron ultrasonic surgical aspirator (CUSA); eventually, a gross total resection was achieved. Histopathological examination revealed hyperchromatic nuclei and loose intercellular matrix with calcification (Fig. 2A). Immunohistochemical analysis demonstrated the tumor was strongly positive for S100 protein (Fig. 2B) but negative for glial fibrillary acidic protein (GFAP) and cytokeratin (CK), which was consistent with a schwannoma. The Ki-67 proliferation index was less than 1%. Immediately after surgery, headache was relieved. The postoperative course was uneventful, and there was no epileptic seizure. After a 6-month follow-up, MRI showed no recurrence (Fig. 3), and the patient remained asymptomatic.

3. Discussion

We retrieved the relevant literatures, and identified 16 cases of schwannomas with calcification. The individual clinical characteristics, MRI features, and surgical outcomes were summarized in Table 1. The locations included cerebellopontine angle region (n=8), sulci olfactorius (n=4), middle cranial fossa (n=2), frontal lobe (n=1), and anterior cranial fossa (n=1). Herein, we reported the first schwannomas with calcification occurring in the temporal lobe. Including the present case, the average age is 41.7 years (range, 14–66 years). There are 9 males and 8 females, yielding a male-to-female ratio of 1:1.25. On MRI, these tumors appeared hypointensity (54.55%), iso- to hypointensity (18.18%), isointensity (9.09%), hyperintensity (9.09%), and heterogeneous intensity (9.09%) on T1-weighted imaging; the tumors appeared hyperintensity (60%), hypointensity (10%), and heterogeneous intensity (30%) on T2-weighted imaging; after contrast medium administration, the tumors appeared heterogeneous (90%) or homogeneous (10%) enhancement. Noteworthily, among these cases, there are 8 patients with calcified schwannomas occurring in the cerebral parenchyma.

The pathogenesis of intraparenchymal schwannomas is still unknown. Generally, schwannomas are considered to originate from the Schwann cells, while the Schwan cells exclusively exist
outside the pia mater forming nerve sheath and there is no such cell in the cerebral parenchyma. According to literatures, there are four theoretical hypotheses:

1. intraparenchymal Schwann cells may be transformed from the pial mesodermal cells;

2. these aberrant Schwann cells may be differentiated from the pluripotent interstitial cells;

3. intraparenchymal schwannoma may arise from the Schwann cells existing within the perivascular nerve plexus and large arteries in the subarachnoid spaces;

4. atypical schwannoma may be derived from the Schwann cells located outside the pia mater forming nerve sheath and there is no such cell in the cerebral parenchyma.
# Table 1
The clinical and radiological profiles of schwannomas with calcification.

| Author                  | Year | Gender | Age  | Symptoms                                   | Location                      | MRI features                                    | Resection extent | Follow-up duration (month) | Recurrence |
|-------------------------|------|--------|------|--------------------------------------------|-------------------------------|------------------------------------------------|------------------|------------------------------|------------|
| Kusumi et al[16]        | 2016 | F      | 66   | Vertigo                                    | Left middle cranial fossa    | T1WI: isointensity                              | GTR              | N.A.                         | N.A.       |
| Zhang et al[17]         | 2012 | M      | 48   | Hearing loss                               | Left cerebellopontine angle  | T1WI: hypointensity; T2WI: hyperintensity; Gd-DTPA: heterogeneously enhancement | GTR              | 6                            | No         |
| Li et al[18]            | 2012 | F      | 16   | Epileptic seizure                          | Right frontal lobe           | T1WI: N.A.; T2WI: hyperintensity; Gd-DTPA: heterogeneously enhancement | GTR              | N.A.                         | N.A.       |
| Gopalakrishnan et al[19]| 2011 | M      | 65   | Hearing loss, facial numbness, asymmetry   | Left cerebellopontine angle  | T1WI: hypointensity; T2WI: hyperintensity; Gd-DTPA: heterogeneously enhancement | GTR              | N.A.                         | N.A.       |
| Choi et al[20]          | 2009 | F      | 39   | Anosmia, intermittent frontal headache     | Right anterior cranial fossa | T1WI: N.A.; T2WI: N.A.; Gd-DTPA: heterogeneously enhancement | GTR              | N.A.                         | N.A.       |
| Saberi et al[21]        | 2008 | F      | 35   | Headache, diplopia, epileptic seizure      | Sulci olfactorius            | T1WI: hypointensity; T2WI: hyperintensity; Gd-DTPA: heterogeneously enhancement | GTR              | 1                            | No         |
| Katoh et al[22]         | 2007 | F      | 59   | Epileptic seizure                          | Left cerebellopontine angle  | T1WI: heterogeneous intensity; T2WI: heterogeneous intensity; Gd-DTPA: heterogeneously enhancement | STR              | N.A.                         | N.A.       |
| Adachi et al[23]        | 2007 | F      | 22   | Convulsion                                 | Sulci olfactorius            | T1WI: N.A.; T2WI: N.A.; Gd-DTPA: heterogeneously enhancement | GTR              | N.A.                         | N.A.       |
| Yako et al[24]          | 2005 | M      | 14   | Headache, vomiting                         | Sulci olfactorius            | T1WI: hyperintensity; T2WI: N.A.; Gd-DTPA: N.A. | GTR              | 12                           | No         |
| Tosaka et al[25]        | 2002 | M      | 36   | Hearing loss                               | Left cerebellopontine angle  | T1WI: isointensity; T2WI: hyperintensity; Gd-DTPA: N.A. | STR              | N.A.                         | N.A.       |
| Bando et al[26]         | 1992 | F      | 28   | Visual field deficiency                    | Sulci olfactorius            | T1WI: hypointensity; T2WI: N.A.; Gd-DTPA: N.A. | GTR              | N.A.                         | N.A.       |
| Atlas et al[27]         | 1992 | M      | 50   | Hearing loss                               | Right cerebellopontine angle | N.A.                                          | GTR              | N.A.                         | N.A.       |
| Beskin et al[28]        | 1989 | M      | 47   | Hearing loss                               | Left cerebellopontine angle  | T1WI: hypointensity; T2WI: hyperintensity; Gd-DTPA: N.A. | GTR              | N.A.                         | N.A.       |
| Horimoto et al[29]      | 1987 | M      | 63   | Facial weakness                            | Right middle cranial fossa   | N.A.                                          | STR              | N.A.                         | N.A.       |
| Thomsen et al[30]       | 1984 | M      | 44   | Hearing loss                               | Right cerebellopontine angle | N.A.                                          | GTR              | N.A.                         | N.A.       |
| Present case             | –    | M      | 46   | Intermittent headache, epileptic seizure   | Right temporal lobe          | T1WI: isointensity; T2WI: heterogeneous intensity; Gd-DTPA: heterogeneously enhancement | GTR              | 6                            | No         |

F = female, Gd-DTPA = gadolinium-diethylene triamine pentaaetic acid, GTR = gross total resection, M = male, N.A. = not available, STR = subtotal resection, T1WI = T1-weighted imaging, T2WI = T2-weighted imaging.
may bring challenges in tumor removal.\(^{[15]}\) In the current case, we believe surgical complete resection can be feasible. However, when dealing with capsule and there is no adhesion with the surrounding tissue, the tumors usually well circumscribed with homogeneous enhancement, and cystic changes can be visible.\(^{[9]}\)

The differential diagnosis of intraparenchymal schwannomas with calcification should include the following entities: (1) psammomomatous meningiomas, which usually show calcification on CT and dural tail sign on MRI;\(^{[8]}\); (2) oligodendrogliomas, which appear hypointensity on T1-weighted imaging and hyperintensity on T2-weighted imaging; the tumors usually well circumscribed with homogeneous enhancement, and cystic changes can be visible.\(^{[9]}\)

Pathologically, intraparenchymal schwannomas exhibit dense spindle-shaped Schwann cells arranged in interlacing fascicles with hyperchromatic nuclei.\(^{[3,10]}\) Immunohistochemical staining can facilitate the diagnosis, which are positive for S-100 protein and cytochrome (CT), but negative for CK, GFAP, epithelial membrane antigen (EMA), desmin, and Bcl-2.\(^{[11–14]}\) The Ki-67 proliferation indexes are usually less than 1%, suggesting a benign behavior.

Since intraparenchymal schwannomas are usually well defined with capsule and there is no adhesion with the surrounding tissue, surgical complete resection can be feasible. However, when calcification is present, the tumor may be hard in nature, which may bring challenges in tumor removal.\(^{[15]}\) In the current case, we attempted to use CUSA for the surgical resection. In literatures, no recurrence was noted. However, we recommend a much longer follow-up.

**Author contributions**

Fan Chen conceived the concept and approved the final manuscript. Shuai Zhao and Junguo Cao are responsible for the design. Dawei Chen is responsible for the data analysis.

**Resources:** Shuai Zhao, Ying Yu, Dawei Chen.

**Writing – original draft:** Fan Chen.

**References**

[1] Rotondo M, Pascale M, Scuotto A. Giant frontal intraparenchymal schwannoma: unexpected diagnosis. BMJ Case Rep 2013; doi: 10.1136/bcr-2013-010350.

[2] Guha D, Kiehl TR, Krings T, et al. Infratemporal schwannoma presenting as classic temporal lobe epilepsy. J Neurosurg 2012;117:136–40.

[3] Gupta A, Sharma D, Dhillon GS, et al. Intracranial periventricular supratentorial intraparenchymal schwannoma. Surg Neurol Int 2016;7(Suppl 40):S1103–5.

[4] Li YP, Jiang S, Zhou PZ, et al. Solitary olfactory schwannoma without olfactory dysfunction: a new case report and literature review. Neurol Sci 2012;33:137–42.

[5] Zagardo MT, Castellani RJ, Rees JH, et al. Radiologic and pathologic findings of intracerebral schwannoma. AJNR Am J Neuroradiol 1998;19:1290–3.

[6] Srivivas K, Kupashankar D, Shas I. Infratemporal schwannoma in a 16-year-old girl: a case report and review of the literature. Case Rep Neurol Med 2013;2013:171494.

[7] Sharma MC, Karak AK, Gaikwad SB, et al. Infratemporal intraparenchymal schwannomas: a series of eight cases. J Neurol Neurosurg Psychiatry 1996;60:200–3.

[8] Goldsmith B, McDermott MW. Meningioma. Neurosurg Clin N Am 2006;17:111–20.

[9] Bhaskar MK, Jaiwal M, Ojha B, et al. Cerebellar cystic oligodendroglioma in a young adult. J Neurosci Rural Pract 2017;8:479–81.

[10] Pearson L, Akture E, Wonderlick J, et al. Microcystic/reticular schwannoma of the frontal lobe: an unusual occurrence. Case Rep Pathol 2017;2017:4728585.

[11] Khursheed N, Rumana M, Ramzan A, et al. Frontal intraparenchymal schwannomas. J Clin Neurosci 2011;18:411–3.

[12] Liegl B, Bennett MW, Fletcher CD. Microcystic/reticular schwannoma: a distinct variant with predilection for visceral locations. Am J Surg Pathol 2008;32:1080–7.

[13] Lau RP, Melamed J, Yee-Chang M, et al. Microcystic/reticular schwannoma arising in the submandibular gland: a rare benign entity that mimics more common salivary gland carcinomas. Head Neck Pathol 2016;10:374–8.

[14] Luzar B, Tanaka M, Schneider J, et al. Cutaneous microcystic/reticular schwannoma: a poorly recognized entity. J Cutan Pathol 2016;43:93–100.

[15] Hayashi F, Sakai T, Sairyo K, et al. Intramedullary schwannoma with calcification in the setting of temporal lobe edema. J Clin Neurosci 2007;14:1207–9.

[16] Zhang Y, Yu J, Qu L, et al. Calcification of vestibular schwannoma: a case report and literature review. World J Surg Oncol 2012;10:207.

[17] Gopalakrishnan CV, Shrivastava A, Nair S. Calcification in vestibular schwannoma: report of two cases and review of the literature. Neurol India 2011;59:642–5.

[18] Choy YS, Sung KS, Song YJ, et al. Olfactory schwannoma-case report. J Korean Neurosci Soc 2009;45:103–6.

[19] Saberi H, Khoshayar P. Olfactory groove schwannoma masquerading as an orbital mass. Neurosciences (Riyadh) 2008;13:73–6.

[20] Katoch M, Aida T, Imamura H, et al. Calcified vestibular schwannoma in the cerebellopontine angle. J Clin Neurosci 2007;14:1207–9.

[21] Adachi K, Yoshida K, Miwa T, et al. Olfactory schwannoma. Acta Neurochir (Wien) 2005;147:655–8.

[22] Bando K, Obayashi M, Tsuneharu F. A case of subfrontal schwannoma. No Shinkei Geka. Neurol Surg 1987;15:1133–4.

[23] Beskin RR, Eick JJ. Calcified vestibular schwannoma in vestibular schwannoma extending into the middle cranial fossa with characteristic CT findings. No Shinkei Geka. Neurol Surg 1987;15:1133–4.

[24] Thomsen J, Klinken L, Tos M. Calcified acoustic neuroma. J Laryngol Otol 1984;98:727–32.