

# Clinical and radiological characteristics of brain abscess caused by Streptococcus species: a cross-sectional study

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## Research article

**Keywords:** Brain abscess; Streptococcus species; Magnetic resonance imaging; Clinical features

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1    **Clinical and radiological characteristics of brain abscess caused**  
2    **by *Streptococcus* species: a cross-sectional study**

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17

18   **Abstract**

19   **Background:** *Streptococcus* species are mostly reported the predominant organisms  
20   causing brain abscess (BA), however, there is no article focusing on the characteristics  
21   of patients with BA caused by *Streptococcus* species to date. This study aimed to  
22   describe the clinical and radiological features of patients with BA caused by  
23   *Streptococcus* species.

24   **Methods:** All patients who were hospitalized due to BA with intracranial pus culture  
25   result of *Streptococcus* species alone after neurosurgical intervention from May 2015  
26   to August 2018 in Huashan Hospital in Shanghai were included in this study. The data  
27   of patient demographics, clinical and radiological presenting features, microbiological  
28   results, surgical and antimicrobial treatment, and outcomes were collected.

29   **Results:** Thirteen patients (10 male, 3 female) of primary brain abscesses were  
30   involved. The most frequent clinical presentations included headache (76.9%), fever  
31   (38.5%) and limb weakness (38.5%). The radiological features of abscesses in these  
32   patients included singularity, big size, thick wall and obvious oedema. The average  
33   abscess diameter before surgery was  $51.62\pm11.00\text{mm}$ . The mean thickness of abscesses  
34   wall was  $5.23\pm1.78\text{mm}$ . The mean range of oedema and distance between abscess  
35   margin were  $93.62\pm16.31\text{mm}$ ,  $26.38\pm8.03\text{mm}$ , respectively. The strains isolated in this  
36   study all belonged to the viridans group and showed high susceptibility to cefotaxime  
37   and levofloxacin. All patients had good outcomes at discharge.

38   **Conclusion:** Patients with BAs caused by *Streptococcus* species had unspecific clinical  
39   signs, but specific radiological features, which might be helpful for early diagnosis.

40

41   **Keywords:** Brain abscess; *Streptococcus* species; Magnetic resonance imaging;

42   Clinical features

43

44     **Background**

45     With development in imaging and surgical techniques, the success in treatment of brain  
46     abscess (BA) has increased significantly [1], but it still remains a kind of disease with  
47     high disability and its incidence might be underestimated. The reported incidence rate  
48     of BA ranged from 0.33 to 0.4 cases per 100,000 population per year in developed  
49     countries [2, 3], while it was much higher in developing country [4]. A study in Taiwan  
50     revealed an annual incidence of BA was 1.88/100,000/year [5], but accurate figures are  
51     not available for large parts of China.

52         The outcome of patient with BA is improved if etiologic agent is identified and  
53         antimicrobial therapy is targeted. The delay of antibiotic treatment was associated with  
54         50% increase of mortality risk per day [6]. *Streptococcus* species are mostly reported  
55         the predominant organisms causing BA, comprising more than 70% of isolates cultured  
56         from bacterial BAs (58% *Streptococcus pneumoniae*; 18.1% group B *Streptococcus*)  
57         [7]. However, there is no article focusing on the characteristics of patients with BA  
58         caused by *Streptococcus* species to date.

59         This study aimed to describe the clinical features, microbiology, radiological  
60         characterization, treatment and clinical outcomes of patients with BAs due to  
61         *Streptococcus* species in a tertiary hospital in Shanghai, and to investigate important  
62         characteristics for early diagnosis.

63

64     **Methods**

65 Study design and patients  
66 All patients who were hospitalized due to BA with intracranial abscess culture result of  
67 *Streptococcus* species alone after neurosurgical intervention from May 2015 to August  
68 2018 in Huashan Hospital in Shanghai were included in this study. Neurosurgical  
69 interventions referred to craniotomy cavity incision or burr hole aspiration.

70 Anonymized details of patient demographics, clinical and radiological presenting  
71 features, microbiological results, routine blood examination, Charlson's weighted  
72 index of comorbidity (WIC) [8], surgical and antimicrobial treatment, and outcomes  
73 were collected from the electronic hospital data.

74

75 Magnetic resonance imaging (MRI)  
76 MRI scans with enhancement were obtained for all patients. BAs were identified by  
77 hypointense signal in T1WI and hyperintense signal in T2WI or fluid-attenuated  
78 inversion recovery weighted imaging (FLAIR), with ring-shaped enhancement and  
79 extensive surrounding oedema [4]. Conventional MRI with diffusion weighted imaging  
80 (DWI) was performed and hyperintensity was observed in all the pyogenic abscess  
81 cavities. The data of lesion number, size, location, range of edema and thickness of the  
82 abscess wall was collected for further analysis.

83

84 Patient evaluation

85 The primary outcome measures were in-hospital mortality and Glasgow Coma Scale  
86 (GCS) at discharge. All intracranial pus samples were identified using standard method  
87 and susceptibility testing was detected using the disc diffusion method recommended  
88 by Clinical and Laboratory Standards Institute (CLSI) [9] at the clinical microbiology  
89 laboratory of Huashan Hospital.

90

91 Statistical analysis

92 The analyses were done using IBM SPSS 22.0 package program. Continuous variables  
93 were expressed as mean  $\pm$  SD and compared using the Student's *t*-test. All *P* values  
94 were two-sided, with a *P* value  $<0.05$  considered statistically significant.

95

## 96 **Results**

97 Clinical characteristics

98 Thirteen patients (10 male, 3 female) who had received surgery or undergone the burr  
99 hole aspiration of BAs were involved. The demographic features were presented in  
100 Table 1. The median age was  $55.23 \pm 15.50$  years (range 23-76). Three (23.1%) of the  
101 patients had comorbid chronic illnesses (hypertension, chronic lung disease, diabetes  
102 mellitus, liver disease). The most frequent clinical presentations included headache  
103 (76.9%), fever (38.5%) and limb weakness (38.5%). Two patients complained of a  
104 reduced mental status. The underlying source of the BA was identified in 2 patients,  
105 with 1 had a contiguous ear infection and 1 had dental infection.

106

107 Foci features

108 BAs were singular in all of the subjects, and 6 (46.15%) of them were multi-  
109 compartment. In 8 (61.5%) patients the abscess was localized at the frontal lobe (Figure  
110 1). The average abscess diameter before surgery was  $51.62 \pm 11.00$ mm. The mean  
111 thickness of abscesses wall was  $5.23 \pm 1.78$ mm. The mean range of oedema and distance  
112 between abscess margin were  $93.62 \pm 16.31$ mm,  $26.38 \pm 8.03$ mm, respectively.

113

114 Laboratory and microbiological findings

115 Seven patients had evaluated peripheral white blood cell counts with leukocytosis.  
116 *Streptococcus* isolated all belonged to the viridans group (5 *Streptococcus* intermedius,  
117 4 *Streptococcus* constellatus, 2 *Streptococcus* gordoni, 1 *Streptococcus* anginosus, 1  
118 *Streptococcus* sanguis). All *Streptococci* species were susceptible to cefotaxime and  
119 levofloxacin, while the susceptibility rate to erythromycin and clindamycin were 46.2%  
120 and 38.5%, respectively.

121

122 Antibiotics and steroid treatment

123 All patients were treated with systemic antibiotic therapy after surgery. Five (38.5%)  
124 of patients were treated with three or more different antibiotic regimens and changes of  
125 intravenous antibiotic treatment were common. The most frequent choice for treatment  
126 was a  $\beta$ -lactam (penicillin, third generation cephalosporin or meropenem) in

127 combination with metronidazole. Intrathecal vancomycin was administered to 53.8%  
128 (n=7) of patients.

129 Before surgery, 3 (23.1%) patients received steroid treatment. After surgery, 4  
130 (30.8%) received steroid, usually for a limited time period.

131

132 Outcomes

133 No patient died during the initial hospital stay. Twelve (92.3%) patients were with GCS  
134 15 at discharge, and the remaining one was with GCS 14. Of these patients, 6 (46.2%)  
135 patients had decreased muscle strength. No cases of recurrent abscesses were observed.

136

### 137 **Discussion**

138 BA is a life-threatening infection and a challenge for physician with high morbidity and  
139 mortality. Early and accurate antibiotic treatment targeted on pathogen before and after  
140 surgery might be helpful for outcomes. Studies based on pathogen is warranted.

141 This study provides a detailed overview of the clinical and radiological  
142 presentation, microbiological features, treatment, and outcomes of adult patients treated  
143 surgically because of BA with positive pus culture of *Streptococcus* species. The male  
144 predominance in BA noted in this study was consistent with previous studies [5, 10].

145 Most of patients were with good clinical conditions, without immunosuppressed status.  
146 Headache, fever were the most common symptoms in BA from the previously  
147 published data [11, 12], and they were also observed in 76.9% and 38.5% of patients in

148 this study, following limb weakness (38.5%), vomiting (23.1%), and walking unstable  
149 (23.1%). No seizure was presented in these patients. Focus identification was successful  
150 in 2 patients, showing the most frequent causes of brain abscess: sinusitis, dental  
151 infections.

152 The frontal lobe was the most common abscess location in the patients, as  
153 described previously [13], which might suggest abscesses due to sinusitis [14]. The  
154 radiological features of abscesses in these patients included singularity, big size, thick  
155 wall and obvious edema. We compared the imaging differences in BAs caused by  
156 *Streptococcus* species and *Klebsiella pneumoniae* (data not shown). The results showed  
157 lesion diameter and thickness of abscesses wall in *Streptococci* species group (N=13)  
158 showed statistically larger than those in *Klebsiella pneumoniae* group (N=7)  
159 (54.63±13.01mm versus 18.27±15.30mm,  $P <0.001$ ; 5.23±1.78mm versus  
160 2.81±1.57mm,  $P =0.007$ ). The range of edema showed statistically wider in  
161 *Streptococcus* species group (26.38±8.03mm) than that in *Klebsiella pneumoniae* group  
162 (15.14±14.29mm) ( $P=0.035$ ). It suggested that different pathogens had identified  
163 imaging presentation, which may contribute to early intervention, and no other studies  
164 have analyzed the relation between them, so further studies will have to be conducted.

165 *Streptococcus* species were the most common bacteria isolated from patients with  
166 BAs, including *Streptococcus milleri* group, *Streptococcus pneumoniae*, et al [7, 15].  
167 However, the strains isolated in this study all belonged to the viridans group. It was  
168 reported that third-generation cephalosporin resistance in less than 8% of *Streptococci*

169 mitis/oralis isolates in the Netherlands [16]. CHINET bacterial resistance surveillance  
170 data showed that resistance rate of *Streptococcus* viridans to cefotaxime, erythromycin  
171 and clindamycin was 11.5%, 65.4% and 58.3%, respectively. The strains in this study  
172 showed higher susceptibility to cefotaxime and erythromycin. The most common  
173 therapy is triple antibiotics medication including a  $\beta$ -lactam, vancomycin and  
174 metronidazole. Metronidazole is part of the antibiotic regime, even if anaerobic bacteria  
175 are not found in culture as they are hard to be detected in routine cultures.

176 All the patients involved had good outcomes at discharge, which were mainly  
177 related to neurosurgical techniques, one of the key factor behind improved prognosis.

178 There are several limitations of this study. First, the number of patients involved  
179 is relatively small. In addition, clinical information on follow-up, such as Glasgow  
180 Outcome Scale results at 1 month or later, and duration of antimicrobial therapy, was  
181 not available in this study. Further prospective studies with a large sample size should  
182 be conducted to increase our understanding of this disease.

183

#### 184 **Conclusions**

185 BA is a rare but dangerous disease and surgical procedures showed good outcomes.  
186 This study demonstrates clinical and radiological characteristics in BA caused by  
187 *Streptococcus* species, and suggest future therapy of BA should consist of early  
188 attempts for microbiological analyses.

189

190    **Abbreviations**

191    BA: Brain abscess; WIC: Charlson's weighted index of comorbidity; FLAIR: Fluid-  
192    attenuated inversion recovery weighted imaging; GCS: Glasgow Coma Scale; DWI:  
193    Diffusion weighted imaging; CLSI: Clinical and Laboratory Standards Institute

194

195    **Acknowledgments**

196    None.

197

198    **Authors' contributions**

199    Jiachun Su and Bin Hu: Conception of study idea, study design, literature review, data  
200    analysis and drafting the manuscript. Yixin Zhang: data collection. Ying Li: Conception  
201    of study idea, study design, and revision of the manuscript.

202

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206    Shanghai (grant number 19YF1405400).

207

208    **Availability of data and materials**

209 The datasets generated and analyzed during the current study are available from the  
210 corresponding author on reasonable request and upon approval from the Ethics  
211 Committee of Huashan Hospital.

212

213 **Ethics**

214 This study protocol was approved by the Ethics Committee of Huashan Hospital. The  
215 approval number was KY2020-031 and a waiver of patient consent was granted.

216

217 **Consent for publication**

218 Not applicable.

219

220 **Competing interests**

221 The authors declared that they have no competing interest.

222

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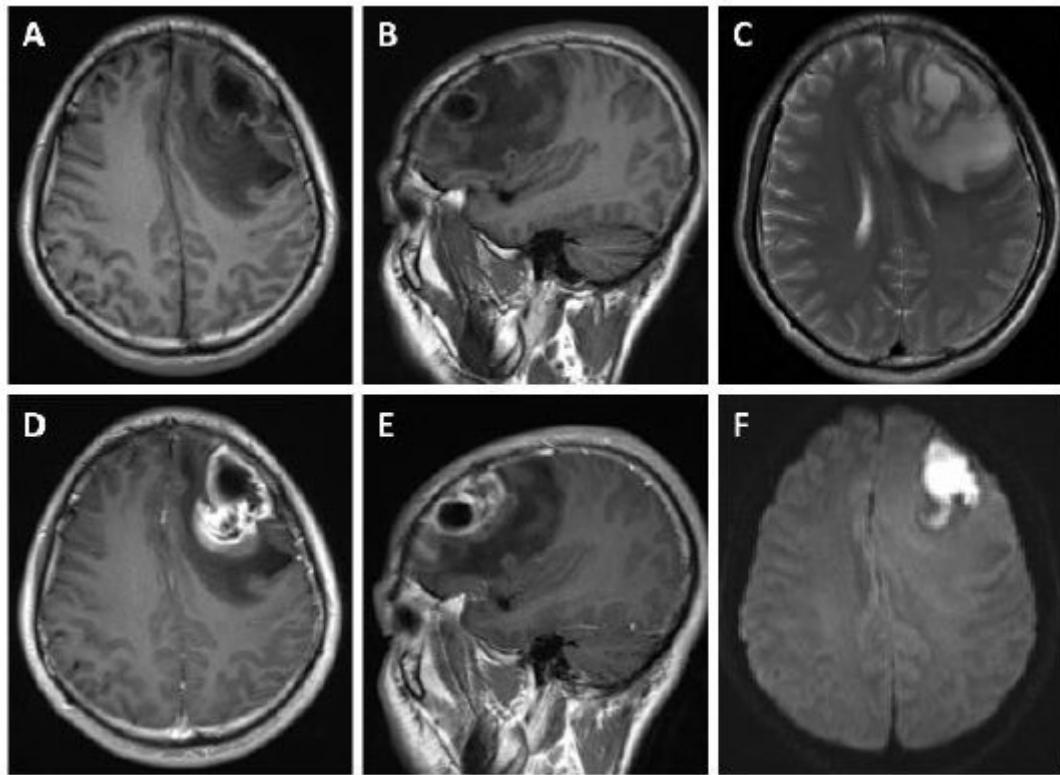
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- 276

## Figures



**Figure 1**

Preoperative T1 weighted MRI (A-B), Preoperative T2 weighted MRI (C), Preoperative T1 weighted enhanced MRI (D-E), Preoperative DWI MRI (F)

## Supplementary Files

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- [table1.pdf](#)