Predictors of Seizure Freedom in Pediatric Low-Grade Gliomas

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Abstract

Objective: Pediatric low-grade gliomas (LGGs) are found in approximately one to three percent of patients with childhood epilepsy. Epilepsy in these patients is often medically refractory and therefore represents a unique cohort with significant morbidity from concomitant pathology. Similar studies in adult patients with low-grade gliomas have identified predictors of seizure freedom including gross-total resection, preoperative seizure control on antiepileptic medication and duration of seizures of less than one year. This study aims to identify similar predictors of seizure freedom in operatively managed pediatric LGGs.

Methods: A retrospective chart review was performed for patients diagnosed with World Health Organization (WHO) Grade I and II gliomas in patients ≤18 years old at a single institution (Indiana University School of Medicine at Riley Hospital for Children in Indianapolis, IN) from 2007-2017. Infratentorial and purely intraventricular lesions were excluded. WHO classification and histologic diagnosis were based on surgical pathology. Tumor grade, location, laterality, seizure status at presentation, and AED requirements pre- and post-operatively were recorded. Chi-squared analyses for independence were performed controlling for age at presentation, resection extent, seizure type, and Engel Class for seizure freedom post-operatively.

Results: Forty-two patients met the inclusion criteria. Preoperative seizures were observed in 23 patients (55%). Presentation with preoperative seizures was highly associated with continued seizure burden post-operatively, independent of the extent of surgical resection. Supratentorial location and the administration of prophylactic pre- and post-operative AEDs were associated with Engel Class I seizure freedom. Temporal location was not significantly associated with medically refractory epilepsy compared with extra-temporal locations.

Conclusions: In our cohort of pediatric LGGs, we find that patients that did not initially present with seizures and those who were treated with prophylactic pre- and post-operative AEDs, were more likely to achieve Engel Class I seizure freedom post-operatively. Tumors located in the temporal location were not significantly associated with a higher seizure burden than other supratentorial, extra-temporal tumors. Neither extent of resection nor electrocorticography-guided resection correlated with improved seizure freedom outcomes during glioma resection.

Introduction

Adults and children with low-grade gliomas (LGGs) often present with seizures which can lead to medically refractory epilepsy [1-4]. LGGs, including glial and glioneuronal tumors, are found in roughly one to three percent of patients with childhood epilepsy; such seizures often present significant morbidity, often more so than other tumor-related symptoms [5-7].

Slow-growing tumors such as dysembryoplastic neuroepithelial tumors (DNETs) and gangliogliomas are more likely than high-grade tumors to be epileptogenic in children [8,9]. The grade of neoplasm is often more life-limiting than the epileptic sequelae in both the pediatric and adult populations; however, when tumor-related epilepsy remains uncontrolled, it significantly contributes to patient morbidity and negatively impacts the quality of life [10,11].

Approximately 70% of all patients with LGGs endure a seizure during the disease process; 30%-50% of them have seizures on presentation, while approximately 9%-30% of patients have seizures as their only presenting symptom [3]. A recent multisite retrospective study found that 24% of pediatric patients with supratentorial LGGs also had seizures on presentation, and that these patients could be stratified into
medically refractory, more than two and less than two seizures. They report a very low rate of postoperative new-onset epilepsy and a significant decrease in epilepsy in these pediatric patients with LGGs. In adult patients presenting with LGGs and epilepsy, predictors of seizure freedom have been identified including gross-total resection, preoperative seizure control on antiepileptic medication and duration of seizures of less than one year. Tumor location also influences the risk for epilepsy, with those localized in the frontal, temporal and parietal lobes being more commonly associated with seizures than those in the occipital lobes. This study aimed to identify predictors of seizure freedom of LGGs among the pediatric population given their significant differences and diversity in histopathology, as well as the duration of disease burden both of the tumor itself and the potential for a secondary seizure disorder.

**Materials And Methods**

A retrospective chart review was performed of all patients at Riley Hospital for Children, with new diagnosis of low-grade glioma between January 1, 2000 and December 31, 2017. Inclusion criteria consisted of surgical resection or biopsy, age ≤18 years at diagnosis, follow-up for at least one year, and pathologic diagnosis of low-grade glioma (grade I or II) as determined by a board-certified pathologist. Posterior fossa and purely intraventricular lesions were excluded due to their typical non-epileptogenic nature. Patients who had lifelong or pre-existing epilepsy were also excluded if it was clear that the epilepsy was present before the tumor.

Comparative oncologic data included date of diagnosis, pathology, anatomical location, the extent of surgical resection, adjuvant radio- or chemotherapy, recurrence rates and progression-free and overall survivals (PFS and OS). The extent of resection was defined as biopsy, subtotal resection leaving behind any residual amount, and gross total resection. Residual or recurrence was identified by a board-certified neuroradiologist using MRI with and without gadolinium contrast.

Seizure data included status at presentation, whether the patient had experienced a seizure at any point in time prior to presentation, anti-epileptic medication use pre- and post-operatively (usually Levetiracetam but Phenytoin was also used in some patients), and Engel class outcome.

**Statistical analysis**

Chi-square analyses with and without Yates correction were performed on calculated pooled rates of seizure freedom (Engel Class I) versus continued seizure burden (Engel Classes II-IV). Values reported include Yates correction if significance was changed, otherwise reported without correction. Initial between-group comparisons were performed using the Pearson chi-squared test with Yates correction as all variables were categorical. Odds ratios with a 95% confidence interval were performed to analyze variables found to be significant (p<0.05) following chi-squared analysis with ratios reported in regard to seizure freedom with a 95% confidence interval. Statistical and survival analyses were conducted using Prism 8 software.

**Results**

A total of 42 patients met inclusion criteria with an average age of 9.76 ± 4.9 years and 27 patients (64%) achieved Engel class I postoperatively and 15 patients (35%) Engel Classes II-IV. The mean follow-up was 58.7 ± 39.5 months with a median PFS of 30.1 months. Complete demographic information is shown in Table 1.

| Age at Diagnosis (years ± SEM) | 9.76 ± 4.9 |
|--------------------------------|------------|
| Gender (# F (%))               | 24 (57)    |
| Tumor Pathology                | n (%)      |
| Astroblastoma                  | 1 (2)      |
| Ependymoma                     | 1 (2)      |
| Fibrillary low-grade astrocytoma| 2 (5)      |
| Ganglioglioma                   | 2 (5)      |
| Juvenile pilocytic astrocytoma  | 22 (52)    |
| Oligoastrocytoma               | 6 (14)     |
| Oligodendroglioma              | 2 (5)      |
| Pilomyxoid astrocytoma         | 1 (2)      |
| Pleomorphic xanthoastrocytoma   | 5 (12)     |
| Tumor Grade | Value |
|-------------|-------|
| I           | 23 (55) |
| II          | 19 (45) |

| Tumor Laterality | Value |
|------------------|-------|
| Left             | 21 (50) |
| Right            | 21 (50) |

| Tumor Location | Value |
|----------------|-------|
| Frontal        | 10 (24) |
| Frontoparietal | 1 (2)  |
| Frontotemporal | 1 (2)  |
| Hypothalamus   | 1 (2)  |
| Insula         | 1 (2)  |
| Optic Nerve    | 2 (5)  |
| Parietal       | 5 (12) |
| Retro-orbital  | 1 (2)  |
| Temporal       | 15 (36) |
| Thalamus       | 4 (10) |
| Midbrain/Thalamus | 1 (2) |

| Seizures at Presentation | Value |
|---------------------------|-------|
| Yes                       | 23 (55) |
| No                        | 18 (43) |
| Unknown                   | 1 (2)  |

| Pre-operative AEDs | Value |
|--------------------|-------|
| Yes                | 30 (71) |
| No                 | 12 (29) |

| Post-operative AEDs | Value |
|---------------------|-------|
| Yes                 | 28 (65) |
| No                  | 14 (35) |

| Surgery | Value |
|---------|-------|
| Biopsy  | 2 (5) |
| GTR     | 25 (60) |
| STR     | 15 (35) |

| Chemotherapy | Value |
|--------------|-------|
| Yes          | 22 (52) |
| No           | 20 (48) |

| Radiation | Value |
|-----------|-------|
| Yes       | 23 (56) |
| No        | 19 (44) |

| Engel Class | Value |
|-------------|-------|
| 1           | 27 (64) |
The majority of tumors were astrocytic (70%) with a nearly even split between grade I, n=22 (51%) and grade II, n=21 (49%). Sixteen (38%) were located in the temporal lobe with the remainder extra-temporal (62%). Most patients presented with seizures pre-operatively and 30 patients (71%) presented on at least one anti-epileptic drug (AED), with three patients (7%) presenting with greater than one year of seizure duration. Of the patients who were Engel 2-4, 15 patients (94%) presented with seizures and all 16 were on at least one AED.

Seizure status at presentation (p<0.001) and pre- (p<0.01) as well as post-operative AED use (p<0.001), and recurrence (p<0.01) had a statistically significant association with Engel outcome (Table 2). However, when looking at the causal relationship, the most significant variables tested were pre-operative and post-operative AED use (Table 3). Pathology, grade, location, laterality, the extent of resection, and adjuvant chemo- or radiotherapy were not significantly associated with seizure freedom. Details of demographics and comparison of variables by pooled Engel class outcome are shown in Tables 1, 2.

| Seizure Freedom | Engel 1 (n=27) | Engel 2-4 (n=15) | P-value |
|-----------------|---------------|-----------------|---------|
| Age at Diagnosis (years ± SEM) | 10.19± 5.26 | 9.00 ± 4.19 | P = 0.75 |
| Gender (#F (%)) | 15 (56) | 9 (60) | P = 0.78 |
| Seizure at Presentation (n(%)) | 10 (38) | 13 (87) | P < 0.01 |
| Seizure Duration (pre) >1yr (n(%)) | 2 (17) | 1 (8) | P = 0.49 |
| Tumor Pathology (n(%)) | | | P = 0.34 |
| Astroblastoma | 1 (4) | 0 |
| Ependymoma | 0 | 1 (7) |
| Fibrillary low-grade astrocytoma | 1 (4) | 1 (7) |
| Ganglioglioma | 1 (4) | 1 (7) |
| Juvenile pilocytic astrocytoma | 17 (63) | 5 (33) |
| Oligoastrocytoma | 3 (11) | 3 (20) |
| Oligodendroglioma | 2 (7) | 0 |
| Pilomyxoid astrocytoma | 0 | 1 (7) |
| Pleomorphic xanthoastrocytoma | 2 (7) | 3 (20) |
| Tumor Grade | | | P = 0.15 |
| I | 17 (63) | 6 (40) |
| II | 10 (37) | 9 (60) |
| Tumor Laterality          | P = 0.63 |
|--------------------------|----------|
| Left                     | 15 (56)  |
| Midline                  | 0        |
| Right                    | 12 (44)  |

| Tumor Location           | P = 0.26 |
|--------------------------|----------|
| 3rd Ventricle            | 0        |
| Frontal                  | 4 (15)   |
| Frontoparietal           | 0        |
| Frontotemporal           | 1 (4)    |
| Hypothalamus             | 0        |
| Insula                   | 1 (4)    |
| Optic Nerve              | 2 (7)    |
| Parietal                 | 4 (15)   |
| Retro-orbital            | 1 (4)    |
| Temporal                 | 9 (33)   |
| Thalamus                 | 5 (9)    |

| Pre-operative AEDs       | P <0.01 |
|--------------------------|---------|
| Yes                      | 15 (56) |
| No                       | 12 (44) |

| Post-operative AEDs      | P < 0.001 |
|--------------------------|-----------|
| Yes                      | 13 (48)   |
| No                       | 14 (52)   |

| Surgery                  | P = 0.80 |
|--------------------------|----------|
| Biopsy                   | 1 (4)    |
| Gross Total Resection    | 17 (63)  |
| Subtotal Resection       | 9 (33)   |

| Chemotherapy             | P = 0.17 |
|--------------------------|----------|
| Yes                      | 12 (44)  |
| No                       | 15 (56)  |

| Radiation                | P = 0.25 |
|--------------------------|----------|
| Yes                      | 13 (48)  |
| No                       | 14 (52)  |

| Intraoperative ECoG      | P = 0.57 |
|--------------------------|----------|
| Yes                      | 5 (42)   |
| No                       | 7 (58)   |

| Recurrence               | P < 0.01 |
|--------------------------|----------|
| Yes                      | 7 (26)   |
| No                       | 20 (74)  |

| Hydrocephalus            | P = 0.30 |
|--------------------------|----------|

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### Table 2: Comparison of variables by pooled Engel class outcome

|                          | Yes | No |
|--------------------------|-----|----|
| Seizure at presentation  | 7 (26) | 2 (13) |
| Extratemporal (supratentorial) vs. temporal | 20 (74) | 13 (87) |

AED - Anti-epileptic drugs; ECoG - Electrocoorticography

| Variable                              | χ²  | p-value | OR (95% CI) |
|---------------------------------------|-----|---------|-------------|
| GTR                                   | 0.45 | 0.799   |             |
| Seizure at presentation               | 8.98 | 0.003   | 0.10 (0.020 - 0.519) |
| Extratemporal (supratentorial) vs. temporal | 0.04 | 0.850   |             |
| Pre-op AEDs administered              | 9.33 | 0.002   | 0.04 (0.002 – 0.740) |
| Post-op AEDs administered             | 11.67 | <0.001 | 0.03 (0.002 – 0.553) |
| Hydrocephalus present                 | 0.91 | 0.341   |             |
| Use of ECoG intraoperatively          | 0.32 | 0.571   |             |
| Recurrence                            | 8.85 | 0.003   | 0.12 (0.030 – 0.533) |
| Duration of seizures ≥1 year          | 0.476 | 0.490   |             |

### Table 3: Chi-square analyses and odds ratios for factors implicated in seizure freedom

GTR - Gross total resection; AED - Anti-epileptic drugs; ECoG - Electrocoorticography

| Variable                              | χ²  | p-value | OR (95% CI) |
|---------------------------------------|-----|---------|-------------|

### Discussion

Achieving seizure freedom for patients with LGGs is one of the primary treatment goals in controlling tumor-associated morbidity and mortality in afflicted patients [16-18]. This goal is of higher importance in pediatric populations in whom the neurodevelopmental impacts of seizures have been shown to lead to lifelong deficits in academic, social, and emotional competencies [19-22]. In our retrospective review of LGG cases at Riley Hospital for Children, we analyzed the factors associated with seizure freedom following operative care. In adults, the most important predictor for seizure freedom in LGGs has been shown to be gross-total resection; however, in our study, we did not observe this same effect [10,13]. Additionally, we did not see the significant impact of other adult predictors for seizure freedom including seizure type or duration of seizures.

The effect of electrocorticography-guided resection on epilepsy outcomes is an active area of research. Studies in similar adult patients demonstrate statistically and clinically significant improvements in post-operative seizure freedom [23]; however, this has not been demonstrated in the pediatric population [24]. Despite routine use at our institution, we found that electrocorticography-guided resection was also not associated with higher rates of seizure freedom. This could potentially be due to electrocorticography not playing a large role in intra-operative surgical guidance, but this point deserves more attention.

The mainstay of LGG treatment remains surgical resection in both adult and pediatric patients [25]. Previous adult studies suggest the extent of resection plays an important role in Engel’s outcome, with some suggesting 80%-90% resection as the threshold for seizure freedom [13,25,26]. Importantly in our study, resection was stratified as biopsy only, subtotal and gross-total, while the extent of subtotal resection was not further classified.

Pre- and post-operative AED use was associated with increased seizure burden, as expected, implying that those patients with decreased burden had a lower AED requirement. In addition, patients with a history of seizures at presentation were less likely to achieve seizure freedom. These results mirror those of a previous multi-site pediatric study [27].

The models in which seizure freedom is assessed have varied between studies. Pediatric population studies report post-operative seizure occurrence prior to one week [27,28] and one month [12] was a negative
prognostic sign for seizure freedom. Similar adult cohort studies have used 6-12 months post-operatively to define Engel's outcome [25,29]. The desirability of this patient perspective may in some way be lost in children as another layer of subjectivity is added by a parent’s appraisal of their child’s disability. Epilepsy is stigmatizing and socially isolating, potentially leading to parental underreporting of seizure burden as parents eagerly wish for their child to regain normal functioning [30]. In our study, seizure freedom was classified according to the patient’s status at the last clinical follow-up, which ranged from 11 to 148 months with a mean of 58.7 +/- 39.5. Engel class rates of 64% recorded at five years are longer than typically reported and compare favorably to the literature [26,28].

A primary limitation of our study was the patient sample size which limited the power of our study. For example, in a study of 255 patients by Chang and colleagues, improvements in seizure freedom by GTR were found to have an effect size of approximately 0.3, as calculated by Cramer’s V. For this effect size to be observed, a sample size of 46 would be necessary, slightly larger than in our study. Additionally, the retrospective nature of the study limits the validity of our conclusions to the extent of our data accuracy.

Conclusions
In our cohort of pediatric LGGs, we find that patients that did not initially present with seizures and those who were treated with pre- and post-operative AEDs were more likely to achieve Engel Class I seizure freedom post-operatively. Tumors located in the temporal lobe were not significantly associated with a higher seizure burden than other supratentorial, extra-temporal tumors. Neither extent of resection nor electrocorticography-guided resection correlated with improved seizure freedom outcomes during glioma resection.

Additional Information
Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. Indiana University Institutional Review Board (IRB) issued approval 1712367515. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References
1. Wells EM, Gaillard WD, Packer RJ: Pediatric brain tumors and epilepsy. Semin Pediatr Neurol. 2012, 19:3-8. 10.1016/j.spen.2012.02.010
2. Chaliil A, Ramaswamy V: Low grade gliomas in children. J Child Neurol. 2016, 31:517-22. 10.1177/0883073815599259
3. Minturn [E, Fisher MJ]: Gliomas in children. Curr Treat Options Neurol. 2015, 15:516-27. 10.1007/s11940-015-0225-x
4. Sirver AJ, Fisher MJ: Pediatric low-grade gliomas. J Child Neurol. 2009, 24:1597-408. 10.1177/0883073809342005
5. Williams BA, Abbott KJ, Manson II: Cerebral tumors in children presenting with epilepsy. J Child Neurol. 1992, 7:291-4. 10.1177/088307389200700509
6. Ullrich NJ: Neurologic sequelae of brain tumors in children. J Child Neurol. 2009, 24:1446-54. 10.1177/0883073809342491
7. Baker SJ, Ellison DW, Gutmann DH: Pediatric gliomas as neurodevelopmental disorders. Glia. 2016, 64:879-95. 10.1002/glia.22945
8. Kerkmhof M, Vecht CJ: Seizure characteristics and prognostic factors of gliomas. Epilepsia. 2013, 54 Suppl 9:12-7. 10.1111/epi.12457
9. Vecht CJ, Kerkmhof M, Duran-Pena A: Seizure prognosis in brain tumors: new insights and evidence-based management. Oncologist. 2014, 19:751-9. 10.1634/theoncologist.2014-0060
10. Englot DJ, Han SJ, Berger MS, Barbaro NM, Chang EF: Extent of surgical resection predicts seizure freedom in low-grade temporal lobe brain tumors. Neurosurgery. 2012, 70:921-8; discussion 928. 10.1227/NEU.0b013e31823c3a30
11. Rudá R, Trefišan E, Soffietti R: Epilepsy and brain tumors. Curr Opin Oncol. 2010, 22:611-20. 10.1097/CCO.0b013e32835de969
12. Uliel-Sibony S, Kramer U, Fried I, Fattal-Valevski A, Constantini S: Pediatric temporal low-grade glial tumors: epilepsy outcome following resection in 48 children. Childs Nerv Syst. 2011, 27:1415-8. 10.1007/s00381-011-1454-5
13. Englot DJ, Berger MS, Barbaro NM, Chang EF: Predictors of seizure freedom after resection of supratentorial low-grade gliomas. A review. J Neurosurg. 2011, 115:240-4. 10.3171/2011.3.JNS11153
14. Tsai ML, Chen CL, Hsieh KL, Miser JS, Chang H, Liu YL, Wong TT: Seizure characteristics are related to tumor pathology in children with brain tumors. Epilepsy Res. 2018, 147:15-21. 10.1016/j.eplepsyres.2018.08.007
15. Lynam LM, Lyons MK, Drazkowski JF, Sirven JI, Noe KH, Zimmerman RS, Wilkens JA: Frequency of seizures...
in patients with newly diagnosed brain tumors: a retrospective review. Clin Neurol Neurosurg. 2007, 109:A54-8. 10.1016/j.clineuro.2007.05.017
16. Duffau H: Surgery of low-grade gliomas: towards a ‘functional neurooncology’. Curr Opin Oncol. 2009, 21:543-9. 10.1097/CCO.0b013e3283330596
17. Klein M, Engelberts NH, van der Ploeg HM, et al.: Epilepsy in low-grade gliomas: the impact on cognitive function and quality of life. Ann Neurol. 2003, 54:514-20. 10.1002/ana.10712
18. Piotrowski AF, Blakeley J: Clinical management of seizures in patients with low-grade glioma. Semin Radiat Oncol. 2015, 25:219-24. 10.1016/j.semaradonc.2015.02.009
19. Bourgeois BF, Prensky AL, Falkes HS, Talent BK, Busch SG: Intelligence in epilepsy: a prospective study in children. Ann Neurol. 1985, 14:438-44. 10.1002/ana.410140407
20. Austin JK, Haverdak J, Dunn DW, Huster GA, Rose DF, Ambrosius WT: Behavior problems in children before first recognized seizures. Pediatrics, 2001, 107:115-22. 10.1542/peds.107.1.115
21. Wo SW, Ong LC, Low WY, Lai PS: The impact of epilepsy on academic achievement in children with normal intelligence and without major comorbidities: a systematic review. Epilepsy Res. 2017, 136:35-45. 10.1016/j.eplepsyres.2017.07.009
22. Choudhary S, Niranjan N, Khichar S, Berwal PK, Barath AS: Behavioral problems and intelligence quotient changes in pediatric epilepsy: a case–control study. J Neurosci Rural Pract. 2017, 8:617-21. 10.4103/jnrp.jnrp_57_17
23. Yao PS, Zheng SF, Wang F, Kang DZ, Lin YX: Surgery guided with intraoperative electrocorticography in patients with low-grade glioma and refractory seizures. J Neurosurg. 2018, 128:840-5. 10.3171/2016.11.JNS161296
24. Robertson FC, Ulrich NJ, Manley PE, Al-Sayegh H, Ma C, Goumnerova LC: The impact of intraoperative electrocorticography on seizure outcome after resection of pediatric brain tumors: a cohort study. Neurosurgery. 2019, 85:357-65. 10.1093/neuros/nyy342
25. Still ME, Roux A, Huberfeld G, et al.: Extent of resection and residual tumor thresholds for postoperative total seizure freedom in epileptic adult patients harboring a supratentorial diffuse low-grade glioma. Neurosurgery. 2019, 85:E332-40. 10.1093/neuros/nyy481
26. Xu DS, Awad AW, Mehalechko C, Wilson JR, Ashby LS, Coons SW, Sanai N: An extent of resection threshold for seizure freedom in patients with low-grade gliomas. J Neurosurg. 2018, 128:1084-90. 10.3171/2016.12.JNS161682
27. Roth J, Bercovich O, Roach A, et al.: Seizures following surgery for supratentorial extratemporal low-grade tumors in children: a multicenter retrospective study. J Neurosurg Pediatr. 2020, 26:27-33. 10.3171/2020.2.PEDS19673
28. Fallah A, Weil AG, Sur S, et al.: Epilepsy surgery related to pediatric brain tumors: Miami Children’s Hospital experience. J Neurosurg Pediatr. 2015, 16:675-80. 10.3171/2015.4.PEDS14476
29. Chang EF, Potts MB, Keles GE, Lamborn KR, Chang SM, Barbaro NM, Berger MS: Seizure characteristics and control following resection in 332 patients with low-grade gliomas. J Neurosurg. 2008, 108:227-35. 10.3171/2008/108/2/0227
30. Rani A, Thomas PT: Parental knowledge, attitude, and perception about epilepsy and sociocultural barriers to treatment. J Epilepsy Res. 2019, 9:65-75. 10.14581/jer.19007