When did the glioblastoma start growing, and how much time can be gained from surgical resection? A model based on the pattern of glioblastoma growth in vivo.

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OBJECTIVES: Observational data on the natural course of tumor growth in humans is sparse, and mathematical models of tumor growth are often needed to answer questions related to growth. In this study, a theoretical model of glioblastoma growth was used to investigate two questions often asked by patients and clinicians. First, when did the tumor start growing? Second, how much survival time can be gained from various extents of surgical resection (EOR)?

PATIENTS AND METHODS: A gompertzian growth curve was fitted from observational data of pre-treatment growth from 106 glioblastoma patients based on repeated volume segmentations. The curve was used to find the theoretical time since tumor initiation. In addition, as a proxy for the potential survival gain from surgery, the number of days until re-growth would reach the preoperative tumor volume were calculated for different extents of resection.

RESULTS: The estimated age of the glioblastomas at diagnosis was median 330 days, but ranging from 156 days to 776 days, depending on the tumor volume at diagnosis. The median survival gains from 50%, 75%, 90%, 95% and 99% EOR were, 1.4, 2.5, 3.6, 4.3, and 5.6 months, respectively. However, survival benefit from surgery also depends on lesion volume. In theory, 100 days may be gained from 95% EOR in a 10 ml lesion or a 50% EOR in a 90 ml lesion.

CONCLUSION: In conclusion, we postulate that glioblastoma might originate median 330 days before the diagnosis, assuming the same growth pattern and biology from day one. The theoretical survival benefit of glioblastoma resection is much higher with higher EORs, suggesting that the last milliliters of resection matter the most. Our data also suggest that gain from resection is higher in larger lesions, suggesting that lesion volume may be taken into...
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