Trends in Management of Intracranial Meningiomas: Analysis of 49,921 Cases from Modern Cohort

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OBJECTIVE: **We sought to characterize patterns and treatment for intracranial meningiomas in the Surveillance, Epidemiology, and End Results set of cancer registries.**

METHODS: **SEER data was queried from 2004–2012 for cases of intracranial meningioma using appropriate topography and histology codes.**

RESULTS: **A total of 49,921 patients with intracranial meningioma were identified. The vast majority of cases were associated with a benign histology (n = 47,047, 94.2%). There were 21,145 patients (42.4%) who underwent surgical management, 2783 who received radiation alone (5.6%), and 25,993 who underwent surveillance only (52.1%). Surgical management decreased in frequency from 48.8% of all cases in 2004 to 38.3% of cases in 2012 (P < 0.001). Radiation alone remained stable over time with a range of 4.8%–6.3% of cases. Observation increased from 45.0% of cases in 2004 to 56.7% of cases in 2012 (P < 0.001). On unadjusted analysis, surgical management was associated with younger age and larger tumor size. The incidence of tumors <2 cm in size increased significantly over the study period from 29.7% in 2004 to 41.7% in 2012 (P < 0.001). After adjusting for tumor size, multivariable analysis demonstrated that the odds of observation as a primary management strategy were greater in 2012 relative to 2004 (odds ratio 1.33, 95% confidence interval 1.21–1.45).**

CONCLUSION: **The incidence of intracranial meningiomas increased, while tumor size at the time of diagnosis decreased. Moreover, the number undergoing no treatment increased as a treatment strategy and was more likely employed for older patients, those of African-American race, and those with smaller tumors.**

INTRODUCTION

Meningiomas are the most common primary intracranial tumor in the United States.[1-3] Although these lesions are relatively common, their clinical management varies significantly according to factors such as age, presentation, location, size, and pathology. Treatment options currently include observation with surveillance scans (a strategy known as active surveillance), radiation, or surgery—alone or in combination with follow-up radiation. Extent of surgical resection has historically been known to correlate to overall survival and decreased risk of recurrence for malignant meningiomas, but treatment paradigms widely vary among individual surgeons and institutions, with no accepted or agreed-upon criteria.[1,4] In particular, prospective and randomized clinical data regarding contemporary treatment trends are sparse.

The Surveillance, Epidemiology, and End Results (SEER) database of the National Cancer Institute includes incidence, treatment, and survival data including patient demographics, tumor site, morphology, staging, initial treatment, and follow-up from cancer registries that cover approximately one third of the U.S. population.[1] As a result of the Benign Brain Tumor Cancer Registries Amendment Act since 2004, the SEER database officially began recording information on nonmalignant brain tumors.

Key words
- Intracranial
- Meningioma
- Tumor management

Abbreviations and Acronyms
DBS: Deep brain stimulation
OR: Odds ratio
SEER: Surveillance, Epidemiology, and End Results

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Table 1. Histology and Topography Codes Included in Analysis

Histology Codes
9530—Meningioma, malignant
9531—Meningothelial meningioma
9532—Fibrous meningioma
9533—Psammomatous meningioma
9534—Angiomatous meningioma
9537—Transitional meningioma
9538—Papillary meningioma
9539—Atypical meningioma
Topography Codes
C700—Cerebral meninges
C710—Cerebrum
C711—Frontal lobe
C712—Temporal lobe
C713—Parietal lobe
C714—Occipital lobe
C715—Ventricle, NOS
C716—Cerebellum, NOS
C717—Brainstem
C718—Overlapping lesion of brain
C719—Brain, NOS
C722—Olfactory nerve
C723—Optic nerve
C724—Acoustic nerve
C725—Cranial nerve, NOS
C751—Pituitary gland
C753—Pineal gland

NOS, Neurologic Outcome Scale.

Large databases such as SEER are a useful tool for analyzing incidence and treatment trends across a large population base. Studies using the SEER data to examine treatment and survival of patients with meningiomas are sparse, and to our knowledge no study to date has examined the evolution of yearly treatment trends in a modern cohort.

MATERIALS AND METHODS

Data Source

Data for this study were obtained from the SEER set of 18 cancer registries, a program of the National Cancer Institute. SEER aggregate data include virtually every cancer diagnosed across diverse and generalizable patient populations, encompassing 28% of the U.S. population.[1]

Inclusion and Exclusion Criteria

The study was limited to the years 2004–2012 as 2004 was the first year benign brain tumors were available in SEER. Patients were included for analysis if their record was confirmed to contain 1 each of the International Classification of Disease for Oncology histology and topography codes detailed in Table 1.

Variables of Interest

Patients were classified as having had surgery with or without radiation, radiation only, or observation. Demographic variables included patient age, race, sex, and year of diagnosis (Table 2). Tumor size was also recorded. Tumors were classified as either benign (which included meningothelial, fibrous psammomatous, angiomatous, and transitional types); malignant potential (which included meningiomatosis, clear cell, and atypical types); or malignant invasive (which included papillary and meningeal sarcomatosis types). For patients who had both surgery and radiation, the sequence of radiation relative to surgery was noted.

Statistical Analysis

Pearson chi-square test, Student's t-tests, and Cochran-Armitage tests were used for trends over time. Multivariable logistic regression analysis fitted for observation management was performed controlling for tumor size, year of diagnosis, age, gender, race, and malignant versus benign tumor behavior code. Statistical analysis was performed using commercially available software (SAS 9.4, Carey, North Carolina, USA). All tests were 2-sided, and P values <0.05 were considered statistically significant.

RESULTS

Patient Population and Demographics

A total of 49,921patients were identified in SEER between 2004 and 2012 with a diagnosis of an intracranial meningioma and meeting criteria for inclusion in the study. The median age of the population was 65 (range 53–77) years. The majority of patients were female (73.1%) and categorized as non-Hispanic Caucasians (69.2%). Most meningiomas (94.2%) were benign. Overall incidence increased over time with a range of 5.2–7.2 cases per 100,000 individuals over the course of the study period.

Practice Patterns

Of the patients included in this study, 21,145 (42.4%) underwent surgical treatment with or without radiation at some point in the initial course of therapy. Another 2783 (5.6%) received radiation therapy alone, and 25,993 (52.1%) underwent active surveillance. Of the patients who received surgery, 1838 (8.7%) had radiation at some point in their clinical course, either before or after surgical intervention. The vast majority of these patients ($n = 1747$, 95.0%) received radiation after surgery. Of the remaining patients receiving both surgery and radiation, 44 patients (2.4%) received neoadjuvant radiation, 14 patients (0.8%) received intraoperative radiation, and 20 patients (1.1%) received both radiation and surgery without information regarding timing.

On unadjusted analyses, there were multiple variables associated with practice pattern. The mean (standard deviation) age for patients undergoing observation alone was significantly different between patients undergoing observation versus radiation alone