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Growth of Incidental Meningiomas

Y. Yoneoka, Y. Fujii, and **R. Tanaka**

Departments of Neurosurgery and Integrated Neuroscience, Brain Research Institute, Niigata University, Niigata, Japan

Summary

The aim of this study was to assess the growth of incidental meningiomas, to establish a strategy for dealing with these tumours.

The cases of 37 patients with a meningioma revealed incidentally by computerized tomography or magnetic resonance imaging, who were followed at least once by an additional imaging study, were reviewed. The tumour volume was calculated, to estimate the annual growth rate of the incidental meningiomas. Nine of the 37 patients (24.3%) showed a considerable increase (the annual growth rate > 1 cu cm/year) in their tumour volume (tumour growth). There was no significant difference in the follow-up period, age, or the volume of tumour between the patients with and without tumour growth. However, a multivariate analysis revealed that the likelihood of tumour growth independently and significantly increased according to a decrease in the age of the patients (Odds ratio 0.18 for one-standard-deviation change (1SD) 12.6 years, $p = 0.042$) and according to an increase in the volume of the tumour (Odds ratio 3.64 for 1SD 4.46 cu cm, $p = 0.042$).

The majority of patients with incidental meningioma can be apparently observed without any surgical intervention, because their annual growth rates are generally less than 1 cu cm/year. However, clinical and radiological observations would be advisable for these patients (especially young patients and patients with a large tumour), in view of the presence of rapidly growing tumours in some of the patients.

Keywords: Meningioma; incidental tumour; growth rate; multivariate analysis.

Introduction

What is the best way of managing patients with incidental meningioma? Computerized tomography (CT) and magnetic resonance imaging (MRI) have been common tools for ruling out intracranial organic lesions in patients, with the result that neurosurgeons have been frequently consulted regarding the strategy for treating asymptomatic meningiomas. However, the strategies for dealing with incidental meningioma vary widely, due to the lack of sufficient information on these tumours, particularly about their natural history, despite previous studies [2, 16]. Unnecessary surgery for an indicental meningioma, when the tumour shows minimal growth, should be avoided in view of the mortality and morbidity of the surgery and the medical economy (the cost of the surgery). This situation prompted us to initiate the present study.

We retrospectively reviewed 37 patients with incidental meningiomas and performed a multivariate analysis regarding the growth of their tumours to explore, and to establish a strategy for dealing with these tumours.

Clinical Material and Methods

Patient Selection

Seventy-one patients (10 men and 61 women) were incidentally diagnosed as having an intracranial meningioma by CT or MRI between April 1986 and March 1997 at our hospital. Their mean age was 61.0 (range 21–82) years. These 71 cases were summarized in Table 1. This series did not include radiation-induced, neurofibromatosis-type-2-associated, or multiple meningiomas. Meningiomas were radiologically diagnosed by the presence of an extra-axial mass, with broad-based attachment along the dura or attachment to the choroid plexus in the ventricles, which was homogeneously and markedly enhanced by contrast medium.

Thirty-four of the 71 patients were excluded because of surgery without any follow-up imaging study or because of no follow-up record. The other 37 patients with incidental meningioma, who were followed by additional CT and/or MRI studies for more than six months after their initial examination, were reviewed. None of the 37 patients had neurological deficits due to the meningiomas at their initial examinations.

Data Collection

CT/MRI scans with the administration of contrast medium were performed using 5-mm-thick slices in all patients to assess the volume of the tumours. The tumour volume was calculated by the method reported by Firsching *et al.* [2] or Kakinuma *et al.* [6] utilizing the NIH image program (developed at the U.S. National Institutes of Health and available on the Internet at http://rsb.info.nih.gov/nih-image/). The annual growth rates (cu cm/year) were determined utilizing the following formula: the difference in the volume (cu cm)

Table 1. *Summary of 71 Incidental Meningiomas*

	Number	Percent
Volume (cu cm)		
0–10	51	71.8
10–20	9	12.7
20–30	5	7.1
30–40	4	5.6
40–	2	2.8
Location		
convexity	24	33.8
falx	10	14.1
parasagittal	9	12.7
parasellar	7	9.9
tent	6	8.5
cerebellopontine angle	5	7
olfactory groove	4	5.6
sphenoid	3	4.2
ventricle	3	4.2
Pressure to the adjacent structures		
yes	57	80.3
no	14	19.7
Edema		
yes	14	19.7
no	57	80.3
Calcification		
yes	9	12.7
no	62	87.3
Total	71	100
23 Surgically removed meningiomas		
histology		
grade 1	21	91.3
fibrous	(14)	(60.9)
meningothelial	(4)	(17.4)
transitional	(2)	(8.7)
angiomatous	(1)	(4.3)
grade 2	2	8.7
atypical	(2)	(8.7)
grade 3	0	0.0
Total	23	100

between the initial and the latest imaging study divided by the time interval (years) of the follow-up period. The patients whose tumour increased at an annual growth rate >1 cu cm/year were defined as showing tumour growth. To assess the tumour growth in the present study, the actual increase in the volume (cu cm/year) was used rather than the relative increase in the volume (per cent/year) because the actual increase seemed more important as a factor influencing the appearance of symptoms in patients with incidental meningioma rather than the relative one.

The sites of the 37 meningiomas were convexity (11 patients), the parasagittal (2), falx (5), tent (5), parasellar (6), cerebellopontine angle (3), sphenoid ridge (3), olfactory groove (1), and lateral ventricle (1). The patients were clinically and radiologically followed up at our hospital as long as possible.

Statistical Analysis

Student's t-test or Welch's t-test was used to test the significance of the differences in clinical parameters between patients with and without tumour growth. A Chi-squared analysis or Fisher's exact probability method was used to assess the differences in the incidence of tumour growth among the sites of attachment of tumour, and between the genders. Ryan's analysis was also used to examine the differences in the incidence between any two of the sites of tumour attachment. A multiple logistic regression analysis was used to test the correlations between the tumour growth and age, gender, the volume of tumour at the first diagnosis, and the length of the follow-up period. Odds ratios presented in this study indicate those for one-standard-deviation (1SD) changes of explanatory variables. Values are expressed as means $\pm$ standard error of the mean. For all tests, probability values of less than 0.05 were considered to indicate statistical significance.

Results

The Incidence of Tumour Growth

The changes in the volume of the 37 incidental meningiomas between the initial and latest imaging studies varied widely (Fig. 1). The majority of the annual growth rates in the 37 patients were less than 1 cu cm/year (Fig. 2). According to our definition of tumour growth, nine (six female and three male) of the 37 patients (24.3%) had tumour growth. The other 28 (26 female and two male) patients had no considerable tumour growth during the follow-up period (4.2 ± 0.7 years).

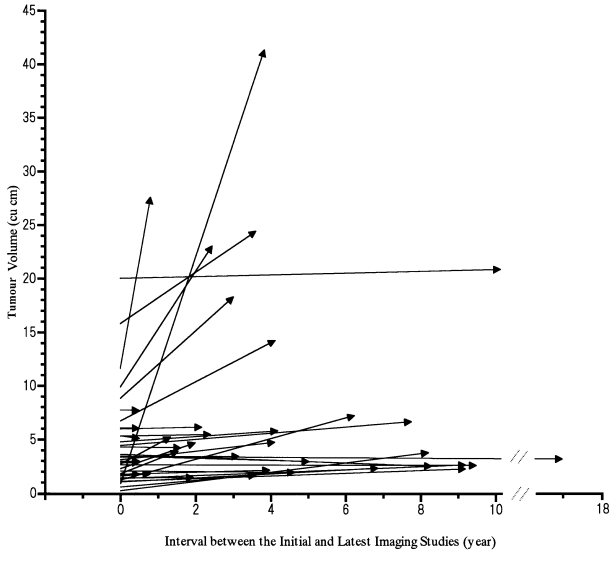

Fig. 1. Graph showing the distribution of the changes in the tumour volume (cu cm) of the 37 patients with incidental meningioma between the initial and the latest imaging studies. Note that the changes in the tumour volume varied widely

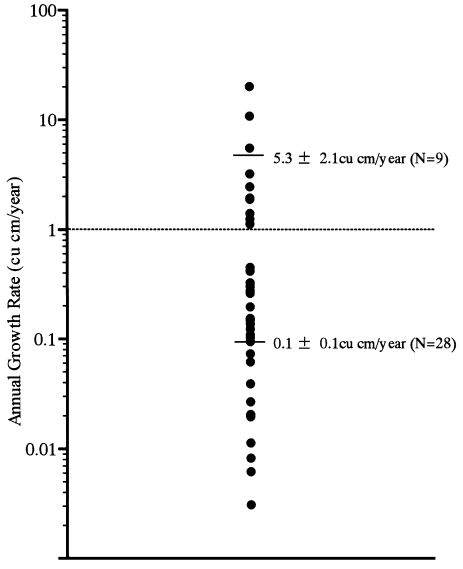

Fig. 2. Graph showing the distribution of the annual growth rates (cu cm/year) of the 37 incidental meningiomas. Note that the majority of the growth rates were less than 1 cu cm/year

Table 2. *Evaluation of Independent Parameters Associated with Tumour Growth Using a Multiple Logistic Regression Analysis in 37 Patients with Incidental Meningioma*

Variables	One standard deviation	Odds ratio[2]	95% Confidence interval	Probability
Age[1] (year)	12.6	0.176	0.035–0.878	0.042
Gender (male/female)	0.86	0.627	0.239–1.642	0.349
Tumour volume at the initial diagnosis[1] (cu cm)	4.46	3.641	1.101–12.04	0.042
Interval between the first and the last examinations (year)	4.19	0.258	0.057–1.160	0.087

[1] These variables are significantly ($p < 0.05$) and independently associated with tumour growth (multiple logistic regression analysis).
[2] Odds ratios indicate changes (ratio) in the probability of tumour growth when explanatory variables increase by one standard deviation.

The Univariate Analysis

The annual growth rate in the 9 patients with tumour growth (5.3 ± 2.1 cu cm/year) was, of course, significantly higher than that in those without tumour growth (0.1 ± 0.1 cu cm/year) (Fig. 2). Although the mean age of the patients with tumour growth (53.2 ± 5.2 years) was younger than that of the patients without tumour growth (60.5 ± 2.1 years), the difference was not significant. The volume of the tumours in the patients with tumour growth (6.7 ± 1.8 cu cm) was larger, though the difference was not significant, than that of the patients without tumour growth (3.7 ± 0.7 cu cm). There was no significant difference in the follow-up period between the patients with tumour growth (3.0 ± 0.5 years) and the other group (4.6 ± 0.8 years). There was also no significant difference in the incidence of tumour growth among the sites of meningiomas. No significant difference in the incidence of tumour growth was observed between female and male patients.

The Multivariate Analysis

A multiple logistic regression analysis was performed to assess independent associations between the tumour growth and clinical parameters (Table 2). The age (Odds ratio 0.18 for 1SD change, 12.6 years, $p = 0.042$) and the volume of tumour (Odds ratio 3.64 for 1SD 4.46 cu cm, $p = 0.042$) were independently and significantly associated with the tumour growth. That is to say, the likelihood of tumour growth decreased with an increase in the age of the patients, and increased according to an increase in the volume of tumour at the initial diagnosis. There was no significant association between the tumour growth and gender, or the follow-up period.

The Appearance of Symptom

Of the 37 patients with incidental meningioma, two patients became symptomatic during the follow-up period. A 79-year-old man with a convexity meningioma had a seizure due to increased peritumoural oedema without tumour growth 2.8 years after the initial diagnosis. A 60-year-old woman with a tentorial meningioma developed hemiplegia due to compression of the brain stem by the enlarged tumour three years after the initial study.

Discussion

Although there are a number of studies on growth analysis of surgically resected meningiomas examined from various viewpoints [1, 3, 4, 7–15, 17, 19], such as Ki67 and MIB-1, no report has sufficiently described the natural history of incidental meningiomas to date.

Only two reports assessed the growth of incidental meningiomas during short follow-up periods [2, 16]. However, they did not include statistical analysis to identify associations between the tumour growth and clinical parameters. Thus this is the first report describing a statistical assessment of the growth of incidental meningiomas, utilizing a multiple logistic regression analysis. The present study revealed two important findings.

First, the patients with incidental meningioma can be divided into two groups; the patients with tumour growth (annual growth rate >1 cu cm/year) and those without tumour growth (1 or <1 cu cm/year). In the present series, nine of 37 patients (24.3%) showed tumour growth. Olivero *et al.* reported that ten of 57 patients with asymptomatic meningioma (17.5%) showed an increase in the maximum diameter of tumour. Firsching *et al.* reported that none of 17 patients with incidental meningioma showed an increase of more than 1 cu cm/year in the volume of the tumour. Our data corroborated the findings of these previous studies that the majority of the incidental meningioma appear to show minimal growth. However, it should be borne in mind that some of the patients, albeit a small number, had a rapid increase in the volume of the tumour (Fig. 2). Hence, therapeutic strategies for dealing with patients with an incidental meningioma should be determined carefully in view of the variety of the tumour growth rates, although the majority of the patients may be observed without any surgical intervention.

Second, the tumour growth seems to be independently and significantly associated with the age of patients and the volume of the tumour at its initial diagnosis, i.e., the tumour growth rate increased as the tumour volume was larger, and as the patient was younger (Table 2). Although it is true that the majority of incidental meningiomas show minimal growth compared with symptomatic meningiomas [5, 6], it should be noted that the patients with a relatively large tumour should be carefully observed by clinical and radiological examination, because they may be at high risk for tumour growth (Fig. 3).

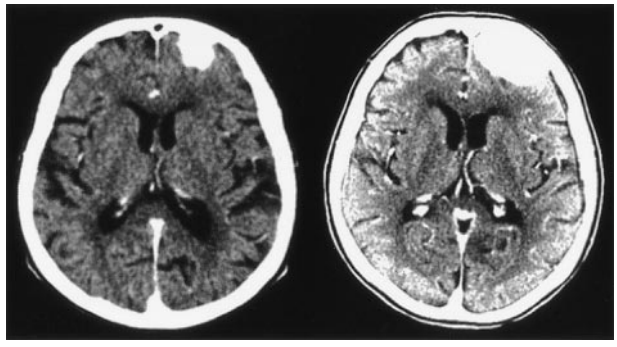

Fig. 3. CT scans of a 72-year-old woman with a convexity meningioma. The initial image (left) and the image taken 9 months later. Note a rapid increase in the tumour volume. The tumour was successfully removed and histologically diagnosed as meningothelial meningioma

Therapeutic Strategy

In one of the previous two studies [2], no patient became symptomatic during the follow-up period (2.1 ± 0.5 years), and in the other study [16], no patient became symptomatic because of tumour growth, and one patient has a seizure during the follow-up period (the mean: 2.7 years). In the present study, one patient had hemiparesis due to tumour growth and one had a seizure without tumour growth during the follow-up period (4.2 ± 0.7 years). Incidental meningiomas appear to rarely become symptomatic within a short follow-up period such as 2 years. Rausing and colleagues reported that in autopsy cases, meningiomas were incidentally found at a rate of 1.44% [18]. Thus, a high percentage of persons with meningiomas may complete their lives unaware of the presence of the tumour.

According to our findings, we suggetst the following strategy for dealing with incidental meningiomas; 1) A follow-up CT and/or MRI should be performed 3 monthly (for young patients or/and patients with a large tumour) and 6 monthly (for the others) after the initial diagnosis in order to rule out a rapidly growing meningioma (including malignant meningioma), and to determine the annual growth rate; 2) the patients with definite tumour growth should be closely observed by the follow-up CT/MRI, with the possibility of surgery; 3) The next CT/MRI for patients with a growth rate >1 and 1–0 cu cm/year should be performed six months and one year after the prior CT/MRI study, respectively; 4) surgery should be considered for patients whose growth rate is estimated to be more than 1 cu cm/year after repeated examinations, taking the patient's age and condition into account.

Conclusions

The majority of patients with incidental meningioma can be observed without any surgical interven-

tion, because their annual growth rates are generally less than 1 cu cm/year. However, clinical and radiological observations would be advisable for the patients at a young age and with a large tumour, in view of the presence of rapidly growing tumours in some of the patients.

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Comment

The authors describe their experience with 37 patients in whom asymptomatic meningiomas were detected. They conclude that the likelyhood of a meningioma to grow is related to young age and the size of the tumor. They base their growth criteria on the increase of a fixed volume of 1 ccm per year.

A report as this is more a discussion remark than a paper. Every department has patients which for individual reasons do not get operated on and are observed, criteria being age, lack of enhancement, degree of calcification, relative risk, lack of parenchymal brain response (edema). This study could be part of a discussion on the criteria which permit the delay of treatment but in general, meningiomas are so easy to operate on and will become symptomatic eventually that one should rather advise operation as early as possible.

M. Westphal

Correspondence: Yuichiro Yoneoka, M.D., Department of Neurosurgery, Brain Research Institute, Niigata University, Niigata, Japan, 1-757 Asahimachi, Niigata, 951-8585 Japan.