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Pre-operative and post-operative cognitive deficits in patients with supratentorial meningiomas

Kalyan Bommakanti[a,*], Shanmukhi Somayajula[b], Alladi Suvarna[b], Aniruddh Kumar Purohit[a], Shailaja Mekala[b], Santoshi Kumari Chadalawadi[b], Padmaja Gaddamanugu[b]

[a] Department of Neurosurgery, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad, Andhra Pradesh, India
[b] Department of Neurology, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad, Andhra Pradesh, India

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ABSTRACT

Objectives: Cognitive deficits caused by extra-axial benign brain tumors like meningiomas and the course of these deficits after surgery is not well known. The aim of the study is to assess the pre-operative and post-operative cognitive functions in patients with meningiomas in the supratentorial compartment.
Materials and methods: In this prospective study, patients with clinico-radiological diagnosis of supratentorial meningioma, operated upon and later confirmed by histopathological examination, were included. The patients were evaluated for cognitive deficits before and after surgery. The various clinical and radiological factors influencing the cognitive status were evaluated.
Results: A total of 57 patients were enrolled into the study. Out of 57, 22 were males and 35 were females. The frontal group had 22 patients, the parietal group had 10 patients, the temporal group had 10 patients, the occipital group had 6 patients, and the suprasellar group had 9 patients. Meningiomas, although extra-axial, caused significant cognitive deficits in 42 patients (73.7%). The highest frequency of cognitive deficits is seen in the frontal and temporal group of meningiomas (90% each). Frontal meningiomas with volume greater than 35 cc and peritumoral edema greater than 40 cc caused a higher frequency of cognitive deficits. Also, patients with raised ICP had significant cognitive deficits. Postoperatively there was a significant improvement in the cognitive functions in the frontal and temporal groups.
Conclusion: Meningiomas cause cognitive deficits in 73.7% of patients. Anatomical location of meningioma, elevated ICP, the volume of meningioma and extent of peritumoral edema significantly influence the incidence of cognitive deficits. Post-operatively, the cognitive deficits improve significantly in the frontal and temporal group.

1. Introduction

Meningiomas are the most common benign intracranial tumors. The prevalence of meningiomas varies from 2.3 cases per 100,000 during life for the general population, to 5.5 per 100,000 if autopsy data are included. [4] Traditionally neurological deficits and survival have been used to assess the morbidity and burden due to brain tumors and to assess outcome after surgical excision. The technical advances in the microsurgical techniques have lead to a considerable decrease in the incidence of fresh neurological deficits and mortality. In this scenario, cognitive functions are increasingly being recognized as important factors affecting the QOL (quality of life). Giovagnoli and Boiardi [3] have found that even subtle cognitive deficits prevent symptom-free survivors from returning back to preoperative autonomy and occupation. Cognitive deficits caused by intra-axial lesions like gliomas are well documented in the literature. But the impact of extra-axial lesions like meningiomas on cognition is not well documented. The results of examinations of patients with gliomas are only of limited value when applied to those with meningiomas because, due to the rapidity of growth and the multiplicity of tumor sites. There are only a few case series and most of the case series are retrospective in nature. Only a few studies have tried to establish a possible relation between meningiomas and cognitive deficits. [19,20] Only a few studies have analyzed the course of cognitive deficits after surgical excision. [17,20] In the studies on postoperative outcome in patients with meningiomas, only the incidence

* Corresponding author.
E-mail addresses: kalyan98omc@yahoo.co.in, kalyan98omc@gmail.com (K. Bommakanti).

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Table 1
Number of patients who took the cognitive tests pre-operatively.

Cognitive test	N
Mental s peed (DSS)	34
Focused attention (CTT-1)	34
Sustained attention (DVT)	33
Verbal fluency (COWAT)	57
Category fluency (ANT)	57
Verbal working memory (verbal N-back test)	57
Visual working memory (visual N-back test)	49
Verbal memory: registration (RAVLT)	57
Verbal memory: immediate recall (RAVLT-IR)	57
Verbal memory: delayed recall (RAVLT-DR)	57
Visuo-spatial ability (CFT)	32
Visual memory-immediate recall (CFT-IR)	32
Visual memory-delayed recall (CFT-DR)	31

of cognitive disturbances on admission was reported. Such disturbances, which included aphasia, confusion, and disorientation were present in 25–62% of patients. [17] In the present study, we have tried to describe the cognitive deficits in patients with supratentorial meningiomas and have also tried to identify the clinical and radiological features which are predictive of the post-operative course.

2. Materials and methods

2.1. Aim

The aim of the study is to assess the pre-operative and post-operative cognitive functions in patients with meningiomas in the supratentorial compartment. We have tried to identify the patient and tumor characters influencing the cognitive functions and their post-operative outcome.

2.2. Methods

This is a prospective study conducted on patients with supratentorial meningiomas, admitted and operated in the department of neurosurgery, Nizam's Institute of Medical Science's, India, from July 2006 to July 2009. Fifty-seven patients were included in the study. Patients aged 17 to 65 years with a clinico-radiological diagnosis of supratentorial meningioma, later confirmed by histopathological examination, were included in the study.

Patients with co-existing major systemic illness, history of head injury, transient ischemic attacks, stroke, multiple meningiomas, recurrent meningiomas, intraventricular meningiomas, meningiomas with infratentorial extension were excluded from the study. Patients with CT (computed tomography) or MRI (magnetic resonance imaging) evidence of co-existent other cerebral lesions were also excluded from the study. Patients with presenting GCS (Glasgow coma scale) less than 15 and patients with a family history of psychiatric illness were also excluded from the study.

The radiological diagnosis was made on the basis of plain and contrast enhanced CT and MRI scans. The diagnosis was later confirmed by histopathological examination in all the patients. The results for psychiatric symptoms were reported published earlier. In this article, we have discussed the results for cognitive deficits.

2.2.1. Assessment of cognitive functions

The cognitive assessment was carried by a neurosurgeon and a psychologist. The battery of tests administered is summarized in supplementary Table 1. Digit symbol substitution test was used to assess mental speed. Similarly color trial test-I was used for assessment of focused attention, digit vigilance test for sustained attention, controlled oral word assosciation test for phonemic fluency, animal names test for category fluency, verbal N-back test for verbal working memory, visual N-back test for visual working memory, Rey's auditory verbal learning test for registration, verbal learning ability, verbal memory and Rey's complex figure test was used for assessment of visuo-constructive abilities, visual learning and memory. Digit symbol substitution test, color trial test-I and digit vigilance test were not administered to illiterate or blind patients as they could not recognize numbers. Similarly visual N-back test and Rey's complex figure test were not administered to patients with impaired vision. The scores of the patients obtained after administering the battery of tests were compared with the normative data of these tests for normal Indian population. The normative data is obtained from results published by National Institute of Mental Health and Neurosciences, India. This data is based on a cognitive assessment of 540 Indian subjects. The subjects had no history of neurological, neurosurgical or psychiatric illness. They had no family history of psychiatric illness or alcohol dependence. First the sample was divided into three categories according to age: 16–30 years, 31–50 years and 51–65 years. Then, these age groups were divided into 3 groups on the basis of education education into subjects who are illiterate, those with up to 10 years of education (school educated) and those with more than 10 years of education (college educated). Each of these were further divided on the basis of gender in to males and females. There were equal number of males and females in each education category. [13] So this sample population of 540 Indian subjects acted as our control group. Test subjects were matched with control subjects for age, gender and education during comparison and analysis. Goryiovagnoli and Boiardi [3] have found that even subtle cognitive deficits prevent symptom-free survivors from returning back to preoperative autonomy and occupations. So, scores 1 standard deviation below the mean, which approximately corresponds to 15th percentile, were considered impaired. And also, a person's overall cognitive status was considered impaired if he had cognitive impairment in even one of the cognitive test administered. The cognitive assessment was done just before surgery and three months post surgery. The pre-op scores and the post-op scores were compared to detect deterioration or improvement in cognitive status.

The size of the tumor and volume of peritumoral edema were calculated from the maximum diameter of the tumor and peritumoral edema on the sagittal, axial and coronal MRI images using the prolate ellipse formula: [2]:

$$\text{Tumorvolume} = \text{length} \times \text{depth} \times \text{width} \times 0.523.$$

On the basis of location meningiomas were classified as frontal meningiomas (olfactory groove meningiomas, frontal convexity meningiomas, anterior one-third parasagittal and falcine meningiomas), suprasellar meningiomas (dorsum sella meningiomas, tuberculum sella meningiomas, clinoidal meningiomas, cavernous sinus meningiomas), temporal meningiomas (sphenoid wing meningiomas, temporal convexity meningiomas), parietal meningiomas (parietal convexity, middle one-third falcine and parasagittal meningiomas), occipital meningiomas (occipital convexity, posterior one third falcine and parasagittal meningiomas).

2.2.2. Statistical analysis

Statistical analysis was carried out using the statistical software SPSS 16.0. The comparisons and correlations have been established using t-test (independent), Mann–Whitney U and Chi Square test. Independent t-test has been used for continuous parametric variables, Mann–Whitney U test has been used for continuous non-parametric variables and Chi-Square test for categorical variables. Analysis of Variance (ANOVA) and Kruskal–Wallis tests were used for the comparison between three or more categories or subgroups. Two-tailed tests of significance were computed and p values below 0.05 were considered significant. For computing the p-value, the