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Original research article

Surgical treatment and prognosis of adult patients with brainstem gliomas

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ARTICLE INFO

Article history:
Received 21 November 2016
Accepted 23 August 2018
Available online xxx

Keywords:
Brainstem glioma
Surgical treatment
Prognosis
MEP
DTI

ABSTRACT

The paper presents 47 adult patients who were surgically treated due to brainstem gliomas. Thirteen patients presented with contrast-enhancing Grades III and IV gliomas, according to the WHO classification, 13 patients with contrast-enhancing tumours originating from the glial cells (Grade I; WHO classification), 9 patients with diffuse gliomas, 5 patients with tectal brainstem gliomas and 7 patients with exophytic brainstem gliomas. During the surgical procedure, neuronavigation and the diffusion tensor tractography (DTI) of the corticospinal tract were used with the examination of motor evoked potentials (MEPs) and somatosensory evoked potentials (SSEPs) with direct stimulation of the fundus of the fourth brain ventricle in order to define the localization of the nuclei of nerves VII, IX, X and XII. Cerebellar dysfunction, damage to cranial nerves and dysphagia were the most frequent postoperative sequelae which were also the most difficult to resolve. The Karnofsky score established preoperatively and the extent of tumour resection were the factors affecting the prognosis. The mean time of progression-free survival (14 months) and the mean survival time after surgery (20 months) were the shortest for malignant brainstem gliomas. In the group with tectal brainstem gliomas, no cases of progression were found and none of the patients died during the follow-up. Some patients were professionally active. Partial resection of diffuse brainstem gliomas did not prolong the mean survival above 5 years. However, some patients survived over 5 years in good condition.

1. Introduction

Brainstem gliomas account for only 1–2% of all adult gliomas and are characterized by poor prognosis. In particular, unfavourable prognosis is related to patients with enhancing high-Grades III and IV gliomas (WHO classification) and diffuse brainstem gliomas. However, in the latter group the prognosis is better than in children [1–3]. A 5-year survival was reported in 58% of adult patients with diffuse brainstem gliomas, which

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https://doi.org/10.1016/j.pjnns.2018.08.008
0028-3843/

is significantly longer than in children [1–3]. Good prognosis is expected after surgical intervention in patients with focal and exophytic tumours [4–9].

Diagnosis of brainstem gliomas was based on the characteristic MRI features [7,8,10–13]. Another significant factor is the use of neuronavigation to determine tumour location and the localization of the corticospinal tract within the neuronavigation system based on the diffusion tensor tractography (DTI) examination. The use of corticospinal tract tractography decreases the frequency of postoperative limb paresis [14]. Frequency of limb paresis is also decreased due to the examination of motor evoked potentials (MEPs) with transcranial electrical stimulation (TES) of the brain [14–16]. The direct electrical stimulation (DES) of cerebral peduncles in tumours of the ventral part of the midbrain or the pyramids of the medulla oblongata enables us to find the corticospinal tract. From the practical point of view, it is vital to localize the nuclei of cranial nerves VII, IX, X and XII on the basis of DES of the fundus of the fourth brain ventricle during the surgical procedure [15].

The aim of the present study is the analysis of surgical treatment results in adult patients with brainstem gliomas. Attention was paid to the following questions:

- what affects the prognosis of these patients;
- what are the benefits of surgical treatment;
- what is the frequency of serious postoperative sequelae and what is their tendency to resolve;
- whether the prognosis depends on tumour location or histological findings;
- whether patients with diffuse brainstem gliomas should undergo surgery;
- what radiological and electrophysiological examinations should be used during surgery to obtain the best surgical outcome.
- Experience of other surgeons in this respect is of great importance. They presented surgical treatment results of brainstem gliomas and discussed significant prognostic factors [2,7,8,14–17,20–24,26–28,30,32].

2. Clinical material and methods

Forty seven patients underwent surgery for brainstem gliomas between 1998 and 2014. 26 of the patients were female and 21 were male (age range 18–74 years; mean age 38.7 years). The follow-up period ranged from 3 months to 16 years (mean follow-up 4.04 years). Table 1 presents surgically treated types of brainstem glioma. The classification was based on the division presented by Botero [17] with some modifications by the authors of this paper.

As it is shown in Table 1, patients with contrast-enhancing malignant and non-malignant brainstem gliomas constituted the largest group ($n = 26$). Nine patients presented with diffuse brainstem gliomas, 7 patients with exophytic brainstem gliomas and 5 patients with focal tectal brainstem gliomas.

Head MRI with PWI, DWI, DTI, 1 HMRS was performed. All the surgical procedures were performed with the use of the neuronavigation system, which was applied to determine tumour location and the course of the corticospinal tract (DTI tractography). In order to preserve the continuity of the corticospinal tract, MEP recording obtained with transcranial electrical stimulation (TES) was used. The localization of the nuclei of nerves VII, IX, X and XII within the fundus of the fourth ventricle was established by DES. Somatosensory evoked potentials (SSEPs) were monitored.

Table 1 – MRI-based radiological classification of brainstem gliomas.

	Cases	
	No	%
1. Adult diffuse intrinsic low-grade brainstem gliomas	9	19
2. Contrast-enhancing malignant brainstem glioma	13	28
3. Contrast-enhancing non-malignant intrinsic glioma	13	28
4. Focal tectal brainstem gliomas	5	11
5. Exophytic brainstem gliomas	7	14
Total	47	100

The extent of resection was confirmed by contrast-enhanced MRI performed within one month after the surgical procedure. The extent of resection was defined either as a gross total resection (when in the follow-up contrast MRI the removal of over 80% of tumour mass was confirmed) or as a partial resection (resection of less than 80% of the baseline tumour mass) [18]. The choice of the surgical approach was determined by tumour location and the result of the course of the corticospinal tract as measured by DTI.

The following surgical approaches were used to remove the brainstem lesions: suboccipital – 22 (47%); subtonsilar telovelar – 8 (17%); far-lateral – 4 (6%); infratentorial, supracerebellar – 4 (6%); retrosigmoid – 4 (6%); temporal-posterior – 3 (5%); subtemporal, transtentorial – 1 (4%); paramedian supracerebellar – 1 (4%). The surgical approach related to surgical treatment of brainstem gliomas was previously described in our paper in 2005 [19].

After the surgical procedure, patients were transferred to the Intensive Care Unit. Two outcome measures were assessed: (1) progression-free survival (PFS), defined as the time from surgery to the increase in tumour size on follow-up FLAIR imaging and/or demonstration of gadolinium enhancement on follow-up imaging or malignant degeneration; (2) overall survival (OS), defined as the time between initial surgery and death.

3. Methodology of statistical analysis

Statistical analysis was performed using STATISTICA 10 software. Survival probability (OS, PFS) was calculated using the Kaplan–Meier method. Differences between the courses of the curves of the impact of the analyzed variables on survival time (OS, PFS) were compared by the log-rank test and the equivalent to the log-rank test for variables with many categories (more than 2).

4. Results

The following were the symptoms reported by patients on admission to the Department of Neurosurgery: instability of

Please cite this article in press as: Majchrzak K, et al. Surgical treatment and prognosis of adult patients with brainstem gliomas. Neurol Neurochir Pol (2018), https://doi.org/10.1016/j.pjnns.2018.08.008