Acta Neurochir (Wien) (1995) 132: 59–65

Acta Neurochirurgica

Staging, Scoring and Grading of Medulloblastoma

A Postoperative Prognosis Predicting System Based on the Cases of a Single Institute

U. Sure[1–3], W. J. Berghorn[1], H. Bertalanffy[1, 3], T. Wakabayashi[2], J. Yoshida[2], K. Sugita[2], and W. Seeger[1]

[1] Neurochirurgische Universitätsklinik Freiburg, Freiburg i. Br., Federal Republic of Germany
[2] Department of Neurosurgery, Nagoya University, School of Medicine, Tsurumai Showa, Nagoya, Japan
[3] Neurochirurgische Universitätsklinik Aachen, RWTH Aachen, Federal Republic of Germany

Summary

Although recently survival of some medulloblastoma patients increased remarcably, it remains a serious diagnosis in others. In order to predict the postoperative prognosis in patients treated for medulloblastoma, a new staging, scoring and grading system was developed.

Sixty-six patients operated on microsurgically between 1975 and 1990 at a single neurosurgical center were fully followed-up. No patient was excluded due to a poor postoperative course. Completion of commonly used radiotherapy protocols was attempted in all patients. Survival of patients was evaluated by the Kaplan-Meier method.

The following 5 parameters were selected to define subgroups: patients' age, tumour location and histology, degree of resection and presence or absence of metastases. Patients older than 10 years had a better prognosis than individuals aged 10 or less ($p < 0.01$), patients with lateral tumours had a better prognosis than patients with midline tumours with brain stem infiltration ($p < 0.05$), patients with complete tumour resection had a more favourable prognosis than individuals with subtotal ($p < 0.01$) or partial resection ($p < 0.001$), patients without metastases at the time of diagnosis had a better prognosis than individuals without such evidence ($p < 0.001$), patients with the desmoplastic tumour variant had a better prognosis than patients with classical tumour histology ($p < 0.01$).

According to the prognosis of a distinct subgroup, scoring points were distributed which correlated with the degree of inter-subgroup significances. The sum of a single patient's scoring points was called the total score. Based on this score, three groups of prognosis were distinguished. The good prognosis group ($n = 29$) showed a significantly better survival ($p < 0.05$) than the moderate prognosis group ($n = 26$), whereas the moderate prognosis group had a significantly better survival ($p < 0.05$) than the poor prognosis group ($n = 11$). A Kaplan-Meier survival rate of 62% was found in patients of the good prognosis group, a rate of 22% in the moderate prognosis group, and a rate of 0% in the poor prognosis group.

It is concluded that this new staging, scoring and grading system is a simple and recommendable prognostic system for all patients treated surgically for medulloblastoma.

Keywords: Medulloblastoma; PNET-PF; grading; prognosis.

Introduction

In 1925 Bailey and Cushing[2] introduced the term medulloblastoma as a distinct tumour entity which differed from all neoplasms previously reported. They described a highly malignant tumour of the cerebellar midline, hypothetically deriving from a bipotential ectodermal cell. This tumour occurred predominantly in childhood and its treatment had an extremely poor outcome. In 1964 Rubinstein and Northfield[30] distinguished the desmoplastic variant from the formerly described medulloblastoma based on the presence of additional reticulin fibers. Lesions without such connective tissue were termed classical, those with partial desmoplasia were called transitional medulloblastoma.

In 1983 Rorke[29] established a new tumour concept. Non-cerebellar tumours, microscopically indistinguishable from medulloblastomas, and cerebellar medulloblastomas were placed into one group called Primitive Neuroectodermal Tumours (PNET's). Rorke introduced a term that Hart and Earle[22] had previously used exclusively for supratentorial malignant small cell tumours. Presently, the abbreviation PNET of the posterior fossa (PNET-PF) is used as a synonym for medulloblastoma.

Survival data of medulloblastomas improved dramatically since their introduction into the literature[3, 5, 9, 10, 14, 20, 21, 28, 36, 37]. Nevertheless, regardless of satisfactory survival in some patients, this tumour entity remains a serious diagnosis in others[19, 21, 25, 32]. For this reason there is a need for an easily applicable prognosis

predicting system that provides useful information concerning a single individual's prognosis.

We have analysed retrospectively patients with medulloblastomas in order to distinguish patient subgroups with significant differences of survival. Based on these subgroups, we have established an early postoperative prognosis predicting system.

Material and Methods

Patients

Seventy patients with the diagnosis of medulloblastoma have been treated between 1975 and 1990 at the Department of Neurosurgery, University of Freiburg, Germany. All patients were operated on by standard microsurgical techniques and strategies[33, 34]. Four patients (6%) were excluded due to incompleteness of their follow-up data. The remaining 66 patients were completely followed-up.

All patients had preoperative and postoperative cranial computerized tomography (CT) and/or magnetic resonance imaging (MRI). Spinal neuroradiological examinations[16, 35, 39] were performed only in paitents with medullary symptoms. Histologically, the classical and the desmoplastic tumour variants were distinguished from each other. If the complete tumour specimen revealed the typical whorled reticuline fiber pattern surrounding tumour cell islands, the tumour was staged as a desmoplastic medulloblastoma[30]. Tumours with few or incomplete desmoplasia were interpreted as a transitional subtype, but were included in the classical medulloblastoma group according to their similar biological behaviour[30].

Following surgery, 62 (94%) patients were treated by radiation. The majority of cases (n = 41 / 66%) received complete radiotherapy with doses of 30–35 Gy to the neuraxis, and a booster of 20 Gy to the posterior fossa. Due to side effects, 9 patients (14%) did not receive complete radiation doses. In 12 of our early patients (18%) the radiation doses have not been exactly documented. Four patients (6%) were not irradiated. Two of them died postoperatively within 4 weeks of unrelated causes, 2 others refused radiotherapy and died within 6 months after the operation due to tumour recurrence.

Thirty-two patients (49%) were subjected to a broad variety of different chemotherapy trials that were used between 1975 and 1990. Groups with similar protocols were too small to be comparable.

Survival, Statistics and Staging

Survival was described by means of the Kaplan-Meier method[24] as to five postoperatively detectable parameters: age, tumour location, degree of resection, presence or absence of metastases, and histology. Based on these parameters, subgroups were defined (staged) in order to detect differences of survival. Survival curves were compared by the Wilcoxon test. A statistical significant ($p < 0.05$) difference between subgroups was considered as prognostic indicator for patient's survival. Non-significant parameters (i.e.: patients' sex) and parameters that were not detectable during the immediate postoperative period such as the completion of the radiotherapy, were not considered for our prognosis predicting system.

Scoring

According to the prognosis of a distinct subgroup, scoring points were distributed correlating with the degree of inter-subgroup significances.

Grading

The sum of a single patient's scoring points defined the total score, and was used to define different prognostic groups.

Results

Staging and Scoring

Age: A highly significantly better survival ($p < 0.01$) was found in the patients older than 10 years compared to patients aged 10 years or less. Patients older than 10 years were therefore scored with 2 points, patients

Table 1. *Staging of Tumour Locations*

No.	Location	n	s (%)
1 a	medial, no infiltration	16	38
1 b	medial, with infiltration	31	19
2 a	lateral	16	62
2 b	cerebello-pontine angle	3	33

n number of patients, *s* Kaplan-Meier survival rate.

Table 2. *Staging of Degree of Resection*

Resection	n	s (%)
Total	25	72
Subtotal	33	23
Partial	5	20
Biopsy	3	0

n number of patients, *s* Kaplan-Meier survival rate.

Table 3. *Scoring of Subgroups*

Parameter	Subgroup	Scoring-No.	n	s (%)
Age	> 10 years	2	33	53
	0–10 year	0	33	19
Location	2 a	3	16	62
	1 a	2	16	38
	2 b	1	3	33
	1 b	0	31	19
Resection	total	4	25	72
	subtotal	2	33	23
	partial	1	5	20
	biopsy	0	3	0
Metastases	no	3	57	41
	present	0	9	0
Histology	desmoplastic	2	10	79
	classical	0	56	31

n number of patients, *s* Kaplan-Meier survival rate.

10 years or younger with 0 points (Table 3). Further subgroups (0–3 yrs: number of patients (n): 12, Kaplan-Meier survival rate (s): 17%, 4–10 yrs: n = 21, s = 21%, 11–18 yrs: n = 10, s = 57%, 19–29 yrs: n = 16, s = 55%, > 29 yrs: n = 7, s = 42%), did not show significant differences (Fig. 1).

Location: Tumours located in the vermis without (subgroup 1 a) and with brainstem (1 b) infiltration were distinguished from lateral lesions within the cerebellar hemispheres (2 a) or within the cerebellopontine angle (2 b) (Table 1). Subgroup 2 a (n = 16, s = 62%) had a remarkably better Kaplan-Meier survival rate than subgroup 1 a (n = 16, s = 38). Similarly, subgroup 2 a showed a significantly better survival ($p < 0.05$) than subgroups 1 b and 2 b (Fig. 2). Accordingly, subgroup 2 a was scored with 3 points (Table 3).

Subgroup 1 a showed a tendency ($p < 0.10$) towards a better survival than subgroups 2 b (n = 3, s = 33%) and 1 b (n = 31, s = 19%), and was therefore scored with 2 points. Subgroup 2 b with a remarkably better survival rate than subgroup 1 b was scored with 1 point. Subgroup 1 b was scored with 0 points (Table 3).

Degree of resection: Tumours were considered totally resected when no macroscopic evidence of tumour

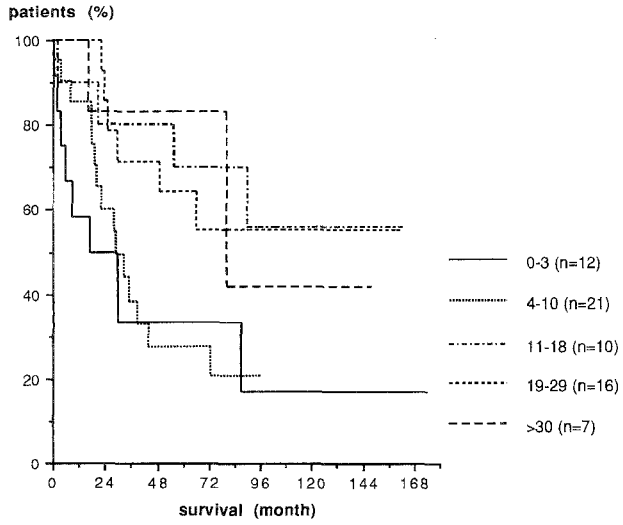

Fig. 1. Kaplan-Meier life table according to the patient's age subgroups. Survival rates see Table 3

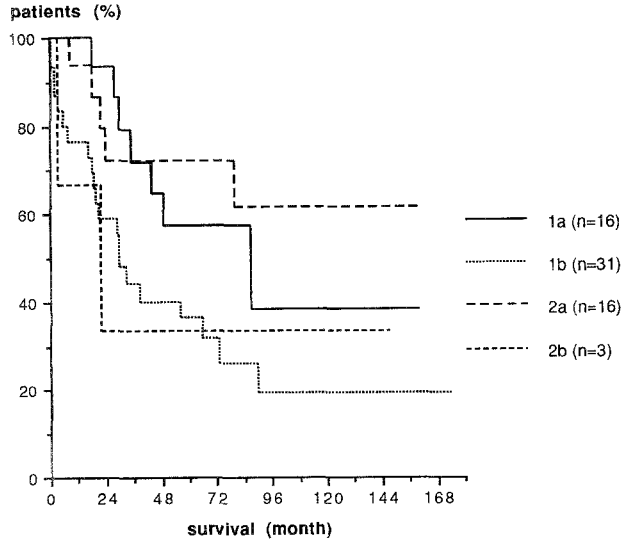

Fig. 2. Kaplan-Meier life table according to the tumour location subgroups. Survival rates see Table 1. *1 a* medial tumours no brainstem infiltration, *1 b* medial tumours with brainstem infiltration, *2 a* lateral tumours, *2 b* cerebellopontine angle tumours

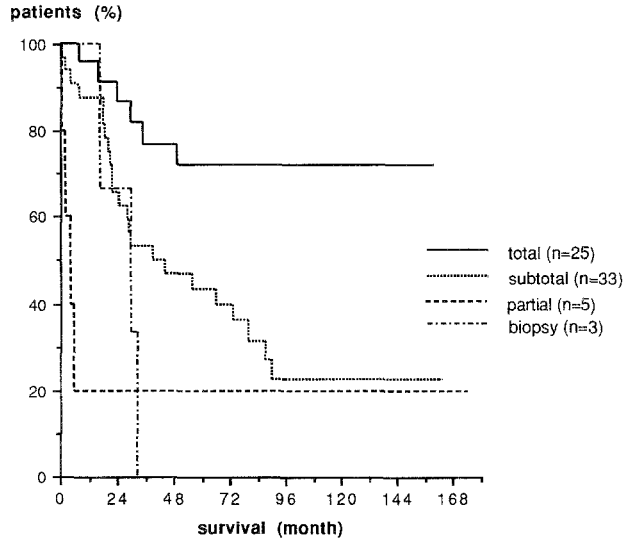

Fig. 3. Kaplan-Meier life table according to the degree of resection subgroups. Survival rates see Table 2

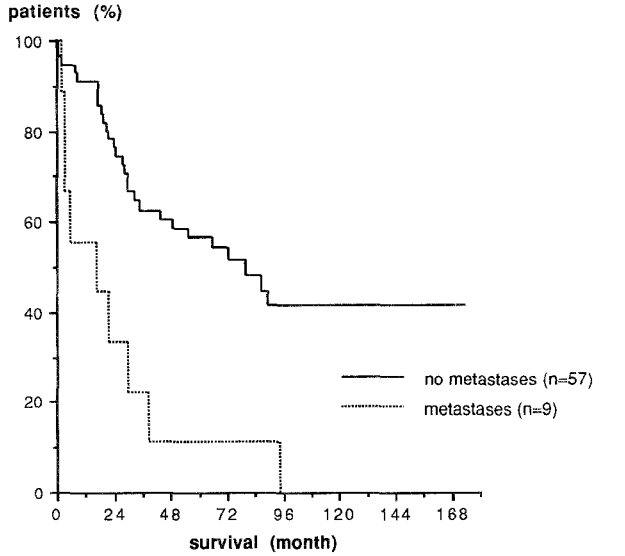

Fig. 4. Kaplan-Meier life table according to the metastases subgroups. Survival rates see Table 3

was present at the end of surgery and the postoperative CT-scan showed no residual tumour (n = 25, s = 72%, Table 2). A subtotal resection (n = 33, s = 23%, Fig. 3) was achieved in patients with tumour infiltration of brainstem, cerebellar peduncles or vessels. A partial resection was carried out in patients with massive brainstem and/or peduncular infiltration (n = 5, s = 20%). In patients with extensive tumour spread (n = 3, s = 0%, Fig. 3), surgery was restricted to tumour biopsy in order to confirm the histological diagnosis prior to palliative radiotherapy.

A highly significantly better survival was found in patients with total resection compared with those who had a subtotal ($p < 0.01$) or a partial resection ($p < 0.001$). Correspondingly, the totally resected subgroup was scored with 4 points. The subtotally resected subgroup had a significantly better survival ($p < 0.05$) than the group with partial resection, and was scored with 2 points. Partially resectd patients were scored with 1 point, those with tumour biopsy all died within 3 years following surgery, with 0 points.

Metastases: Patients without metastases at the time of surgery (n = 57, s = 41%) showed a highly significantly better survival ($p < 0.001$) than patients with metastases (n = 9, s = 0%, Fig. 4). Accordingly, the subgroup without metastases was scored with 3 points, the subgroup with secondary tumour manifestations with 0 points (Table 3).

Histological findings: Patients with the desmoplastic variant (n = 10, s = 79%) showed a highly significantly better survival than patients with the classical variant (n = 56, s = 31%, Fig. 5). The lesions of 8 patients with evidence of reticuline fibers in only a small part of the tumour were regarded as transitional tumour types, and subsequently included in the subgroup of patients with classical tumours. Patients with the desmoplastic variant were scored with 2 points, those with the classical tumour variant with 0 points (Table 3).

Some patients presented with an unusual combination of age, tumour histology and location. Three individuals with a desmoplastic tumour were younger than 10 years (30%), 12 patients with a classical tumour were older than 18 years (21%). In 3 patients with a desmoplastic variant (30%), the lesion was located in the cerebellar midline. In contrast to these, 9 patients with a classical variant (16%) were treated for tumours of the cerebellar hemispheres.

Grading

Three distinct prognostic groups were defined according to the total score of each patient, the highest possible score being 14, the lowest 0.

Patients with a score of 0–4 points were graded as having a poor prognosis, those with 5–8 points a moderate, and individuals with 9–14 points as having a good prognosis. According to this scheme, 29 patients (44%) showed a good, 26 patients (39%) a moderate and 11 patients (17%) a poor prognosis.

Survival of the 3 prognostic groups was evaluated by the Kaplan-Meier method (Fig. 6). Patients belong-

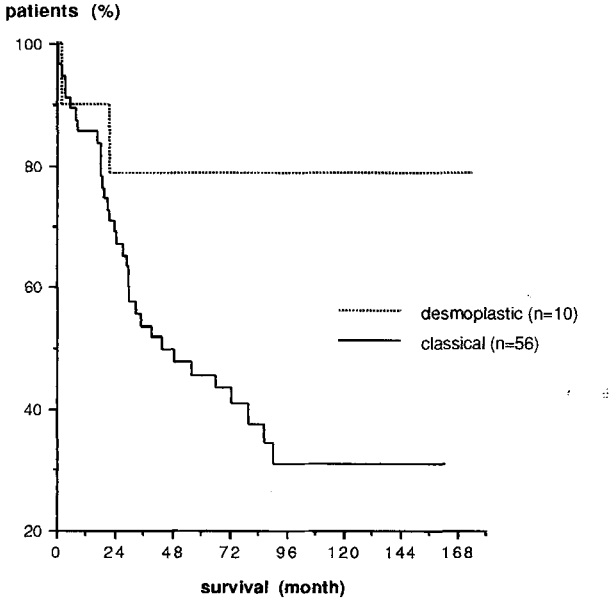

Fig. 5. Kaplan-Meier life table according to the tumour histology subgroups. Survival rates see Table 3

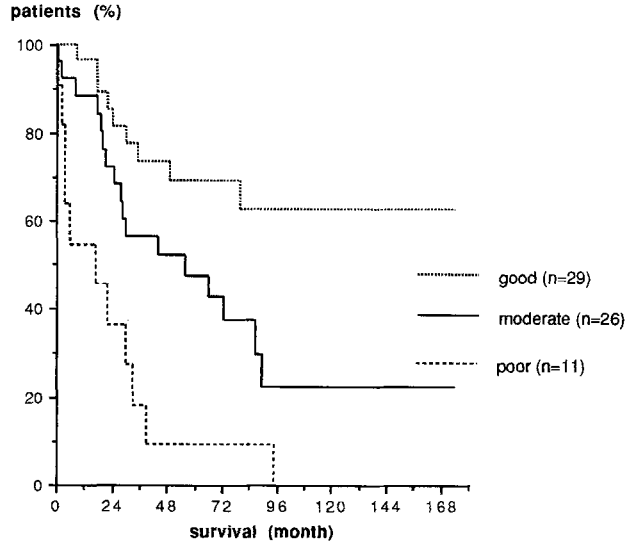

Fig. 6. Kaplan-Meier life table according to the prognosis groups. Survival rates see Table 4

Table 4. *Grading of Prognosis Group*

Prognosis	Final scoring number	n	s (%)
Good	9–14	29	62
Moderate	5– 8	26	22
Poor	0– 4	11	0

n number of patients, *s* Kaplan-Meier survival rate.

ing to the good prognosis group (s = 62%) survived significantly longer ($p < 0.05$) than those of the moderate prognosis group (s = 22%), whereas the moderate prognosis groups showed a significantly better survival ($p < 0.05$) than the poor prognosis group (s = 0%, Table 4).

Comparison of patients treated by surgery and radiotherapy with those who underwent additional chemotherapy, did not show significant differences of survival. At the end of our study, 30 patients (45%) had survived. The median survival time of all patients was 55 months.

Discussion

In 1969 Chang *et al.*[9] introduced an operative staging system in order to distinguish several clinical findings in patients harbouring a medulloblastoma using a scheme similar to the TNM system for other malignancies. A number of authors have meanwhile adopted this system for staging medulloblastomas[7, 15, 17–20, 23, 25, 42]. However, some authors pointed out that Chang's staging system does not provide a reliable prediction for the prognosis of patients with medulloblastoma[16, 19].

A critical review of the literature reveals numerous studies concerning the prognosis of medulloblastoma patients which have excluded those individuals with poor preoperative, intraoperative or postoperative courses[6, 7, 10, 19, 20, 26, 28]. In our opinion, such results are not reliable for the prediction of postoperative prognosis. In the present study, no patient has been excluded from analysis. Therefore, our system can be applied to any patient harbouring a medulloblastoma following surgery.

The influence of the age on patients' outcome is generally accepted. Our data suggested a prognostic difference in patients being 10 years old and younger and those older than 10. Previously, prognostic cut-offs have been described between 3 and 10 years[10, 18, 19, 28]. The proposal of 3 years as a prognostic cut-off in the staging system of Laurent *et al.*[26] has been either denied or applied for different ages by numerous investigators[7, 13, 18, 19, 25, 28, 40]. The exclusion of distinct patient groups such as non-irradiated individuals, might explain these diverging opinions.

The influence of tumour location on patients' prognosis was also mentioned by many authors[5, 10, 13, 28, 30]. In accord with our own data, most of them reported a better prognosis for patients with lateral tumours compared to patients with midline lesions. However, our results demonstrated that lateral tumours can be subdivided into cerebello-pontine angle lesions and cerebellar hemispheric tumours, the latter bearing a more favourable prognosis than the former. Additionally, numerous authors emphasized a better prognosis in patients without brainstem involvement compared to patients with brainstem infiltration, which is confirmed by our data[9, 10, 14, 25, 26, 28].

Commonly, midline tumours cause hydrocephalus. Therefore, Chin and Maruyama suggested the presence of postoperative hydrocephalus as being a parameter for poor prognosis[11, 12]. We believe that the use of this parameter as a prognostic factor is unreliable, since the hydrocephalus may have been treated or not before tumour removal. Some centers routinely performed preoperative shunt implantation in patients with cerebellar midline tumours, others, however, avoided preoperative shunting in order to reduce the risk for extra-axial tumour seeding[4]. The fact that degree of tumour resection significantly influences the prognosis in patients with medulloblastomas has been reported by many authors[8, 19, 25, 26, 28, 40–42] and also confirmed by our own results.

The presence of metastases at the time of tumour diagnosis indicates a poor prognosis[1, 4, 17, 21, 25, 39]. Recently, some authors[16, 19, 25] applied Chang's metastases staging system[9] (M0–M4) in their own series. Concurring with our data, these authors did not find a prognostic difference between patients with different types of metastases (M0–M4).

While some authors described significant differences of prognosis in patients with classical and desmoplastic tumour variants[3, 10, 18], others have denied such differences[13, 28]. The reason for such discrepancy may be explained by the fact that in some of these studies tumours with even slight evidence of desmoplasia might have been misdiagnosed as desmoplastic medulloblastomas. These tumours, however, should be classified

as medulloblastomas of the transitional type bearing a similar prognosis as those of the classical type[30], and should therefore be classed into one group. The fact that classical and desmoplastic lesions may occur in a variety of unusual combinations of the patient's age as well as tumour histology and location underscores the importance for a prognosis predicting system that recognizes in formation from all these different prognostic parameters.

Contrary to the generally accepted prognostic value of the above mentioned factors, some prognostic parameters are still controversially debated in the literature. Packer *et al.*[27] described a better prognosis for patients with undifferentiated tumours as compared to patients with glial, neuronal or ependymal differentiation, whereas these findings were denied by other investigators[7, 14, 31, 38]. Recent development in molecular and cytogenic biology, such as an accurate detection of cell differentiation[7, 27, 31], DNA-ploidity[31, 32, 42], chromosomal aberations[31] or the proliferative index of tumour cells[31, 32], offers the possibility of detecting new and reliable prognostic parameters. Presently, these methods have not yet led to clear results for determining the patient's prognosis[31]. The future use of such methods in centers with modern diagnostic equipment, however, may give more detailed information about a single patient's prognosis.

Conclusion

Previously published medulloblastoma staging systems[9, 11, 12, 26, 32] have no provided reliable information about a single patient's prognosis at the time of the histological diagnosis. Therefore, a new postoperative medulloblastoma prognosis predicting system based on 5 parameters was developed. A newly designed 14-point scoring system enables a simple staging (Table 3). The distinction of three prognostic groups (good, moderate and poor) allows an accurate prognostic grading for any patient (Table 4). No sophisticated diagnostic equipment is required to perform a complete staging, scoring and grading with the 5 proposed parameters.

The present prognosis predicting system has been developed on the basis of the data of a single institute's patients. In contrast to other reports, no patient was excluded because of a poor postoperative course or incomplete postoperative radiotherapy protocol. Therefore, the present system can be applied in all surgically treated patients, provided standard radiotherapy will be aimed at postoperatively.

Acknowledgement

The authors appreciate the constructive criticism of Dr. Kiyoshi Saito (Department of Neurosurgery, Nagoya University School of Medicine, Japan) during the preparation of the manuscript. Dr. Ulrich Sure was sponsored by a Sugita-scholarship.

References

1. Allen JC, Meyers P, Epstein F (1981) Medulloblastoma. Tumor dissemination at diagnosis associated with young age and poor prognosis. Proc Am Assoc Cancer Res 22: 404 (Abstract)
2. Bailey P, Cushing H (1925) Medulloblastoma cerebelli. A common type of midcerebellar glioma of childhood. Arch Neurol Psych 14: 192–224
3. Berger EC, Elvidge AR (1963) Medulloblastomas and cerebellar sarcomas. J Neurosurg 20: 139–144
4. Berger MS, Baumeister B, Geyer JR, Milstein J, Kanev PM, Le Roux PD (1991) The risks of metastases from shunting in children with primary central nervous system tumours. J Neurosurg 74: 872–877
5. Berghorn WJ (1982) Untersuchungen zur biologischen Wertigkeit des klassischen und des desmoplastischen Medulloblastoms. Dissertation aus der Neurochirurgischen Klinik der Universität Düsseldorf, Düsseldorf, Germany, pp 1–77
6. Berry MP, Jenkin RD, Keen CW, Nair BD, Simpson WJ (1981) Radiation treatment for medulloblastoma: a 21-year review. J Neurosurg 55: 43–51
7. Caputy Aj, Mc Cullough DC, Manz HJ, Patterson K, Hammock MK (1987) A review of the factors influencing the prognosis of medulloblastoma. J Neurosurg 66: 80–87
8. Carrie C, Bouffet E, Brunat-Mentigny M, Philip T, Lacroze M (1989) Les tumeurs cerebrales primitives de l'enfant partie II: Etude topographique et traitment. Bull Cancer 76: 255–272
9. Chang CH, Housepian EM, Herbert C (1969) An operative staging system and a megavoltage radiotherapeutic technic for cerebellar medulloblastomas. Radiology 93: 1351–1359
10. Chatty EM, Earle KM (1971) Medulloblastoma: a report of 201 cases with emphasis of the relationship of histological variants to survival. Cancer 28: 977–983
11. Chin HW, Maruyama Y (1981) Proposed clinical staging system for medulloblastoma. Int J Radiat Oncol Biol Phsy 7: 1285 (Abstract)
12. Chin HW, Maruyama Y (1984) The CT assisted staging system for medulloblastoma. 3rd Annual Meeting of the European Society for therapeutic Radiology and Oncology, September 9–15, Jerusalem, Israel, p 297
13. Choux M (1982) Medulloblastoma in children. Childs Brain 9: 280–283
14. Choux M, Lena G (1983) Le medulloblastome. Neurochirurgie 28 [Suppl 1]: 229 p
15. Cornu P, Chattellier G, Fauchon F, Foncin JF, Faillot T, Dorwling-Carter D, Philippon J (1990) Pronostic des medulloblastomes de l'adulte. Neurochirurgie 36: 218–224
16. Deutsch M, Reigel DH (1980) The value of myelography in the management of childhood medulloblastoma. Cancer 45: 2194–2197
17. Deutsch M (1988) Medulloblastoma: staging and treatment outcome. Int J Rad Oncol Biol Phys 14: 1103–1107
18. Dexter D, Howell DA (1965) Medulloblastomas and arachnoidal sarcomas. Brain 88: 367–374

19. Evans AE, Jenkin DT, Sposto R, Ortega JA, Wilson CB, Wara W, Ertel IJ, Kramer S, Chang CH, Leikin S, Hammond GD (1990) The treatment of medulloblastoma. Results of a prospective randomized trial of radiation therapy with and without CCNU, vincristine and prednisone. J Neurosurg 72: 572–582
20. Gartton GA, Schomberg PJ, Scheitauer BW, Shaw EJ, Ilstrup DM, Blackwell CA, Laws ER, Earle JD (1990) Medulloblastoma – prognostic factors and outcome of treatment: Review of the Mayo Clinic experience. Mayo Clin Proc 65: 1077–1086
21. Geyer R, Levy M, Berger MS, Milstein J, Griffin B, Bleyer WA (1991) Infants with medulloblastomas: a single institution review of survival. Neurosurgery 29: 707–711
22. Hart MN, Earle KM (1973) Primitive neuroectodermal tumors of the brain in children. Cancer 32: 890–897
23. Inoue I, Yoshida J, Kageyama N (1985) Analysis of various factors related to the prognosis of medulloblastoma. No Shinkei Geika 13: 1283–1289 (in Japanese)
24. Kaplan EL, Meier P (1958) Nonparametric estimation from incomplete observations. J Am Stat Assoc 53: 457–481
25. Kopelson G, Linggood RM, Kleinmann GM (1983) Medulloblastoma. The identification of prognostic subgroups and implications for multimodality management. Cancer 51: 312–319
26. Laurent JP, Chang CH, Cohen ME (1985) A classification system for primitive neuroectodermal tumors (medulloblastomas) of the posterior fossa. Cancer 56: 1807–1809
27. Packer RJ, Sutton LN, Rorke LB, Littman PA, Sposto R, Rosenstock JG, Bruce DA, Schut L (1984) Prognostic importance of cerebellar differentiation in medulloblastoma of childhood. J Neurosurg 61; 296–301
28. Park TS, Hoffman HJ, Hendrick EB, Humphreys RP, Laurence LE (1983) Medulloblastoma: clinical presentation and management. J Neurosurg 58: 543–552
29. Rorke LB (1983) The cerebellar medulloblastoma and its relationship to primitive neuroectodermal tumors. J Neuropathol Exp Neurol 42: 1–15
30. Rubinstein LJ, Northfield DW (1964) The medulloblastoma and the so called "arachnoidal cerebellar sarcoma". Brain 87: 379–412
31. San Galli F, Maire JP, Guerin J (1991) Medulloblastome: vers de nouveaux facteurs pronostiques. Neurochirurgie 37: 3–11
32. Schofield DE, Yunis EJ, Geyer R; Albright AL, Berger MS, Taylor SR (1991) DNA content and other prognostic features in childhood medulloblastoma. Proposal of a scoring system. Cancer 69: 1307–1314
33. Seeger W (1980) Microsurgery of the brain, Vol II. Springer, Wien New York
34. Seeger W (1986) Planning strategies of intracranial microsurgery. Springer, Wien New York
35. Stanley P, Suminski N (1988) The incidence and distribution of spinal metastases in children with posterior fossa medulloblastoma. Am J Pediatr Hematol Oncol 10: 283–287
36. Stiller CA, Bunch KJ (1990) Trends in survival of childhood cancer in Britain diagnosed 1971–1985. Br J Cancer 62: 806–815
37. Sure U (1993) Untersuchungen zum Medulloblastom. Inauguraldissertation der Medizinischen Fakultät der Universität Freiburg, Freiburg, Germany, pp 1–145
38. Taomoto K, Tomita T, Raimondi AJ, Leestma JE (1987) Medulloblastomas in childhood: histological factors influencing patients' outcome. Childs Nerv Syst 3: 354–360
39. Tomita T, McLone DG (1983) Spontaneous seeding of medulloblastoma: results of cerebrospinal fluid cytology and arachnoid biopsy from the cisterna magna. Neurosurgery 12: 265–267
40. Watt TJ, Winfield JA (1987) Analyzing factors influencing medulloblastoma prognosis. J Neurosurg 67: 471–472
41. Woo SY, Mc Cullough D, Sinks LF (1984) Primary therapy of medulloblastoma with surgery, radiation and adjuvant methotrexate and BCNU – a pilot study. J Neurooncol 2: 288 (Abstract)
42. Yasue M, Tomita T, Engelhard H, Gonzalez-Crussi F, Mc Lone DG, Bauer KD (1989) Prognostic importance of DNA ploidity in medulloblastoma of childhood. J Neurosurg 70: 385–391

Correspondence: Ulrich Sure, M.D., Neurochirurgische Universitätsklinik, Klinikum Aachen, RWTH Aachen, Pauwelstraße 30, D-52057 Aachen, Federal Republic of Germany.