ORIGINAL ARTICLE

MALIGNANT PERIPHERAL NERVE SHEATH TUMORS OF THE HEAD AND NECK: MANAGEMENT OF 10 CASES AND LITERATURE REVIEW

Amir Minovi, MD,[1] Oliver Basten, MD,[2] Ben Hunter, BSc, MBBS, MRCS,[3] Wolfgang Draf, MD, PhD, FRCS,[1] Ulrike Bockmühl, MD, PhD[1]

[1] Department of Otorhinolaryngology, Head and Neck and Facial Plastic Surgery, Klinikum Fulda gAG, Teaching Hospital of the Philipps-University Marburg, Pacelliallee 4, 36043 Fulda, Germany.
E-mail: u.bockmuehl.hno@klinikum-fulda.de
[2] Department of Pathology, Klinikum Fulda gAG, Teaching Hospital of the Philipps-University Marburg, Pacelliallee 4, 36043 Fulda, Germany
[3] Department of Otorhinolaryngology and Head and Neck Surgery, Plymouth Hospitals NHS Trust, Derriford, Plymouth, Devon PL6 8DH, United Kingdom

Accepted 8 August 2006
Published online 12 December 2006 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hed.20537

Abstract: *Background.* This study analyzes the management and outcomes of a series of 10 malignant peripheral nerve sheath tumors (MPNST) of the head and neck.

Methods. From 1984 to 2004, 10 patients underwent surgical treatment of a MPNST. We retrospectively reviewed presenting symptoms, radiological findings, surgical management, and follow-up status and performed a literature review.

Results. Eight tumors were located at the lateral skull base; 2 involved the vagus nerve in isolation. Two lesions were growing within the sinonasal tract. The most common presenting symptom was a rapidly enlarging cervical mass. Seventy percent of the tumors could be resected completely. Long-term follow-up showed a 2-year disease-specific survival rate of 50% and 5-year survival rate of 20%. Negative prognostic indicators were advanced tumor stage, early recurrence, and presumably also the presence of von Recklinghausen's disease. Postoperative adjuvant radiotherapy was found to make no difference in outcome.

Conclusions. Although rare, MPNST is one of the most aggressive tumors in the head and neck area. Complete tumor removal is the mainstay of treatment and most important prognostic factor of MPNST. Adjuvant radiotherapy should be used to assist surgical excision in local control. The role of adjuvant chemotherapy remains controversial. ©2006 Wiley Periodicals, Inc. *Head Neck* **29:** 439–445, 2007

Keywords: malignant peripheral nerve sheath tumors; malignant schwannoma; head and neck; surgery

Correspondence to: U. Bockmühl

Partly presented at the 5th EUFOS Congress, Rodes, Greece, September 2004.

This paper is dedicated to Professor Draf for his 65th birthday.

Malignant peripheral nerve sheath tumors (MPNSTs) comprise a group of tumors that arise from peripheral nerves or that display differentiation along the lines of the various elements of the nerve sheath, including Schwann cells, perineural fibroblasts, or fibroblasts.[1] MPNST is a relatively new term for tumors that formerly were called malignant schwannoma, neurofibrosarcoma, or neurogenic sarcoma, which in general belong to the

uncommon group of malignant mesenchymal tumors. MPNSTs account for about 5% of all soft tissue sarcomas.[2,3] MPNSTs occur in equal frequency sporadically or are associated with neurofibromatosis, particularly with neurofibromatosis type 1 (NF1).[3,4] Rarely, MPNSTs arise subsequent to radiation treatment.[1] Usually MPNSTs are found in the extremities and the trunk and, unlike benign schwannomas, are seldom found in the head and neck area.[5–7] MPNSTs are highly aggressive tumors characterized by rapid growth with infiltration of surrounding tissue and hematogenous metastases.[5,8]

Because of the rarity of this tumor, there are only few reports, and little information is available on the clinical management of MPNST occurring in the head and neck area. To contribute additional information, we present our long-term results of a relatively large series of 10 patients, who underwent surgery. In addition, we review the literature for all published cases of head and neck MPNSTs, comparing therapeutic strategies and outcome.

MATERIALS AND METHODS

During a period of 20 years (1984–2004), 10 patients with a diagnosis of MPNST were treated at the Department of Otorhinolaryngology of the Klinikum Fulda gAG (Teaching Hospital of the Philipps-University Marburg). In a retrospective analysis, we reviewed the clinical records and evaluated the patient profile data that consisted of age, sex, clinical symptoms, site of the lesion, radiographic findings (CT and/or MRI), surgical approach, rate of recurrence, and survival. Pathologic slides were available for all patients and were reviewed by a senior pathologist. In all cases, the diagnosis of MPNST could be confirmed.

RESULTS

The mean age at diagnosis was 42 years (range, 14–76 years) with 6 female and 4 male patients. The most common symptom was a painless, rapidly enlarging cervical mass with no nerve palsy associated. Most tumors were located at the lateral skull base, most likely originating from the vagus nerve. In 2 cases, the vagus nerve was affected in isolation. Two further patients had tumor manifestation in the paranasal sinuses. Seven patients were referred for primary treatment, and 3 patients were admitted because of recurrent disease.

One patient had neurofibromatosis type I, and another patient had undergone surgery for a previous solitary neurofibroma.

All patients were treated with wide radical tumor resections. In 7 cases, we resected ipsilateral cervical lymph nodes. Seventy percent of the tumors could be excised completely. Tumors located at the lateral skull base or originating from the vagus nerve were treated through a classical cervical approach. Of the 2 patients with paransal sinus tumors, 1 was treated via a lateral rhinotomy and 1 by an endonasal micro-endoscopic tumor resection.

No distant metastases were identified in any of the patients. Unlike other reported series, we found lymph node metastases in 2 patients. One patient received preoperative chemotherapy without any signs of tumor regression. Three patients were referred for postoperative radiotherapy. One patient developed a recurrence during this treatment. The long-term survival was very poor. Four patients showed at least 1 local recurrence within 2 years. Fifty percent of the patients died because of the disease within 2 years. Two patients are still under follow-up and remain disease free after 7 and 8 years, respectively. The 2-year survival rate was 50%, and the 5-year survival rate was 20%. The patients with the worst prognosis were those with neurofibromatosis or who had recurrent disease within a short period. All patients who presented with a recurrent tumor died during the follow-up period. On average they survived 20 months postoperatively. In contrast, patients with a primary disease survived an average 44 months. The results of our patient series are summarized in Table 1.

Case 1. A 42-year-old woman (patient 6 in Table 1) presented with a 3-month history of unilateral nasal obstruction with purulent discharge. Nasal endoscopy revealed a polypoid tumor mass in the left nasal cavity. The MRI showed a tumor in the left nasal cavity extending into the paranasal sinuses without infiltrating the orbit and periorbit, respectively (Figure 1A). Endonasal tumor removal was performed, including the resection of the anterior skull base and the dura. The histologic analysis confirmed MPNST (Figure 2). The patient has remained disease free for 7 years (Figure 1B).

Case 2. A 14-year-old girl (patient 1 in Table 1) with known von Recklinghausen's disease had a 3-month history of a cervical mass and hoarse-

Table 1. Clinical data of the patient cohort.

Patient	Sex	Age	Tumor site	Tumor type	Resection	Postop treatment	Progression	Survival, mo	Death
1*	F	14	LSB	PT	Subtotal	Chemotherapy	Recurrent tumor	14	DOD
2	F	15	LSB	PT	Total	Chemotherapy	Recurrent tumor	50	DOD
3	F	19	LSB	Recurrent	Total		LNM	12	DOD
4	M	24	VN	PT	Total	RT, Chemotherapy	LNM	13	DOD
5	F	30	LSB	PT	Subtotal	RT, Chemotherapy		22	DOD
6	F	42	PS	PT	Total			84	AWOD
7	M	54	LSB	Recurrent	Total			25	DOD
8	F	73	VN	PT	Total			96	AWOD
9	M	75	LSB	Recurrent	Subtotal		Recurrent tumor	22	DOD
10	M	76	PS	PT	Total		Recurrent tumor	29	DOD

Abbreviations: F, female; LSB, lateral skull base; PT, primary tumor; DOD, dead of disease; LNM, lymph node metastasis; M, male; VN, vagus nerve; RT, radiotherapy; PS, paranasal sinuses; AWOD, alive without disease.
**Combination with von Recklinghausen's disease.*

ness. A biopsy of the mass revealed an MPNST. Preoperative chemotherapy with ifosfamid, actinomycin D, and vincristine did not result in tumor regression. The patient was then referred to our hospital for surgical treatment. Examination revealed right-side recurrent laryngeal nerve palsy. The MRI showed a tumor in the parapharyngeal space invading the jugular foramen (Figure 3A). For tumor resection, a radical neck dissection was performed. Histologic examination confirmed MPNST (Figure 4). The patient had a recurrence develop within 1 year and died 14 months after the initial surgery.

DISCUSSION

Our study is one of the largest reported series of head and neck MPNST. The primary aim of this analysis was to review the treatment outcome of our patients, to compare it with the cohorts described to date, and finally to attempt to optimize the treatment strategy for patients with these highly malignant tumors.

Approximately 10% of all MPNSTs are described to occur in the head and neck area.[5,8,9] Ghosh et al[8] published one of the largest series of MPNSTs, involving 115 patients, of whom 14% presented with a head and neck tumor mass. Yet rarely, MPNSTs have been reported to involve the sinonasal tract.[1,6,9–12] In our patient group, we found 2 sinonasal MPNSTs that were both resected totally.

MPNSTs occur infrequently in children. Only 10% to 20% are diagnosed in the first 2 decades of life.[13] MPNST is typically a disease of adults, as most tumors occur in patients between 20 and 50 years of age.[1,14,15] Patients with NF1, however, develop these tumors at an earlier age. In 2 large series, the average age at time of diagnosis for patients with NF1 was 29 and 36 years, compared

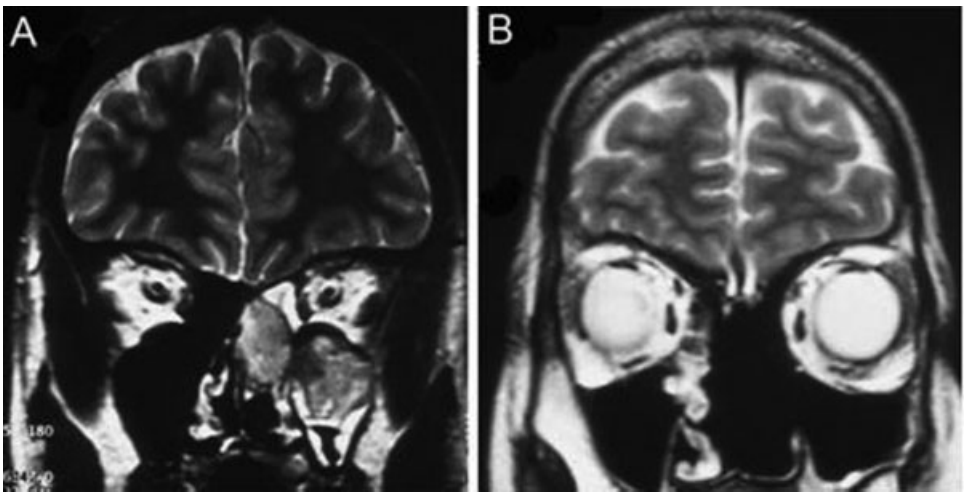

FIGURE 1. (**A**) Preoperative T2-weighted coronal MR image showing a tumor formation within the left ethmoid and maxillary sinus. (**B**) T2-weighted coronal MR image 7 years after endonasal tumor resection without sign of recurrence.

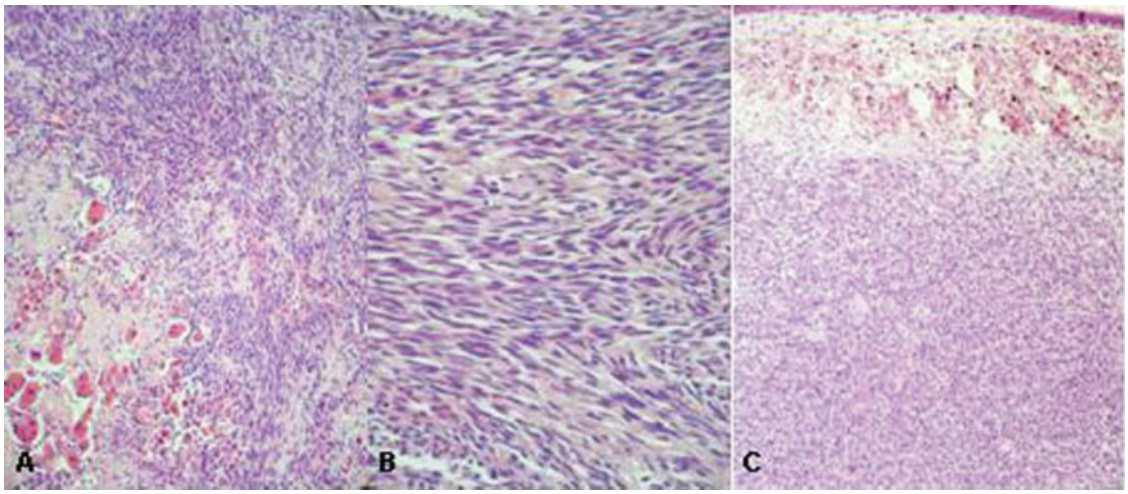

FIGURE 2. (**A**) Atypical spindle cells infiltrating skeletal muscle (hematoxylin-eosin stain, original magnification ×200). (**B**) Atypical spindle cells in herringbone pattern (hematoxylin-eosin stain, original magnification ×400). (**C**) Atypical spindle cells beneath the mucosal layer of the respiratory tract (hematoxylin-eosin stain, original magnification ×100). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

with 40 and 44 years, respectively, in patients without the disease.[1,3] The sex ratio of patients with MPNSTs varies with presentation. Because patients with NF1 have a male sex predomination, they are more predisposed to develop MPNSTs.[2,3] In contrast, in patients with sporadic MPNSTs, like in our series, the sex ratio is equal to or slightly biased toward women.[1,8,14]

As with other series, the most common symptom of our patients was a rapidly enlarging cervical mass.[6,7,11,16–18] Only 2 patients had an associated hoarseness due to recurrent laryngeal nerve palsy. The 2 patients with sinonasal tumors were initially seen for unilateral nasal obstruction. Thus, presenting symptoms are nonspecific and not helpful in making the diagnosis.

No single straightforward consensus exists regarding the optimal treatment for patients with MPNSTs.[5,8,14,19–21] Although the prognosis is considered very poor, the introduction of sophisticated surgical procedures combined with adjuvant radiation therapy and chemotherapy has improved the survival rates compared with reports in early literature.[8,10,11,13,14,16,20,22] In general, overall 5-year survival rates across all anatomic sites as described in the largest series of patients with MPNST vary between 49% and 60%.[2,5,8,10] Lower survival rates (15%) were reported at anatomically difficult locations such as the retroperitoneum and the thoracic cavity[3] but also in the head and neck area.[6] In our study, we found an almost similar low 5-year survival rate of only 20%. In survival statistics restricted to head and neck MPNST, analysis revealed 5-year survival rates between 15% and 47%.[1,6,11,13,16] Table 2 gives an overview of all series and case reports of head and neck MPNSTs published to date, including the treatment modalities used and the outcome achieved.[1,6,7,10–13,15–18,21,23–29]

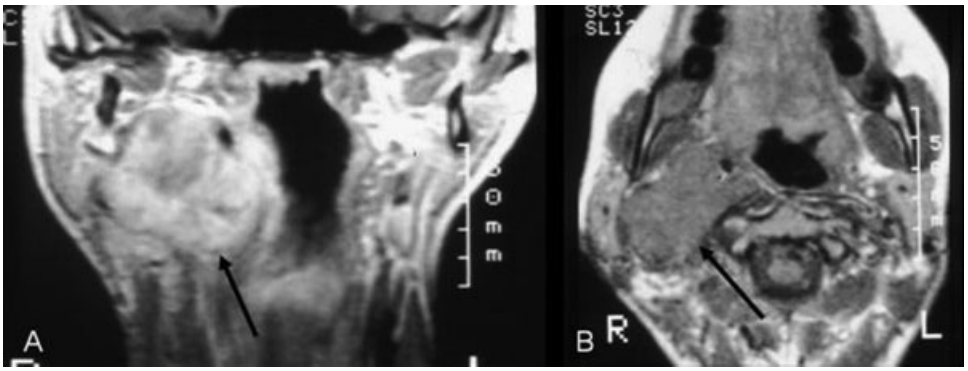

FIGURE 3. Preoperative T1-weighted coronal (**A**) and axial (**B**) MR images showing a tumor formation within the right upper parapharyngeal space invading the jugular foramen.

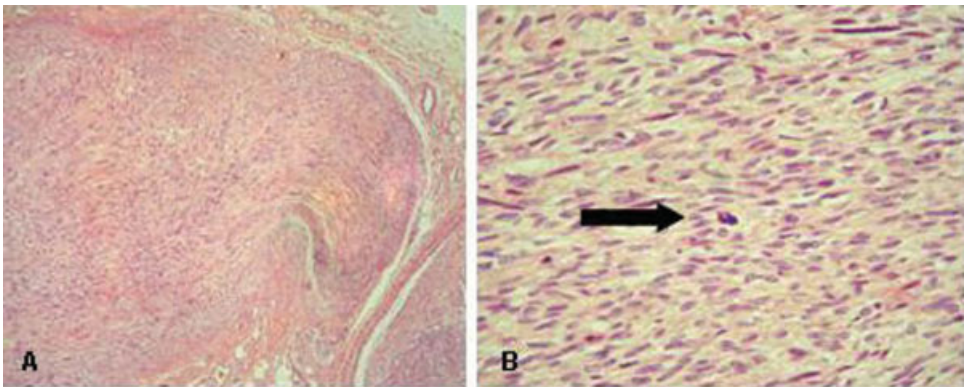

FIGURE 4. (**A**) Atypical spindle cells infiltrating a peripheral nerve (HE, magnification ×100). (**B**) Atypical spindle cells in parallel bundles with atypical mitotic figures marked with the arrow (HE, magnification ×400). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Summarizing, the literature survival rates are described to depend on tumor size, location, status of surgical margins, stage, grade, association with NF1, and a history of previous radiation therapy.[1–3,6–8,10,11,13–16,22] As in other studies, our series also indicates that complete surgical removal of the MPNST is the mainstay of treatment and most important prognostic factor.[7,11,13–15] This is supported by our analysis. Patients in whom a total tumor resection was impossible showed lower survival rates, with a mean outcome of 19 months only compared with patients whose tumors could be resected completely surviving a mean of 30 months. Graeger et al[16] showed that excisional biopsy with grossly negative margins without wide excision resulted in a 74-month survival on average, whereas wide excision with pathologically negative margins resulted in a mean survival of 115 months. In head and neck MPNST, this is usually performed through a transcervical approach, which often means a preparation similar to a neck dissection. However, because lymphatic spread is rare, we and others do not recommend a routine lymphadenectomy (prophylactic neck dissection), but it is indicated in cases with clinical or radiological suspicion of lymph node metastasis.[5,8,11,14] Failure to perform adequate wide excision is generally associated

Table 2. Published clinical studies and case reports of malignant peripheral nerve sheath tumors of the head and neck.

Author	Year of publication	No. of cases	Treatment	5-y overall survival rates, %	Death (cases)
Carli[13]	2005	35	Surgery, RT, Chemotherapy	47	21
Goepfert[11]	1977	23	Surgery, RT	26	10
Ducatman[1]	1986	23	Surgery	34	–
Greager[16]	1992	17	Surgery, RT, Chemotherapy	47	–
Bailet[6]	1991	16	Surgery, RT	15	14
				Mean survival, mo	
Hoffmann[17]	1988	9	Surgery, RT	58	3
Colmenero[15]	1991	7	Surgery, RT, Chemotherapy	25	3
Basso-Ricci[21]	1989	3	Surgery, RT	96	-
Bojsen-Moller[23]	1984	3	Surgery, RT, Chemotherapy	16	3
Colreavy[7]	2000	2	Surgery, RT, Chemotherapy	13	2
Kurita[24]	1982	2	Surgery, RT, Chemotherapy	54	1
White[10]	1971	2	Surgery, RT	5	2
McGuirt[25]	1986	1	Surgery, RT, Chemotherapy	36	–
Elias[26]	1993	1	Surgery, RT, Chemotherapy	12	1
Karmody[27]	1978	1	Surgery, RT	36	1
Fernandez[12]	1993	1	Surgery, RT	12	1
Bruchhage[18]	1998	1	Surgery	27	–
Nagasaka[28]	2000	1	Surgery, Chemotherapy	34	1
Hidaka[29]	2001	1	Surgery, RT	11	1

Abbreviations: RT, radiotherapy.

with an unacceptably high local recurrence rate. It is the main cause of death (45%–60%).[1–3,7,15] This is in agreement with our observation as patients with poor outcome developed at least 1 tumor recurrence within 2 years. Unlike in other reported series, we diagnosed lymph node metastases in 2 patients (29%). In contrast, no distant metastases were identified in any of our patients. In the literature, distant metastasis is described to appear in 16% to 68%.[1–3,7,15] If MPNSTs metastasize, they most often do so to lungs, followed by bone and pleura.[14]

MPNST is often associated with NF1, and several authors have reported lower survival rates in this patient group.[1,8,22,30] Sordillo et al[22] analyzed 165 patients with MPNSTs and found 5-year survival rates of patients with and without von Recklinghausen's disease of 23% and 47%, respectively. Reasons for this poor prognosis include: a tendency toward larger tumors, poorer differentiation, higher rates of metastases, and multifocality.[1,8,30] The incidence of MPNST is as high as 30% in NF1 patients.[8,19] In our series, 1 patient had NF1, and this patient survived only 14 months. Overall survival was reported to be even more discouraging in children with NF1, whatever treatment used.[13]

Historically, malignant schwannomas were considered to be radioresistant.[1–3,5,19] This limited response may reflect older radiotherapeutic techniques rather than biologic behavior. More recently, several authors have recommended postoperative radiation therapy to decrease the incidence of local recurrences, to treat isolated recurrences, or as primary therapy for unresectable lesions.[11,13,14,17,21] Basso-Ricci[21] observed that 14 of 25 (56%) patients were free of disease 3 years after combined therapy consisting of surgery and postoperative radiation. This percentage is higher compared with other series of patients who prevalently underwent only surgery.[1,16] As recommended by Basso-Ricci[21] and Carli et al,[13] radiotherapy should be delivered using megavoltage photon or electron beam energies, with conventional fractionation (1.8 to 2.0 Gy daily for 5 days a week) or with hyperfractionated accelerated radiotherapy (2 daily fractions of 1.6 Gy, with a 6- to 8-hour interval). The recommended dose changed over the years and also varied, according to the presence of microscopic residual disease or gross tumor, from 65 to 70 Gy (recommended dose for unresectable gross tumor) to 45 Gy (recommended dose using hyperfractionated accelerated modality for microscopic residues).[13] However, in our present series, 2 patients received adjuvant radiation therapy without showing improvement of survival.

The role of systemic chemotherapy of MPNSTs remains controversial. Favorable responses to chemotherapy have only been reported occasionally, so MPNST is regarded as a scarcely responsive tumor.[14,31] However, adjuvant chemotherapy has been used successfully in soft tissue sarcomas outside the head and neck area.[32–34] Carli et al[13] showed an overall response rate of 45% after primary chemotherapy in children with adult type MPNST. Even more remarkable is the reported response rate of 65% if using regimens containing ifosfamide.[13] In the present study, 1 patient received 2 cycles of chemotherapy preoperatively, without any signs of tumor regression. Although, the data (especially of Carli et al[13]) are still inconclusive, adjuvant chemotherapy with an ifosfamide/doxorubicin regimen might be administered additionally to patients with residual disease after initial surgery and in grade 3 tumors larger than 5 cm.

CONCLUSION

To conclude, MPNST is a rare tumor that behaves as 1 of the most aggressive malignant lesions in the head and neck area, with a particularly high rate of local recurrence, although distant metastases can also occur. Based on our results and the literature review, our treatment recommendations are as follows: (1) as complete surgical removal is the strongest predictor of survival, every effort should be made to perform radical tumor excision with as wide a margin of normal tissue as is feasible to achieve free histologic margins; (2) adjuvant therapies are recommended according to the risk of local and distant relapse, based on residual disease after initial surgery, tumor size, and grade.[1,13] Adjuvant radiotherapy should be used to assist surgical excision in local control whether tumor-free margins could be obtained or not.[1,13,14,21] As advocated for pediatric MPNSTs, adjuvant chemotherapy with an ifosfamide/doxorubicin regimen might also be an additional treatment option in adult patients with residual disease after initial surgery and in grade 3 tumors larger than 5 cm. Following the results of Carli et al,[13] primary chemotherapy should be attempted in all patients when macroscopically complete conservative surgery is initially unfeasible but could be enabled by drug-induced tumor shrinkage.

However, further studies are needed to determine the role of multimodality treatment in the

management of head and neck MPNSTs and to establish consensus regarding optimal therapy regimens.

REFERENCES

1. Ducatman BS, Scheithauer BW, Piepgras DG, Reiman HM, Ilstrup DM. Malignant peripheral nerve sheath tumors. A clinicopathologic study of 120 cases. Cancer 1986;57:2006–2021.
2. Wong WW, Hirose T, Scheithauer BW, Schild SE, Gunderson LL. Malignant peripheral nerve sheath tumor: analysis of treatment outcome. Int J Radiat Oncol Biol Phys 1998;42:351–360.
3. Hruban RH, Shiu MH, Senie RT, Woodruff JM. Malignant peripheral nerve sheath tumors of the buttock and lower extremity. A study of 43 cases. Cancer 1990;66:1253–1265.
4. Doorn PF, Molenaar WM, Buter J, Hoekstra HJ. Malignant peripheral nerve sheath tumors in patients with and without neurofibromatosis. Eur J Surg Oncol 1995;21:78–82.
5. Das Gupta TK, Brasfield RD. Solitary malignant schwannoma. Ann Surg 1970;171:419–428.
6. Bailet JW, Abemayor E, Andrews JC, et al. Malignant nerve sheath tumors of the head and neck: a combined experience from two university hospitals. Laryngoscope 1991;101:1044–1049.
7. Colreavy MP, Lacy PD, Hughes J, et al. Head and neck schwannomas—a 10 year review. J Laryngol Otol 2000; 114:119–124.
8. Ghosh BC, Ghosh L, Huvos AG, Fortner JG. Malignant schwannoma. A clinicopathologic study. Cancer 1973;31:184–190.
9. Russell WO, Cohen J, Enzinger F, et al. A clinical and pathologic staging system for soft tissue sarcomas. Cancer 1977;40:1562–1570.
10. White HR Jr. Survival in malignant schwannoma. An 18-year study. Cancer 1971;27:720–729.
11. Goepfert H, Lindberg RD, Sinkovics JG, Ayala AG. Soft-tissue sarcoma of the head and neck after puberty. Arch Otolaryngol 1977;103:365–368.
12. Fernandez PL, Cardesa A, Bombi JA, Palacin A, Traserra J. Malignant sinonasal epithelioid schwannoma. Virchows Arch A Pathol Anat Histopathol 1993;423:401–405.
13. Carli M, Ferrari A, Mattke A, et al. Pediatric malignant peripheral nerve sheath tumor: the Italian and German soft tissue sarcoma cooperative group. J Clin Oncol 2005;23: 8422–8430.
14. Fuchs B, Spinner RJ, Rock MG. Malignant peripheral nerve sheath tumors: an update. J Surg Orthop Adv 2005; 14:168–174.
15. Colmenero C, Rivers T, Patron M, Sierra I, Gamallo C. Maxillofacial malignant peripheral nerve sheath tumours. J Craniomaxillofac Surg 1991;19:40–46.
16. Greager JA, Reichard KW, Campana JP, Das Gupta TK. Malignant schwannoma of the head and neck. Am J Surg 1992;163:440–442.
17. Hoffmann DF, Everts EC, Smith JD, Kyriakopoulos DD, Kessler S. Malignant nerve sheath tumors of the head and neck. Otolaryngol Head Neck Surg 1988; 99:309–314.
18. Bruchhage KL, Bockmuhl U, Dahm MC. Zervikale Manifestation eines malignen Schwannoms. Laryngorhinootologie 1998;77:235–237.
19. D'Agostino AN, Soule EH, Miller RH. Primary malignant neoplasms of nerves (malignant neurilemomas) in patients without manifestations of multiple neurofibromatosis (von Recklinghausen's disease). Cancer 1963;16: 1003–1014.
20. Vieta JO, Pack GT. Malignant neurilemmomas of peripheral nerves. Am J Surg 1951;82:416–431.
21. Basso-Ricci S. Therapy of malignant schwannomas: usefulness of an integrated radiologic. Surgical therapy. J Neurosurg Sci 1989;33:253–257.
22. Sordillo PP, Helson L, Hajdu SI, et al. Malignant schwannoma—clinical characteristics, survival, and response to therapy. Cancer 1981;47:2503–2509.
23. Bojsen-Moller M, Myhre-Jensen O. A consecutive series of 30 malignant schwannomas. Survival in relation to clinico-pathologic parameters and treatment. Acta Pathol Microbiol Immunol Scand [A]. 1984;92:147–155.
24. Kurita S, Nagata K, Mihashi S. Neurogenic malignant neoplasm of the neck—report of 3 cases. Kurume Med J 1982;29Suppl:S175–S178.
25. McGuirt WF, Browne JD. An anterolateral approach to the anterior skull base: report of a malignant schwannoma of the pterygomaxillary space. Otolaryngol Head Neck Surg 1988;98:323–327.
26. Elias MM, Balm AJ, Peterse JL, Keus RB, Hilgers FJ. Malignant schwannoma of the parapharyngeal space in von Recklinghausen's disease: a case report and review of the literature. J Laryngol Otol 1993;107:848–852.
27. Karmody CS. Malignant schwannoma of the trigeminal nerve. Otolaryngol Head Neck Surg 1979;87:594–598.
28. Nagasaka T, Lai R, Sone M, Nakashima T, Nakashima N. Glandular malignant peripheral nerve sheath tumor: an unusual case showing histologically malignant glands. Arch Pathol Lab Med 2000;124:1364–1368.
29. Hidaka T , Akisada T, Takemoto T, et al. Case report of a malignant schwannoma in the neck with rare pathologic findings. Nippon Jibiinkoka Gakkai Kaiho 2001;104:208–211.
30. D'Agostino AN, Soule EH, Miller RH. Sarcomas of the peripheral nerves and somatic soft tissues associated with multiple neurofibromatosis (von Recklinghausen's disease). Cancer 1963;16:1015–1027.
31. Santoro A, Tursz T, Mouridsen H, et al. Doxorubicin versus CYVADIC versus doxorubicin plus ifosfamide in first-line treatment of advanced soft tissue sarcomas: a randomized study of the European Organization for Research and Treatment of Cancer Soft Tissue and Bone Sarcoma Group. J Clin Oncol 1995;13:1537–1545.
32. Rooser B, Attewell R, Berg NO, Rydholm A. Prognostication in soft tissue sarcoma. A model with four risk factors. Cancer 1988;61:817–823.
33. Storm FK, Eilber FR, Mirra J, Morton DL. Neurofibrosarcoma. Cancer 1980;45:126–129.
34. deCou JM, Rao BN, Parham DM, et al. Malignant peripheral nerve sheath tumors: the St. Jude Children's Research Hospital experience. Ann Surg Oncol 1995;2: 524–529.