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Combined transfacial and neurosurgical approach to malignant tumours of the ethmoid sinus

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Abstract

In order to understand the risks and benefits of a combined transfacial and neurosurgical procedure for neoplasms of the ethmoid sinus, we reviewed all patients who underwent this surgical approach in our department between 1986 and 1994.

The study included 41 patients. Pathological diagnoses included adenocarcinoma (31 patients), squamous cell carcinoma (three patients), aesthesioneuroblastoma (three patients), other (four patients). The overall morbidity rate was 39 per cent, and the post-operative mortality rate was 2.5 per cent. Complications were statistically more likely in patients with bone skull base reconstruction. The main carcinologic failures were local recurrences (24 per cent) and metastases (22 per cent). The one-year, three-year and five-year Kaplan Meir survival rates were respectively 84 per cent, 53 per cent and 36 per cent. In conclusion, the mortality and morbidity were acceptable, especially when no bone skull base reconstruction was performed. Better local control justifies a combined procedure with post-operative radiotherapy when tumours involve or reach the skull base.

Key words: Paranasal sinus neoplasms; Ethmoid sinus; Surgery, operative; Morbidity; Mortality

Introduction

Paranasal sinus tumours represent three per cent of upper aerodigestive tract cancers (Rice, 1985; Sisson *et al.*, 1989) and ethmoid sinus carcinoma is even rarer and accounts for only 20 per cent of all sinonasal malignancies (Sisson *et al.* 1989; Kraus *et al.*, 1990). Transfacial approaches traditionally used for neoplasms of the ethmoid sinus are unsuitable for tumours that reach and/or invade the skull base. En bloc resection via a combined neurosurgical and transfacial approach decreases local failures in such malignant neoplasms (Capper and Radstone, 1986; Cheesman *et al.*, 1986; Panje *et al.*, 1989; Wax *et al.*, 1995). Morbidity and mortality related to the combined approach were initially high. As experience with this procedure increased, morbidity and mortality declined.

In order to better understand the risks and benefits of this surgical approach, we reviewed all patients who underwent a combined transfacial and neurosurgical procedure for neoplasm of the ethmoid sinus in our department between 1986 and 1994.

Materials and methods

From 1986 to 1994, 41 patients underwent a combined transfacial and neurosurgical procedure for neoplasms of the ethmoid sinus in our Department. Only patients whose tumour epicentre was believed to be in the ethmoid sinus were included in this analysis. Benign tumours and primary maxillary antral tumours have been excluded from analysis. The patients ranged in age from 20 to 72 years, with a mean age of 53 years. There were 39 male and two female patients.

Symptoms on presentation had been present from one to 24 months, with a mean of four months (Table I). Pathological diagnoses are presented in

TABLE I
SYMPTOMS ON PRESENTATION (41 PATIENTS)

Symptoms	No. of patients
Nasal obstruction	6
Epistaxis	4
Ocular	3
Nasal obstruction and epistaxis	7
Nasal obstruction and facial pain	4
Nasal obstruction and ocular	1
Epistaxis and facial pain	3
Facial pain and ocular	2
Nasal obstruction, epistaxis and facial pain	2
Nasal obstruction, epistaxis and ocular	1
Nasal obstruction, facial pain and ocular	2
Unknown	6

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TABLE II
PATHOLOGICAL DIAGNOSES (N = 41)

Adenocarcinoma	31
Squamous cell carcinoma	3
Aesthesioneuroblastoma	3
Neuroendocrine carcinoma	1
Anaplastic carcinoma	1
Malignant melanoma	1
Rhabdomyosarcoma	1

Table II. The main symptoms experienced by our patients were nasal obstruction and epistaxis. There was a significant exposure to wood dust in 26 cases (out of 31) (84 per cent) of ethmoid sinus adenocarcinomas. The mean exposure was 26 years with a range from one to 50 years. The mean delay between the end of the exposure and the diagnosis was 15 years (range 0–42 years). Tumour site and extensions were determined by axial and coronal computed tomography (CT) with contrast enhancement for all patients, and magnetic resonance imaging (MRI) (T1- and T2-weighted images with gadolinium enhancement) for 29 patients (Table III).

All patients underwent a combined transfacial and neurosurgical approach. In our department, a combined procedure is performed when the tumour involves the cribiform plate, or the anterior fossa, or when the tumour is located near the upper roof of the ethmoid sinus. Excluding the patients who had had radiation treatment previously (n = 8) and one post-operative death, all patients received post-operative radiotherapy (n = 32). Twenty-one patients underwent neoadjuvant chemotherapy, including 20 adenocarcinoma. The drugs used were fluorouracil (1 g/m^2 per day), cisplatin (20 mg/m^2 per day) and epirubicin (70 mg/m^2 first day). The course duration was five days and chemotherapy was administered every 21 days. An assessment with CT or MRI, performed after the last course, allowed us to analyse the clinical response to neoadjuvant chemotherapy. Six patients (out of 21) (29 per cent) in this series had a partial response to neoadjuvant chemotherapy, two patients (10 per cent) a complete response, 13 patients (62 per cent) had no response.

Surgical technique

A bicoronal incision was used in all cases with a bifrontal craniotomy and then transfacial access was performed via a lateral rhinotomy. Dural grafts were put in place only when intradural extension of the tumour required a larger dural opening that could not be closed primarily.

In 25 patients (61 per cent), bone grafts or coral blocks were used to reconstruct the surgical defect of the anterior skull base: allografts of irradiated bone in five cases; bone sheets in 10 cases; madreporic coral block in 10 cases.

A pericranial flap was interposed between the open floor of the anterior cranial fossa and the frontobasal dura in 31 patients. Frontal sinuses were cranialized by removing the posterior wall and cleaned of mucosal residue.

The average duration of follow-up for the 41 patients was 31 months (median: 28; range: 1–90). The number of patients lost to three-year and five-year follow-up was 11 and 17, respectively. The chi-squared test was used for analysis of variables. Statistical analysis of survival was based on the product limit method of Kaplan and Meier. Comparison of survival was performed with the log rank test.

TABLE III
RADIOLOGICAL INVESTIGATION DEMONSTRATED INVOLVEMENT OF THESE STRUCTURES (41 PATIENTS)

Ethmoid sinus	
unilateral	25 (61%)
bilateral	16 (39%)
Nasal fossa	34 (83%)
Cribiform plate	27 (66%)
Orbit	25 (61%)
Sphenoid sinus (anterior wall)	13 (32%)
Anterior cranial fossa	9 (22%)
Maxillary sinus	5 (12%)
Pterygomaxillary space	2 (5%)

Computed tomography for all patients, magnetic resonance imaging for 29 patients.

Results

At the time of surgery, a cribiform plate involvement was found in 22 patients (54 per cent), a dural involvement in 10 patients (24 per cent), and a brain invasion in six patients (15 per cent). When the tumour was located near the cribiform plate without radiological involvement (n = 14), a cribiform plate invasion was found in four cases (out of 14) (29 per cent) during the surgical excision (three adenocarcinoma, one aesthesioneuroblastoma). The periorbita was involved in 12 patients, but only three patients underwent orbital clearance. Nine patients underwent resection of involved periosteum with frozen - section control of adjacent orbital contents.

The post-operative course was uneventful in 25 patients (61 per cent). Sixteen patients (39 per cent) experienced transient or permanent complications after surgery (Table IV). One death (two per cent) occurred from pulmonary embolism. Epidural haematoma occurred in one patient, transient cognitive impairment in five patients. Other neurological complications are presented in Table IV. Osteomyelitis of the frontal bone flap was seen in four patients, requiring bone flap removal in all cases. Osteomyelitis of the bone skull base reconstruction was seen in

TABLE IV
COMPLICATIONS AMONG THE 41 PATIENTS: 16 PATIENTS

Complications	No. of patients
Cerebrospinal fluid leakage	4
Meningitis	1
Wound infection	2
General complication	2
Neurological complications	2
Cerebrospinal fluid leakage and meningitis	1
Meningitis and other neurological complications	1
Wound infections and neurological complications	1
Meningitis, other neurological complications and infections	1
Death	1

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TABLE V
COMPLICATIONS

	Bone reconstruction (n = 25)	No bone reconstruction (n = 15)
No complication	12 (48%)	12 (80%)
Cerebrospinal fluid leakage	5 (20%)	–
Meningitis	3 (12%)	1 (6.7%)
Neurological complications	4 (16%)	2 (13.5%)
Osteomyelitis of the frontal bone flap	3 (12%)	1 (6.7%)
Osteomyelitis of the bone skull base reconstruction	6 (24%)	–

six patients, requiring bone removal in four patients. All these four patients had had a coral block reconstruction. For patients with osteomyelitis of the frontal bone flap or the bone skull base reconstruction, seven patients underwent post-operative radiotherapy (50 Grays for two patients, 65 Grays for five patients) and two had had radiation treatment previously. The post-operative course, in the patients who underwent a bone or a coral reconstruction and in the patients who did not, is summarized in Table V. Complications were statistically more likely in patients with bone sheet or coral block skull base reconstruction (p = 0.048). Hospital stay ranged from 10 to 62 days with a mean of 24 days.

Carcinologic results

At the conclusion of the study, 15 patients are alive with no evidence of disease with a mean of 34 months following completion of the therapy. Two patients are alive with metastasis, two other patients with a local recurrence and 22 patients died. Six patients died with no evidence of disease, one of whom died in the post-operative period. Sixteen patients died with evidence of disease. Twenty-three patients (56 per cent) experienced a carcinologic failure (Table VI). All the patients who did not achieve a complete response after treatment (progression of residual disease) died. The mean time for local recurrences was 18 months (median: 14, range: 8–40 months). The sites of local recurrences are presented in Table VII. Local recurrence was successfully treated in two patients. Local recurrence was not encountered in patients who achieved a partial or a complete clinical response to neoadjuvant chemotherapy (eight patients). Cervical nodes (three patients: one adenocarcinoma, two other) have always been associated with local recurrences. The mean time for metastasis was 13 months (median: 12, range: seven to 23 months). The sites of metastasis are presented in Table VIII. The second primary sites were the lung in two cases, and the colon in one case.

For the entire group of patients (n = 41) the one-year, three-year and five-year Kaplan-Meier survival rates were respectively 84 per cent, 53 per cent and 36 per cent. For adenocarcinoma (n = 31), the results were comparable (one-year: 86 per cent, three-year: 62 per cent, five-year: 39 per cent).

When the tumour was close to the cribiform plate without radiological involvement (n = 14), the overall survival at one year was 100 per cent, at three years 83 per cent, at five years 50 per cent. For other patients (n = 26), the overall survival at one year was 81 per cent, at three years 38 per cent, at five years 32 per cent; the survival at three years was statistically significantly different (p = 0.04) (Fig. 1).

TABLE VI
CARCINOLOGIC EVOLUTIONS (23 PATIENTS)

	No. of patients
Progression of residual disease	4
Local recurrences	6
Metastases	7
Local recurrences and cervical nodes	1
Local recurrences and cervical nodes and metastases	2
Local recurrences and second primaries	1
Second primaries	2

Discussion

In our institution, adenocarcincoma is the most common malignancy of the ethmoid sinus agreeing with other series which have shown the same predominance (Saunders and Ruff, 1976; Knegt *et al.*, 1985; Roux *et al.*, 1989). In these series there is a significant exposure to wood dust in the majority of patients (Saunders and Ruff, 1976; Klitenberg *et al.*, 1984; Capper and Radstone, 1986; Roux *et al.*, 1989; Van Tuyl and Gussack, 1991). We found 84 per cent in our study. The most common spread of tumour in this series occurred via the middle meatus involving the nasal cavity (83 per cent). Bilateral involvement of the ethmoids as a result of septal invasion crossing over to the controlateral nasal cavity was frequently observed. Other reports have also demonstrated this occurrence (Biller *et al.*, 1989; Van Tuyl and Gussack, 1991). Erosion of the lamina papyracea was common, but the orbital periosteum was relatively resistant to tumour invasion. Periorbital invasion had been an indication for exenteration but

TABLE VII
SITES OF LOCAL RECURRENCES (10 PATIENTS)

	No. of patients
Brain	2
Maxillary sinus	2
Orbit	1
Frontal sinus	1
Orbit + cavern.	1
Ethm + Pteryg.	1
Ethm + skull + sphen.	1
Orbit + Skull + sphen. + cavern.	1

Ethm: ethmoid sinus; Skull: skull base; Sphen.: sphenoid sinus; Cavern.: cavernous sinus; Pteryg.: pterygomaxillary space.

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TABLE VIII
SITES OF METASTASES (NINE PATIENTS)

	No. of patients
Brain, spinal cord	3
Lung	1
Skin	1
Brain + liver	1
Lung + bone	1
Lung + bone + skin	1
Bone + liver + skin	1

it is controversial (Perry *et al.*, 1988; Harrison, 1989; Lavertu *et al.*, 1989; Sisson *et al.*, 1989; Kraus *et al.*, 1990; Stern *et al.*, 1993). In our series, three of the 12 patients with periorbital invasion underwent orbital clearance because of massive orbital involvement. For the other (nine patients) the frozen section control of adjacent orbital contents were negative and we preserved the eye.

In our Department, when tumour is located near the superior roof of the ethmoid sinus, without radiological involvement (14 patients), a combined procedure is also performed. The incidence of cribiform plate invasion at the time of surgical excision justifies this procedure. The overall morbidity was 39 per cent and the post-operative mortality was 2.5 per cent. These results are comparable with those reported in the literature (Ketcham and Van Buren, 1985; Shah *et al.*, 1987; Catalano *et al.*, 1994; Kraus *et al.*, 1994; McCutcheon *et al.*, 1996). McCutcheon *et al.* (1996) reported a morbidity of 36 per cent and a mortality of one per cent. Catalano *et al.* (1994) presented a craniofacial series of 73 cases in which the overall morbidity was reported to be 63 per cent, and the mortality to be 2.7 per cent. Infection and CSF leak were much more common when bone or coral block was used to reconstruct the operative defect in the floor of the anterior fossa. As a consequence solid grafts are no longer used to perform the reconstruction of the skull base. Instead a pericranial flap, sometimes with abdominal subcutaneous fat, is interposed between the open floor of the anterior cranial fossa and the frontobasal dura (Johns *et al.*, 1981; Jackson *et al.*, 1986). Pericranial placement alone seems sufficient to prevent prolapse of the intracranial contents into the paranasal sinuses and infection (Johns *et al.*, 1981; Blacklock *et al.*, 1989; McCutcheon *et al.*, 1996; Roux *et al.*, 1996)

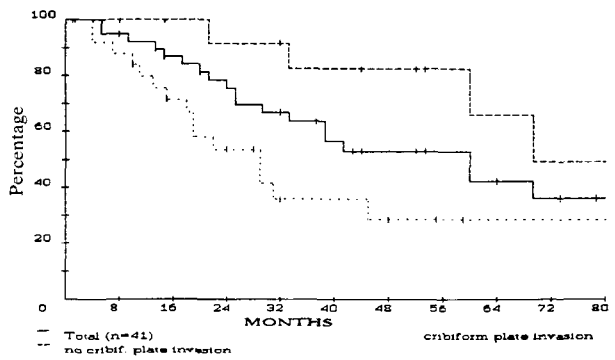

FIG. 1
Kaplan Meier survival.

even if post-operative radiotherapy is used. Encephalocele formation was not seen when bone reconstruction was not performed.

Involvement of dura, brain and sphenoid sinus were often observed in our series, and they have been reported to be associated with an increased risk of local recurrence (Shah *et al.*, 1987; Lund and Harrison, 1988; Lavertu *et al.*, 1989; Sisson *et al.*, 1989; Van Tuyl and Gussack, 1991; Kraus *et al.*, 1992; Catalano *et al.*, 1994; Brasnu *et al.*, 1996). Local control was obtained in 71 per cent of our patients and justifies for us a combined procedure. En bloc resection by a combined procedure seems to decrease local failure in malignant neoplasms that reach or invade the skull base (Cheesman *et al.*, 1986; Biller *et al.*, 1989; Panje *et al.*, 1989; Sisson *et al.*, 1989; Kraus *et al.*, 1990; Roux *et al.*, 1991; Close and Mickey, 1992; Osguthorpe, 1994). Catalano *et al.* (1994) advocate post-operative radiotherapy for tumours with dural and/or brain invasion. Kraus *et al.* (1992) reserved post-operative radiotherapy for positive surgical margins, aggressive histological finding, involvement of dura, brain or sphenoid sinus. For better local control we advocate post-operative radiotherapy in all patients with malignant neoplasms that reach or invade the skull base even if surgical margins are uninvolved (for positive margins, the mean dose is 65 Gy; for negative margins, the mean dose is 50 Gy. Other authors (Harrison, 1989; Sisson *et al.*, 1989; Stern *et al.*, 1993) advocate the use of pre-operative radiotherapy but some authors have suggested that pre-operative radiation therapy may be associated with a higher complication rate (Jesse, 1965; Sisson *et al.*, 1989; Kraus *et al.*, 1990; Roux *et al.*, 1991).

Isolated metastases were common in our series, and the rate was higher compared with rates obtained in other series (Kraus *et al.*, 1992). This higher rate seems to be related to brain and spinal cord metastases. In our series, tumour frequently involved the brain or the dura and this may explain distant brain or spinal cord metastases. Recurrence in regional lymph nodes was unusual and all patients with regional metastases had uncontrolled local diseases. This justifies our practice and others not to first-order lymph nodes (by surgery or radiotherapy) routinely (Kraus *et al.*, 1992).

As in other reports (Brasnu *et al.*, 1996), local recurrence was not encountered in patients who had a clinical and radiological (partial or complete) response to chemotherapy. Although this response did not occur in the majority of cases. Three-year and five-year cure rates are similar to those reported elsewhere in the literature (Sisson *et al.*, 1989; Roux *et al.*, 1991). As in other reports (Lund and Harrison, 1988; Van Tuyl and Gussack, 1991; Kraus *et al.*, 1992) a poor prognosis (with a survival statistically less likely) was noted with involvement of the cribiform plate, dura or brain.

Conclusions

The mortality and morbidity of combined procedure are acceptable. The use of pericranial flap

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without bone skull base reconstruction decreases morbidity. At present, we no longer use bone grafts to perform the reconstruction of the skull base. Good local control is obtained by a combined transfacial and neurosurgical procedure, and we advocate post-operative radiotherapy in all patients who undergo a combined procedure for malignant tumours of the ethmoid sinus.

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