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Carotid Body Tumors at High Altitudes: Quito, Ecuador, 1987

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Carotid body tumors seem to be encountered more frequently in people living at high altitudes. Twenty lesions operated in 19 patients at a general hospital in Quito, Ecuador over a period of only 5 years are reported. All patients lived in the highlands of the Andean region. There was no operative mortality, and morbidity was comparable to other series. No malignant cases were found. A higher degree of suspicion to recognize tumors and to operate at an earlier stage of development and thereby diminish operative morbidity is recommended. The great reliability of contrast angiogram and the development of other noninvasive diagnostic techniques is stressed. A study of the incidence of this lesion in the entire country should be made in the future.

The carotid body, extending approximately 4 cm in length over the carotid bulb and the internal and external carotid arteries, is a nonchromaffin-, nonepinephrine-secreting structure that functions as a chemoreceptor sensitive to changes in pH, carbon dioxide, and oxygen tensions of circulating blood. Its own blood flow is many times greater than that of the brain.

Carotid body tumors are histologically composed of nests of epithelioid cells separated by a vascular stroma. From the ultrastructural point of view, Bosq et al. [1] have described 2 types of cells: main cells, characterized by a cytoplasm with interdigital extensions, large mitochondria, lipid bodies, myelinated structures, a variety of neurosecretory granules, and a cytoplasmic membrane with junction complexes similar to desmosomes; and, supratentacular cells, located at the periphery of the lobules, in the form of caps of the main cells, separating them from the vascular connective stroma, and characterized by being fusiform with fine cytoplasmic extensions and few cytoplasmic organelles. These tumors are encapsulated and very vascular. They gradually surround the carotid bulb, invade it and progressively extend along the carotid artery, drawing blood from the vasa vasorum. The vagus and hypoglossus cranial nerves and the sympathetic chain may be encased and functionally affected. The neighboring muscles and even the base of the skull may be invaded [2]. Because of its strategic location and the delicate surgical technique which its resection requires, its management has a very special interest.

Hyperplasia and frank neoplasms can develop when these organs are stressed by chronic hypoxia. Few reports concerning patients living at high altitudes have been published: mainly those from Colorado, Mexico, and Peru [3, 4]. In these areas, the occurrence of chemodectomas appears to be about 10 times more frequent than at sea level. Throughout this article we present our epidemiological and surgical experience with patients from the Andean region of Ecuador.

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Material and Methods

Ecuador is a country located on the Pacific Coast of South America. The Andean mountain range divides it into 3 regions: the Coast, the Sierra, and the Amazonian Forest. Its capital, Quito (9,240 feet high; one million inhabitants), is located in an Andean valley. The 540-bed Social Security Hospital provides care to workers and to some Indian peasants, mostly from the Andean region, living at altitudes of between 6,500 and 13,000 feet.

We have reviewed carotid body tumors resected on 19 patients at the Otorhinolaryngology and Head and Neck Surgery Service and the Vascular Surgery Service of the Social Security Institute in Quito during a 5-year period from 1981 to 1985. The patients included 5 men and 14 women, from 30 to 81 years of age (average, 52.5 yr). Nine were from Quito and 10 were from other Andean provinces (Fig. 1). All of the patients lived at high altitudes. In 2 cases (11%), there were probable familial antecedents of similar tumors, and, in 4 cases, there was a history of cigarette smoking. All of the patients presented an asymptomatic neck mass of 3 months' duration (average, 31.9 mo). Other reported symptoms were headache and dizziness.

One patient had bilateral lesions. Nine tumors were located on the right side and 11 on the left. Their size ranged from 3 to 8 cm (average, 4.35 cm). Their consistency was generally soft. Twelve of them were found depressible and pulsatile.

A fine-needle aspiration for cytology was done in 4 cases, but was not diagnostic in any case. A biopsy had been tried in a patient in another hospital, but only a hyperplastic lymph node had been removed. Twelve (60%) of the 20 lesions were correctly diagnosed as carotid body tumors before surgery on clinical and angiographic examination. The carotid angiogram, generally performed by a femoral route, was diagnostic in all

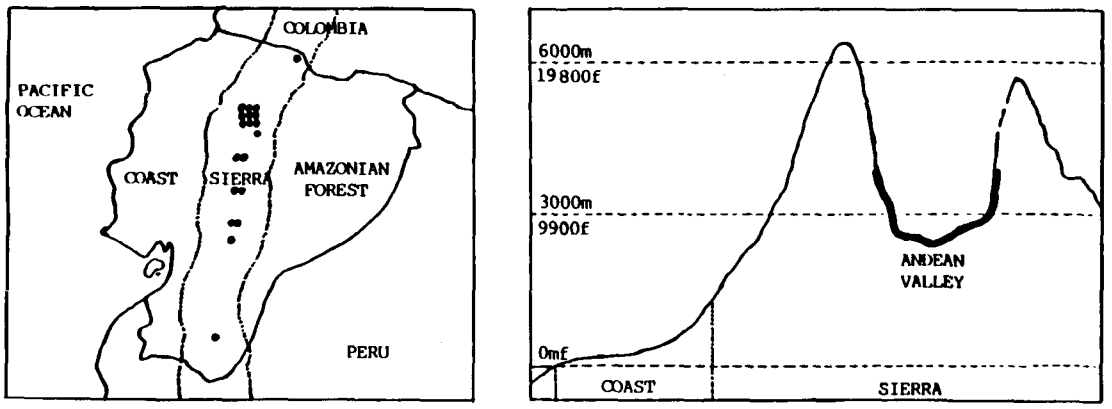

Fig. 1. Geographic distribution of patients with carotid body tumors.

the cases in which it was done. Other preoperative diagnoses were lymphadenopathy and benign tumor.

The surgical procedures were performed according to the technique previously described [5]: an incision along the anterior border of the sternocleidomastoid muscle was used; the common facial vein was ligated and the internal jugular vein was retracted posteriorly; the carotid arteries were dissected and controlled by tape slings; the 10th, 11th, and 12th cranial nerves as well as the sympathetic chain were carefully dissected and avoided; a subadventitial dissection of the tumor was done. The tumor could be completely excised in all the cases. In 2 patients, a vascular procedure was done: it consisted of a limited excision of the carotid bifurcation followed by an end-to-end anastomosis. In 2 other cases, the external carotid artery was sacrificed. Finally, in another patient, an accidental tear of the carotid bulb was immediately sutured. In the rest of the cases, the tumor was dissected free of the vessels without any intraoperative complication. The operations lasted between 70 and 250 minutes. One unit of blood was used in 3 patients, 2 in one, and 3 in another. In 14 cases, no blood replacement was necessary.

Results

We have had no mortality in our series. We have, however, had some morbidity as is shown in Table 1. Three of the 8 complications were considered important. In 4 of the 6 neurological and cranial nerve-related complications, the size of the tumor exceeded 6 cm. A 46-year-old woman presented an aphasia of Wernicke because of a probable infarction at the perisylvanian area 48 hours after the operation; she recovered completely 3 months later. Two other patients presented with marked dysphagia and abundant pharyngeal secretions which required nutritional support; they became better about 4 months after the operation. The other complications were minor and were managed appropriately. The histological review of all of the cases confirmed the diagnosis of carotid body tumor. In 6 cases, immunohistochemical studies for neurophysin, neuron-specific enolase, factor VIII-related antigen, S-100 protein, and keratin were performed and their results were negative.

The oldest of our patients died 1 year after the operation of an unrelated disease; 2 patients were lost to follow-up. We have not found any recurrence in the other patients.

Table 1. Postoperative morbidity.

	n
Dysphagia and dysphony	5
Wernicke's aphasia	1
Pulmonary embolism	1
Wound hematoma	1

Discussion

In the review of Parry et al. of 222 histologically diagnosed cases at 12 medical centers in the United States, there was a marked female predominance—2:1, a mean age of 44.7 yr, a 7.2% association with other extraadrenal paragangliomas, and a 7.2% familial occurrence [6]. In the epidemiologic review of Grufferman et al. of 923 patients with carotid body tumors, 9.5% belonged to families with at least one similar diagnosis [7]. In this group of patients, there was a 32% incidence of bilaterality. This increased frequency of bilaterality in familial cases has already been noted [8]. A great majority of our patients were female, with a mean age at diagnosis of 52.5 years. We had only 1 patient with bilateral tumors, but she did not refer to any familial history. On the other hand, we had 2 cases (11%) with familial history.

The common clinical presentation was an asymptomatic, slow-growing, rubbery mass in the upper neck. While some minor associated symptoms such as headaches and dizziness were present in some of our patients, we did not have such previously described clinical pictures as pharyngeal obstruction, cranial nerve palsies, carotid body syndrome, Horner's syndrome, or Reader's syndrome [2, 9–11]. The size of the lesions was similar to that reported in other series. The pulsatile character of the tumor was not a constant nor a reliable sign for us. While, in the Memorial Hospital series, needle cytology was diagnostic in 40% of the cases, this procedure, that might certainly be hazardous, was not helpful in 4 of our patients in whom this procedure was done [2]. We did not practice any incisional biopsy because of the known danger of hemorrhage and neurologic injury [2, 10, 12]. As in most series, angiography

was always diagnostic in our hands. It was, however, not performed in all of the cases, mainly because we, as described by other authors, were sometimes thinking of other diagnoses such as lymphadenitis, lymphoma, hemangioma, schwannoma, etc. As a 2.25% complication rate has been reported with contrast angiography by retrograde femoral approach, other diagnostic methods (safer and possibly as reliable) including radionuclide angiography and dynamic computed tomography have been proposed [13–15]. Other noninvasive techniques such as static gray-scale ultrasound and magnetic resonance imaging have also been proposed as eventually helpful in diagnosis [16, 17]. A correct preoperative diagnosis is achieved in 20–60% of cases [2, 10, 16, 18]. Our 60% diagnostic accuracy may have been due to the relative frequency with which we see these lesions in our hospital.

Surgical resection has been universally accepted as the treatment of choice, although observation has been advised in older patients [18]. Radiotherapy has been advocated after incomplete tumor excision [2, 9, 10, 19].

We have not used preoperative embolization, a technique with probable substantial morbidity [20], which has, however, been recommended by several authors to facilitate surgery, to reduce the risk of hemorrhage, and to avoid lesions to the arteries during the operation [21]. To improve this vessel dissection, even microsurgery has been reported [22]. Indeed, at surgery, a very cautious dissection has been our principal concern. So, we have been able to preserve the carotid artery complex in 80% of the cases.

Operative mortality has decreased from about 20% in the earlier series [23] to current rates between 0% and 2%. Postoperative morbidity, especially that related to cranial nerve palsies, remains an important problem: in 10 of 30 cases in the Lahey Clinic series [18], in 7 of 39 in the Cleveland Clinic series [9], in 7 of 40 in the Memorial Hospital series [3], in 5 of 13 in a Mayo Clinic series [27], and in 4 of 15 in the present series. This kind of complication is usually associated with tumors of great size [18, 25]. This morbidity should be reduced if tumors are operated at an early stage and if the most gentle nerve dissection is done. While we had one case of postoperative Wernicke's aphasia, a complication not reported in the series that we have reviewed, we did not find other complications such as hemiplegia, apnea, hypertension, etc. [2, 10, 11, 26]. Meyer et al. [27] have reported a 0% cerebrovascular sequelae with the use of intraoperative monitoring of the cerebral vascular flow, selective use of shunts, tumor-adventitial plane of dissection, preservation of the carotid artery complex, and mobilization of the parotid gland.

The negative results of the immunoperoxidase staining tests performed by one of us are in agreement with the absence of a specific immunohistochemical profile for paragangliomas, as described by Bosq et al. [1].

We have not had any malignant tumor. To evaluate malignant potential, in our cases, a longer follow-up will be necessary because malignancy cannot be predicted solely on histologic criteria, but on clinical behavior such as local agressivity and recurrence, or demonstration of distant metastases. Because of this lack of definition, the number of malignant carotid body tumors is unknown. The reported incidence varies between 2% and 25% [28].

An important point of this study is the fact that our series of 20 tumors found in 19 patients over a period of only 5 years in 1 hospital seems to indicate that these lesions are somewhat more frequent here than in other areas of the world as is shown in Table 2 [29–36]. All of our patients came from the highlands of the Andean region just as did 22 of the 24 cases of Saldana's Peruvian series [3] and all of the cases of Rodríguez-Cuevas' Mexican series [36]. This fact is in agreement with those reports about the presence of enlarged carotid bodies in some laboratory animals and human beings as well as a higher frequency of chemodectomas, when subjected to chronic hypoxia [3].

In recent Ecuadorian symposia, carotid body tumors have only been reported in cities (Quito, and Cuenca) from the Andean region, in spite of the fact that half of the Ecuadorian population and medical services are located in the Coastal region. In the future, an attempt to identify all, or at least most, of the cases of carotid body tumors in the entire country should be made in order to assess the real incidence and geographical distribution of this lesion.

Table 2. Recent series on operated carotid body tumors.

Institution	Patients	Years	Patient/ year
Memorial Hospital, New York [2]	44	41 (1937–1977)	1.1
Cleveland Clinic, Cleveland [9]	39	57 (1922–1978)	0.7
	15	14 (1965–1978)	1.1
Lahey Clinic, Burlington [18]	39	–	–
Mayo Clinic, Rochester [24]	34	10 (1966–1975)	3.4
University of Michigan, Ann Arbor [12]	16	30	0.5
Charity Hospital, New Orleans [29]	9	– (since 1948)	–
University of San Francisco, San Francisco [30]	15	19 (1963–1981)	0.8
Northwestern University, Chicago [31]	17	16 (1970–1985)	1.1
University of Toronto, Toronto [10]	27	25	1.1
University of Leyden, Leyden [24]	34	22 (1958–1979)	1.5
Royal Victoria Infirmary, Newcastle [32]	25	30 (1956–1985)	0.8
C.H.U. Pitié-Salpetrière, Paris [19]	28	8 (1973–1980)	3.5
C.H.U. Timone, Marseille [33]	11	12 (1971–1982)	0.9
Hopital Saint-Antoine, Paris [20]	13	21 (1966–1986)	0.6
Institut Gustave Roussy, Villejuif [34]	7	23 (1960–1982)	0.3
Hopital Croix-Rousse, Lyon [35]	13	12 (1972–1983)	1.1
Republic of China's review [11]	63	24 (1958–1981)	2.6
Lima hospitals, Lima [3]	24	17 (1955–1971)	1.4
Mexico City General Hospital, Mexico City [36]	29	22 (1962–1983)	1.3
Social Security Hospital, Quito	19	5 (1981–1985)	3.8

Résumé

Les tumeurs du glomus carotidien (GC) semblent plus fréquentes en haute altitude. Vingt tumeurs du GC ont été opérées chez 19 patients dans une période de 5 ans dans un hopital général à Quito. Tous les patients habitaient les hauts plateaux des Andes. Il n'y avait pas de mortalité; la morbidité était similaire aux autres séries. Il n'y avait pas de tumeur maligne. Il faut

penser à cette lésion plus souvent pour en faire le diagnostic et l'opérer plus tôt, réduisant ainsi la morbidité opératoire. L'angiographie et d'autres méthodes non invasives sont fiables. Des auteurs suggèrent d'entreprendre une étude de l'incidence de cette affection pour le pays dans son ensemble.

Resumen

Los tumores del cuerpo carotídeo parecen ocurrir con mayor frecuencia en personas que residen a grandes altitudes. Se informan 20 lesiones operadas en 19 pacientes en un hospital general de Quito, Ecuador en un período de apenas 5 años. La totalidad de los pacientes residía en zonas altas de la región andina. No hubo mortalidad operatoria, y la morbilidad fue comparable a la informada en otras series. No encontramos casos de malignidad. Se debe mantener un alto índice de sospecha frente a pacientes con masas cervicales laterales, con el objeto de que estos tumores puedan ser reconocidos y operados en fases tempranas de su desarrollo a fin de disminuír la morbilidad y mortalidad. Se enfatiza la gran confiabilidad de la angiografía de contraste y el desarrollo de otras técnicas no invasivas de diagnóstico. Creemos que en el futuro debe realizarse un estudio sobre la incidencia de esta lesión en el territorio nacional.

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