

Excision of Head and Neck Tumors Combined with Carotid Artery Resection without Arterial Blood Vessel Reconstruction

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OBJECTIVE To summarize our clinical experience in treating 31 patients with neck masses undergoing carotid artery resection without arterial anastomosis (vascular reconstruction) in Tianjin Cancer Hospital during a period from 1979 to 2002.

METHODS Preoperatively, patients were instructed to apply pressure to the carotid artery. Tumor excision combined with carotid artery resection (TECCAR) was conducted after an accurate testing of valid cerebral blood supply and compensation.

RESULTS Among the study patients, 17 were male and 14 female, with the age ranging from 14 to 58 years. Of the 31 cases, 23 were carotid body tumors (8 malignant), 2 vagal body tumors (1 malignant), 4 carotid aneurysms, and 2 were metastatic tumors from the cervix involving carotid artery. Of the patients, a subtotal resection of the head and neck masses was conducted in 22 cases. Intraoperative death did not occur, and postoperative CNS or cerebrovascular complications (CVC) were not found.

CONCLUSION TECCAR without arterial anastomosis is a safe and feasible procedure. In addition, this method of surgery has more advantages in comparison to an arterial anastomosis: *i*) Tumor resection was more complete. *ii*) Complications such as thrombus, infection, and lethal hemorrhage etc., were rare after surgery; *iii*) Postoperative radiotherapy, if needed, would be safe and acceptable; *iv*) It was a more simplified operational procedure.

KEY WORDS: tumor, carotid artery resection, without arterial blood-vessel reconstruction.

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Introduction

Head and neck tumors with carotid artery involvement remain a problem for surgical treatment because a ligation or excision of the affected carotid artery may result in severe cerebrovascular complications (CVCs), even death. Complete removal of the tumor and the involved carotid artery so as to improve the curative effect remains a clinical problem in the field of head and neck oncologic surgery and urgently needs to be resolved.

We learned through a review of the development of carotid surgery, that surgical procedures for tumor excision combined with carotid artery resection (TECCAR) mainly include the following methods: *i*) The traditional operational technique, performs a conventional vascular repair after removal of the tumor and carotid artery in order to restore the normal blood supply. The measures taken are various, mainly including autologous or artificial blood vessel transplantation and repair. However, many postoperative cerebrovascular complica-

tions have been reported to date. *ii*) The basicranial arterial bypass circuit is utilized (BABC) for blood supply when TECCAR without blood vessel reconstruction is conducted. In our paper, the latter is reported and discussed.

Materials and Methods

Clinical data

Since the success of the first case of a neck mass in the carotid artery undergoing TECCAR without vascular reconstruction in our hospital in 1979, this type of surgery has been conducted in 31 patients until April, 2002. Of the patients, 17 were male and 14 female. The age of the patients ranged from 14 to 58 years. In a majority of the patients, 21 (67.8%), were at the age ranging from 21 to 40. In the 31 cases, there were 23 with carotid body tumors (CBT) (8 malignant), 2 with vagal body tumors (VBTs) (1 malignant), 4 with carotid aneurysms, and 2 with metastatic cancer from the cervix involving carotid artery. Of the 31 cases, subtotal tumor resection was performed in 22.

Selection of cases

In order to reduce the postoperative CVCs and intraoperative deaths, subjects with a favorable physical condition, at the age of less than 60, and without existing atherosclerosis or a history of cerebrovascular disease were selected.

Preoperative preparation

The patients were required to perform an exercise of applying pressure to the carotid artery before the planned carotid artery resection so as to thoroughly open the Circle of Willis and, as a result, to meet the blood supply requirements of the affected carotid during the surgery.

The human carotid artery is paired, and the blood flow of the bilateral carotid arteries is exchanged via the BABC. Potential contralateral blood supply may compensate for the decreased blood flow to the area supplied by the affected carotid artery. However, under normal conditions, the bilateral carotid arteries carry blood to the areas they supply, and once unilateral blood supply is blocked, whether or not the BABC communicating branch can be opened in time so as to satisfy the requirements of the affected side (or contra-lateral) will be based somewhat on each patient's individual condition.

To ensure immediate and sufficient contralateral blood supply after blockage of a unilateral carotid artery, a preoperative exercise of applying pressure to the carotid artery for an unremitting blockage of the carotid blood flow was conducted by the patients in the Department of Head and Neck Surgery of the hospital since 1979. This exercise facilitates a sufficiently opened BABC communicating branch and an immediate contralateral compensation of blood supply after the unilateral carotid artery is blocked. The details of the method are

as follows: manual application of pressure to the carotid artery b.i.d. or t.i.d.; the tolerance time for blocking the blood flow should be over 30 min each time; a valid wave-amplitude difference (WAD) of $\leq 30\%$ detected by computerized rheoencephalography (CREG) is valid, and a period ranging from 2 weeks to over 6 weeks is needed for performing this exercise prior to surgery.

The CREG detector has been used in our hospital since 1979. It reflects the state of cerebral blood circulation and supply by tracing changed electroconductive waveforms caused by a change in the capacity of intracerebral blood flow over time. The condition of the blood supply of BABC was assessed before the preoperative exercise and during the excision of the carotid artery. After blocking the common carotid artery, the tolerance time of the patients may reach over 30 min, and compared to the WAD before the application of pressure, the WAD value of $\leq 30\%$ was defined as the critical value of a valid cerebral BCBS.

The manual application of pressure to the carotid artery recommended by our hospital is a repetitive exercise, and it is required to be performed 2 or 3 times a day. After checking the predictive indicators (bilateral WAD value of $\leq 30\%$ shown by CREG), the exercise needs to be done for 2–6 weeks, in order to reach a steady state of the compensated blood supply required for the surgery. The bilateral WAD on CREG approached a value of $\leq 30\%$ in all of the 31 cases as a result of this preoperative exercise, and surgery was conducted after assessment of bilateral WAD values.

Surgical procedure

General anesthesia was utilized for the operations, and 1,000–1,500 ml of blood was reserved. Based on the following steps, the surgery was conducted under CREG monitoring: *i*) Initially, the paraneoplastic tissue was dissected thoroughly, without separation from the tumor in order to reduce hemorrhage. *ii*) The distal segment of the external carotid artery was disconnected and then the internal carotid artery was dissected followed by dissection of the bifurcation of carotid artery. Blood infusion was necessary before blocking the carotid artery. To achieve this, the common carotid artery was blocked, the required values of the bilateral WAD was shown on the CREG, and then the proximal end of external carotid artery was blocked, with continuous CREG assessment. The blocking time was extended to over 30 min, and TECCAR could be performed if the WAD value was valid and within the normal limits, with resection of the ganglion sympatheticum included in the TECCAR. *iii*) The surgical procedure was conducted under close monitoring of CREG, with a rigorous control of the balance between blood loss and transfusion. A position with the head elevated and the feet down for a period of 48 h was adopted after surgery, and the continuous CREG was monitored closely by a specialized nurse. Symptomatic treatment was given immediately based on a change in

the patient's condition.

Results

Ever since the first patient receiving tumor excision combined with carotid bifurcation resection and without arterial blood vessel reconstruction was successful in 1979, this mode of surgery was used in 31 cases with head and neck masses until 2002^[1,2]. There were no intraoperative deaths or postoperative CVCs in these cases. During the follow-up, 3 of these patients died of postoperative failure of tumor control, i.e., 1 case with malignant CBT developing distant metastasis and 2 cases, originally diagnosed with metastatic carcinomas, relapsing or developing distant metastasis during a period of 2–5 years after surgery. The other 28 patients have been alive and well for a period of 6–29 years, respectively, following the surgery without any manifestation of insufficient cerebral blood supply. In the 28 patients, 3 who were accountants had clear thinking and a good capacity to perform calculations, while 1 who was an electrician and frequently did work at high altitude sites, did not have apparent dizziness. All of these patients appeared to have good function of all 4 extremities.

Discussion

Some cases of neck tumors which have involved the wall of the carotid artery have been treated by the excision of the tumor along with the artery in surgery. However, since excision of the carotid artery is a high risk procedure, and is associated with increased postoperative complications including CVC^[3–10], this method of surgery is infrequently practiced and cautiously adopted today.

Over the past few years, artificial or autologous vascular repair has been more commonly employed after excision of the carotid artery. In 1953, Conley et al. conducted an autologous great saphenous vein transplantation, when treating a patient with neck cancer and carotid artery involvement, in order to repair an arterial defect following the excision of a tumor together with the involved artery. Surgical procedures of the same kind had been performed in 17 cases until 1956, with an operative mortality of 41%. Subsequently, the outcome of the surgery improved after many years of practice; nevertheless, postoperative CVCs occurred from time to time until 2002, with an incidence rate ranging from 9.0% to 30%^[5–8], and with an operative mortality of 6.8%.

Cases receiving TECCAR without blood vessel reconstruction have also been reported. In 1982, Brennan and Jafeck^[9] accomplished their first case of TECCAR without arterial reconstruction. The method of surgery had been employed in 7 cases until 1991, with preoperative blockage of carotid blood flow for a period of 15–20

min, and with a measurement of refluxing pressure of the carotid artery. If the value of measured arterial pressure was over 70 mmHg, a carotid artery resection could be conducted. Both postoperative CVCs and the death rate were 29%.

Henceforward, some reports have indicated that the preoperative temporary blockage of the blood flow measured by the CREG was not enough to fully represent a permanent state of cerebral compensated blood supply^[10]. In 1988, de Vries et al.^[11], implemented the TECCAR without arterial reconstruction in 13 cases, with a blockage of the carotid blood flow for a period of 15–20 min. In order to ensure a safe surgical procedure, the surgery was performed only on the patients who had a normal limit of refluxing pressure and had ¹³³xenon electroencephalography confirmation of a valid state of cerebral blood supply; therefore, 5 of the cases with a defect in cerebral blood supply were ruled out, and 8 with normal cerebral blood supply were qualified. Surgery with excision of the carotid artery was successful in all the 8 cases.

To further understand the mechanism of cerebral blood supply after unilateral carotid artery excision following the exercise of pressure application to the carotid artery, 6 cerebral hemodynamic and imaging determinations were carried out in the subjects who did the valid exercise of carotid artery pressure application before the surgery and were alive and well. The results of these determinations allowed for preliminary conclusions as follows^[4]: *i*) A normal state of cerebral compensated blood supply was present in all the subjects; *ii*) Primary methods of compensation of blood supply included increasing the blood flow rate, thickening the inner diameter of blood vessel and opening the BABC communicating branch, and *iii*) The preoperative exercise of application of pressure to the carotid artery plays a role in setting up a sufficient BCBS.

In conclusion, after a strict selection of cases, the preoperative exercise of manual application of pressure to block the carotid blood flow and the correct assessment of the compensated cerebral blood supply, it should be safe to implement this method of surgery. In addition, this type of surgery may have more than the following advantages compared with the surgery in combination with arterial reconstruction: *i*) A more thorough tumor resection is achieved because of exclusion of the vascular reconstruction; *ii*) No complications such as postoperative thrombus, infection or fatal hemorrhage etc., occurred, with a 0% incidence rate of thrombosis; *iii*) Postoperative radiotherapy, if needed, is not difficult to be applied; *iv*) This is a simplified operational technique.

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