Endovascular Treatment of the Carotid Artery Rupture with Massive Hemorrhage

Background. To assess the efficacy and safety of endovascular embolization in the treatment of the carotid artery rupture.

Methods. A series of 21 patients who had carotid artery rupture (CAR) with massive transoronasal or transcervical hemorrhage, all treated with endovascular embolization, were reviewed. There were 17 males and 4 females ranging in age from 21 to 79 years, with a mean of 47 years. The pre-disposing factors of the CAR were head and neck tumors associated with surgical treatment and/or post-radiation therapy (n = 17), surgical complications (n = 1) and trauma (n = 3). Detachable balloons with liquid adhesives were used in 13 patients for vascular occlusion and obliteration of pseudoaneurysm of the internal or common carotid artery. Liquid adhesives and/or coils were used in 8 patients, in whom only the branches of the external carotid artery were involved (n = 6), or obliterate a taint of a pseudoaneurysm with preservation of the ICA (n = 2).

Results. Endovascular treatment was technically successful in all 21 cases of the CAR with cessation of profuse hemorrhage immediately after embolization. No recurrence of bleeding was observed. Two patients developed hemiparesis several hours after closure of the carotid artery (10%). Three patients had a transient ischemic attack; all were turned to normal neurological conditions later (14%). Ten patients having advanced head and neck cancer died during the follow-up period owing to the disease itself. Clinical follow-up period for these patients lasted 2 to 48 months, with a mean of 16 months.

Conclusions. Therapeutic endovascular embolization of the CAR is the primary invasive modality for treating CAR with profuse hemorrhage. It was proven both safe and effective over a relatively long follow-up period.

METHODS

From 1996 to 2001, 21 patients were referred to our Department for diagnostic angiography and endovascular embolization.
embolization to manage massive hemorrhage caused by the CAR. Information collected from the charts and angiograms included patient age and sex, predisposing factors, blood infusion and angiographic findings (Table 1).

There were 17 male and 4 female patients aged 21 to 79 years with a mean age of 47 years. The predisposing factors of the CAR were head and neck carcinomas (HNCs) after surgical treatment and/or post-radiation therapy (n = 17), surgical complication (n = 1) and trauma (n = 3). All 21 patients were treated initially by nasal packing with gauze or intranasal balloons, but the bleeding continued or recurred after removal of the packing. The volume of blood transfusion was 1000 to 13800 mL, with a mean of 5500 mL (Table 1).

With the patients under local anesthesia, the femoral arteries were catheterized by means of a percutaneous technique. Angiographies of bilateral carotid and verteobasilar arteries were assessed for potential pseudoaneurysm formation, vascular rupture and intracranial hemodynamic circulation. Thirteen patients who had HNC were proved by angiography to have pseudoaneurysm formation and/or rupture of the ICA (n = 6) (Fig. 1), carotid bulb (n = 4) (Fig. 2), or common carotid

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<th>Predisposing factors</th>
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<th>Angiographic findings</th>
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CB = carotid bulb; CCA = Common carotid artery; ICA = Internal carotid artery; IMA = Internal maxillary artery; NBCA = N-butyl-2-cyanoacrylate; NPC = Nasopharyngeal carcinoma; R/T = Radiation therapy; S/P = Post-surgery; TIA = transient ischemic attack.
artery (CCA, n = 3). Therapeutic permanent balloon occlusion was performed for vascular occlusion and obliteration of the pseudoaneurysm (Fig. 1B). The latex Debrun de tachable balloons (Balt Co, Paris, France) attached on 2F microcatheter were navigated to the affected arteries and inflated with contrast media. A 30-minute occlusion test was then performed and tolerance was assessed by neurological examination. Before detachment of the balloons, the liquid adhesive of 60% N-butyl-2-cyanoacrylate (NBCA, Melsungen AG, Melsungen, Germany)/lipiodol mixture was injected via a microcatheter with catheter tip positioned into the pseudoaneurysm under fluoroscopic control to occlude the pseudoaneurysm. In this series, a balloon occlusion test was attempted in all 13 but five patients owing to unstable hemodynamics and unconsciousness. All 8 pa-

Fig. 1. A 49-year-old male with nasopharyngeal carcinoma post-radiation therapy. (A) Left CCA angiogram showed focal narrowing of petrous ICA (arrow head) with pseudoaneurysm formation (arrow). (B) Postembolization left CCA angiogram revealed total occlusion of the ICA and complete obliteration of the pseudoaneurysm.

Fig. 2. A 44-year-old male with laryngeal carcinoma post-surgical tumor resection and radiation therapy. (A) Left CCA angiograms revealed a pseudoaneurysm formation with contrast extravasation at the carotid bifurcation (arrow heads). Segmental narrowing (arrows) of cervical ICA and branches of the ECA were attributed to radiation-induced arteritis. (B) Postembolization of plain film of neck showed balloons at the CCA and ICA (arrows), in between NBCA casts (arrow heads) were found.
tients could tolerate the occlusion test.

Six patients with pseudoaneurysms of branches (lingual and internal maxillary arteries) of the external carotid artery (ECA) were treated with NBCA/lipiodol mixture (n = 4) or coils (n = 2) for arterial occlusion and obliteration of those pseudoaneurysms (Fig. 3). Technique of the injection of the NBCA was the same as described above. Two patients with pseudoaneurysm formation at the cavernous ICA owing to trauma or surgical injury were treated by coils with NBCA (n = 1) (Fig. 4) and coils alone (n = 1) with preservation of the ICA blood flow.

Postembolization control angiograms were routinely obtained to assess the effectiveness of cessation of hemorrhage caused by CAR. The nasal pack was maintained throughout the procedure. The packs were removed immediately afterward, allowing for evaluation of bleeding and reembolization if necessary.

**RESULTS**

The results and follow-up findings are listed in Table 1. Among 17 patients with a history of HNC, 9 had resection of the tumor with adjuvant radiation therapy, and the rest 8 patients had radiation therapy alone. Three trau-

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**Fig. 3.** A 56-year-old male with nasopharyngeal carcinoma post-surgical tumor resection and radiation therapy. (A) Left CCA angiograms revealed a pseudoaneurysm at the distal internal maxillary artery (arrow). (B) Postembolization left CCA angiograms showed obliteration of the pseudoaneurysm by deposition of the coils.

**Fig. 4.** A 33-year-old female with pituitary macroadenoma post-transsphenoidal surgery one month ago before angiography. (A) Left lateral CCA angiograms depicted a pseudoaneurysm formation with contrast extravasation (arrow heads) at the cavernous portion of the ICA. (B, C) Postembolization angiograms showed almost total obliteration of pseudoaneurysm with preservation of the ICA blood flow. Radiopaque NBCA and coils were noted at the pseudoaneurysm (arrow).
matic patients suffered from CAR with lac er a tion of the in ter nal maxillary ar tery (n = 2) and cav ern ous ICA (n = 1). One pa tient had a CAR due to sur gi cal in jury of the cav ern ous ICA. The rup ture sites in this se ries in cluded 8 ICAs, 4 ca rotid bulbs, 3 CCAs and 6 ECAs; all were pre cisely lo cal ized by angio graphic study. Com plete ces sion of bleed ing was achieved in all pa tients (100%) im me di ate ly af ter em bol iza tion tak ing a mean of 95 minutes (range 60 to 150 min utes). The pro cess in cluded prep a ra tion of the pa tient, bal lo on oc clu sion test and endo vascular pro ce dures. Even though blood pres sure dur ing em bol iza tion was low and hemody namics com pro mised, af ter bleed ing points were oc cluded, the blood pres sure soon in creased in all pa tients. Nin e teen pa tients (90%) had no se ri ous or per ma nent com pli ca tion. Two pa tients de vel oped per ma nent hemiparesis af ter oc clu sion of the af fected ca rotid ar tery. Three pa tients had trans cient is chemic at tach and re turned to nor mal neu ro log i cal con ditions later (14%). Ten pa tients of ad vanced HNCs died dur ing fol low up pe riod ow ing to dis ease it self. Clin i cal dis plasa tions later (14%). Ten pa tients of ad vanced HNCs died dur ing fol low up pe riod ow ing to dis ease it self. Clin i cal

**DISCUSSION**

CAR of ten re sults in cat a stro phic hem or rhage. It is a well-known com pli ca tion of ag res sive man age ment of HNC by sur gi cal re sec tion and/or ra di a tion ther a py. CAR oc curs af ter the adventi tal, a pro tec tive layer sur round ing the ves sel, is de stroyed or dam aged through a va ri ety of pro ce dures. The loss of thick ness of the ca rotid ar tery wall may lead to CAR.

Ra di cal sur gery of head and neck tu mor is an im por tant fac tor of pro duc ing the CAR. Sur gi cal dis sec tion of the ca rotid adventi tal and vasa va so rum, depriv ing the ar tery of vas cu lar sup ply and weak en ing the ves sel walls, leads to is chemic dam age and ren ders it prone to rup ture. In the pres ent se ries, 9 out of 17 HNC pa tients had un der gone large sur gical re sec tions and re con struc tions. An other risk fac tor re lated to the sur gery is the com pli ca tion of flap ne cro sis, wound in fec tion and pharyngocutaneous fis tula. In our se ries, 5 pa tients had a pharyngocutaneous fis tula that con trib uted to ca rotid rup ture patho gene sis.

Irradia tion is known to cause in jury to intracranial blood ves sels. It ac cel er ates the pro cess of ath ero sclero sis and re sults in nar row ing of af fected ar ter ies. Ra di a tion might also cause CAR be cause of ob lit er a tion of the vasa va so rum, in jury to smooth mus cles of the ves sel s, adventi tal fi bro sis and weak en ing of the ves sel walls.29,13 McCre a dy et al.6 re ported 20 pa tients with ra di ation-in duced in jury to nor mal ar ter ies; ar ter ial disrup tion oc curred in 12 pa tients and ar ter ial ste no sis was de tected in 8 pa tients. Ra di ation-in duced ar ter io pathy has two mani fac tions: ar ter ial ste no sis or oc clu sion and ar ter ial rup ture. Ar ter ial rup ture with pseudoaneu rysm for ma tion usu ally oc curs in atherosclerotic ves sel seg ments.14 As il lus trat ed by the angio graphic find ings in our 11 pa tients (Figs. 1, 2). It has long been known that pa tients at high est risk of the CAR are those who have been treated with ra di a tion for pri mary or met a static car ci no ma.29,15 Of ten in con junc tion with a rad i cal neck dis sec tion. This se ries of 17 pa tients with HNC had all been treated with ra di a tion ther a py for con trol of the pri mary or re cur rent tu mor.

Per sis tent or re cur rent tu mor is also com mon in pa tients with CAR. Tumor may di rectly in vade the con tent s, the ca rotid sheath or the neigh bor ing struc tures to cause rup ture of af fected ar tery. Ketcham et al.13 re ported that 53% of their pa tients had tu mor iden ti fi ed at the time of rup ture. Citardi et al.16 re ported that 40% pa tients in their se ries had bio sy-proved re cur rent or re si dual tu mor. In our se ries, 3 of the 17 pa tients (18%) who had CAR were at trib uted to the tu mor en case ment or in vasion.

Forth un tely, the de vel op ment of the CAR can be fore seen. There may be a gen er al ized oo zing from a tu mor mass. Ne cro sis of the skin and an ex posed ar tery that ap pears dry and crusted may be seen. Bal looning of the ca rotid ar tery sug gests that rup ture will oc cur within hours. Early mi nor sen ti nel bleed ing that oc currs prior to the mas sive hem or rhage should alert the phy si cian to sen t the pa tient for angi o gram to ver ify the CAR. CAR fre quently in volved a heavy blood loss. Tight na sal and oral pack ing should be per formed first in or der to cease or nasal bleed ing. Such pack ing, how ever, is in ef fec tive, since the bleed ing is mas sive re sult ing from rup ture ar tery. In our se ries, a mean of 5500 mL blood trans fu sion was needed be cause of un stable hemody namics of the pa tients be fore em bol iza tion. Once the vi tal signs were
stabilized, the patient was sent to angio-room for diagnostic angio grams and embolization there after.

Emergency surgical ligation of the CCA or ICA has been used to manage patients with CAR. This approach, however, has generally resulted in an unacceptable rate of major complications, such as death and stroke. Endovascular embolization has displaced ad vantages over surgical ligation, such as the more distal access to the bleeding points, demonstration of bleeding points, control of multiple bleeding points, no need for general anesthesia and short procedure time. The goal of embolization is not directed toward curing the patient’s underlying disease, but is palliative for controlling of catastrophic hemorrhage and prolonging patient life, whether caused by tumors, trauma or postsurgical complications.

For the patients with CAR who had been treated by surgical treatment and/or radiation therapy for HNCs, the best approach is with detachable balloons, since these provide good control in positioning and deposition, usually permitting rapid and complete arterial occlusion upon inflation and immediate cessation of oronasal bleeding caused by CCA or ICA rupture. An important potential complication of endovascular therapy for carotid balloon occlusion is stroke, which may result from either hemodynamic insufficiency or thromboembolic phenomena. To minimize the risk of postocclusion thromboemboli, a second balloon was detached below the first balloon and the pseudoaneurysm of the carotid artery. In an attempt to decrease the risk of both acute and delayed hemodynamic ischemia related to occlusion of the ICA/CCA, we also attempted to perform conventional balloon occlusion test of the ICA/CCA in all patients before detach ing the balloon, since this test had been proved useful in identifying some patients who could not tolerate percutaneous occlusion of the ICA/CCA. In our series, the majority of patients could tolerate the proce dure of balloon occlusion test as expected. Be cause the involved CCA or ICA had certain narrowing owing to radiation-induced arteritis or tumor encasement, the ipsilateral blood flow to intracranial circulation might be already hemodynamic compromised and compensated by contralateral carotid artery and vertebral-basilar system.

The major complication of permanent balloon occlusion noted in this series of patients was ischemic stroke such as hemiparesis, monoparesis, aphasia or coma or combination of these. A patient failing test occlusion creates a therapeutic dilemma. In this situation, EC-IC bypass surgery may be performed in limited patients in order to increase ipsilateral cerebral perfusion. Recently, Macdonald et al. have reported a case of the carotid artery occlusion by balloon embolization. In our series, balloon embolization proved completely successful in stopping carotid artery bleeding and in preventing rupture. Furthermore, no patient experienced rebleeding after balloon embolization. This is in contrast to reports of the carotid artery occlusion by surgical ligation. Recurrent bleeding from the carotid artery after adequate ligation has been documented in 10% to 36% of patients undergoing ligation.

Posttraumatic, iatrogenic or post-radiation injury in the cervical or proximal portions of the common carotid artery is usually easier to treat by endovascular embolization than ICA to achieve nearly 100% success rate. In our series, we had successfully treated 6 patients of the CAR in involving the ECA or its branches. We also successfully treated 2 patients of the CAR at the cavernous ICA with balloon occlusion caused by trauma or surgical complication by depositing coils and/or NBCA into the target site to occlude the pseudoaneurysm with preservation of the ICA blood flow. The majority of pseudoaneurysms of the ICA result in massive epistaxis are based in the cavernous segment and run ture into the sphenoid sinus. In our series of 87 patients with intracavernous aneurysms, trauma was identified as an etiologic factor in 8% of cases. Chambers et al. re ported a 30% mortality rate in their review of 100
patients with pseudoaneurysm of the ICA. Be cause the ICA is healthy, the goal of treat ment is obliterate a tion of a pseudoaneurysm with preservation of the ICA blood flow. By using endovascular coil embolization, we satisfactorily treated two patients of the CAR re sulting from traumatic and surgical injury in jure of intracavernous carotid pseudoaneurysm.

The immediate and long-term successful rates in our series were 100%. The major and minor complication rate in our series was 5% and 15%, respectively, similar to the report of Chaloupka et al. They had 10% of mortality rate, 10% of minor complications as well as 5% of recurrent hemorrhage in their series. In this study, the endovascular procedure provided the patients with two months to several years of ad ditional life time. We advocated that any patient who had a history of HNC after surgical resection and/or radiation therapy presenting with transoronasal or transcervical bleeding, regardless of how remote it was, should be considered for possible CAR. In addition, a pattern of significant recurrent bleeding with failure to respond to nasal packing should prompt rapid evaluation with a carotid angiography.

On the basis of our experiences, we have found that endovascular embolization is a succesful way to manage CAR with hem orrhage. It has many advantages. For example, embolization is percutaneous. It can be done without general anesthesia, and treatment may be undertaken immediately after diagnostic angiography to save time. The technique is both efficient and safe, and allows rapid completion of the procedure in a relatively short period of time. It should be considered as the primary treatment modality in CAR with hemorrhage.

REFERENCES

21. Higashida RT, Halbach VV, Dowd C, Barbwek SL,

