Endovascular Treatment of Acute and Subacute Hemorrhage in the Head and Neck

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Objective: Acute and subacute hemorrhage in the head and neck often represent a life-threatening situation. The goal of this study is to evaluate the indications for and contributions of endovascular techniques in the diagnosis and management of such severe cases.

Design: Seventy-two patients with acute or subacute intractable hemorrhage of the head and neck were treated over a period of 5 years: 2 patients had experienced trauma; in 6 cases the cause of bleeding was iatrogenic; and in 2 patients intraosseous arteriovenous malformations were manifested. Fifteen patients had tumors, 9 of whom had prior radiotherapy. Forty-seven patients presented with epistaxis (41 idiopathic and 6 during anticoagulation therapy). The endovascular therapy was performed using polyvinyl alcohol particles, fibered platinum or electrolytically detachable coils (Guglielmi detachable coils; Target Therapeutics, Fremont, Calif), a stent, glue (Ethibloc; Ethicon GmbH, Norderstedt, Germany, and Histoacryl; B. Braun Melsungen AG, Melsungen, Germany), or with a combination of these different embolic materials.

Results: The acute bleeding was successfully controlled in all cases. Fourteen patients (7 with epistaxis, 5 with tumors, and 2 with arteriovenous malformations) had to be embolized more than once before the bleeding could be controlled. The idiopathic, traumatic, iatrogenic, and remaining tumoral cases were treated only once. The long-term morbidity was 1.9%.

Conclusions: Owing to the recent continuous advances in interventional radiologic techniques, it is possible to treat both acute and subacute life-threatening head and neck hemorrhage most efficiently. In many cases the endovascular therapy complements surgery.

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Acute and subacute hemorrhage in the head and neck may be due to various factors and can lead to disastrous situations. The management of major bleeding in the head and neck region can be complex and difficult. If conservative therapy is unsuccessful, catheter angiography can play a major role in localizing the source of the bleeding and—in a second step—occluding the damaged vessel by the same endovascular approach.

The most frequent cause of acute hemorrhage in the head and neck region is epistaxis, which can be caused by hypertension, trauma, a vascular malformation, Rendu-Osler-Weber disease, or a bleeding disorder; it might also be idiopathic or associated with a tumor.1-3 Severe craniomaxillofacial trauma or iatrogenic damage can also initiate intractable bleeding.5-10 Direct bleeding from head and neck tumors or as a complication following radical neck dissection and radiation therapy is rare,11-14 which is also true for arteriovenous malformations (AVMs), especially intraosseous AVMs of the jaw. The most dangerous complication of this entity is massive arterial hemorrhage, which may occur either spontaneously or following tooth extraction.15,16 The aim of this study is to evaluate the advantages and limitations of angiography and endovascular treatment of acute or subacute bleeding in this region in correlation to the different pathological patterns and locations.

RESULTS

The acute bleeding could be controlled in all cases. The long-term morbidity rate was 1.9%.

In 2 patients, cerebrovascular accidents during or directly after the endovascular procedure were manifested as a result of thromboembolic events. Both patients had epistaxis and a generalized arteriosclerotic disease. In one case the embolic cerebral complication resulted in...
PATIENTS, MATERIALS, AND METHODS

MATERIALS AND METHODS
Seventy-two patients (45 male and 27 female, aged 11 to 92 years [mean age, 51 years]) suffering from acute or subacute hemorrhage of the head and neck were admitted to our institution over a period of 5 years. Four patients (2 having experienced trauma and 2 children) were treated under general anesthesia; in the remaining 68 we used the transfemoral approach with local anesthesia of the groin.

Bilateral selective angiography of the common, internal, and external carotid arteries was performed on a biplanar, high-resolution angiography unit (Angio G-ring CAS 500; Toshiba Corporation, Tokyo, Japan). Thanks to the G-ring construction of the angiography equipment, an unlimited approach to the head and neck of the patient is possible for anesthetists as well as surgeons.

A 5.5F (Cook Europe A/S, Bjaeverskov, Denmark) or 6F (Balt Corporation Montmorency, France, or Cordis Corporation, Miami, Fla) guiding catheter was placed in the common or external carotid artery. High-resolution digital fluoroscopy with biplanar road-mapping capability and subtraction techniques was used to enable image-guided, safe catheterization of the damaged artery by a variable-stiffness 0.018-in Tracker or Fast-Tracker microcatheter (Target Therapeutics, Fremont, Calif.).

For occlusion of the damaged vessel, different embolic materials were available: polyvinyl alcohol (PVA) particles in the range of 150 to 500 µm (Contour; Interventional Therapeutics Corporation, San Francisco, Calif.), fibered platinum coils (Target Therapeutics), electrolytically detachable coils (Guglielmi detachable coils [GDC], Target Therapeutics), Ethibloc (Ethicon GmbH, Norderstedt, Germany), Trombovar 3% (Promedica, Paris, France), and Histaoctyl (B. Braun Melsungen AG, Melsungen, Germany) used alone or in a mixture with Lipiodol (Guerbet AG, Zurich, Switzerland). In 1 case a noncovered self-expanding stent (Wallstent Schneider, Zurich) in combination with GDC was used. In 20 patients a combination of different embolic materials was used.

PATIENTS
Trauma
A 17-year-old man presented with life-threatening intractable bleeding due to multiple maxillofacial fractures despite continuous blood transfusion. After a car crash, another young man, a physician, developed persistent epistaxis due to nose fracture.

Iatrogenic Bleeding
A 49-year-old man presented with persistent hemorrhage after puncture of the jugular vein and accidental puncture of the proximal common carotid artery with formation of a broad-necked false aneurysm. In 1 patient, epistaxis occurred after a biopsy of a hemangioma of the nasal cavity, and in 4 cases epistaxis occurred following septoplasty.

Intraosseous AVMs
In the first case, a 12-year-old girl was hospitalized with hypovolemic shock after having developed massive oral hemorrhage following extraction of the first molar in the left maxilla. A high-resolution computed tomographic (CT) scan of the maxilla showed an osteolytic lesion with cortical bone destruction. Following contrast administration, large vessels were visualized inside the lesion. In the second case, an 11-year-old girl experienced severe bleeding from the left mandible during a meal. A high-resolution, contrast-enhanced CT scan showed an extensive osteolytic lesion with cortical bone destruction and teeth hanging free in the venous pouch of the AVM.

Tumors
In 9 patients, the bleeding occurred following previous neck dissection and radiation therapy for head and neck tumors. In 3 cases the tumor was a squamous cell carcinoma and in 2 cases an adenoid cystic carcinoma of the oropharynx or hypopharynx. In 1 case the radiation therapy and neck dissection had been performed 24 years before. Palliative embolization of huge bleeding tumors was performed in 2 patients: one with incurable metastasis from a hypernephroma, and the other with an incurable adenoid carcinoma of the maxilla with extension into and destruction of the skull base. Two patients had juvenile angiofibromas, one from a hemangioma of the maxillary sinus, and the other with a fibrosarcoma of the maxillary sinus.

Epistaxis
Forty-seven patients with epistaxis were included in this group; 41 had idiopathic epistaxis, and 6 were under anticoagulation therapy. All patients had failed to respond to treatment with anterior and posterior nasal packing. Failure to respond was defined as recurrent bleeding after pack removal or persistent epistaxis despite packs and reversal of anticoagulation.

TR A M U}

Angiograms of both common carotid arteries of the patient with severe maxillofacial trauma showed contrast extravasation bilaterally of different branches of the maxillary artery. Large vessels were occluded with glue (Hystoacryl and Lipiodol). Smaller branches were occluded with PVA particles and fibered platinum coils. Complete stoppage of the hemorrhage after embolization was confirmed clinically as well as angiographically. Reconstructive maxillofacial surgery was possible with good results. During follow-up, a trismus was noted for some weeks.

In the other case, a left external carotid angiogram showed the bleeding source to be the sphenopalatine artery. After selective catheterization, embolization with PVA particles was performed.
IATROGENIC BLEEDING

In the group with iatrogenic bleeding, a false aneurysm of the common carotid artery, which had occurred following an attempt to insert a jugular vein catheter, was successfully occluded by deposition of fibered platinum coils into the neck of the pseudoaneurysm (Figure 1) without recurrence of bleeding or displacement of the coils during the follow-up period of 4 years.

Six other patients with iatrogenic bleeding presented with persistent epistaxis. Embolization was performed with PVA particles. In one case bleeding persisted after particle embolization, so the main stem of the sphenopalatine artery was occluded by the deposition of fibered platinum coils.

INTRAOSSEOUS AVMs

The selective angiography of the left external carotid artery of the first patient in the group with intraosseous AVMs confirmed the diagnosis of a high-flow AVM supplied by branches of the left maxillary and facial arteries. Following diagnostic angiography, embolization of the maxillary artery was carried out with Ethibloc. The feeders originating from the facial artery were occluded with PVA particles resulting in an angiographically complete obliteration of the AVM. A follow-up CT scan a few months later showed progressive sclerosis of the maxilla. Control magnetic resonance imaging performed 2 years later indicated disappearance of the AVM. No bleeding had occurred during the overall follow-up period of 5 years.

Angiograms of the left common carotid artery of the second young girl with life-threatening hemorrhage from an intraosseous AVM showed the diameter and flow of the external carotid artery to be larger than that of the internal carotid artery (Figure 2A). A delayed and slack contrast filling of the ipsilateral middle cerebral artery occurred as a result of blood redistribution away from the internal into the external carotid artery. Selective arteriography of the left external carotid artery showed the AVM to have 2 components. One was an AV fistula shunting into the intraosseous venous pouch. A second compartment consisted of a capillary-venous malformation.

The acute endovascular treatment was carried out in 3 stages. First the fistula was embolized transarterially with a mixture of Histoacryl and Lipiodol. In a second session, the capillary-venous components were embolized using PVA particles. Finally, the venous pouch was embolized directly under fluoroscopy through a small burr hole by injection of 2 mL of pure Histoacryl during manual compression of the carotid artery and jugular vein at the neck and direct deposition of fibered platinum coils and GDCs. A subsequent angiogram revealed nearly complete devascularization of the AVM in the left mandible (Figure 2B-C). Unfortunately bleeding occurred 2 years after the first endovascular treatment. Ligation of the left external carotid artery for control of the hemorrhage was performed at another institution. In follow-up, 2 direct percutaneous embolizations (one with Ethibloc and the other with a mixture of Histoacryl and Lipiodol) were performed. The exact position of the needle in the remaining intraosseous venous pouch was guided using a frameless computer-assisted navigation system. The application of the embolic material was controlled by fluoroscopy. Finally, mild reconstructive surgery was performed. No bleeding has occurred since that time.
TUMORS

In 3 cases with prior radiation therapy following neck dissection for head and neck tumors, the cause of bleeding was false aneurysms. In the first case, a small aneurysm at the proximal part of the superior thyroid artery was occluded using glue (Histoacryl and Lipiodol). In the second case, the source of bleeding was a false aneurysm of the external carotid artery at the origin of the superior thyroid artery. In a first treatment step, a basket was created inside the aneurysm using 2 GDCs and was subsequently filled in with additional fibered coils. In this way, the acute bleeding was stopped. However, 1 week later, a subtle, non–life-threatening bleeding occurred.

Angiograms of the common carotid artery showed a ventral displacement of the coil material inside the sac of the false aneurysm. Carotid stents were not available to us at this time; therefore, surgical ligation of the external carotid artery was performed to completely control the bleeding.

Two years later a similar case with life-threatening hemorrhage after neck dissection and radiotherapy for a hypopharyngeal carcinoma was referred to our department. The angiogram of the right common carotid artery showed the source of the bleeding to be an aneurysmal stump of the external carotid artery following ligature. An attempt to occlude the stump with GDC was unsuccessful. In this case a self-expanding Wallstent (40 mm in length, 6 mm in diameter) was placed at the level of the carotid bifurcation. The tip of a microcatheter was inserted through the mesh of the stent into the sac of the aneurysm, and the lumen was occluded by deposition of 1 GDC (Figure 3A-D), whereas the lumen of the adjacent internal carotid artery was safely protected from coil extrusion by the mesh of the stent. Antiplatelet therapy was performed. No bleeding occurred during the 2-year follow-up. Occlusion of the aneurysm as well as normal blood flow through the internal carotid artery was confirmed by ultrasound, Doppler sonography, and magnetic resonance angiography. Invasive control catheter angiography was not performed.

In most other cases previously irradiated following neck dissection for head and neck tumors or incurable tumors, different vessels were identified angiographically as contributing to the bleeding. A complete stoppage of the acute or subacute hemorrhage was achieved after embolization with PVA particles. In 2 cases of incurable tumors, renewed embolization was necessary within 3 to 12 months.

Two young patients with angiofibromas and mild epistaxis could not be treated conservatively owing to the extension of the tumor. Two elective embolizations were necessary and embolization was achieved after embolization with PVA particles. In 2 cases of incurable tumors, renewed embolization was necessary within 3 to 12 months.

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EPISTAXIS

In the group with epistaxis, bilateral selective angiographic studies of the common internal and external ca-

Figure 2. Intraosseous arteriovenous malformation (AVM). A, Angiogram of the left common carotid artery (lateral view) shows the diameter of the external carotid artery to be larger than the internal carotid artery (arrowheads) and depicts the large intraosseous venous pouch that drains the AVM. B, The follow-up angiogram of the left common carotid artery after 3 sessions of treatment shows complete devascularization of the facial intraosseous AVM. C, The plain film radiograph shows the embolization material inside the venous pouch of the mandible.
rotid arteries were performed in all cases. The probable site of bleeding could not be identified angiographically in all cases, especially not in the idiopathic group. Superselective catheterization of the sphenopalatine artery on both sides was performed, and for embolization, normal-sized PVA particles (150-500 µm) were used. In 10 cases additional collateral flow to the nasal cavity through the facial artery was detected angiographically, and this was also catheterized superselectively and embolized subsequently using PVA particles.

Six patients with idiopathic and anticoagulation-associated epistaxis needed a second embolization for bleeding 1 day after pack removal, but in the follow-up period of 19 to 36 months, there has been no recurrence. The other patients with epistaxis experienced complete cessation of bleeding following 1 endovascular treatment performed in all cases bilaterally, even when only unilateral bleeding was confirmed clinically and/or angiographically.

Procedural complications occurred in 2 cases of epistaxis. Both patients were men aged between 70 and 80 years, and both had generalized artherosclerotic disease. In the first case, the embolic cerebral complication resulted in light residual neurologic symptoms; in the other case a moderate neurologic deficit occurred.

Because of recent and ongoing developments in endovascular technology, emergency treatment with endo-

**Figure 3.** After radiation therapy following neck dissection for a squamous cell carcinoma of the hypopharynx, A, an angiogram of the right common carotid artery (lateral view), shows a ligated stump of the external carotid artery and minimal contrast agent extravasation (arrow). B, C, and D, Right common carotid angiogram after stent placement and embolization with Guglielmi detachable coils shows occlusion of the external carotid stump and normal width and patency of the stented segment of the common and internal carotid artery.
vascular embolization of acute bleeding in the head and neck region can be a complementary alternative to surgical therapy. Modern microcatheters allow superselective, image-guided catheterization of distal bleeding feeders. We have used this technique in acute bleeding from different origins. Use of an angiography suite with high-resolution digital fluoroscopy and simultaneous biplanar road-mapping capability, subtraction techniques, and biplanar digital subtraction angiography has produced good results. In all cases, head and neck surgeons were involved in the planning of the therapy from the beginning. The G-arm design and the refined interventional neuroradiologic angiography equipment enable an optimized approach to the head and neck region of the patient for the anesthetist as well as the surgeon. This offers the option to perform combined operative procedures during angiography. Based on our experience and in agreement with the literature,1-10,16-41 embolization performed by a multidisciplinary team is a successful way to treat uncontrollable hemorrhage.

Endovascular embolization has been considered an alternative treatment of severe epistaxis that has failed to respond to conservative therapy with packing or that was impossible to cauterize. After performing internal and external carotid artery angiography to detect the main source of bleeding and any possible dangerous anastomoses between the 2 arterial systems, superselective catheterization and embolization from branches of the external carotid artery can be performed.19 The most reliable embolization material is PVA particles, which allow the afferent vessels to remain open, thus permitting all possibilities of reembolization.3,35

In cases of epistaxis from vascular tumors such as angiofibromas, additional angiography and elective preoperative embolization after emergency treatment may be necessary to allow complete preoperative devascularization of the tumor.7,44,45 In cases of life-threatening intractable bleeding due to traumatic maxillofacial fractures with extensive soft tissue swelling, it is important to perform angiography as soon as possible. Superselective angiography may be required to obtain more detailed information related to the bleeding artery and clarification of the real extent of contrast extravasation; this enables the embolization to be performed as close to the bleeding source as possible. Thus complications such as cranial nerve palsies or recurrent bleeding from anastomotic channels can be avoided.6,20,25 However, before superselective angiography and contrast injection is performed, the embolic material must be fully prepared for immediate injection because bleeding can increase dramatically as a result of this diagnostic procedure. In one of our cases, glue was used instead of particles to embolize and stop the life-threatening bleeding as rapidly and completely as possible. However, this type of embolic agent tends to penetrate the capillary vessels, often inducing a focal necrosis. Glue should be used only in a restrictive manner and by an experienced neuroradiologist so as to reduce the complications to a minimum. This disadvantage seems to explain the resulting trismus—although reversible—in our patient. Usually, particles and/or coils are the material of choice in studies for the endovascular treatment of traumatic vascular lesions in the head and neck.6,8 These materials are more controllable and safer and easier to handle, thus substantially reducing the risk of necrosis.

Because of the close relationship of the carotid artery and internal jugular vein, there are several risks that must be considered. The common carotid artery might be punctured during the process of the insertion of a venous catheter, causing subsequent bleeding. Pseudoaneurysms and AV fistulas are also risks. Embolization, as performed in our case after mandatory diagnostic angiography with fibered platinum coils, can be a definitive alternative to surgery.

The most common vascular complication following radical neck dissection and irradiation is carotid artery rupture. Other vascular complications such as AV fistulas, internal carotid artery thromboses, and internal carotid artery pseudoaneurysms, or especially pseudoaneurysms of the main stem of the external carotid artery, are rare.7,12,96,47 Pseudoaneurysms of branches of the external carotid artery are considerably more common.19 Surgery following neck dissection and radiation therapy has an increased risk of postoperative wound breakdown and subsequent arterial exposure; therefore, endovascular treatment is a valid alternative to surgery.

The most feared complication of embolization near the carotid bifurcation is reflux or misplacement of the embolization agent into the internal carotid artery. Another complication is the growth of a false aneurysm with displacement of the embolization material, as occurred in 1 patient following GDC occlusion of the aneurysm. Owing to recent developments in intravascular stent technology of the extracranial carotid artery, this technique may become an attractive new option for treatment of aneurysms and/or pseudoaneurysms of the carotid or vertebral arteries. As reported, stent placement is sufficient for durable complete occlusion of small aneurysms.20 In larger aneurysms, an additional GDC placement into the aneurysm through the stent mesh is needed for complete obliteration. With this technique, the risk of coil migration from the lumen of the aneurysm through the neck of the aneurysm into the patent vessel is eliminated, as both lumina are separated by the mesh of the stent. The combined endovascular treatment of a carotid or vertebral artery pseudoaneurysm with GDCs and endovascular stents seems to be minimally invasive, safe, and efficient.20-30,49-51

In the event of spontaneous bleeding into the oral cavity, AVMs should be considered among potential differential diagnoses,10,31-41 especially in young patients. The management of intraosseous angiomias is complex, and CT and magnetic resonance imaging are essential both for diagnosis and therapy planning as well as for documentation of the degree of devascularization and resorption after embolization.13 Depending on the location, extent, and hemodynamics of the AVM, embolization may be performed by the transarterial or transfemoral approach or following image-guided percutaneous puncture and injection of glue and/or coils directly into the nidus or venous pouch of the AVM.

The only condition for a complete exclusion of an AVM is the surgical removal or embolization of the ni-
dus of the angioma, which means the arteriovenous connection itself, including the proximal segment of the draining veins. Of all the materials available for embolization, liquid embolization agents are most useful, since only they can reach the fistula and the proximal vein. The appropriate use of glue seems to offer a high rate of cure and/or clinical stabilization of these AVMs.

The permanent complication rate in our relatively small group of patients was 1.9%. All complications were related to the angiography and not to the embolization and occurred in 2 elderly patients suffering from artherosclerotic vessel disease. In one case the embolic cerebral complication resulted in a light residual neurologic deficit, and in the other, a moderate neurologic deficit. The incidence of neurologic deficit associated with cerebral angiography varies between 1% and 7%. Almost all cases of complications with persistent deficit occurred in patients with artherosclerotic disease, which may reflect the difficulty of performing angiography in this population. Minor but temporary complications following embolization, such as low-grade fever, facial pain, and trismus, are possible.

Our experience in the endovascular treatment of 72 patients suffering from acute and subacute bleeding in the head and neck region shows that endovascular therapy is a complementary method to surgery. This is especially true in patients without a clearly known or circumscribed source of bleeding. Endovascular treatment should be considered also if surgery may be difficult or may result in potentially devastating postoperative complications (eg, after radiation therapy) or if an AVM is present and surgery must be radical and potentially mutilating.

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