Case Reports

Pseudoaneurysm of the Vertebral Artery

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Pseudoaneurysms of the vertebral artery are rare. Their treatment depends on the location, size, cause, and coexisting injuries. The surgical management of a 22-year-old man who had a large pseudoaneurysm in the 1st portion of the right vertebral artery is described, and an additional 144 cases from the medical literature are briefly reviewed. ***(Tex Heart Inst J 1999;26:90-5)***

The anatomic description of the vertebral artery specifies 4 segments or parts: the 1st part originates in the subclavian artery and proceeds to the foramen of the transverse process of the C6 vertebra. The 2nd part proceeds from the C6 level to the exit above the transverse process of C1. The 3rd and 4th parts proceed from C1 to a juncture with the contralateral vertebral artery, forming the basilar artery inside the cranium. The 3rd and 4th parts are accessible only by craniotomy.

This report describes the case of a 22-year-old man who presented in 1994 with a pseudoaneurysm in the 1st portion of the right vertebral artery. This pseudoaneurysm was most likely the result of an automobile accident that had occurred 5 years earlier.

Case Report

A 22-year-old, lean, muscular man presented in November 1994 with a pulsatile mass, 8 cm in diameter, in the right lateral neck triangle. The mass was found during a routine pre-employment physical examination. The patient had no symptoms and was unaware of the mass. Upon detailed questioning, he reported involvement in a car accident about 5 years earlier. At that time he had been treated in the emergency room and was found to have lacerations of the head and neck, and bruising of the anterior chest wall without fractures of ribs or sternum. The 1994 studies of the mass included ultrasound, which showed the presence of an aneurysm; and angiography, which indicated that this was a pseudoaneurysm located in the 1st portion in the right vertebral artery (Fig. 1). In addition, magnetic resonance imaging clearly delineated the pseudoaneurysm (Fig. 2).

Several therapeutic options were considered, one of which was to perform endovascular occlusion proximally and distally. Another was to use a combined endovascular/surgical approach (retrograde balloon insertion preoperatively in the right brachial artery to occlude the right subclavian artery, along with surgical exposure through a neck incision). A 3rd option was to use a solely surgical approach by performing a combined transverse neck and sternum splitting incision. After considering the available literature and noting that endovascular manipulation sometimes resulted in an unfavorable outcome, the patient chose surgical treatment alone.

Surgical exposure was achieved through a "trap-door" incision. The attachment of the sternocleidomastoid muscle was partially divided, with the sternal head still attached. The innominate artery and the proximal subclavian artery were controlled with Silastic tape from inside the chest, and the distal subclavian artery was controlled through the neck incision, lateral to the pulsatile mass. The size of the mass made the dissection tedious but not hazardous. The pseudoaneurysm was carefully dissected from the surrounding structures. The recurrent laryngeal nerve could be identified only as it passed under the right subclavian artery. Medially, the mass reached the trachea; therefore, the mass could not be fully mobilized posteromedially. This is a step that would have been preferable in or-

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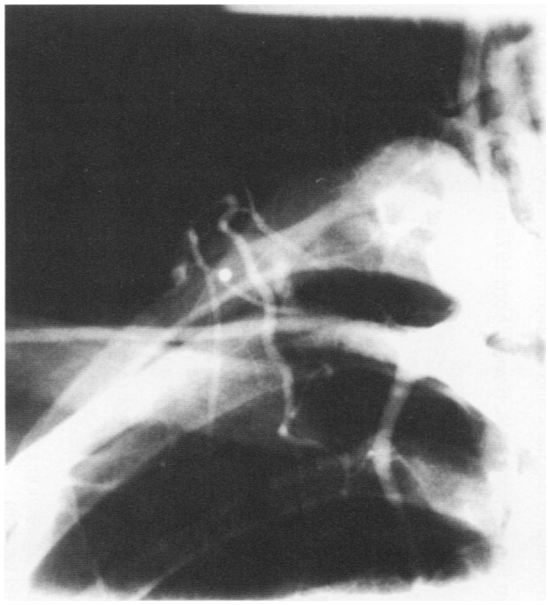

Fig. 1 *Angiogram of the right subclavian artery reveals a pseudoaneurysm, adjacent to the right common carotid artery, arising from the lateral aspect of the right vertebral artery. The pseudoaneurysm lies just above the 1st rib.*

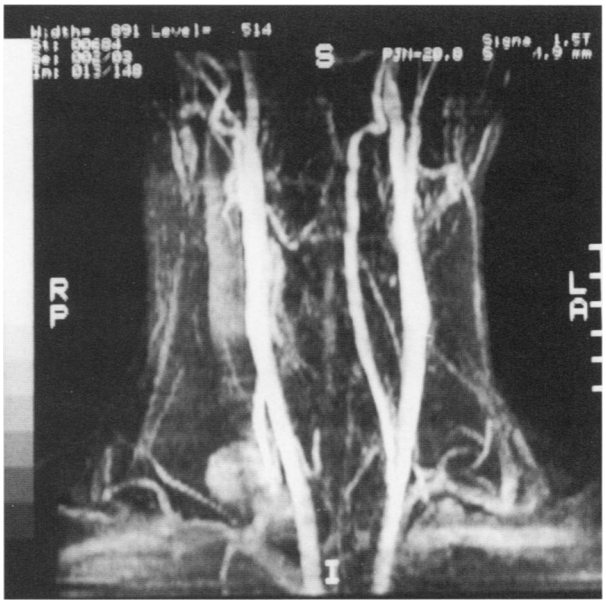

Fig. 2 *Magnetic resonance image of the base of the neck. The method of choice in the neck—2-dimensional, time-of-flight magnetic resonance angiography—was performed using a maximum-intensity pixel algorithm. A superior saturation band was placed to suppress inflowing signal from venous flow in the jugular vein. Findings: aneurysmal dilatation of the origin of the right vertebral artery. Flow-related enhancement is less intense than in the true lumen of the right vertebral artery itself because of slower flow in the pseudoaneurysm.*

der to avoid potential tearing of fragile tissues, which could cause uncontrolled hemorrhage.

At this point, the pseudoaneurysm was intentionally entered and the resultant bleeding was controlled by occlusion of the subclavian artery, both proximally and distally. Back-bleeding from the distal vertebral artery continued at the point of entry of the artery in the foramen of the C6 transverse process. A small balloon catheter was placed into the bleeding orifice to control the back-bleeding while the orifice was sutured. The balloon was then deflated and removed. The proximal portion of the vertebral artery, which was very close to the subclavian artery, was also sutured from inside the aneurysm. A portion of the aneurysmal sac was excised, and the operation was completed routinely with a suction drain placed in the neck portion of the incision.

The patient's postoperative course was uneventful and he was discharged on the 4th postoperative day. At the most recent follow-up in February 1999 (5 years postoperatively), the patient had no residual complaints, no neurologic deficits, and was working as a truck driver.

Discussion

The incidence of isolated trauma to the vertebral artery is very low. Such injuries are usually described in papers related to injuries of the head and neck; seldom do they merit an exclusive report. This is most likely because injuries causing trauma to the vertebral artery often disrupt surrounding structures.

The natural history of the vertebral artery pseudoaneurysm is not well known, in part, because so few cases have been reported. The clinical manifestation can be that of a local mass, or neurologic symptoms related to posterior brain circulation (either microembolization or insufficiency). Some pseudoaneurysms may rupture; spontaneous thrombosis may also occur. The duration of the development also varies—from weeks to many years.

Twenty-seven reports[1-27] were found in the English medical literature; they described 144 cases of injuries to the vertebral artery. These results are tabulated in tables I[1-27] and II.[1,3,6,8,13-24,26,27] Penetrating injury was by far the most common cause of isolated trauma to the vertebral artery; of the cases reviewed, only 22 of 144 were attributed to blunt trauma. As shown by these reports, blunt injuries can result in thrombosis or in total disruption of 1 or both vertebral arteries. Such injuries are attributed to chiropractic manipulations, sporting activities (such as collisions, falls, and martial arts), and traffic-related trauma. A relatively young age group (in the first 3 decades of life) seems to be more prone to the blunt injuries, possibly because of 1) their greater mobility and activity and 2) the greater elasticity and flexibility of the skeletal structures around the thoracic inlet and in the cervical spine.

TABLE I. Description of 144 Vertebral Artery Injuries

Reference/ Year	No. Pts.	Type of Injury	Other Injuries	Death	Treatment	Comments
Wiener I, Flye MW[1]/1984	1	Penetrating GSW	No	No	Proximal and distal ligation	Pseudoaneurysm of left VA, C2–C3 level, 5- to 10-mm size, 0.22 caliber GSW; 23-year-old man
Kobernick M, Carmody R[2]/1984	1	Blunt MVA	Yes	Yes	Embolization (Gianturco coil)	Complete transection of right VA, 3 cm from its origin; 22-year-old man
Roper PR, et al.[3] 1984	1	Penetrating SW	No	No	Embolization (coils ×2 [Cook Inc.], above and below the aneurysm)	SW to left VA 2 years earlier; 3-cm pseudoaneurysm and arteriovenous fistula at C3 level; 32-year-old man
Hunt TK, et al.[4] 1969	3	Penetrating SWs and GSWs	Yes	—	Ligation in all VA injuries	146 penetrating wounds of the neck, 14 at base of neck
Stapleford RG, et al.[5]/1981	1	Penetrating GSW	Yes	No	Proximal and distal ligation through neck and mandible: split incision	Right VA transection at C3 level; 21-year-old man
Davidson KC, et al.[6]/1975	1	Blunt: chiropractic manipulation	No	No	None	Pseudoaneurysm of right VA, very small, residual, central nervous system defects; 42-year-old woman
Buscaglia LC, Crowhurst HD[7] 1979	5	Penetrating: GSW (1); iatrogenic (2); SW (2)	Yes	No	Proximal ligation, transverse cervical incision, distal balloon catheter occlusion leaving balloon in after clipping the catheter	Deflation of the balloon may occur after several months without recurrence of arteriovenous fistula
Case ME, et al.[8] 1979	1	Blunt: sudden turn of head	No	Yes	Proximal and distal ligation	Severe neck deformity; pseudoaneurysm at C4 level apparently ruptured and bled into the neck and left hemithorax; 64-year-old woman
Reid JD, Weigelt JA[9]/1988	43	Blunt (2); penetrating (41)	No: 12 Yes: 31	Yes: 5	Proximal and distal ligation (28); proximal ligation (13); delayed ligation (1); no treatment (1)	Both blunt injuries from MVA. Review from 1976 to 1987
Marks RL, Freed MM[10]/1973	1	Blunt: football collision	Yes	No	None	Bilateral VA thrombosis, fracture of C5 vertebral body, quadriplegia; 16-year-old adolescent boy
Murray DS[11] 1957	1	Blunt: sawmill injury	Yes	Yes	Amputation of right arm	Postmortem examination showed thrombosis of right VA with softening of right cerebellum; 16-year-old adolescent boy
Simeone FA, Goldberg HI[12]/1968	1	Blunt: MVA	Yes	Yes	"Evacuation" of left VA	Unstable cervical spine fracture, bilateral VA thrombosis; 40-year-old man
Fakhry SM, et al.[13]/1988	4	Blunt: athletic (1); MVA (3)	Yes	No	Intravenous heparin and supportive treatment	Tiny pseudoaneurysm of right VA (1); left VA occlusion and right VA dissection (1); minimal injury to a VA (1); left VA dissection (1)
Amaral JF, et al.[14] 1990	1	Penetrating: subclavian vein catheterization	Yes	No	Proximal and distal ligation via sternotomy and neck incision	Large pseudoaneurysm of right VA near its origin from subclavian artery; 72-year-old woman
Kaplan SS, et al.[15] 1993	1	Blunt, presumed posttraumatic	No	No	Proximal and distal detached balloon occlusion, endovascular technique	Postpartum dissection and tiny pseudoaneurysm at C5 level; 41-year-old woman

Ouchi H, et al.[16] 1965	1	Blunt	No	No	Proximal and distal ligation via transverse cervical incision	Small pseudoaneurysm of right VA close to the subclavian artery; 29-year-old man
O'Connel JD, et al.[17]/1975	2	Penetrating SW (1); blunt (1)	Yes: Penetrating; No: Blunt	No	Proximal ligation alone for penetrating SW; bedrest for blunt trauma	Pseudoaneurysm of right VA between occiput and atlas enlarged after proximal ligation; 31-year-old man lost to follow-up A 2-cm aneurysm of the left VA just above the foramen magnum thrombosed spontaneously; 20-year-old man
Wilkinson DL, et al.[18]/1988	1	Blunt	No	No	Resection of pseudoaneurysm, presumably with proximal and distal ligation; incision not described	A 5- x 4-cm pseudoaneurysm of left VA close to its origin in subclavian artery with arteriovenous fistula, cause unknown; 53-year-old woman
Anand VK, et al.[19] 1993	1	Penetrating GSW (in WW II, treated 41 years later)	Yes	No	Resection of pseudoaneurysm with proximal and distal ligation through neck incision	Right VA pseudoaneurysm at C3–C4 level, eroding vertebral bodies and compressing spinal cord; 67-year-old man
Matas R[20] 1893	1	Penetrating GSW	No	No	Packing with small cotton pledgets after exploration through suboccipital incision	Pistol (0.44-caliber) injury in right occipital region, large pseudoaneurysm of right VA at C2–C3 level; 21-year-old man A classic paper with review of 20 other VA aneurysm cases and 22 other injuries to VA
Hiatt JR, et al.[21] 1989	1	Penetrating SW	Yes	No	Anticoagulation with warfarin	Small left VA pseudoaneurysm at C1–C2 level, occlusion of left internal carotid artery close to the base of the skull; 46-year-old woman
Aoki H, et al.[22] 1992	1	Penetrating: cannulation of internal jugular vein	No	Yes	Emergency exploration and oversewing of bleeding from the VA	Severe chronic obstructive pulmonary disease, very large hematoma in the base of neck from a ruptured pseudoaneurysm of right VA; 72-year-old man died 11 days postoperatively
Blickenstaff KL, et al.[23]/1989	25	Blunt (4); penetrating (21)	Yes	No	Observation (12); embolization (6); proximal and distal ligation (3); proximal ligation (4)	Two small (<5-mm) pseudoaneurysms were observed; 2 pseudoaneurysms were embolized, 1 of which led to neurologic symptoms
Royle CA, et al.[24] 1986	1	Penetrating: scissors	No	No	Endovascular obliteration with a detachable balloon filled with silicone monomers	A 12- x 20-mm left VA pseudoaneurysm at C3 level; the VA remained patent; 23-year-old man
Golueke P, et al.[25] 1987	23	Blunt (1); penetrating (22); GSW (19); SW (2); shotgun (1)	Yes	Yes	Embolization (8); others not described	Complications of embolization included dissection of contralateral VA and syncopal episodes, necessitating suboccipital surgical distal ligation of VA; misplacement of a coil
Hayes P, et al.[26] 1980	1	Blunt: farming injury	Yes	Yes	Proximal ligation at subclavian level followed by distal ligation 9 days later	Large left VA pseudoaneurysm at C2–C3 level; 76-year-old man died of pneumonia
Hatzitheofilou C, et al.[27]/1988	20	Penetrating SW (20)	Yes: 13	Yes: 1	Surgical treatment in all	One 3- x 3-cm right VA pseudoaneurysm at C4–C5 level; 19-year-old woman Another case with disastrous results: balloon occlusion of distal VA ending in quadriplegia and death

GSW = gunshot wound; MVA = motor vehicle accident; SW = stab wound; VA = vertebral artery

TABLE II. Description of 22 Pseudoaneurysms of the Vertebral Artery

Ref. No.	Patient		Pseudoaneurysm			Treatment**	Outcome
	Age	Sex	Location*	Size (mm)	Cause		
1	23	M	C2-3, II, L	5–10	Penetrating	S	Good
3	32	M	C3, II, L	30	Penetrating	P	Good
6	42	F	C2, II, R	~5	Blunt	C	No follow-up
8	64	F	C4, II, L	15	Blunt	S	Died, rupture
13	21	M	C2, II, R	5	Blunt	P	Good
14	72	F	C7, I, R	>50	Penetrating	S	Good
15	41	F	C5–6, II, L	~5	Blunt	P	Good
16	29	M	C7, I, R	~10	Blunt	S	Good
17	31	M	C1, IV, R	~10	Penetrating	S	No follow-up
17	20	M	C1, IV, L	~25	Blunt	C	Good
18	53	F	C7, I, L	50	Blunt	S	No follow-up
19	67	M	C3–4, II, R	~10	Penetrating	S	Good
20	21	M	C2–3, II, R	~70	Penetrating	S	Good
21	46	F	C1–2, II, L	10	Penetrating	C	Good
22	72	M	C7, I, R	~50	Penetrating	S	Died, rupture
23***	—	—	—	<5	—	C	—
23***	—	—	—	<5	—	C	—
23***	—	—	—	—	—	P	Persistent pseudoaneurysm
23***	—	—	—	—	—	P	Persistent hemianopsia
24	23	M	C3, II, L	20	Penetrating	P	Good
26	76	M	C2–3, II, L	~20–40	Blunt	S	Died of associated injuries
27	19	F	C4–5, II, R	30	Penetrating	S	Good

* I, II, and IV indicate segments of the vertebral artery.
** C = conservative treatment (either observation or heparinization); P = percutaneous (endovascular) approach; S = surgical treatment (either proximal alone or proximal and distal ligation) through various approaches
*** The authors mention 7 vertebral artery pseudoaneurysms, but in the text no individual information is provided. Four of 7 cases are presumed to have been treated surgically.

The 144 cases of injury to the vertebral artery yielded 22 pseudoaneurysms, 8 of which were the result of blunt trauma, 10 the result of penetrating injury, and 4 of uncertain origin. A separate description of the pseudoaneurysms is shown in Table II. The sizes of the pseudoaneurysms varied widely, from very small (a few millimeters) to very large (5 cm or more). All of these can cause symptoms—mostly neurologic in nature—or there may be no noticeable effects. Sometimes the pseudoaneurysms can be safely observed; however, spontaneous thrombosis or rupture may occur (see tables I and II, Treatment and Comments).

The advent of newer technologies has changed the process of diagnosing injury to the vertebral artery, and has altered therapeutic methods even more. Although the modern technology of endovascular occlusion or exclusion is being used with increasing frequency, it is not risk free. Various sources agree[13,23,27] that treatment of patients with vertebral artery pseudoaneurysms must be determined individually. Endovascular intervention is probably best applied in patients who have small aneurysms with or without arteriovenous fistula. Aneurysms in the 3rd and 4th portion of the artery are the most difficult to treat.

It is surmised that this report might prompt some criticism to the effect that this case would have been ideally suited to endovascular intervention, and that the surgical approach was inappropriate. However,

the "state-of-the-art" of endovascular interventions and the enthusiasm for minimally invasive procedures should not prevent us from performing a safe and successful procedure that is demonstrably free of potentially devastating complications such as distal embolization, dissection, thrombosis, perforation, and, last but not least, the creation of another pseudoaneurysm in the access (femoral) artery. Deaths have been described by Kobernick and Carmody[2] and Hatzitheofilou and coworkers[27] after vertebral artery endovascular procedures (Table I).

A couple of cases are comparable to that of the patient described herein: one is the case reported by Amaral and colleagues[14] (Table I), but it is dissimilar in that his case was due to penetrating injury. The other is the case reported by Wilkinson and associates[18] (Table I), in which the cause of the pseudoaneurysm was unknown. Both patients were treated surgically with a good outcome. In fact, to my knowledge, no reports in the medical literature describe the use of endovascular techniques to treat an aneurysm as large as that found in this patient.

Surgical approaches can be variable and must also be tailored to the individual patient. Brief summaries of surgical approaches appear in Table I (particularly references 14, 23, and 27). The consensus of these authors[14,23,27] seems to be that the large pseudoaneurysms, especially when located in the proximal vertebral artery, should be treated surgically, whereas those in the 3rd and 4th portions can more safely be approached percutaneously.

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