Unilateral Stenosis of the Vertebral Artery – Secondary Finding with no Prognostic Relevance?

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Summary. The outcome of 142 patients suffering from ischemic cerebral circulation disorders was followed up over a period of 33 months on average. The spontaneous course of 25 patients with unilateral, hemodynamically ineffective stenoses of the vertebral artery was compared with that of 107 patients without vertebral artery stenoses. Within the first 12 months, novel clinically manifest cerebrovascular events were observed in 16.0% of patients without vertebral artery stenosis (deaths 5.0%), but in only 4.3% of the patients with vertebral artery stenosis (no deaths). Within 30 months, only 2 of the 13 patients with vertebral artery stenosis had suffered a new cerebrovascular attack. At the end of the observation period, 39.3% of the patients without vertebral artery stenosis and 48.0% of the patients with vertebral artery stenosis were significantly disabled in their social life or had died. An additional unilateral hemodynamically irrelevant vertebral artery stenosis did not influence the rate of reinfarction or the remission of neurological deficits, independently of age, the degree of the circulatory disorder, the vascular territory involved, the presence of an organic psychosyndrome, or of additional stenoses in the carotid arteries. Consequently, a vertebral artery stenosis narrowing the vessel diameter to less than ⅓ is without prognostic relevance.

Key words: Vertebral artery stenosis – Cerebral angiography – Cerebrovascular diseases – Stroke – Prognosis

Introduction

From a number of clinical studies we know that the prognosis of patients having manifest circulatory disorders in the vertebrobasilar territory is not necessarily better than the one of patients suffering from cerebrovascular events in the carotid territory [3, 8, 12, 34].

Nevertheless, the relevant literature contains only a few publications concerning the spontaneous course of patients with stenoses or obstructions of the vertebral arteries. Such comparatively less interest may be related to the poor surgical consequences for the vertebral arteries as compared to the well accessible carotid arteries. Detection of obliterating changes in the vertebral artery is only rarely of relevance for the vascular surgeon. Furthermore, angiographic investigation of the vertebral territories has only recently become

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routine due to the advent of catheters in cerebral arteriography.

As to date at almost all large diagnostic institutes a four-vessel investigation of the large craniocervical arteries can be performed, and the individual sections of the vertebral artery can be approached using Doppler-sonography, the caring physician will be increasingly confronted with the question of the diagnostic and prognostic relevance of stenoses or obstructions of the vertebral arteries.

Patients and Methods

The results are based on examination of 142 patients (95 male, 47 female) with cerebral circulatory disorders of ischemic origin. The first clinical manifestation of cerebrovascular disease had occurred at a mean age of 46.2 ± 13.1 years, the mean age at admission was 48.2 ± 12.9 years.

During the stay in hospital, the degree of the circulatory disorder was determined [transient ischemic attack (TIA), prolonged reversible ischemic neurological deficit (PRIND), or completed stroke], as was the localization of the ischemic territory from a clinical point of view (carotid or vertebrobasilar territory). Also, the degree of organic psychosyndrome in the subacute state after the last clinically manifest attack was attested. The degree of organic psychosyndrome was assessed using a modified rating scale proposed by Berner [4], whereby in relation to the degree of dementia or personality changes the degree 0 (no recognizable organic psychosyndrome) to 3 (severe organic psychosyndrome) was attributed.

All patients underwent four-vessel cerebral arteriography with visualization of the aortic arch as well as the extra- and intracranial sections of the four large craniocervical vessels [25].

After a mean observation period of 33.0 ± 18.6 months, 136 of the 142 patients were reinvestigated clinically, the other 6 patients had died in the mean time secondary to novel cerebral infarctions. In all cases the spontaneous course was rated. Patients who had surgery performed on craniocervical vessels or those who underwent anticoagulation therapy are not included in the present investigation.

At the end of the observation period, the degree of social disability of the surviving patients was rated using a modified [24] Rankin scale [36] (degree 0–3). Nondisabled patients received the degree 0, severely disabled patients received the degree 3. Patients who had died received the degree 4.

It was the aim of the present study to answer the question whether patients with unilateral vertebral stenoses (VS) between 80% and 34% of the original diameter would have a poorer long-term outcome than patients with normal vertebral arteries as assessed by angiography.

In order to do so, the results of 107 patients with normal vertebral arteriograms were compared with the results of 25 patients with unilateral VS. The degree of social disability was compared at the end of the observation period. The results of 10 patients with vertebral obstructions or bilateral VS were eliminated from the study.

In addition, we investigated whether within an observation period of 12 or 30 months there was a higher incidence of clinically manifest circulatory disorders in patients with unilateral VS than there was in patients without VS.

Furthermore, the prognostic relevance of unilateral VS was investigated in single subgroups in order to assess whether the prognosis deteriorates if a unilateral VS occurs in certain constellations [age under or over 55 years; transient cerebral attacks (TIA, PRIND), completed stroke; clinical focal signs in the carotid territory or in the vertebrobasilar territory; patients with or without organic psychosyndrome in the subacute state; normal carotid arteriogram, stenoses or obstructions of the carotid arteries]. Statistical evaluation was performed using χ^2.

Results

Degree of Social Disability at the End of the Observation Period

In the total population, 39.3% (42/107) of the patients without VS and 48.0% (12/25) of the patients with unilateral VS were severely disabled socially or had died at the end of the observation period (Table 1). All 5 patients who died during the observation period were initially without VS.

Among the younger patients aged under 55 years, 33.8% (26/77) of the subgroup without VS and 40.0% (6/15) of the subgroup with VS were severely disabled or had died at the end of the observation period. Among the patients older than 55 years, 53.3% (16/30) of the subgroup without VS and 60.0% (6/10) of the subgroup with VS scored 2–4 in disability.

In the subgroup with transient cerebral attacks (TIA, PRIND), 14.3% (6/42) of the patients without VS and 12.5% (1/8) of the patients with VS were severely disabled socially at the end of the observation period. In the subgroup with completed stroke, the percentages were significantly higher [55.4% (36/65) of the patients without VS and 64.7% (11/17) of the patients with VS].

In cases of focal neurological signs exclusively within the carotid territory, 45.3% (24/53) of the patients without VS and 46.7% (7/15) of the patients with VS were severely disabled or had died at the end of the observation period. In cases with clinical focal signs in the vertebrobasilar territory, 33.3% (18/54) of the patients without VS and 50.0% (5/10) of the patients with VS showed a score of 2–4 at the end of the observation period.

Among the patients with a normal carotid angiogram 35.1% (26/74) of the subgroup without VS and 33.3% (4/12) of the subgroup with VS were severely disabled or had died at the end of the observation period. In the cases with stenoses or obstructions within the carotid territory, the percentage for patients without VS was 48.5% (16/33) and that for patients with VS was 61.5% (8/13).

Table 1. Severity of social disability at the end of the observation period in patients with normal vertebral angiograms and in patients with unilateral vertebral artery stenoses (VS)

| | Social disability score | | | | χ^2 |
| | Patients without VS ($n = 107$) | | Patients with VS ($n = 25$) | | |
	0–1	2–4	0–1	2–4	
All patients	65	42	13	12	0.641 NS
Ages: $\leq$ 55 years	51	26	9	6	0.215 NS
> 55 years	14	16	4	6	0.135 NS
Transient circulatory disorder	36	6	7	1	0.018 NS
Completed stroke	29	36	6	11	0.479 NS
Clinical carotid system	29	24	8	7	0.009 NS
Vertebrobasilar system	36	18	5	5	1.018 NS
Carotid angiogram normal	48	26	8	4	0.015 NS
Stenosis-Occlusion	17	16	5	8	0.637 NS
OPS grade 0	30	15	8	6	0.422 NS
grade 1–3	35	27	5	6	0.456 NS

In the subgroup without an organic psychosyndrome in the subacute state, 33.3% (15/45) of the patients without VS and 42.9% (6/14) of the patients with VS had a higher degree of social disability at the end of the observation period. In the subgroup with organic psychosyndrome of various degrees in the subacute state, 43.5% (27/62) of the patients without VS and 54.5% (6/11) of the patients with VS were severely disabled or had died.

Patients with unilateral VS were not more severely disabled socially at the end of the observation period than were patients without VS (as related to the total group of patients as well as to any single subgroup investigated).

Novel Clinically Manifest Events Within an Observation Period of 12 Months

In total 100 of 107 patients without VS and 23 of the 25 patients with unilateral VS were followed up over a period of 12 months minimum. Novel clinically manifest cerebral circulation disorders were observed in 16.0% (16/100) of the patients without VS and in only 4.3% (1/23) of the patients with VS.

The events in the group without VS were of different severity: (1) in 5 patients, transient cerebral attacks (TIA, PRIND) in the carotid territory were found; (2) in 5 patients, transient cerebral attacks (TIA, PRIND) in the vertebrobasilar territory had occurred; (3) in 1 patient, a completed stroke in the vertebrobasilar territory had occurred; and (4) in 5 patients, a completed stroke with fatal outcome was noted. In the 1 patient with a novel event in the group with VS, a PRIND in the carotid territory was observed.

The incidence of novel clinically manifest circulation disorders within the observation period of 12 months in relation to the various clinical and angiographic patterns is shown in Table 2.

Novel clinically manifest cerebral circulation disorders were observed in 25.0% (13/52) of the patients with clinical signs from the vertebrobasilar territory and normal vertebral

Table 2. Novel clinically manifest events within an observation period of 12 months in patients with normal vertebral angiograms and in patients with unilateral vertebral artery stenoses (VS)

	New manifest events				χ^2
	Patients without VS ($n = 100$)		Patients with VS ($n = 23$)		
	No	Yes	No	Yes	
All patients	84	16	22	1	2.132 NS
Ages: $\leq$ 55 years	63	11	13	1	0.596 NS
$>$ 55 years	21	5	9	0	2.019 NS
Transient circulatory disorder	32	9	6	1	0.213 NS
Completed stroke	52	7	16	0	2.094 NS
Clinical carotid system	45	3	13	1	0.014 NS
Vertebrobasilar system	39	13	9	0	2.859 NS
Carotid angiogram normal	58	10	11	1	0.349 NS
Stenosis-Occlusion	26	6	11	0	2.397 NS
OPS grade 0	40	3	12	1	0.008 NS
grade 1–3	44	13	10	0	2.830 NS

angiograms, but in none of the 9 patients with clinical signs from the vertebrobasilar territory and proven VS.

It should also be noted that novel ischemic events became manifest in 18.8% (6/32) of the patients with stenoses or obstructions exclusively within the carotid territory, however, such events occurred in none of the 11 patients with stenoses or obstructions in the carotid territory and additional VS.

Novel Clinically Manifest Events
Within an Observation Period of 30 months

Of the 25 patients with unilateral VS 13 were observed over a minimum of 30 months. The relatively small number did not permit statistical comparison with the course of the patients without VS. However, it may be mentioned, that in only 2 of the 13 patients with VS, a novel clinically manifest cerebral circulation disorder was observed within the period of 30 months. One of these patients suffered a PRIND in the carotid territory, the other a TIA in the vertebrobasilar territory.

Discussion

VS is mostly of arteriosclerotic origin [9, 13] and is located predominantly at the vessel's origin when branching from the subclavian artery or in its proximal section [9, 10, 13, 16, 19, 22, 23, 26, 33, 50]. Only rarely are distal obstructions identified [7].

Stenosing or obstructing lesions of the vessel wall in craniocervical arteries have been found, however, in clinically healthy subjects [15] as well as in patients without clinical manifestations of cerebrovascular disease [10, 27]. These are clinically silent secondary findings at angiography or autopsy [9, 16, 30, 35, 38, 39, 47]. The vertebral arteries can be the site of such alterations as often as the carotid arteries [9, 10, 16].

On the other hand, it is known that in only a portion of patients with clinically manifest cerebral circulation disorders, stenoses or obstructions of the craniocervical arteries are detectable [2, 6, 10, 13, 19, 20, 22, 23, 28, 40, 42, 45–50]. The localization of the stenosis is not always related to the clinical site of ischemia [6, 13, 28, 40, 42, 43, 46]. In particular in the vertebrobasilar territory, there is a poor correlation between clinical symptoms and pathomorphological changes in the vessels [6, 9, 14, 16, 19, 21, 22, 28, 40, 42, 45, 46, 47, 50].

With clinical focal lesions in the vertebrobasilar territory, angiographic changes in the respective artery are only rarely found. Vice versa, vertebral stenoses or obstructions that have been detected are often clinically silent [6, 9, 13, 14, 16, 19, 28, 40, 46, 47].

The notion that unilateral vertebral stenoses or obstructions are well tolerated in general is often cited in the literature [13, 14, 17, 26, 43]. In particular, slowly developing stenoses of the vertebral artery are often without clinical symptoms [13], since in this region efficient collateralization is possible [13, 17, 26]. According to Dorndorf and Kahrweg [14], unilateral isolated vertebral obstruction is more often clinically asymptomatic than is unilateral obstruction of the carotid artery.

In particular in the vertebrobasilar territory, inborn anomalies or hypoplasias are seen relatively frequently [9, 22, 26, 45]. In many cases, differences in caliber of the vertebral arteries are observed, the diameter of the left vessel being frequently larger than the one of the right [22]. Sometimes, the union of the arteries on the clivus forming the basilar artery is absent, whereby the smaller vessel ends as the posterior inferior cerebellar artery [22, 45]. In the case of asymmetric vertebral arteries, clinical symptoms of ischemia are to be expected if the dominant artery is subject to stenosis [26]. If obliterations of the vertebral arteries are accompanied by clinical focal signs in the vertebrobasilar territory, such an ischemic lesion is ipsilateral to the vascular lesion in 70% to 80% of cases [2, 20].

Only a few publications have dealt with the prognostic relevance of stenosing or obliterating alterations of the vertebral arteries [2, 7, 20, 32, 33, 37, 48, 49], whereby special attention was paid to possible differences in the further course of the patients as compared to that of patients with carotid lesions.

According to Asplund et al. [2], patients with stenoses or obstructions in the vertebrobasilar system have a better long-term prognosis than patients with such changes in the carotid territory. The reinfarction rate as well as the death rates are not higher for patients with stenoses or obstructions of the vertebral arteries than they are for patients without stenosing lesions in these arteries (observation period of the surviving patients: 12 years minimum!). Fogelholm and Aho [20] were able to follow up 141 patients with ischemic brain stem infarctions over a mean period of 46.5 months. In 45% of the surviving and in 45% of the deceased, obstructions had been found in one or both vertebral arteries. According to McDowell et al. [32], the chance of remission for patients with obstructions in the vertebrobasilar system is good if the patient survives the first 6 months following the initial clinical event. Rompel and Wiedenmann [37] reported a lethal outcome in about 50% of cases having an obstruction in the territory of the carotid siphon or of the trunk of the middle cerebral artery, but of less than 20% in cases with obstructions in the vertebrobasilar system. Observations [48] in patients with juvenile stroke showed a somewhat better prognosis for stenoses or obstructions in

the vertebrobasilar system than for respective changes in the carotid system. Finally, Moufarrij et al. [33] observed 96 patients with severe uni- or bilateral vertebral stenosis (obstruction of $\geq$ 50% of the diameter) over a mean period of 4.6 years. Only in 2 patients, fatal brain stem infarction occurred, in both cases an additional basilar artery stenosis was present. However, according to the results of Caplan [7], distal obstructions seem to have a poor prognosis.

In the present investigation, only patients with unilateral vertebral stenosis were considered in which the narrowing of the vessel's caliber ranged between 80% and 34% of the original diameter. Such stenoses leaving at least one-third of the vessel's diameter open, seem to be hemodynamically irrelevant [1, 5, 11, 18, 29, 31, 41, 44].

In conclusion, a unilateral (additional) vertebral artery stenosis obviously is without any prognostic relevance. Patients with a unilateral hemodynamically irrelevant vertebral artery stenosis were not more socially disabled at the end of the observation period than patients without such a lesion. This result is not only true for the total group, but is also valid for distinct subgroups of patients which were formed according to various clinical and angiographic parameters. Independent of age, degree of circulatory disorder, clinically involved vessel system, presence or absence of an organic psychosyndrome, or of any other additional stenosing changes in the carotid system, unilateral hemodynamically irrelevant vertebral artery stenosis does not seem to influence the reinfarction rate nor the long-term prognosis (degree of social disability) of a given patient.

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