Clinical presentation of posterior cerebral artery occlusions – Clinical rationale for a more aggressive therapeutic strategy?

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A B S T R A C T

Introduction: A proximal occlusion of the posterior cerebral artery (PCA) can affect patients severely and clinical outcome might be poor. Aim of this paper is to describe clinical presentation, diagnostic findings and outcome of patients suffering from ischemia in the PCA territory.
Methods: We conducted a retrospective analysis of clinically affected patients with imaging-based evidence of ischemia within in the PCA territory at a comprehensive stroke center over a six-year period. Clinical (including demographics, National Institutes of Health Stroke Scale, NIHSS, modified Rankin Sclae, mRS), imaging (including occlusion site and brain infarction) and therapeutic data were evaluated. A favorable outcome was defined as an mRS ≤ 2.
Results: Two hundred thirty-five patients were clinically affected with evidence of PCA ischemia detected by cross-sectional imaging. One-hundred fourty-five patients demonstrated an occlusion of the PCA including 43/145 (30%) with P1 occlusion, 80/145 (55%) with P2 and 22/145 (15%) with P3 occlusion. The most frequent symptom was hemi−/ quadrantanopsia (181/235, 77%). Sixty-eight patients (29%) suffered from hemiparesis. The occurrence of a hemiparesis was associated with a P1 occlusion (27/43, 63% vs. 41/192, 21%; $p < 0.0001$). Hemi−/quadrantanopsia was less frequently associated with a P1 occlusion (26/43, 61% vs. 155/192, 81%; $p = 0.0043$). P1 occlusions more frequently showed thalamic infarction (28/43, 65% vs. 65/192, 34%; $p < 0.0001$). At discharge, patients with P1 occlusion more often showed a poor outcome (mRS > 2, 30/43, 70% vs. 55/192, 29%; $p < 0.0001$).
Conclusion: Hemiparesis due to P1 occlusion is a common phenomenon in stroke patients and associated with a poor clinical outcome.

1. Introduction

Acute ischemic stroke (AIS) is a medical emergency [1]. Even though it has been possible to reduce the number of stroke deaths by up to 38% in the last 15 years by means of comprehensive care centers, standardized treatment programmes and new therapy options [2], there are still unanswered questions regarding the best possible treatment especially for posterior circulation strokes. (See Table 1.)

The most frequent manifestation of an ischemia within the PCA territory are visual field defects [3]. Motor and sensitive loss symptoms often occur in proximal PCA occlusions [4] and hemiplegia may result if the cerebral crus is involved. If the infarct is limited to the thalamus,

movement is often uncoordinated and atactic [5]. In addition, neuropsychological deficits are frequently found [6,7]. Acute recanalization therapies of AIS include intravenous thrombolysis (IVT) and endovascular mechanical thrombectomy (MT) as long as patients are admitted to hospital in a timely manner [8]. As seriousness of some symptoms might be misinterpreted by the patients (such as visual or neuropsychological deficits), admission to hospital can be delayed and only conservative management can be applied.

There is still limited data that evaluates the clinical outcome of patients suffering from PCA occlusions, especially in large case series. A few individual studies indicate improvement or persistence of individual symptoms in particular visual field deficits after rehabilitation therapy

Table 1
Demographic data.

	Total	P1	P2	P3	No occlusion
N	235	43	80	22	90
M:F	96:139	22:21	54:26	13:10	51:39
(N, [%])	[41:59]	[51:49]	[68:32]	[57:43]	[57:43]
Age (yrs., mean ± S.E.M [range])	69 ± 14 [23–93]	73 ± 13 [43–93]	71 ± 12 [31–93]	66 ± 14 [33–86]	65 ± 15 [23–89]
Therapy (N, [%])					
IVT	36 [15]	8 [19]	22 [28]	2 [9]	4 [4]
IVT + ME	2 [1]	1 [2]	1 [1]	-	-
ME	1 [0.4]	1 [2]	-	-	-
Symptoms (N, [%])					
hemiparesis	68 [29]	27 [63]	25 [31]	3 [14]	13 [14]
sensomot. D	38 [16]	9 [21]	16 [20]	3 [14]	10 [11]
hemianopsia	181 [77]	26 [61]	62 [76]	20 [91]	73 [81]
infarction area (N, [%])					
thalamus	84 [36]	28 [65]	36 [45]	3 [14]	17 [19]
hippocampus	49 [21]	14 [33]	28 [35]	1 [5]	6[7]
occipital lobe	189 [80]	33 [77]	62 [77]	18 [82]	76 [84]
Imaging (N, [%])					
CT	55 [23]	11 [25.5]	20 [25]	6 [26]	17 [19]
MRI	53 [23]	11 [25.5]	13 [16]	9 [39]	21 [23]
CT + MRI	127 [54]	21 [49]	47 [59]	8 [35]	52 [58]
mRS at discharge (median [range])	2 [0–5]	3 [0–5]	2 [0–5]	2 [0–4]	2 [0–5]
mRS = 0 (N, [%])	19 [8]	1 [2]	5 [6]	1 [5]	12 [13]
mRS = 1	22 [9]	0	6 [8]	2 [9]	14 [16]
mRS = 2	109 [46]	12 [28]	34 [43]	15 [68]	48 [53]
mRS = 3	42 [18]	9 [21]	21 [26]	2 [9]	10 [11]
mRS = 4	35 [15]	15 [35]	13 [16]	2 [9]	5 [6]
mRS = 5	8 [3]	6 [14]	1 [1]	0	1 [1]

P1: vessel occlusion in the P1-Segment; P2: vessel occlusion in the P2-Segment; P3: vessel occlusion in the P3-Segment; IVT: intravenous thrombolysis; MT: mechanical thrombectomy.

[9–12]. Recently, two multicenter studies were published demonstrating that endovascular MT is technically feasible and safe for treatment of isolated PCA occlusions [13,14]. Meyer et al. reported a successful reperfusion rate of 86% in 43 affected patients with early neurological improvement in 59% and an excellent functional outcome in 46% [13]. Clarençon et al. showed a low procedure-related complication rate (<5%) and a favorable outcome in 59% in s small cohort of 22 patients [14]. However, there are no randomized studies on endovascular MT for isolated PCA occlusions so far.

In this work, we describe the clinical presentation, the diagnostic findings and the outcome of patients suffering from ischemia in the PCA territory.

2. Methods

In this single center study patients suffering from ischemia in the PCA territory were retrospectively analyzed. The patients were consecutively admitted to our comprehensive stroke center from January 2011 to August 2017.

Inclusion criteria were the presence of an ischemia in the PCA territory in cross-sectional imaging including diffusion-weighted imaging (DWI) in magnet resonance imaging (MRI) or computed tomography (CT). Exclusion criteria were ischemic infarctions or vessel occlusions other than the PCA and haemorrhagic infarcts. Patients were selected using a keyword search in the database of radiologic information system (RIS) and picture and archiving and communication system (PACS). This provided all reports which contained the designation "posterior" and the corresponding patient name and date of birth.

The initial neurological deficits, baseline parameters, National Institutes of Health Stroke Scale (NIHSS) and modified Rankin Scale (mRS) at admission and discharge were reported. Clinical symptoms including presence of hemiparesis or a sensorimotor deficit, speech disorder, neglect, hemi−/ or quadrantenanopsia and the existence of a gait and memory disorder were considered. The type of treatment included conservative therapy, application of IVT and MT in combination with IVT when possible.

The PACS was used to determine the date and time of acquisition, the imaging procedure, the vascular lesion, infarct location, and bleeding complications. The thalamus, the hippocampus, the cerebral crus, the internal capsule and the occipital lobe were identified as possible localization sites. Vessel occlusion was assigned to segments P1, P2 and P3 of the PCA using CT or MR angiographies [4].

The clinical outcome at discharge was measured with mRS in a dichotomized manner. A favorable outcome was defined as an mRS ≤2.

All statistical calculations were performed on a standard personal computer with the SPSS 25.0.0.1 program (IBM, Armonk, USA). For the analyses, the X^2 test for dichotomized, nominal or ordinal scaled characteristics and the Fisher test for dichotomized variables were used as statistical test procedures. The significance level was set at $p < 0.05$. According to the guidelines of the local ethics committees, ethics approval was given for the acquisition of patient data, which was conducted in accordance with the Declaration of Helsinki (no: 20–1605).

3. Results

Two-hundred thirty-five patients fulfilled inclusion criteria. Single imaging was done with CT in 55/235 (23%) patients and MRI in 53/235 (23%) patients. One hundred and twenty-seven individuals (54%) received both CT and MRI during the hospital stay. An occlusion of the PCA was found in 145/235 (62%) patients, of which 43/145 (30%) had P1, 80/145 (55%) P2 and 22/145 (15%) P3 occlusion. No PCA occlusion could be detected in 90/235 (38%) patients. Hemiparesis was present in 68/235 (29%) patients. The occurrence of a hemiparesis was associated with a P1 occlusion in 27/43 (63%) patients compared to the remaining 41/192 (21%; $p < 0.0001$).

A sensorimotor deficit was initially found in 38/235 (16%) patients. Thereof, 9/38 (24%) individuals had P1 occlusion, 16/38 (42%) and 3/38 (8%) patients an occlusion of P2 and P3, respectively. In 10/38 patients (26%) with a sensorimotor deficit, no vessel occlusion was detectable. The occurrence of a sensorimotor deficit was not associated with a P1 occlusion (9/38, 24% vs. 29/197, 15%; $p = 0.3623$).

The most common symptom was a hemi−/quadrantanopsia found in 181/235 patients (77%). Hemi−/quadrantanopsia was less frequently associated with a P1 occlusion (26/43, 61% vs. 155/192, 81%; $p = 0.0043$). However, in most of them no detectable vessel occlusion was observed (73/181, 40%).

In 84/235 patients (36%), the ischemia was located within the thalamus. In the subgroup of patients with a P1 occlusion, 28/43 patients (65%) showed involvement of the thalamus. In comparison, the thalamus was less frequently involved in P2 (36/80, 45%) and P3 (3/22, 14%) occlusions as well in patients with non-detectable vessel occlusions (17/90, 19%; $p < 0.0001$). The remaining infarct areas showed no significant statistical association with the occlusion sites.

A total of 36/235 (15%) patients received IVT. Of those, 8/36 (20%) had a P1, 22/36 (61%) a P2 and 2/36 (5%) a P3 occlusion, respectively. At discharge, 7/8 (88%) patients with P1 occlusion and IVT had a poor outcome. Three out of 235 (1%) patients received successful reperfusion by MT including two cases with combined IVT. One patient had been admitted and discharged with an unchanged mRS of 3, one had improved from 4 to 3, one had improved from 2 to 1. None of the patients had worsened as a result of endovascular therapy.

In 85/235 (36%) patients, clinical outcome was poor at discharge. Of those, patients with P1 occlusion more often exhibited an mRS >2 (30/43, 70%) compared to patients with distal (P2: 35/80, 44%; P3: 4/22,

18%) or undetectable occlusion (16/90, 17%; $p < 0.0001$). A worse functional outcome, measured by a higher mRS value at discharge, was significantly associated with the presence of P1 occlusion compared to patients without P1 closure (p < 0.0001).

4. Discussion

This study demonstrates the seriousness of a proximal PCA occlusion in terms of clinical presentation and outcome of affected patients. This is in contrast to previous studies which described the rather benign course of AIS patients due to PCA occlusion [3,15]. These studies found that patients with PCA infarction have a good outcome especially when compared to patients with middle cerebral artery (MCA) ischemia [15]. In 2011, Arboix et al. published the most recent and largest retrospective single center study to characterize the clinical presentation, predictive factors and specifics of posterior cerebral infarction in 232 patients [16]. The patients characteristics such as age, gender distribution and outcome at discharge did not differ significantly from the subjects investigated in this study. The number of patients with an mRS ≤ 1 at discharge was 19% in the Arboix-study and 17% in our cohort. Similar results were also found for a mRS-score of 2–3 (59% vs. 64%) and for a mRS-score of 4–5 (22% vs. 18%).

Frequent symptoms in the Arboix study were motor weakness (39%), sensitive disorders (51%), hemianopsia (41%) and speech disorders (30%). The clinical symptoms in our subjects differed more clearly. In this study, hemi−/quadrantanopsia was the predominand symptom (77%), motor or sensitive deficits were found in slightly fewer patients (29% and 16%, respectively) compared to Airboix. The reason for the different results is the definition criteria of the symptoms. Arboix did not include patients with quadrantanopsia in the group of visual field defects [16]. The exact location of the infarct or vascular occlusion was not determined in the study by Arboix et al. and in the studies by Brandt et al. and Kumral et al. this aspect was not examined in a comparable way [3,15,16].

This study showed that patients with initial hemiparesis were significantly more likely to have an occlusion in the P1 segment. Equivalent to this, these patients more often had a thalamic infarction compared to patients with more distal vascular occlusions. The first section of the PCA up to the junction with the posterior communicating artery supplies deeper located core areas of the midbrain and diencephalon [4]. The arterial inflow to the thalamus and subthalamus comes mainly from small perforating branches. These structures play an important role in the control of fine motor functions. An ischemia in this area explains the occurrence of motor deficits up to a hemiparesis [4]. For clinical routine it is important to distinguish this group of patients from stroke patients in the territory of the MCA. In addition to the presence of specific symptoms for posterior infarction, e.g. neuropsychological deficits, the absence of symptoms typical for MCA ischemia, e.g. aphasia, is crucial for clinical diagnosis [4]. Furthermore, the clinical differentiation of patients with a distal vascular occlusion in the P2 or P3 segment is important.

We showed that the presence of hemi−/quadrantenanopsia is rather associated with distal or undetectable vascular occlusion. The outlets from the P2 segment of the PCA supply the lateral geniculatum corpus and the visual radiation adjacent in the temporal lobe. Branches of the P3 segment are responsible for the arterial supply of the occipital lobe, especially the sulcus calcarinus including the area striata. These structures are causally affected in a hemi−/quadrantenanopsia [4]. Some P3 branches communicate with arteries of the anterior circulation, e.g. the posterior pericallosal artery from the PCA and the pericallosal artery from the anterior cerebral artery. In proximal P1 occlusions only the thalamus can be affected by ischemia, while the arterial supply of the visual tract and the occipital lobe comes from collaterals [4]. In summary, this means that especially in patients with hemiparesis and

without hemi−/quadrantanopsia a P1 occlusion might be suspected.

This study shows that patients with a P1 occlusion have a poorer functional outcome compared to patients with distal or undetectable vascular occlusions as they are are more frequently affected by hemiparesis. Although patients with distal vascular occlusion suffer less frequently from hemiparesis, their mobility is nevertheless severely limited by a hemi−/quadrantanopsia and the resulting driving ban. Therefore, the goal of treatment should be a reperfusion of the PCA territory, especially in patients with proximal occlusion.

Although in the current study only three patients received MT, we propose a more aggressive therapeutic strategy with regard to endovascular treatment in this stroke cohort due to the clinical seriousness especially of proximal PCA occlusions. Our suggestion is supported by the results of the post hoc analysis of the prospective, multicenter, open label Trevo Reciever Registry which demonstrated a favorable outcome in 59% after successful reperfusion of PCA occlusions using MT[14]. Another current study reported similar promising results in patients with isolated PCA occlusions and MT with an excellent functional outcome (mRS ≤ 1 at discharge) in 42% [13].

5. Conclusion

Hemiparesis in patients with a proximal PCA occlusion is a frequent event and clinical outcome is poor. Further studies on alternative treatment strategies, in particular endovascular MT, should be conducted to establish an improved therapy concept.

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