

## Occupational Rehabilitation of Patients with Posterior Cerebral Artery Stroke and Anatomical Variations of the Circle of Willis

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### Abstract

**Aim and background:** Considering its great importance in connecting the internal carotid with the vertebrobasilar system, the circle of Willis, a major anastomotic arterial system located at the base of the brain, may present various anatomical configurations that become possible triggers for certain cerebro-vascular diseases such as strokes or aneurysms. The present study wants to highlight the importance of clinical findings related to anatomical variations in the circle of Willis that could lay at the basis of the development of posterior cerebral artery stroke (PCA stroke), interconnecting them with occupational rehabilitation of such patients.

**Material and methods:** We did a research of data published over the last 1 years, from several international medical libraries and databases such as Pubmed, Google Scholar, Cambridge Core, using the following specific keywords combination: "circle of Willis, anatomical variants, posterior cerebral artery stroke, cognitive and language disorder", and "posterior cerebral artery stroke, occupational therapy, occupational rehabilitation". A descriptive review was realized describing several types of occupational rehabilitation techniques involved in the case of patients with PCA stroke, considered as a consequence of variations of the circle of Willis.

**Results:** There are taken into consideration the connections between PCA stroke and specific clinical pathologies represented mainly by cognitive, behavioral, visual and language disorders and the rehabilitation in these cases, which has been little investigated in the specialty literature, with a focus on occupational therapy procedures.

**Conclusion:** A correct knowledge upon the clinical consequences of anatomical variants of the circle of Willis, in this case, related to PCA stroke would be very useful not only to surgeons, pathologists and anatomists, but also to bedside clinicians.

**Keywords:** Circle of willis; PCA stroke; Anatomical variations; Occupational rehabilitation

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### Background

Considering its great importance in connecting the internal carotid with the vertebrobasilar system, the circle of Willis, a major anastomotic arterial system located at the base of the brain, may present various anatomical configurations that become possible triggers for certain cerebro-vascular diseases such as strokes or aneurysms. A proper knowledge on the abnormalities and anatomical variants that appear at this level becomes essential in the planning of surgery for certain cerebro-vascular diseases such as cerebral infarction, brain hemorrhages and aneurysms. The frequency of these anatomical variations has been mainly

investigated in countries like England, Holland, Poland, Italy, China, and, even in an extensive manner, in India and Pakistan, whereas in Romania there is still a demand for such anatomical studies. Both anterior and posterior circulations of the brain circulations are connected by the posterior communicating arteries (PCOM), which make up the circle of Willis. In the cases of cerebral vascular occlusions, it is the circle of Willis and the collateral circulations that supply blood to the occluded areas. Symptoms associated with PCA strokes vary from anomic aphasia, cognitive and behavioral dysfunctions to severe visual impairments, dysphagia, consciousness and memory alterations and clinically differentiate PCA stroke amongst other cerebrovascular pathology due to variations in the circle of Willis [1,2].

The present study wants to highlight the importance of clinical findings related to anatomical variations in the circle of Willis that could lay at the basis of the development of posterior cerebral artery stroke (PCA stroke), interconnecting them with occupational rehabilitation of such patients.

## Materials and Methods

We did a research of data published over the last 15 years, from several international medical libraries and databases such as Pubmed, Google Scholar, Cambridge Core, using the following specific keywords combination: "circle of Willis, anatomical variants, posterior cerebral artery stroke, cognitive and language disorder", and "posterior cerebral artery stroke, occupational therapy, occupational rehabilitation". A descriptive review was realized describing several types of occupational rehabilitation techniques involved in the case of patients with PCA stroke, considered as a consequence of variations of the circle of Willis.

## Results

In the present study there is a focus on the interrelation between PCA stroke, as part of the posterior circulation of the brain and of the circle of Willis, and the development of clinical cognitive, behavioral, language and speech impairments in patients and their assessment and eventual management, according to clinical outcomes [3,4]. Representing approximately 20% of all ischemic strokes, posterior circulation strokes come in contrast with the anterior circulation one, presenting certain several differences in presenting symptoms, clinical approach and management strategies for the medical specialist [5].

Rare variations of the circle of Willis were revealed by Klimek-Piotrowska et al consisting of atypical findings related to posterior communicating artery (PCOM), anterior communicating artery (AcomA), anterior cerebral artery (ACA), posterior cerebral artery (PCA) and interrelating with the common findings of their study, such as: "bilateral hypoplasia of PcomAs" (27% of cases) and "unilateral hypoplastic PcomAs" (19% of cases) [5].

Jin et al investigated the presence of incomplete posterior circulation as being present in subjects without hypertension at a higher rate than in those with hypertension [6].

Studies conducted by Eftekhari et al examined only male cases, whereas in other studies by Lazorthes et al; Riggs and Rupp; Fisher, the gender ratio was not noted. Additionally, De Silva

et al through a global chi-square test revealed that there were significant variations in the CW among intra and inter-ethnic groups such as Caucasian, African and Asian [1,5].

In PCA strokes there appears a characteristic type of aphasia, consisting in problematic finding of words, named anomic aphasia. The patients maintain a certain degree of fluency in their speeches and use repetitions at a normal degree, preserving a good level of general comprehension. There exists, on the other hand, the possibility of paraphasic mistakes insertion within their speech [7].

Memory and concentration issues, which trigger reading difficulty, are related as well to anomic aphasia and usually consist of short-term memory loss. This fact also involves a slower communication, with difficulties [2].

In an occupational reinsertion and rehabilitation context, in the case of strokes developed at the level of arteries that compose the circle of Willis, there are several case presentations from literature that we wanted to highlight in our study.

Hodgson et al underlined that following stroke the patients must be managed by an interprofessional team including the neurologist, intensive care unit nurses, radiologists, physical therapists, occupational and speech therapists. They aim to bring the patient as close as possible to pre-stroke functioning levels. Depending on the level of neurological deficits at the time of admission the prolonged rehabilitation could be necessary with no guarantee of full recovery [8].

Stultjens et al classified the occupational therapy interventions for stroke patients into training of sensory-motor and cognitive functions, training of skills (e.g. learn to compensate for impairments), education of primary caregivers, provision of splints or slings and advice in the use of assistive devices [9].

Literature data sustain the importance of occupational therapy in rehabilitation of patients after stroke involving medial cerebral artery, too.

Darien described the case of a 71-year-old patient admitted to a skilled nursing facility after subacute right medial cerebral artery infarct. The patient, presented with significant left sided hemiparesis complicated by several comorbidities, received interventions from nursing, occupational therapy, speech therapy and social services. After 35 days of a progressive plan of care the patient increased his independence with bed mobility, transfers between bed and wheelchair, performed wheelchair mobility and his sitting balance and standing tolerance had improved [10].

Aras et al investigate the effect of speech and language therapy in patients with post-stroke aphasia according with artery involvement. The magnetic resonance imaging was used to identify the involved artery and the aphasia assessment was performed with Gülhane Aphasia Test-2. The study included more than 100 patients and prove that speech functions could be better improved in patients with middle cerebral artery involvement compared to patients with anterior or posterior cerebral artery involvements [11].

Miyoshi et al presented the case of a 60-year-old woman with

aphasia on the third day after neck clipping of a ruptured aneurysm at the origin of the duplicated middle cerebral artery. The patient received linguistic rehabilitation for dysnomia and she recovered from the aphasia after 6 months [12].

In the case of patients with PCA stroke, as a possible consequence of variations in the circle of Willis, occupational therapy may play a significant part in the acute phase through interventions such as: positioning and seating, positioning of the upper limb, mobilization techniques, pressure injuries prevention, ADLs by engaging patients into daily living activities for improving their self-care (e.g.: bathing, dressing, the use of linking behaviors-one task at a time focusing), the use of adaptive medical equipment, compensatory techniques for cognitive and visual impairments, shoulder pain assessment and management, offering recommendations on further rehabilitation steps to follow depending on patient's global needs (nursing homes with occupational therapy facilities included, post-acute units/settings or home settings) [13-15].

There are certain language skills that maintain in the case of patients with anomic aphasia: speech articulation, oral reading, writing after dictation and word repetition. A Croatian study published in 2011 by Sinanovic et al highlights the fact that continuous speech therapy plays an important role in the recovery of post stroke aphasias, independently to the type of stroke and sex factors, obtaining better results in younger patients [14].

Within the mentioned Croatian study it is also mentioned that in the case of aphasia, treatment should be initiated as soon as possible because of the period required for speech recovery, and the global neurological rehabilitation of patients [14]. There is evidence in the specialty literature regarding the fact that specific personalized language therapy was a very beneficial factor for aphasic patients with PCA stroke [7,16].

## Conclusion

Although PCA strokes represent rare forms of stroke, this particular type of cerebro-vascular pathology often leads to significant visual, cognitive, language or motor disorders.

Occupational therapy interventions alongside with speech therapy and physiotherapy have often proven beneficial for these patients, by maximizing global physical and mental functions, providing better degrees of independence and autonomy in post-stroke patients. In the case of acute phases and older age, there is recommended that the patients submit to an acute care unit within a medical institution, whereas in the case of younger patients in non-acute phases, a good option would be home disposition. A correct knowledge upon the clinical consequences of anatomical variants of the circle of Willis, in this case, related to PCA stroke, would be very useful not only to surgeons, pathologists and anatomists, but also to bedside clinicians.

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