Coll. Antropol. **34** (2010) 3: 1081–1085
Original scientific paper

Ultrasound Evaluation of Extracranial Carotid Artery Lesions in Parkinsonian Patients

Ivanka Štenc Bradvica[1], Davor Jančuljak[1], Silva Butković-Soldo[1], Ana Marija Mrđen[2], Goran Kondža[3] and Refmir Tadžić[3]

[1] Department of Neurology, Osijek University Hospital Center, Osijek, Croatia
[2] Department of Neurology, Zadar General Hospital, Zadar, Croatia
[3] School of Medicine, Osijek University, Osijek, Croatia

A B S T R A C T

The purpose of this investigation was to determine the atherosclerotic changes in patients with vascular parkinsonism and in patients with idiopathic Parkinson's disease, in order to evaluate the possible influence of the extracranial pathology of carotid arteries in developing lacunar cerebral infarcts. Degree of stenosis and plaque morphology of the extracranial part of carotids in both group of patients were evaluated by color Doppler flow imaging ultrasound investigation and the results were compared. We selected two matched groups of patients with parkinsonism: 22 patients with vascular parkinsonism, and 28 with idiopathic Parkinson's disease.The atherosclerotic changes found in patients with Parkinson's disease showed mild carotid lesions with mostly stable calcified plaques and lesser risk for embolic cerebral intravascular events contrary to the higher degree of carotid stenosis found in patients with vascular parkinsonism with mostly mixed plaques prone to embolization. Therefore, we suggest performing ultrasonographic examination of the extracranial part of carotid arteries in all patients with parkinsonism to assess risk of vascular accidents originating from carotid lesions. That would enable adequate treatment of parkinsonism and prevent further occurrence of intracranial vascular changes.

Key words: *vascular parkinsonism, Parkinson's disease, atherosclerosclerotic changes, plaque morphology, color Doppler ultrasonography*

Introduction

Vascular parkinsonism is characterized by sudden onset and rapid progression of clinical symptoms, absence or poor response to substitute therapy, postural instability with a shuffling gait and absence of tremor[1]. It is a clinically different entity from idiopathic Parkinson's disease. The term vascular parkinsonism was introduced by Critchley in 1929, who at first called it »atherosclerotic parkinsonism«[2].

Patients who suffer from idiopathic parkinsonism are not expected to have obvious atherosclerotic changes on extracranial and intracranial blood vessels, except for asymptomatic changes which can be present in the general population.

Nakaso et al. reported a mild hypertrophy of the intima-media thickness of the carotid artery, which has been established as a marker for systemic atherosclerosis, in Parkinson's disease patients compared with normal subjects[3]. These changes were primarily detected in patients treated with L-dopa for a longer period of time and in patients with an elevated homocysteine level in plasma connected with a certain genotype.

Atherosclerosis is a well known risk factor for development of cerebrovascular disease and intracranial cerebral pathology such as lacunar infarcts, present in patients with vascular parkinsonism, or may cause even greater territorial ischemic stroke[4–7].

Patients with vascular parkinsonism are expected to have atherosclerotic changes on extracranial part of carotids contributing the developing of intracranial pathology such as basal ganglia lacunar infarcts[4].

Received for publication May 12, 2010

Vascular pathology was proved whereas the finding in the substantia nigra was normal thereby excluding idiopathic parkinsonism[8–10]. Results of some clinical and epidemiological studies have not revealed significant differences in the incidence of atherosclerosis between Parkinson's disease patients and general population[11]. These authors investigated possible cerebral hemodynamic alteration in patients with Parkinson's disease in assessing with extracranial Doppler ultrasonography where no significant differences with healthy controls were found.

CT and MR are methods used for detection cerebral anomalies which can cause symptoms of parkinsonism, such as hydrocephalus, subdural haemathoma, cerebral neoplasm and multiple cerebral infarcts[12].

Many cases described in literature confirm that cerebrovascular lesions correlate to parkinsonian signs[13,14]. These studies point out rapid onset, poor response to L-dopa therapy and sometimes reversibility of motor symptomatology.

At present, there is a relatively small number of published papers on atherosclerotic changes on the extracranial part of carotids in patients with a clinical picture of parkinsonism.

For now it is still uncertain whether, and to what extent, cerebrovascular lesions influence the symptomatology of parkinsonism, in particular if present in basal ganglia. Therefore, it is important to determine the influence of vascular lesions to the development of parkinsonism and to determine the type of atherosclerotic changes on extracranial vessels.

The purpose of this investigation was to determine whether the morphology of atherosclerotic changes on extracranial carotid arteries and the degree of stenosis present in patients with vascular parkinsonism and patients with Parkinson's disease differ and influences the intracranial vascular pathology.

Patients and methods

Fifty patients of both genders with symptoms of parkinsonism have been involved in the study, all of them older than 40 years who were treated and monitored in the Outpatient Clinic for Extrapyramidal Disorders at the Department of Neurology, Clinical Hospital Center in Osijek.

The patients were divided into two groups: patients with vascular parkinsonism and patients with idiopathic Parkinson's disease.

A Color Doppler examination was performed using the Aloka Color Doppler with an ultrasound linear probe**,** frequency ranging from 5 to 10 MHz which was placed on the patient's neck, laterally from thyroid lobes. During the examination, the patient is on his back and his neck is hyperextended. Every patient had ultrasound examination in B mode first and then colored and duplex Doppler flow imaging and quantification of spectral imaging in order to detect the presence of stenosis of carotid internal artery and the level of damage.

Early carotid lesion was assessed through the measurement of intimomedial thickness (IMT) of the common carotid artery 1cm proximal to the carotid bulb on the far wall.

To evaluate the stenosis doppler criteria used in our ultrasound laboratory we used the criteria proposed from the relevant ultrasound laboratory at the Clinical Hospital Center in Zagreb, » Sestre milosrdnice«[15].

Criteria for mild stenosis (at least two)

- systolic lumen reduction ≤ 50%
- Systolic blood flow velocity (BFV) ≤ 120–170cm/s
- BFV internal carotid artery (ICA)/ BFV common carotid artery (CCA) ≤ 1.8

Criteria for moderate stenosis(at least two)

- systolic lumen reduction 51–75%
- systolic BFV ≤ 171–299cm/s
- BFV ICA/BFV CCA 1,9–3,9

Criteria for severe stenosis (at least two)

- systolic lumen reduction ≥ 75%
- systolic BFV > 300 cm/s
- BFV ICA/BFV CCA ≥ 4
- Inverse circulation in the ophthalmic artery

Criteria for pseudooclusion (at least two)

- systolic lumen reduction ≥ 95%
- systolic BFV < 0.5 m/s
- absence of diastolic flow

Criteria for occlusion

- lumen filled with plaques
- absence of colour coded flow and power doppler colour coded flow

Criteria for intracranial carotid occlusion

- color coded and power Doppler flow in the whole lumen
- systolic BFV ≤ 0.5 m/s
- absence of diastolic flow

The sonographer was blinded to the diagnosis of the patients in order to avoid expectation bias.

Statistical methods used are the chi-square test and theYates' correction factor. Statistically significant difference was taken at $p < 0.01$. In cases of several types of pathological findings in a patient, the most severe finding in case of stenosis and the most frequent in plaque detection regardless of whether it is the right, or left carotid tree, was taken.

Results

A group of 50 patients was divided into two subgroups, according to the clinical picture and performed neuroradiological examinations like computed tomography (CT) or magnetic resonance (MR). Out of 50 patients with signs of parkinsonism, 28 (56%) suffered from the idiopathic type, out of whom 17 (61%) men and 11 (39%)

women, whereas 22 (44%) patients suffered from the vascular type and thus 10 (45%) men and 12 (55%) women.

Using the χ^2-test, no statistically significant difference in age between the two subgroups (χ^2-test, p=0.771), and sex (χ^2-test, p=0.285) were found, so therefore they were suitable for comparison.

The majority of men who suffer from idiopathic (42%) and vascular parkinsonism (40%) were 70–79 years old. The majority of women who suffer from idiopathic parkinsonism (64%) and vascular parkinsonism (42%) were 60–69 years old.

In further analyses we compared normal and pathological findings on the extracranial arteries between the groups of patients. The results are shown in Table 1.

When comparing the pathological findings on the extracranial part of carotids in patients with idiopathic parkinsonism and vascular parkinsonism, we found a high percentage of patients with a pathological finding on carotids in both groups, in particular in those with vascular parkinsonism 22 (100%).

There is also a significant number of pathological findings on the extracranial part of carotids in patients who suffer from Parkinson's disease, 22 (79%) patients.

A statistically significant difference was found between pathological and negative findings (χ^2-test, p=0,024).

Analysing the distribution of the pathological findings by CDFI according to age within individual groups we have obtained the following results shown on Figure 1.

Our data show that, in both groups of patients, the frequency of pathological findings on extracranial arteries is proportional to age. They are most frequent in patients at the age of 60 to 69 (idiopathic parkinsonism, 10 (45,5%) and vascular parkinsonism 7 (31,8%) patients), and in those who are 70–79 years of age (idiopathic parkinsonism 10 (45,5%) and vascular parkinsonism 8 (36,4%) patients).

Age distribution of pathological findings in the two subgroups is not statistically significant (χ^2-test, p=0,422).

The pathological atherosclerotic changes on the extracranial arteries like the stenosis degree and plaque morphology we found are presented in Table 2. and Table 3.

Our data suggest that 54% of patients with Parkinson's disease have the mildest atherosclerotic changes on

TABLE 1
FREQUENCY OF PATHOLOGICAL FINDINGS ON THE EXTRACRANIAL PART OF CAROTID ARTERIES IN PATIENTS WITH IDIOPATHIC AND VASCULAR PARKINSONISM

	Parkinsonism		Total N (%	p*
	Idiopathic	Vascular		
	N (%)	N (%)		
Normal finding	6 (21)	0	6 (12)	0.024
Pathological finding	22 (79)	22 (100)	44 (88)	
Total	28 (100)	22 (100)	50 (100)	

*χ^2-test

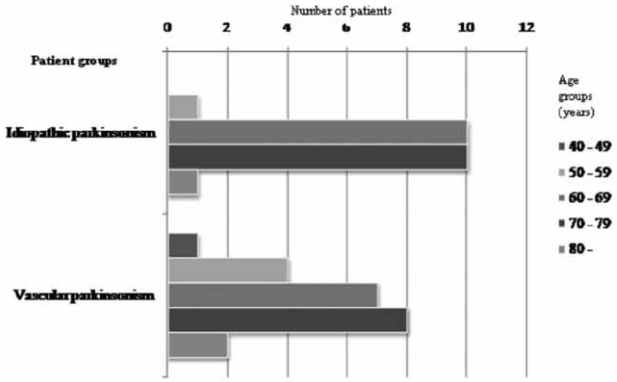

Fig.1. Age distribution of parkinsonian patients with pathological findings on carotid arteries demonstrated by color doppler flow imaging.

the extracranial arteries in the form of the early carotid lesions. No cases of severe stenosis or occlusion were detected (Table 2).

Comparison of the stenosis degree on carotids in patients who suffer from idiopathic parkinsonism with the changes in patients with vascular parkinsonism shows a statistically significant difference (χ^2 test, p<0,001). When comparing stenosis degree in patients with vascular parkinsonism and the idiopathic parkinsonism, the results suggest a greater frequency of mild stenosis in 18 (82%) patients with vascular parkinsonism, and early carotid lesion in 15 (68%) patients with idiopathic parkinsonism. There was no case of severe stenosis or occlusion detected.

We studied the plaque characteristics in patients with idiopathic and vacular parkinsonism (Table 3).

In patients with idiopathic parkinsonism calcified plaques were detected in 64% of the cases. Mixed plaques

TABLE 2
FREQUENCY OF PATHOLOGICAL FINDINGS CDFI DEPENDING ON THE STENOSIS DEGREE IN THE GROUP OF PATIENTS WITH IDIOPATHIC AND VASCULAR PARKINSONISM

Stenosis degree	Parkinsonism		Total	p*
	Idiopathic	Vascular		
	N (%)	N (%)	N(%)	
Early carotid lesion	15 (68)	2 (9)	17 (39)	<0.001
Mild stenosis	5 (23)	18 (82)	23 (52)	
Moderate stenosis	2 (9)	2 (9)	4 (9)	
Severe stenosis	0	0	0	
Occlusion	0	0	0	
Total pathological findings	22 (100)	22 (100)	44 (100)	
Negative findings	6 (100)	0	6 (100)	
Total	28 (100)	22 (100)	50 (100)	

*χ^2-test

TABLE 3
OCCURRENCE OF PLAQUES IN PATIENTS WITH IDIOPATHIC PARKINSONISM AND VASCULAR PARKINSONISM

Plaque morphology	Parkinsonism		Total	p*
	Idiopathic	Vascular		
	N (%)	N (%)	N(%)	
Predominantly calcified plaque	18 (64)	6 (27)	24 (48)	<0,001
Mixed plaque	4 (14)	14 (64)	18 (36)	
Predominantly soft plaque	0	2 (9)	2 (4)	
Summary	22 (78)	22 (100)	44 (88)	
No pathology	6 (21)	0	6 (12)	
Total	28 (100)	22 (100)	50 (100)	

*χ^2-test

were found in 14% of the cases. None of the patients in this subgroup had prevalently soft plaques.

Statistically significant difference was proved between the occurrence and plaque characteristics on the extracranial part of carotids between patients with idiopathic parkinsonism and patients with vascular parkinsonism (χ^2 test, $p<0,001$).

In patients who suffer from Parkinson's disease mostly stable and calcified atherosclerotic plaques were found.

When comparing characteristics of plaques in patients with vascular parkinsonism we noted that they had mostly mixed plaques in 14 (64%) patients, calcified plaques were found in only 6 (27%) patients with and soft plaques were found in 2 (9%) of the cases. Patients with idiopathic parkinsonism had mostly predominantly calcified plaque in 18 (64%) of the cases.

Discussion

Parkinson's disease is a neurodegenerative disorder with a pathophysiological basis of absence of L-dopa in substantia nigra. According to the most recent studies the changes occur also in the peripheral autonomic nervous system and these have been studied intensively[16].

Patients with early parkinsonian signs have mostly idiopathic form of disease, and only a small number of patients in that group have vascular or atherosclerotic parkinsonism.

They are characterized with morphological substrate of multiple lacunar infarctions, localized mostly in the basal ganglia, although they can occur in the frontal lobes and in the deep subcortical white matter [17–20].

Stenosis in the extracranial part of carotid arteries has been confirmed as a risk factor for developing intracranial cerebrovascular pathology[5–7,21]. Cerebrovascular diseases and their consequences, including vascular parkinsonism, are the third mortality cause in the world, but in Croatia, especially in our region of eastern part of Croatia, cerebrovascular diseases are the leading cause of mortality[22].

A certain percentage of the general population has prevalently asymptomatic carotid disease[7,23–25]. With regard to that we also expected that our patients with Parkinson's disease would have certain pathological changes on the extracranial part of carotid arteries.

Our research has shown a slightly higher percentage of pathological but non-symptomatic findings in patients with idiopathic Parkinson disease mainly detected as higher IMT values on common carotid artery, which could be a consequence of long term L-dopa therapy[3].

In another study no significant differences in Doppler parameters of carotid arteries were found between idiopathic parkinsonism patients and matched controls[11].

A special attention has been paid to the plaques present in the extracranial part of carotids in patients with Parkinson's disease. Most of our patients had predominantly calcified plaques which do not result in high-degree stenosis. Compared to the findings of Rektor et al. we found in our group of idiopathic Parkinsonian patients greater presence atherosclerotic plaques than they did[26]. However, calcified atherosclerotic plaques,also called stable plaques because of lower tendency to bleeding into plaque, are good prognostic factor for lower cerebral embolism incidence in idiopathic form of Parkinson's disease.

Patients with vascular parkinsonism have different pattern of atherosclerotic changes on carotid arteries. In 18 of our patients with vascular parkinsonism we detected mild degree of carotid stenosis and 14 (64%) patients had mixed plaques prone to cerebral embolism. That ultrasonographic findings correspond well to the neuroradiological and clinical findings in patients with vascular parkinsonism.

Conclusion

Parkinson's disease is a neurodegenerative disorder which, despite adequate therapy, progresses and results in patient's disability. Therefore, it is important in a group of patients with symptoms of parkinsonism to detect those who suffer from a secondary, vascular, type in order to slow down the development of multiple infarctions of lacunar type.

If the pathology on the extracranial part of carotids were detected on time, we could prevent further progression of cerebrovascular pathology and the clinical signs in patients who suffer from idiopathic parkinsonism could be milder.

On the basis of these findings we conclude that atherosclerotic changes on the extracranial part of carotid arteries are very important predictor of intracranial cerebrovascular pathology. Therefore, ultrasonographic diagnostics and detection of plaque morphology and stenosis degree in all patients with symptoms of parkinsonism is necessary in case of both idiopathic and vascular type.

REFERENCES

1. TANNER CM, HUBBLE JP, CHAN P, Epidemiology and genetics of Parkinson´s disease in: WATTS L.R., KOLLER C.W. Movement disorders Neurologic Principles and Practise. (New York: Mc Graw-Hill, 1997) 137. — 2. CRITCHLEY M, Brain, 52 (1929) 23. — 3. NAKASO K, YASUI K, KOWA H, KUSUMI M, UEDA K, YOSHIMOTO Y, TAKESHIMA T, SASAKI K, NAKASHIMA K, J Neurol Sci, 207 (2003) 19. — 4. SIBON I, TISON F, Curr Opin Neurol, 17 (2004) 49. — 5. LOVRENČIĆ-HUZJAN A, BOSNAR M, HUZJAN R, DEMARIN V, Acta clin Croat, 38 (1999) 159. — 6. DEMARIN V, ŠERIĆ V, TRKANJEC Z, Medix, 37/38 (2001) 40. — 7. FABRIS P, ZANOCCHI M, BO M, FONTE G, POLI L, BERGOGLIO I, FERRARIO E, PERNIGOTTI L, Stroke, 25 (1994) 1133. — 8. JELLINGER K, Acta Neurol Scand, 105 (2002) 414. — 9. MARK MH, SAGE R, WALTERS AS, DUVIOSIN RD, MILLER DC, Mov Disord, 10 (1995) 450. — 10. HUGHES AJ, DANIEL SS, KILFORD L, J Neurol Neurosurg Psychiatry, 55 (1992) 181. — 11. HAKTANIR A, YAMAN M, ACAR M, GECICI O, DEMIREL R, ALBAYRAK R, DEMIRKIRKAN K, Neurosci Lett, 391 (2006) 131. — 12. YAMANOUCHI H, NAGURA H, Stroke, 28 (1997) 965. — 13. SCIGLIANO G, MUSICCO M, SOLIVERI P, GIRROTI F, GIOVANNINI P, FETONI V, CARACENI T, Advan Neurol, 69 (1996) 305. — 14. WINIKATES J, JANKOVIC J, Arch Neurol, 56 (1999) 98. — 15. DEMARIN V, LOVRENČIĆ-HUZJAN A, et al, Neurosonologija (Školska knjiga dd, Zagreb, 2009). — 16. STACY M, JANKOVIĆ J, Neurol Clin, 10 (2) (1992) 341. — 17. ZIJLMANS JCM, THIJSSEN HOM., VOGELS OJM, KREMER HPH, PHOELS PJE, SCHOONDERWALDT HC, MERX JL, VAN 'T HOF MA, THIEN TH, HORSTINK MWIM, Neurology, 45 (1995) 2183. — 18. REIDER-GROSWASSER I, BORNSTEIN NM, KORCZYN AD, Eur Neurol, 35 (1995) 46. — 19. INZELBERG R, BORNSTEIN NM, REIDER I, KORCZYN AD, Neuroepidemiology, 13 (1994) 108. — 20. MURROW RW, SCHWEIGER GD, KEPES JJ, KOLLER WC, Neurology, 40 (1990) 897. — 21. HORNER S, NIEDERKORN K, NI XS, FISHER R, FAZEKAS F, SCHMIDT R, DUFT M, Nervenartzt, 68 (1997) 967. — 22. DEMARIN V, LOVRENČIĆ-HUZJAN A, ŠERIĆ V, VARGEK-SOLTER V, TRKANJEC Z, VUKOVIĆ V, LUPRET V, KALOUSEK M, DE SYO D, KADOJIĆ D, LUŠIĆ I, DIKANOVIĆ M, VITAS M, Acta clin Croat, 40 (2001) 127. — 23. PRATI P, VANUZZO D, CASAROLI M, CHIARA A, BIASI F, FERUGLIO GA, TOUBOUL PJ, Stroke, 23 (1992) 1705. — 24. GOSTOMZYK JG, HELLER WD, GERHARDT P, LEE PN, KEIL U. Klin Wochenschr, 66 (suppl XI) (1988) 58. — 25. MANNAMI T., KONISHI M, BABA S, NISHI N, TERAO A, Stroke, 28 (1997) 518. — 26. REKTOR I, GOLDEMUND D, SHEARDOVA K, REKTOROVA I, MICHALKOVA Z, DUFEK M, Parkinson Relat D,15 (2009) 24.

I. Štenc Bradvica

Department of Neurology, Osijek University Hospital Center, Huttlerova 4, 31000 Osijek, Croatia
e-mail: mario.bradvica@vip.hr

ULTRAZVUČNA PROCJENA OŠTEĆENJA EKSTRAKRANIJSKIH KAROTIDNIH ARTERIJA U BOLESNIKA S PARKINSONIZMOM

SAŽETAK

Svrha ovoga istraživanja bila je ispitati aterosklerotske promjene u bolesnika s vaskularnim parkinsonizmom i idiopatskom Parkinsonovom bolešću da bi se procijenio mogući utjecaj patologije ekstrakranijskih karotidnih arterija na nastanak lakunarnih moždanih infarkta. Stupanj stenoze i morfologija plakova u ekstrakranijskim dijelovima karotida ispitani su usporedbom rezultata u obje grupe bolesnika pomoću pretrage obojenog Doppler ultrazvučnog prikaza. Odabrali smo dvije usporedive skupine bolesnika s parkinsonizmom: 22 bolesnika s vaskularnim parkinsonizmom i 28 sa idioptskom Parkinsonovom bolešću. Aterosklerotske promjene u bolesnika sa Parkinsnovom bolešću pokazale su blaža oštećenja karotida sa većinom stabilnim kalcificiranim plakom i manjim rizikom za embolijski moždani intravaskularni događaj, nasuprot višem stupnju karotidne stenoze u bolesnika s vaskularnim parkinsonizmom s većinom mješovitim plakovima koji su skloniji embolizaciji. Stoga, smatramo da je svim bolesnicima s parkinsonizmom potrebno učiniti ultrazvučno ispitivanje karotidnih arterija da bi se procijenio rizik vaskularnih akcidenata koji potječu iz oštećenja karotidnih arterija. To bi doprinijelo adekvatnom liječenju parkinsonizma i spriječilo nastanak promjena u intrakranijskim krvnim žilama.