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Ahmed El-Bassiouny
Ain Shams University

Ayman Nassef
Ain Shams University

Eman Awad
Ain Shams University

Hossam Eldin Afify
Ain Shams University

Mohamed A. Shafik
Ain Shams University

See next page for additional authors

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Endovascular management of medically refractory intracranial arterial stenosis

Authors

Ahmed El-Bassiouny, Ayman Nassef, Eman Awad, Hossam Eldin Afify, Mohamed A. Shafik, and Romany A. Yousef

Original Article

Endovascular management of medically refractory intracranial arterial stenosis

Ayman Nassef[a], Eman Awad[a], Ahmed El-Bassiouny[a], Hossam Eldin Afify[a], Mohamed A. Shafik[a], Romany A. Yousef[b]

[a]Department of Neurology, Faculty of Medicine, Ain Shams University, [b]Department of Neurology, El Mataria Teaching Hospital, Cairo, Egypt

Abstract

Background

Despite aggressive medical therapy, the risk of recurrent stroke in patients with symptomatic intracranial arterial (ICA) disease is as high as 15% per year. In patients with severe stenosis (>70%) and in certain high-risk groups, the risk of recurrent stroke has been reported to be as high as 25% per year.

Objective

Our study aimed to follow-up the patients after ICA stenting by using transcranial duplex (TCD).

Patients and methods

This is a retrospective single-center study carried out on data of patients recruited to Neurovascular Unit of El Mataria Teaching Hospital during the period from June 2015 to June 2016. A total of 25 patients were enrolled. TCD before and after stenting data were collected from the patients' files.

Results

Our study showed significant decreased in mean flow velocity and percent of stenosis after intracranial stenting.

Conclusion

Our study concluded that TCD is a good method for follow-up of patients after ICA stenting.

Keywords: Intracranial arterial stenosis, mean flow velocity, stenting

Introduction

Transcranial duplex (TCD) measures blood flow velocity and direction in the major intracerebral arteries distal to the carotid arteries [1]. Several TCD findings have been highly associated with critical carotid stenosis such as reduced ipsilateral middle cerebral artery flow velocity and development of collateral flow patterns, as reversed flow in the ipsilateral anterior cerebral artery or augmented flow velocity in the contralateral anterior cerebral artery suggests collateral flow from the contralateral intracranial arterial (ICA), and reversed flow in the ipsilateral ophthalmic artery implies collateral flow from the external carotid artery to the ICA. The use of TCD can also be extended to detect middle cerebral artery microemboli stemming [2].

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Although recent advances in ultrasonographic evaluation of plaques are promising, different ultrasound scan studies have varied widely in both sensitivity and specificity for determining plaque morphology and other stroke etiologies. Currently, it seems that the ability of ultrasound scan to predict signs of vulnerability in the preoperative phase is limited. New computer-assisted image analysis software is being introduced that should improve this technique's accuracy [2].

Because transcranial Doppler ultrasound is noninvasive, it is a promising alternative to cerebral angiography for the

Correspondence to: Romany A. Yousef, MS.c, 16 Ibrahiam Nagy ST -Shoubra _ Cairo 11672, Egypt, Fax: 01281377190, Tel: 002022209248. E-mail: romanykingdom@yahoo.com

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evaluation of the collateral supply. To determine the accuracy of TCD for evaluation of the collateral supply [3].

The TCD has been recommended by the American Association of Neurology for the evaluation of the collateral pathways in the condition of an ICA occlusion [4]. The great advantage of TCD is its noninvasiveness and its ability for repeated examinations without any risk to patients' health. The major disadvantage of TCD is its dependence on the temporal and nuchal bone windows, which are more frequently absent in women and older patients than in men and younger patients, and its dependence on the experience of the examiner. An adequate temporal bone window usually will be found in ~90% of the patients, but the transnuchal approach to the Basilar Artery is able to be used in only 70% of the patients [5]. The newly introduced color-coded TCD ultrasound can help to locate the bone windows more quickly but is also restricted principally to the limitations mentioned previously. A patent anterior communicating artery (ACoA) can easily be shown by TCD, even without compression tests. The results confirm those of previous studies that found for the TCD, as compared with angiography, a sensitivity between 84 and 94% and a specificity of 92% for the evaluation of the collateral flow through the anterior part of the circle of Willis [6].

Aim of the work

Our study aimed to follow-up the patients after ICA stenting by using TCD.

Patients and methods

This is a retrospective single-center study carried out on data of patients recruited to Neurovascular Unit of El Mataria Teaching Hospital during the period from June 2015 to June 2016. A total of 25 patients were enrolled. TCD before and after stenting data were collected from the patients' files.

Methods

All the collected patients' data from the files were as follows:

(1) Full history taking, including family history of stroke, past history of any risk factor, and history of present illness.
(2) Clinical assessment.
(3) Laboratory investigations including complete blood count, liver and renal function tests, prothrombin time, partial thromboplastin time, blood sugar level, glycated hemoglobin, and lipid profile.
(4) ECG, transthoracic echocardiography, or transesophageal echocardiography as clinically indicated.
(5) Transcranial Doppler by Zaho *et al*. (2011) criteria before and after 3 months of stenting [7].

Statistical analysis

(1) The collected data were revised, coded, tabulated, and introduced to a PC using Statistical Package for the Social Science (IBM Corp. Released 2011, IBM SPSS Statistics for Windows, Version 20.0.;IBM Corp. Armonk, New York, USA). Data were presented, and suitable analysis was done according to the type of data obtained for each parameter.
(2) Descriptive statistics:
   (a) Mean, SD, and range for parametric numerical data, whereas median and interquartile range for nonparametric numerical data.
   (b) Frequency and percentage of nonnumerical data.
(3) Analytical statistics:
   (a) Student's *t* test was used to assess the statistical significance of the difference between the means of two study groups.
   (b) Mann–Whitney test (*U* test) was used to assess the statistical significance of the difference of a nonparametric variable between two study groups.
   (c) χ^2 test was used to examine the relationship between two qualitative variables.
   (d) Fisher's exact test was used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells.
   (e) Wilcoxon's signed rank test was used to assess the statistical significance of the difference of an ordinal variable (score) measured twice for the same study group.
   (f) McNemar test was used assess the statistical significance of the difference between paired qualitative variable.

Level of significance was as follows:

(1) *P* value more than 0.05: nonsignificant.
(2) *P* value less than 0.05: significant.
(3) *P* value less than 0.01: highly significant.

Results

Demographic data and risk factors of patients

The intervention group included 17 (68%) females and eight (32%) males. The age of the patients ranged from 49 to 73 years, with a mean age of 58.4 ± 6.78 years. The age and sex characteristics of the study cases are shown in Table 1.

Regarding the risk factors, 14 (56%) cases were smokers, 18 (72%) cases were diabetic, 20 (80%) cases were hypertensive, six (24%) cases had heart disease, 10 (40%) cases had dyslipidemia, 15 (60%) cases had previous transient ischemic attack, 12 (48%) cases had one previous stroke,

Table 1: Age and sex characteristics of all cases

	Mean±SD
Age	58.40±6.78
Sex [*n* (%)]	
Female	17 (68.0)
Male	8 (32.0)

11 (44%) cases had two previous stroke, two (8%) cases had more than two previous stroke in the same stenotic territories, and no cases were known to be alcoholics or drug addicts. All these data are demonstrated in Table 2.

Regarding mean flow velocity before stenting, the mean was 122.55 m/s with SD 33.52, and after 3 months of stenting, it became 77.94 m/s with SD of 35.11, as shown in Table 3, which mean that the mean decreased after intervention.

Regarding percent of stenosis, 19 (86%) cases had more than 70% stenosis and three (13.6%) cases had less than 70% stenosis before intervention, but after 3 months of intervention, 11 (64.7%) cases became within normal, five (29.4%) cases had less than 70% stenosis and one (5.9%) case had more than 70% stenosis.

Regarding the change of percent of stenosis among the cases in 3 months, no change occurred in four (23.5%) cases, the percent decreased in 11 (64.7%) cases, and the percent increased in two (11.8%) cases. These data are demonstrated in Table 4.

Discussion

Because transcranial Doppler ultrasound is noninvasive, it is a promising alternative to cerebral angiography for the evaluation of the collateral supply. To determine the accuracy of TCD for evaluation of the collateral supply [3].

The current study aimed to follow-up the patients after ICA stenting by using TCD.

The current study revealed that females were more prevalent in our retrospective study (17/25, 68%) (Table 1), which is against what is reported in a previous study [8], which found male patients represented 62% among self-expandable stent group and 87% among balloon expandable stent.

The current study revealed that the mean age of our patients was 58.40 years (Table 1), which is younger than patients in a previous study, in which the mean age among intervention group was 61 years [9].

The current study revealed that transient ischemic attack was the most prevalent risk factor (32/50, 64%) (Table 2).

All patients were assessed by TCD according to the Zaho criteria. Regarding percent of stenosis, 86% (19/25) of patients had more than 70% and were symptomatic, and 14% (6/25) of the patients had less than 70% stenosis.

Regarding mean flow velocity at baseline before stenting, the mean was 122.55 m/s with SD of 33.52, and after 3 months of stenting, it became 77.94 m/s, with SD of 35.11, as shown in Table 3, which mean that the mean decreased after stenting.

For the TCD checking, Luo *et al.* [10] found that the sensitivity of TCD in detecting ischemic cerebrovascular disease was 82.3%, which was comparable to that of DA.

Our study is in general agreement with previous studies that validated various blood flow velocity criteria for intracranial stenoses [11]. The SONIA trial evaluated the performance of TCD against invasive angiography for identification of more than or equal to 50% intracranial stenosis [12].

Table 2: Distribution and stratification of the risk factors

	n (%)
Smoking	
No	11 (44.0)
Yes	14 (56.0)
Alcohol	
No	25 (100.0)
Yes	0 (0.0)
Drug addict	
No	25 (100.0)
Yes	0 (0.0)
DM	
No	7 (28.0)
Yes	18 (72.0)
HTN	
No	5 (20.0)
Yes	20 (80.0)
Previous TIA	
No	10 (40.0)
Yes	15 (60.0)
Cardiac	
No	19 (76.0)
Yes	6 (24.0)
Dyslipidemia	
No	15 (60.0)
Yes	10 (40.0)
Number of previous stroke	
Once	12 (48.0)
Twice	11 (44.0)
>Twice	2 (8.0)

DM, diabetes mellitus; HTN, hypertension; TIA, transient ischemic attack

Table 3: Mean flow velocity before and after stenting

	Mean±SD	Minimum	Maximum
MFV at baseline	122.55±33.52	18.00	200.00
MFV at 3 months	77.94±35.11	50.00	200.00

MFV, mean flow velocity.

Table 4: Percent of stenosis before and after intervention according to Zaho criteria

	n (%)
Percent of stenosis before intervention	
<70%	3 (13.6)
>70%	19 (86.4)
Percent of stenosis after 3 months of intervention	
Within normal	11 (64.7)
<70%	5 (29.4)
>70%	1 (5.9)
Change in percent of stenosis	
No change	4 (23.5)
Decreased	11 (64.7)
Increased	2 (11.8)

Our study has some limitations. First, although we had four tertiary care academic centers, our study is limited by a relatively small number of patients, and at the moment, we cannot provide accuracy data for vessels such as internal carotid artery, anterior cerebral artery, and posterior cerebral artery. Second, we did not perform DSA in all patients with stroke who had TCD and the decision-making management to perform DSA could have been influenced by TCD results.

Conclusion

At the end of this study, we can conclude that TCD was reliable to follow-up patients with ICA stenting.

Recommendations

(1) Early detection of ICA stenosis in clinically suspected patients who present with recurrent stroke at the same arterial territory should be done through TCD.
(2) Regular follow-up should be done to control the vascular risk factors and achieve an ideal BMI with encouragement of physical activity to prevent the progression of ICA stenting.

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Conflicts of interest

There are no conflicts of interest.

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