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Assessment of Cerebral Collaterals in Acute Ischemic Stroke by CT Cerebral Angiography and Its Relation to the Functional Outcome

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THIS STUDY aims at evaluating the relationship between the state of cerebral collateral blood vessels and the functional outcome of patients with acute ischemic stroke with or without thrombolytic therapy. The study was carried out in the inpatient sector of the neurology department at Ain Shams University hospitals. A sample of 30 patients with acute ischemic stroke was collected and CT cerebral angiography was done to assess the clot burden score and the collateral score. MRI stroke protocol was performed to assess the structural collaterals through diffusion weighted image, FLAIR, NIH, and MRS. There was a statistical significant difference between stroke patients who received treatment and patients who did not receive traetment in relation to collateral score, clotting burden score, modified Rankin scale after three months, onset by hours and door to needle. Computed tomography angiography and MRA played an important role in the assessment of the collateral blood vessels, clot burden score, infract volume and also predicted the need for recombinant tissue plasminogen activator (rtPA) and the degree of improvement. There was a significant correlation between the modified Rankin scale and the clotting burden scale, the collateral scale and the infract volume. Patients with good NIH score and MRS show a higher level of improvement. It could be concluded that the collateral status as assessed by CTA is considered an excellent predictor of a favorable functional outcome in acute ischemic stroke patients. Patients with good collateral status will benefit from recanalization and patients with poor collaterals likely will not benefit even when recanalization occurs.

Keywords: Cerebral collaterals, Acute ischemic stroke**,** CT cerebral angiography.

Introduction

Stroke is the second most common cause of death in the world. It ranks the sixth in disease burden and is expected to rise to the fourth by 2020. For middle-income countries, this cerebrovascular disease is the first leading cause of death and the third leading cause for disease burden (Hokmabadi et al., 2016).

Ischemia is the main cause of stroke, typically due to the occlusion of a cerebral artery as a result of progressive atherosclerosis or an embolus from the heart or neck vessels (Truelsen et al., 2006). In some patients the blockage or occlusion can develop within small intracranial vessels, often because of uncontrolled hypertension or diabetes (Adams et al., 1993). Irrespective of the cause or mechanism of ischemia, collateral flow "i.e, perfusion via alternative or indirect pathways" might off set potential injury to the brain (Liebeskind, 2007).

In the setting of acute ischemic stroke, the extent of collateral circulation influences the size of the final infarct and the growth of the penumbra. Hence, the relationship between the collateralization grade and the predictability of infarct evolution has been a primary focus in recent years (Verma et al., 2015).

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Many factors impact the success of recanalization, including clot composition, thrombolytic technique, extent of clot burden, site of clot impaction, and collateral supply. More proximal and increased clot length is harder to treat, leading to a worse outcome compared with a shorter distal clot. Patients with a hyper-attenuated middle cerebral artery (MCA) sign, essentially a marker of proximally located thrombus, have been shown to have a larger final infarct volume and worse functional outcome. Tandem internal carotid artery (ICA)/MCA occlusions have lower early recanalization and early neurologic improvement rates compared with isolated MCA occlusion (Nave et al., 2018).

Persistent anterior cerebral circulation occlusion is one of the most devastating clinical events, often causing severe neurologic deficit or death. The current stroke strategy focuses on recanalization as one of the most important factors to reduce tissue at risk and reverse neurologic deficits. (Kim et al., 2017).

Older perfusion measurement techniques suffered from a lack of speed, resolution, ability to accurately quantify perfusion, and reproducibility of blood flow values. With the development of helical and spiral computed tomography (CT) and echo-planar magnetic resonance (MR) imaging. Very rapid imaging techniques that make it possible to rapidly follow a bolus of contrast material or image a large area of the brain are available now, thereby increasing the accuracy and applicability of these techniques (Latchaw et al., 2003).

Additionally, in the last decade, several clinical trials have investigated the effects of endovascular treatment in the setting of an intracranial or extra cranial large artery occlusion. Several studies, recently proved that endovascular treatment is more effective than the standard medical care, with or without intravenous thrombolysis (Martins et al., 2012). Among these patient specific characteristics, collateral status has emerged as an independent factor that is associated with angiographic and clinical outcomes in acute ischemic stroke patients (Liebeskind et al., 2014).

Digital subtraction angiography has been used to identify collateral vessels in patients with acute stroke, but because of its invasive nature it has not gained popularity. Newer imaging techniques, especially multimodal cranial CT scans, can assist with identification of pial collaterals. Evidence is emerging that this information could help to improve long-term prognosis. Additionally, patients with good collaterals might respond better to reperfusion therapy and have a lower risk of hemorrhagic complications from such treatments than do other patients (Miteff et al., 2009).

Although the effects of clot burden have been indirectly examined via the hyperattenuated arterial sign on noncontrast CT (NCCT) and directly via conventional angiographic studies, these have only recently been assessed and quantified with CT Angiography (CTA). Many clinical and radiologic variables impact the decision for thrombolysis and route of administration. Treatment decisions need to be made rapidly due to the narrow therapeutic window. CTA is widely available and provides a rapid assessment of many of the variables needed to make these decisions. CTA improves infarct depiction and delineation and provides a noninvasive assessment of cervical and intracranial circulation (Vagal et al., 2016).

Conventional angiographic evaluation has advantages, including its reliable demonstration of occlusion vs. subtotal occlusion, well standardized recanalization grading, and high resolution visualization of leptomeningeal collaterals (Higashida et al., 2003). However, it has several limitations such as being invasive, requires more expertise and time to perform and carries a small risk of thrombotic events. Second, the results of angiographic collateral studies would mostly be incomplete (e.g., not including the venous phase, no contralateral or vertebrobasilar view), especially in acute setting. In addition, it is not possible to simultaneously examine both anterior and poster circulation-derived collaterals. Last, the information obtained regarding the effect of collateral status on the anterior and lateral views in conventional angiography cannot easily be correlated with axial images typically used to depict CT or MRI of ischemic injury (Souza et al., 2012).

This work aims at evaluating the relationship between the state of cerebral collateral blood vessels and the functional outcome of patients with acute ischemic stroke with or without thrombolytic the rapy.

Materials and Methods

The study design

This study is a prospective study. The patients were enrolled from the inpatient sector of the neurology department at Ain Shams University hospitals. This study had been conducted through the period from October 2017 to March 2018.

The sample consisted of 30 patients diagnosed with acute ischemic stroke and admitted at the Emergency Room during the first 24hr of onset of the neurological deficit, then transferred to the inpatient sector of the neurology department at Ain Shams University hospitals.

Inclusion criteria

1. Age 18 years or older.
2. Clinical diagnosis of ischemic stroke with a measurable neurological deficit.
3. Gender: males and females.
4. Able to provide informed consent before enrollment in the study.

Exclusion criteria

1. Clinical suspicion of subarachnoid hemorrhage even with normal CT.
2. Past history of intracranial hemorrhage in the last 6 months.
3. Contrast induced nephropathy or allergy.

Methods

Informed consent from patients if they are aware of their conditions and from first degree relative if they are in coma was obtained. This consent was approved by the Ethical committee of National Center of Radiation Research and Technology.

The cases were assessed using the following measures:

1. Full neurological history.

2. Full general and neurological examination.

3. The National Institutes of Health Stroke Scale (NIHSS), was done to all patients on admission (Spilker et al., 1997).

4. CT cerebral angiography:

a) CT Angiography Clot Burden Score (CBS) was assessed to define the extent of the thrombus found in the proximal anterior circulation by location and the patients were scored on a scale that ranged from 0 to 10.

- A score of 2 is subtracted if the thrombus is found in each of the supraclinoid internal cerebral arteries (ICAs), the proximal half of the middle cerebral artery (MCA trunk) and the distal half of MCA trunk.

- A score of 1 is subtracted if the thrombus is found in the infraclinoid ICA, anterior cerebral artery (ACA), and for each affected M2 branch. The thrombus can be partially or completely occlusive.

- A score of 10 is normal, implying clot absence. A score of 0 implies a complete multi segment vessel occlusion (Puetz et al., 2008).

b) The collaterals were assessed by CTA via the Collateral score (CS) in which the collateral grading system was scored on a scale from 0 to 3.

- A score of zero indicated absent collateral supply to the occluded MCA territory. A score of 1 indicated collateral supply filling less than or equal 50% but more than 0% of the occluded MCA territory.

- A score of 2 was given for collateral supply filling >50% but <100% of the occluded MCA territory.

- A score of 3 was given for 100% collateral supply of the occluded MCA territory (Kucinski et al., 2003).

5. MRI stroke protocol: (Which is commonly used to evaluate the structural collaterals)

a. By using MRA, the degree of the anatomical visualization of the cerebral collaterals into bad or good collateral state in acute stroke patients can be assessed, MRA can determine alterations of cerebral circulation within large cerebral arteries (Kinoshita et al., 2005).

b. Diffusion-weighted image in which lesion volume and lesion pattern are associated with the degree of collateral flow in acute ischemic stroke where large lesion volume and cortical lesion pattern on diffusion-weighted image are frequently found in patients with poor collaterals (Souza et al., 2012).

c. Fluid attenuation inversion recovery (FLAIR) in which the presence of the distal hyper-intense vessels and the absence of perisylvian sulcal effacement are associated with good collaterals and favorable outcome in patients with acute middle cerebral artery stroke (Lee et al., 2009).

6. Follow up:

The patients were followed up once after one week by the National Institutes Of Health Stroke Scale (NIHSS) and another time after 3months by clinical assessment through modified rankin scale (MRS) (Wilson et al., 2002).

Statistical methods:

- Mean, Standard deviation (±SD) and range for parametric numerical data, while Median and Interquartile range (IQR) for non-parametric numerical data.

- Frequency and percentage of non-numerical data.

Analytical statistics:

1. Student T Test was used to assess the statistical significance of the difference between two study group means.

2. Correlation analysis: To assess the strength of association between two quantitative variables. The correlation coefficient denoted symbolically "r" defines the strength and direction of the linear relationship between two variables.

Chi-Square test was used to examine the relationship between two qualitative variables.

Results

Clinical and demographic data

The study included 30 patients, 21 males (70 %) and 9 females (30%). The mean age was 58.1±10.087 and the age range was between 22 and 75 years.

Out of all patients 56.6% had Diabetes Mellitus (DM), 66.6% had Hypertension (HTN), 36.67% had cardiac diseases and 43.33% had past history of transient ischemic attacks. Approximately two thirds of patients (73.3%) were smokers and had dyslipidemia (73.3%) and (20%) were alcoholics.

In relation to the onset of the stroke in "hours", all patients were presented by acute onset of neurological deficit ranging between 1 to 24hr and the mean was 6.683± 6.6849hr.

50% were the patients who received recombinant tissue plasminogen activator (rtPA) and 50% who were not. Less than two thirds (63.3%) of the cases had anterior circulation stroke while (36.67%) had posterior circulation stroke. The mean infraction volume was 27.37± 23.353cm^3.

Fifty percent of patients showed good visualization of the anatomical collateral state and 50% showed a bad visualization of the anatomical collateral state by MRA.

Regarding to MRS, less than two thirds (60%) of patients showed a good score "less than or equal 2" while 40% showed a bad score "more than 2".

There was a statistical significance difference between the NIHSS of the patients on admission and after one week of stroke onset ($P<0.001$), and 48.4% of them showed improvement.

Comparison between group A (patients who received rtPA) and group B (patients who didn't receive rtPA)

The study showed that most of the patients who received rtPA (93.3%) did not have past history of transient ischemic attacks or previous ischemic stroke with a significant statistical difference between the two groups ($P<0.001$), while there were no significant statistical difference in other demographic and clinical data.

When comparing the patients who received rtPA with those who did not, the study showed a significant statistical difference between the two groups as regard CS, MRS after 3 month and the onset of stroke. This indicates that the group of patients who received rtPA had better (higher) CS, lower MRS after 3 months (good outcome) and shorter duration of stroke onset; meanwhile there were no significant differences between the two groups as regards age (P= 0.608) , CBS (P= 0.524) and infarction volume (P= 0.359).

Regarding the NIHSS of both groups, there was a significant difference concerning the NIHSS on admission (P= 0.038) and that after one week (P= 0.027) and this means that the patients who received rtPA showed better NIHSS on admission and also after one week.

A significant improvement of NIHSS was noted after one week when compared to the base line NIHSS (P<0.001), the degree of improvement was 60.5% in patients who received rtPA while 36.3% in patients who did not receive rtPA. Besides, there was a statistical significant difference (P= 0.031) between the patients who received rtPA and those who did not as regards the degree of improvement.

Factors related to the stroke outcome

There was no statistical significant correlation between the MRS and sex, risk factors and site of infarction (Table 1).

There was a statistical significant difference between the patients with good Modified Rankin Scale (MRS) and bad MRS as regards CBS (P=0.033), CS (P=0.001), and infract volume (P= 0.033), the patients with good MRS were having less degree of disability and less occlusion.

The higher the CBS, the higher percentage of collateral refilling by CS and the larger infarction volume (Table 2).

In patients with good MRS after 3 months, there was a statistical significant difference between NIHSS on admission and after one week (P<0.001); patients showed 64.6% degree of improvement. While the patients with bad MRS after 3 month, showed 24.1% degree of improvement. This is in addition to a statistical significant difference between NIHSS on admission and after one week (P<0.001). as shown in (Table 3).

Predictors of stroke outcome

Regression analysis showed that there is a statistical association between MRS as a dependent variable and CS as an independent variable, in which the CS can predict the functional outcome of the stroke (Table 4).

Factors related to collateral state:

1) Collateral state by MRA

Comparing between patients with good collateral state by MRA and those with bad collateral state (Table 5), the study proved that when the collaterals were good by MRA the patients were noticed to be having good outcome by MRS, higher percentage of hypertension and lower percentage of anterior circulation stroke.

Other parameters as sex, DM, cardiac disease, presence of past history of transient ischemic attacks, smoking, alcohol and dyslipidemia were insignificant.

TABLE 1. Factors related to stroke outcome (Modified Rankin Scale).

		MRS after 3 months						Chi-Square	
		Bad		Good		Total			
		N	%	N	%	N	%	X^2	P-value
Sex	Female	5	41.67	4	22.22	9	30.00	1.296	0.255
	Male	7	58.33	14	77.78	21	70.00		
DM	Negative	6	50.00	7	38.89	13	43.33	0.362	0.547
	Positive	6	50.00	11	61.11	17	56.67		
HTN	Negative	2	16.67	8	44.44	10	33.33	2.500	0.114
	Positive	10	83.33	10	55.56	20	66.67		
Cardiac	Negative	7	58.33	12	66.67	19	63.33	0.215	0.643
	Positive	5	41.67	6	33.33	11	36.67		
PH of TIAor stroke	Negative	5	41.67	12	66.67	17	56.67	1.833	0.176
	Positive	7	58.33	6	33.33	13	43.33		
Smoking	Negative	4	33.33	4	22.22	8	26.67	0.455	0.500
	Positive	8	66.67	14	77.78	22	73.33		
Alcohol	Negative	11	91.67	13	72.22	24	80.00	1.701	0.192
	Positive	1	8.33	5	27.78	6	20.00		
Dyslipidemia	Negative	2	16.67	6	33.33	8	26.67	1.023	0.312
	Positive	10	83.33	12	66.67	22	73.33		
Site	Posterior	2	16.67	9	50.00	11	36.67	3.445	0.063
	Anterior	10	83.33	9	50.00	19	63.33		

TABLE 2. Factors related to stroke outcome, infarction volume and collateral state.

		MRS after three months						T-Test	
		Bad (more than 2)			Good (less than or equal two)			t	P-value
CBS	Range	1	-	9	2	-	10	-2.237	0.033*
	Mean± SD	6.917	±	2.746	8.889	±	2.083		
CS	Range	0	-	3	1	-	3	-7.209	<0.001*
	Mean± SD	0.75	±	0.866	2.667	±	0.594		
Age	Range	22	-	72	50	-	75	-1.768	0.088
	Mean± SD	54.25	±	13.15	60.667	±	6.651		
Onset (Hours)	Range	1.83	-	24	1.58	-	24	0.972	0.339
	Mean± SD	8.486	±	6.289	6.097	±	6.785		
Infarct volume (cm³)	Range	1.1	-	72	0.07	-	70	-2.237	0.033*
	Mean± SD	31.217	±	23.182	24.820	±	23.774		
		Bad		Good		Total		Chi-Square	
		N	%	N	%	N	%	X^2	P-value
Site	Posterior	2	16.67	9	50	11	36.67	3.445	0.063
	Anterior	10	83.33	9	50	19	63.33		

TABLE 3. Comparison between MRS after three months and NIHSS on admission and after one week.

NIHHS		MRS after 3 months						T-Test	
		Bad			Good			t	P-value
On admission	Range	5	-	21	1	-	10	4.930	<0.001*
	Mean± SD	11.333	±	4.030	5.000	±	3.010		
After one week	Range	4	-	19	0	-	8	5.307	<0.001*
	Mean± SD	8.667	±	3.846	2.444	±	2.595		
% of Change			24.1%			64.6%		-4.520	<0.001*
Differences	Mean± SD	2.667	±	1.371	2.556	±	1.149		
Paired Test	P-value		<0.001*			<0.001*			

TABLE 4. Predictors of stroke outcome .

	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	Std. Error	Beta		
NIHSS on admission	-0.006	0.050	-0.054	-0.116	0.908
NIHSS after one week	-0.015	0.058	-0.133	-0.262	0.796
CBS	-0.005	0.028	-0.026	-0.182	0.857
CS	0.284	0.086	0.676	3.309	0.003*
Infarct volume (cm³)	0.000	0.003	0.019	0.147	0.885
Dependent Variable: MRS					

(CS) collateral score, (CBS) clot burden score .

When the collateral state was good by MRA there were higher CBS (less arterial occlusion), higher CS and good outcome by MRS. The other parameters as age, onset of stroke and infract volume were insignificant (Table 6).

There was a statistical significant difference between collateral state by MRA and NIHSS upon admission and after one week times (P<0.001).

For the bad collateral state by MRA , there was a statistical significant difference between NIHSS score on admission and after one week (P<0.001) with the clinical improvement only = 25.8%; while for the good collateral state by MRA, there was a statistical significant difference between NIHSS on admission and after one week (P<0.001) with the degree of improvement = 71%

There is a statistical significant difference as regards the degree of improvement in NIHSS on admission and after one week among both subgroups (P<0.001).

TABLE 5. The association between the collateral state by MRA and the clinical risk factors.

		Collateral state by MRA						Chi-Square	
		Bad		Good		Total			
		N	%	N	%	N	%	X^2	P-value
Sex	Female	6	40.00	3	20.00	9	30.00	1.429	0.232
	Male	9	60.00	12	80.00	21	70.00		
DM	Negative	8	53.33	5	33.33	13	43.33	1.222	0.269
	Positive	7	46.67	10	66.67	17	56.67		
HTN	Negative	2	13.33	8	53.33	10	33.33	5.400	0.020*
	Positive	13	86.67	7	46.67	20	66.67		
Cardiac	Negative	9	60.00	10	66.67	19	63.33	0.144	0.705
	Positive	6	40.00	5	33.33	11	36.67		
PH of TIA or stroke	Negative	6	40.00	11	73.33	17	56.67	3.394	0.065
	Positive	9	60.00	4	26.67	13	43.33		
Smoking	Negative	5	33.33	3	20.00	8	26.67	0.682	0.409
	Positive	10	66.67	12	80.00	22	73.33		
Alcohol	Negative	14	93.33	10	66.67	24	80.00	3.333	0.068
	Positive	1	6.67	5	33.33	6	20.00		
Dyslipidemia	Negative	2	13.33	6	40.00	8	26.67	2.727	0.099
	Positive	13	86.67	9	60.00	22	73.33		
Site of infarction	Posterior	2	13.33	9	60.00	11	36.67	7.033	0.008*
	Anterior	13	86.67	6	40.00	19	63.33		
MRS after	Bad	12	80.00	0	0.00	12	40.00	20.000	<0.001*
	Good	3	20.00	15	100.00	18	60.00		

TABLE 6. Comparison between the patients with good and bad collateral state by MRA.

		Collateral state by MRA						T-Test	
		Bad			Good			t	P-value
Age	Range	22	-	72	50	-	75	-1.618	0.117
	Mean ±SD	55.200	±	11.971	61.000	±	7.031		
CBS	Range	1	-	10	7	-	10	-3.031	0.005*
	Mean ±SD	6.867	±	2.900	9.333	±	1.234		
CS	Range	0	-	3	2	-	3	-7.872	<0.001*
	Mean ±SD	0.933	±	0.884	2.867	±	0.352		
Onset (Hours)	Range	1	-	24	1	-	24	0.434	0.668
	Mean ±SD	7.233	±	6.219	6.133	±	7.605		
	Mean ±SD	452.667	±	357.041	393.667	±	440.898		
Infarct volume (cm^3)	Range	1.1	-	72	0.07	-	70	0.978	0.336
	Mean ±SD	31.553	±	23.161	23.204	±	23.577		
MRS after three month	Range	1	-	5	0	-	2	9.292	<0.001*
	Mean ±SD	3.133	±	0.990	0.333	±	0.617		

2) Clot burden score(CBS)

High CBS was frequently related to male, diabetic, non-hypertensive patients with posterior circulation stroke (Table 7).

3) Collateral score (CS)

High score of CS is correlated with the non-hypertensive patients, patients with no past history of TIA or stroke and patients with posterior circulation stroke (Table 8).

Correlation between CBS and CS with other parameters

Better collaterals were associated with lower NIHSS on admission and after one week, good out come by MRS after 3 month and small infarction volume (Table 9).

Figure 1 illustrates A 64-year old male patient, hypertensive presented with acute onset of neurological deficit within 2 hours. NIHSS on admission was 8, CBS was 10 and CS was 2. MRA showed good anatomical visualization of the vessels. He received rtPA & the NIHSS after one week was 3 and MRS after 3 months was 1.

Figure 2 illustrates A 57-year old male patient, hypertensive presented with acute onset of neurological deficit within 1.5 hours. The NIHSS on admission was 8, CBS was 7 and CS was 3. MRA showed good anatomical visualization of the vessels. He received rtPA & the NIHSS after one week was 6 and the MRS after 3 months was 1.

TABLE 7. Comparison of CBS with patients' risk factors.

		CBS				T-Test	
		N	Mean	±	SD	t	P-value
Sex	Female	9	6.667	±	3.674	-2.162	0.039*
	Male	21	8.714	±	1.586		
DM	Negative	13	6.923	±	3.303	-2.412	0.023*
	Positive	17	9.000	±	1.173		
HTN	Negative	10	9.400	±	1.075	2.111	0.044*
	Positive	20	7.450	±	2.800		
Cardiac	Negative	19	7.842	±	2.522	-0.730	0.472
	Positive	11	8.545	±	2.583		
PH of TIA or stroke	Negative	17	8.059	±	3.092	-0.100	0.921
	Positive	13	8.154	±	1.625		
Smoking	Negative	8	7.125	±	3.643	-1.291	0.207
	Positive	22	8.455	±	1.969		
Alcohol	Negative	24	7.917	±	2.717	-0.791	0.436
	Positive	6	8.833	±	1.472		
Dyslipidemia	Negative	8	8.500	±	2.507	0.517	0.609
	Positive	22	7.955	±	2.572		
Site	Posterior	11	9.727	±	0.647	3.047	0.005*
	Anterior	19	7.158	±	2.734		

TABLE 8. Comparison of CS according to patients` clinical characteristics.

		CS				T-Test	
		N	Mean	±	SD	t	P-value
Sex	Female	9	1.444	±	1.236	-1.402	0.172
	Male	21	2.095	±	1.136		
DM	Negative	13	1.692	±	1.032	-0.835	0.411
	Positive	17	2.059	±	1.298		
HTN	Negative	10	2.600	±	0.843	2.484	0.019*
	Positive	20	1.550	±	1.191		
Cardiac	Negative	19	2.053	±	1.129	0.925	0.363
	Positive	11	1.636	±	1.286		
PH of TIA or stroke	Negative	17	2.353	±	1.057	2.627	0.014*
	Positive	13	1.308	±	1.109		
Smoking	Negative	8	1.500	±	1.309	-1.120	0.272
	Positive	22	2.045	±	1.133		
Alcohol	Negative	24	1.750	±	1.225	-1.410	0.169
	Positive	6	2.500	±	0.837		
Dyslipidemia	Negative	8	2.500	±	0.926	1.729	0.095
	Positive	22	1.682	±	1.211		
Site	Posterior	11	2.545	±	1.036	2.461	0.020*
	Anterior	19	1.526	±	1.124		

Discussion

This study aims at evaluating the relationship between the state of the cerebral collateral blood vessels and the functional outcome of patients with acute ischemic stroke with or without thrombolytic therapy.

TABLE 9. Correlation between both CBS and CS and the stroke outcome.

Correlations				
	CBS		CS	
	r	P-value	r	P-value
CS	0.499	0.005*		
NIHSS on admission	-0.406	0.026*	-0.757	<0.001*
NIH after one week	-0.452	0.012*	-0.792	<0.001*
% of change	-0.565	<0.001*	-0.715	<0.001*
Age	0.300	0.107	0.113	0.551
MRS after three month	-0.394	0.031*	-0.885	<0.001*
Onset (hr)	0.166	0.379	-0.244	0.193
Infarct volume (cm^3)	-0.255	0.033*	-0.210	0.045*

Case 1:

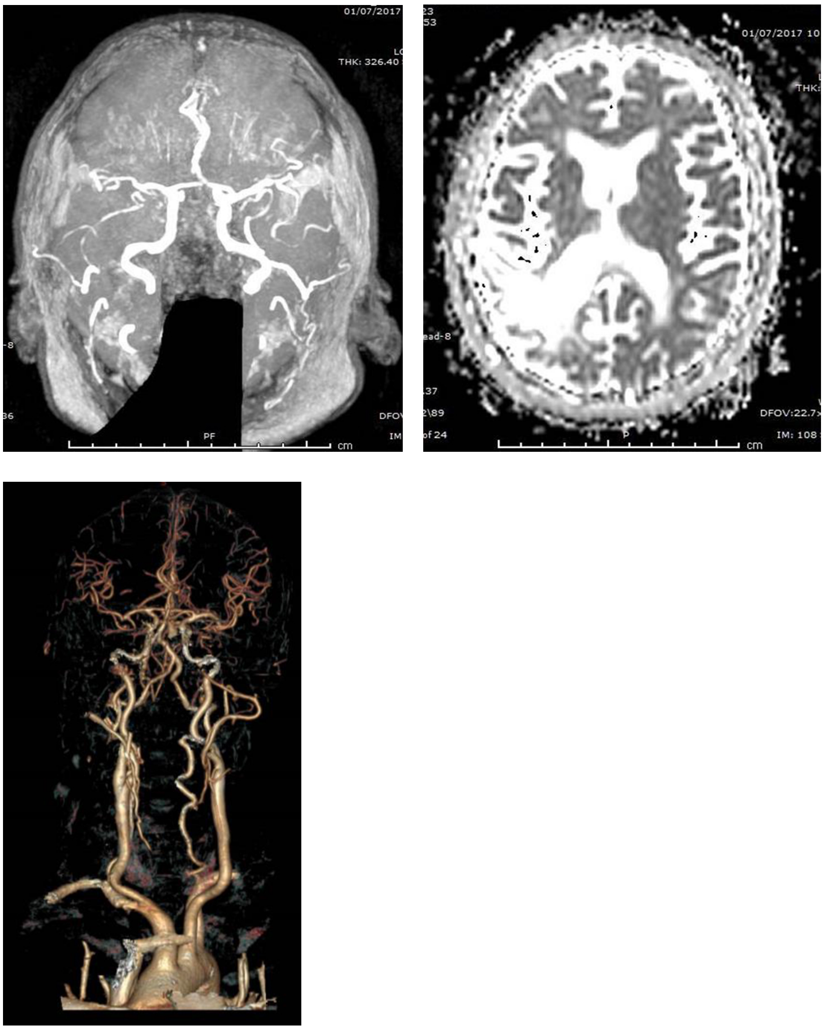

Fig. 1. A 64-year old male patient, hypertensive presented with acute onset of neurological deficit within 2hr. NIHSS on admission was 8, CBS was 10 and CS was 2. MRA showed good anatomical visualization of the vessels. He received rtPA & the NIHSS after one week was 3 and MRS after 3 months was 1.

Case 2:

Fig. 2. A 57-year old male patient, hypertensive presented with acute onset of neurological deficit within 1.5hr. The NIHSS on admission was 8, CBS was 7 and CS was 3. MRA showed good anatomical visualization of the vessels. He received rtPA & the NIHSS after one week was 6 and the MRS after 3 months was 1.

The group of patients who received rTPA had better outcome by MRS and better NIHSS on admission and after one week than those who did not receive rtPA, the present results were consistent with those of Leonard et al. (2013) who demonstrated that early neurological improvement during the first 24hr after intravenous thrombolysis is always associated with better functional outcomes at 3 months by MRS in acute ischemic stroke patients. Another study by Tan and his colleagues (2009) reported that recanalization rates are also higher following intravenous rtPA in patients with smaller clot extent.

Moreover the findings of Pashapour et al. (2013) indicated that intravenous thrombolytic therapy is accompanied by favorable short and long-term results in patients with ischemic stroke. Symptoms are less severe and recovery is higher in patients with small vessel occlusion. Age, sex and time between symptoms onset and drug administration were capable of forecasting disease outcome. Considering the findings of this study, intravenous thrombolytic therapy can be recommended especially in milder episodes and small vessel occlusion subgroups.

The degree of the collateral supply through peripheral leptomeningeal sources is critically important and correlates with the presence of smaller final infarct volume. Evaluation of collateral supply remains challenging due to their diminutive size and complex routes (Tan et al., 2009), consistently the current study shows inverse correlation between the collateral scores and the volume of infarction.

Adequate collateral circulation may contribute to the maintenance of tissue viability in the absence of recanalization. In both intravenous thrombolysis and endovascular trials, shorter time to treatment was associated with better odds for positive outcome (Prabhakaran et al., 2015).

Good pial or leptomeningeal collateral circulation predicts better clinical responses to intra-arterial treatment even 5 hours after the onset of the stroke, suggesting that collateral status could extend the time window for endovascular procedures (Ribo et al., 2011). Therefore, collateral flow to penumbral tissue beyond the clot has clinical implications in the setting of acute endovascular therapy (Hwang et al .,2015)

The findings of the present study are in accordance with those of Alves et al., (2018) who stated that collateral scores are associated with thrombus characteristics in which the patients with higher collateral scores had lower thrombus burden. The association between clot burden score and MRS score seems to be partially explained by lower clot burden score leading to higher collateral score. There is also an important impact of the collateral score on the association of thrombus attenuation which increases with functional outcome.

The present study proved that the patients with higher CBS were associated with higher CS, small infarction volume, lower NIHSS on admission and after one week and good outcome by MRS. This is consistent with Tan et al., (2009) who stated that CTA-derived assessment of clot extent (CBS) is an independent predictor of clinical and radiologic outcomes in acute ischemic stroke. Patients with smaller clot extent are more likely to have smaller baseline infarcts and lower baseline NIHSS scores, achieve a good clinical outcome, and have smaller final infarct size.

In addition, this study demonstrated the correlation between a CTA-derived score of clot extent and CT-derived collateral score. Also Tan et al. (2009) stated that CBS and CS demonstrate high interobserver reliability collateral state and that the better the collateral state the better will be the functional outcome.

Regarding the stroke risk factors, the current results reveal that high CBS is correlated with males, diabetic, non- hypertensive and posterior circulation stroke patients. In parallel, the high scoring of the CS is correlated with non-hypertensive patients, patients with no past history of TIA or stroke and patients with posterior circulation stroke.

The previous data was conducted with Tan et al. (2009) where patients with higher CBS and CS were having higher baseline Alberta Stroke Program Early CT Score (ASPECTS), lower baseline NIHSS scores, earlier presentation, and smaller final infarct volume. No rtPA or sex differences were found for those patients with higher CBS and CS.

It has been noticed in this study that there is a statistical correlation between CBS and MRS after three months , NIHSS on admission and after one week, and infarction volume, but by regression analysis there were no statistical correlation between CBS and other parameters. Also Tan et al. (2009) stated that a CBS threshold of 6 has a modest sensitivity and specificity and could be considered an adjunct to other imaging and clinical features, including baseline NIHSS, infarction volume and clinical outcome.

All patients included in the study were examined through CTA in order to assess the clot burden score. Similarly, Gerbe et al. (2016) found that CTA-collateral status is important to indicate a good outcome in ischemic stroke patients treated with endovascular therapy (EVT). CTA-collaterals are thus well suited for patient selection in EVT. However, the independent effect of reperfusion on outcome tended to be stronger than that of CTA-collaterals.

Moreover, multimodal MRI provides a number of tools to assess the collateral flow, however with some limitations. MRA can determine alterations of cerebral circulation within large cerebral arteries, with less spatial resolution compared to CTA. FLAIR images on MRI are able to show vascular hyper-intensities distal to an occluded cerebral artery, due to the presence of a slow and retrograde blood flow in collateral vessels (Cuccione et al., 2016).

Conclusion:

The collateral status as assessed by CTA is considered an excellent predictor of a favorable functional outcome in acute ischemic stroke patients. Good collateral status favors the benefit of the patients from recanalization and patients with poor collaterals likely will not benefit even when recanalization occurs.

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تقييم الاوعية الجانبية المخية في حالات الجلطة المخية الحادة بإستخدام الأشعة المقطعية بالصبغة على الشرايين المخية وعلاقتها بالنتيجة الوظيفية

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تعتبر السكتة الدماغية من المشاكل الصحية الكبرى حيث بلغ تعداد الحالات بما يقارب 15 مليون مريض جديد على مستوى العالم. تعتبر السكتة الدماغية سبب أصيل للوفاه والأعاقة طويلة المدى وتعتبر حاليا السبب الثالث من الأسباب المؤدية للوفاة بعد أمراض القلب والسرطان، كما زاد معدل الوفاه مابعد حدوث السكتة الدماغية بنسبة 33% خلال السنة الاولى وبنسبة 80% خلال العشر سنوات مابعد السكتة الدماغية.

تختلف الإختلالات الوظيفية ما بعد حدوث السكتة الدماغية على حسب ما إذا كان نقص الدم مؤقتا أو دائما حيث يمكن للخلايا أن ترجع لطبيعتها خلال 30 دقيقة إلى أربع ساعات من حدوث الجلطة ولكن بعد 8 ساعات من نقص الدم لا يمكن للخلايا إصلاح نفسها والعودة إلى طبيعتها. وترجع قدرة الخلايا على اصلاح نفسها إلى عامل مهم وهوالأوعية الدموية الفرعية أو الجانبية المحيطة لمكان الجلطة والتى تسمح بمرور الدم إلى المنطقة المصابة.

وقد تم تعزيز أهمية الأوعية الدموية الطرفية المحيطة بمكان الجلطة عن طريق الأشعة المقطعية والفحوصات القائمة على الصبغة ورسم الأوعية الدموية والتى لها دور فى تحديد إمكانية ومدى تقدم حالة المرضى فى حالة عمل إجراء يهدف إلى اعادة توصيل الدم إلى المنطقة المصابة.