Acute renal impairment in stroke patients; an Upper Egypt clinical, laboratory and radiological study

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Abstract

Background: acute renal impairment is a common complication after acute stroke. More than one fourth of patients developed acute kidney injury in the first 2 days after the ictus.

Aim of the work: To study the prevalence of acute renal impairment in acute stroke patients and to study the clinical characteristics, laboratory and radiological findings of stroke patients with and without acute kidney injury.

Subjects and Methods: The study included 500 patients admitted to the Neurology department of Sohag university hospital, Alhelal hospital and Sohag general hospital presented by stroke within the first 48 hours. Patients with a history of renal disease or receiving dialysis for chronic renal failure were excluded. Patients were subjected to detailed medical and neurological evaluation. Stroke severity assessed by NIHSS, Glasgow coma scale and MRCS of power. CT brain was done for all patients and laboratory studies were done including serum urea, creatinine, calculated creatinine clearance, uric acid, electrolyte assessment, random blood sugar, liver functions test, coagulation profile and complete blood count and erythrocyte sedimentation rate.

Results: Renal impairment was reported in 122 patients (24.4%). The mean age "mean ± SD" of patients without AKI was 61.61±12.977 and that of patients with AKI was 64.71±10.653. In patients without AKI, the percentage of male was 52.1% and in patients with AKI, male percentage was 56.5%. In patients without AKI, we reported the following; hypertension (25.1%), ACEIs (44%), atrial fibrillation (10.8%), coma (2.8%), DM (36.5%), hyperlipidemia (34.1%), smoking (29.6%), cardiac disease (31.4%), hyperuricemia (14%), TIA (1.8%), drug abuse (3.1%), mean Na level (139.6±6.6), mean K+ (4.2±1.6), mean Ca^{++} (9.1±.5), echogenic grade (I) kidney on U/S (7.4%), cerebral infarction (68%), cerebral hemorrhage (31%) and hemorrhagic infarction (0.7%). In patients with AKI, we reported the following; hypertension (19.6%), ACEIs (55%), atrial fibrillation (11.4%), coma (5.4%), DM (36.8%), hyperlipidemia (30.3%), smoking (23.7%), cardiac disease (26.2%), hyperuricemia (25%), TIA (1.6%), drug abuse (7.3%), mean Na level (134.9±6.3), mean K+ (4.2±.9), mean Ca^{++} (8.5±.8), echogenic grade (I) kidney on U/S (59.1%), cerebral infarction (56.5%) and cerebral hemorrhage (41%).

Conclusion: we found that the prevalence of renal impairment in acute stroke patients is 24.4% and its predictors were age, conscious level, presence of speech abnormality, hypertension, hyperuricemia, RHD, drug abuse, presence of casts, crystals and albumin in urine, elevated ALT enzyme, leucocytosis and high ESR.

INTRODUCTION

Stroke, after cardiovascular disease and cancer, is the third cause of death in developed countries[1,2]. Generally acute renal failure (ARF) is defined as an abrupt and sustained decline in renal function, which results in disturbances in electrolyte and acid-base homeostasis, derangement in extracellular fluid volume and retention of nitrogenous waste products. ARF develops in about 5% of all hospitalized patients and in 5-25% of patients admitted to ICUs, and the highest incidence, approximately 50%, has been reported in patients with septic shock[3-8]. It was found that acute kidney injury (AKI) is a common complication after acute stroke. More than one fourth (27%) of patients developed AKI in the first 2 days after the ictus[9].

AIM OF THE WORK

To study the prevalence of acute renal impairment in acute stroke patients and to study the clinical characteristics, laboratory and radiological findings of stroke patients with and without acute kidney injury.

PATIENTS AND METHODS

The study was done on 500 patients admitted to the Neurology department of Sohag university hospital, Alhelal hospital and Sohag general hospital presented by stroke within the first 48 hours. Diagnosis of stroke was confirmed by CT. Patients with no confirmed CT brain or those suspected of having transient ischemic attack (TIA) were excluded from the study. Also patients with a history of renal disease or receiving dialysis for chronic renal failure were excluded.

Patients were subjected to:

Detailed medical and neurological evaluation, with special stress on the following parameters:

Age, gender, history of hypertension, diabetes mellitus, hypercholesterolemia, hyperuricemia, past history of TIA or ischemic stroke, presence of ischemic heart disease or cardioembolic disease, atrial fibrillation (AF), previous and current antiplatelet treatment, current alcohol overuse, smoking or substance abuse. Systolic and diastolic hypertension is considered when systolic blood pressure ≥140mmHg and diastolic blood pressure ≥90 respectively.Diabetes mellitus was diagnosed based on history of fasting blood glucose levels >126 mg/dL and/or the use of anti-diabetic agents.

Definition of acute kidney injury (AKI): All patients with a rise in serum creatinine value or fall in GFR (as per RIFLE, whichever was greater) were included in the AKI group and were assigned to a category in the RIFLE classification[10].

Determination of the stroke severity on admission according to: NIHSS, Glasgow coma scale and MRCS of power.

Computerized tomography (CT) brain.

Ischemic stroke: To confirm the diagnosis of stroke and to determine the distribution of stroke

Hemorrhagic stroke: Topographic classification of the hematoma will be assessed as the following: hematomas that predominantly affected the subcortical white matter of the cerebral lobes will be defined as lobar, while those in the basal ganglia, thalamus, or both will be defined as deep. Mass effect will be defined as the presence of midline shift displacement by ≥ 5 mm on brain CT.

Other neuroimaging investigations if need: MRI, CT angiography for SAH

Laboratory studies:

Serum urea, creatinine, calculated creatinine clearance (ml/min), was calculated by use of a recent version of the Cockcroft-Gault equation as follows:

(140-age) X 1.26 X weight (kg) X k/ plasma creatinine (μmol), where; k=1 if male or 0.85 if female[11,12].

Uric acid, electrolyte assessment; Na+, K+, Ca++, random blood sugar, liver functions test, coagulation profile, complete blood count (CBC) and erythrocyte sedimentation rate (ESR).

Statistical analysis

Analysis of data was carried out using the "Statistical Program for Social Sciences" (SPSS) for windows version 19.0. Categorical variables were expressed as frequency and percentage while continuous variables were expressed as mean±standard deviation. Pearson Chi-square and independent student's (t) test were used in univariate analysis. P value < 0.05 was used as a significance level.

RESULTS

Demographic data

The study was carried on 500 patients, 266 males (53.2 %) and 234 females (46.8%), presented with stroke within the first 48 hours of onset. The mean age of patients (Mean ±SD) is 62.37±12.5.

Prevalence of renal impairment

Renal impairment (creatinine 1200 μm) was reported in 122 patients (24.4%).

Demographic data in both groups (without AKI and with AKI)

The mean age "mean ± SD" of patients without AKI was 61.61±12.977 and that of patients with AKI was 64.71±10.653 (P-value=0.017). In patients without AKI, the percentage of male was 52.1% while female percentage was 47.8% and in patients with AKI, male percentage was 56.5%, while female percentage was 43.4%, (P-value = 0.3).

Clinical characteristics and risk factors of both groups of patients (table 1):

Hypertension was reported in 25.1% of patients without AKI versus 19.6% of patients with AKI (P-value=0.218). The mean±SD of SBP/DBP in patients without AKI was 156.9±30.3/90.4±11.7 versus 165.66±33.7/96.1±18 in patients with AKI (P-value= 0.007). The most common type of treatment was ACEIs (44%) in patients without AKI versus 55% in patients with AKI (P-value= 0.000). AF was the most common type of cardiac arrhythmia reported in patients without and with AKI (10.8% and 11.4% respectively) (P-value= 0.000). Coma (GCS<8) was reported in 2.8% of patient without AKI and in 5.4% of patient with AKI (P-value=0.000). The most common type of speech abnormality in patient with and without AKI was dysarthria (39% and 6.4% respectively) (P-value=0.000). Right hemiplegia was reported in 43.1% and 59% of patient without and with AKI respectively while left hemiplegia was reported in 40.7% and 32.7% (P-value= 0.001). Fits were reported in 5% of total patients, most of them were focal fits (3.4%), while generalized tonic clonic fits was reported in 1.6% of patients (P-value= 0.000).

The total percentage of DM among stroke patients was 36.6% and about 36.5% reported in patients without AKI versus 36.8% reported in patients with AKI (P-value=0.940). IDDM was reported in 19.8% of patients without AKI versus 25.4% in patients with AKI (P-value=0.227) while NIDDM reported in 16.6% in patients

without AKI versus 11.4% in patients with AKI (P-value=0.22). Mean RBS was 190.8±(105.1) of patients without AKI versus 220.8±(127.6) in patients with AKI (P-value= 0.010). Hyperlipidemia was reported in 34.1% of patients without AKI versus 30.3% in patients with AKI (P-value=0.438). Smoking was reported in 29.6% of patients without AKI versus 23.7% in patients with AKI (P-value=0.211). Cardiac disease was reported in 31.4% of patients without AKI versus 26.2% in patients with AKI (P-value=0.288). Hyperuricemia was reported in 14% of patients without AKI versus 25% in patients with AKI (P-value=0.003). Mean uric acid was 5.2±2 of patients without AKI versus 6.4± 4.3 in patients with AKI with statistically significant difference between both groups (P-value= 0.000). TIA was reported in 1.8% of patients without AKI versus 1.6% in patients with AKI (P-value=0.878). Dysarthria was the most prevalent speech deficit and reported in 1.5% of patients without AKI versus 1.6% of patients with AKI (P-value=0.850). Previous stroke was reported in 10.8% of patients without AKI versus 14.7% in patients with AKI (P-value=0.236). Right hemiplegia was the most prevalent motor deficit and reported in 6.6% of patients without AKI versus 9% of patients with AKI (P-value= 0.618). Drug abuse was reported in 3.1% of patients without AKI versus 7.3% in patients with AKI (P-value= 0.044). Opium was the most common abused substance and reported in 1.8% of patients without AKI versus 5.7% in patients with AKI (P-value= 0.07).

Laboratory findings

1-Prevalence of renal impairment: renal impairment (creatinine ≥1.2 mg) was reported in 24.4% of total number of patients.

Table 1: Clinical characteristics and risk factors of both groups of patients:

Clinical data	Without AKI	With AKI	P value	Clinical data	Without AKI	With AKI	P value
HTN				IHD	103(27.2%)	33(27 %)	
Not hypertensive	95(25.1%)	24(19.6%)	0.218	**MI/cardiac**			
Hypertensive	283(74.8%)	98(80.3%)		No MI	365(96.5 %)	118(96.7 %)	0.932
SBP	156.90±30.3	165.66± 33.7	0.007	MI	13(3.5%)	4(3.2%)	
DBP	90.40±11.7	96.15± (18)		**Duration**			
Duration				Non MI	279(73.8 %)	93(76.2 %)	
Non hypertensive	95(25.1%)	24(19.6%)		First discovered	8(2.1%)	0(0 %)	0.425
First discovered	106 (28 %)	45(36.8%)	0.173	< 2 years	34(8.9 %)	11(9%)	
< 2 years	50(13.2 %)	9(7.3 %)		2-5 years	40(10.5 %)	15(12.2%)	
2-5 years	61(16.1 %)	25(20 %)		> 5	17(4.4%)	3(2.4 %)	
> 5 years	66(17.4 %)	19(15.5%)		**CCU admission**			
Treatment				No CCU	367(97 %)	120(98.3 %)	
Not hypertensive	95(25.1%)	24(19.6%)		CCU/MI	11 (3%)	2(1.6%)	0.443
ACEIs	166(44 %)	67(55%)	0.238	**RHD**			
B blockers	50(13.2 %)	14(11.4%)		No RHD	364(96.2 %)	122(100 %)	0.031
Ca channel blockers	37(9.7 %)	12(9.8 %)		RHD	14(3.7 %)	0	
Diuretics	9(2.3 %)	0		**Open HS**			
Pulse				No	378(100 %)	120(98.3 %)	0.077
Mean	81.91±(7.2)	82.92±(6.8)	0.178	Yes	0	1(0.8 %)	
Regular	317(83.8 %)	100(82%)	0.490	**Uric acid**			
Irregular	61(16.1%)	22(18%)		Normal	325(86 %)	91(75 %)	0.003
Type of irregularity				Hyperuricemia	53(14%) 5.2± 2.0	31(25 %) 6.4± 4.3	0.000
AF	41(10.8%)	14(11.4%)	0.885	**TIA**			
Ventricular ectopic	20(5.2%)	8(6.5 %)		No TIA	371(98%)	120(98.3%)	0.878
DM				TIA	7(1.8%)	2(1.6%)	
Non diabetic	240(63.4%)	77(63.1%)	0.940	**Deficit**			
Diabetic	138(36.5 %)	45(36.8%)		Normal	371(98.1 %)	120(98.3 %)	
Duration				Dysarthria	6(1.5 %)	2(1.6 %)	0.850
Non diabetic	240(63.1%)	77(63.4%)		Left hemiplegia	1(0.2 %)	0(0%)	
First discovered	49(12.9%)	11(9%)	0.319	**Duration before stroke**			
< 2 years	29(7.6 %)	7(5%)		Normal	371(98.1%)	120(98.3 %)	
2-5 years	28(7.4%)	16(13%)		< 2 years	7(1.8%)	2(1.6%)	0.842
> 5 years	32(8.4 %)	11(9 %)		2-5 years	1(0.2%)	0	
Type				**Treatment**			
Not diabetic	240(63.1%)	77(63.4%)		Normal	371(98.1%)	120(98.3 %)	
NIDDM	63(16.6 %)	14(11.4 %)	0.227	No ttt	4(1 %)	2(1.6 %)	0.750
IDDM	75(19.8%)	31(25.4%)		Antiplatelet	1(0.2 %)	0	
Regular /not on treatment			0.873	**Previous stroke**			
Not diabetic	240(63.1%)	77(63.4%)		No	337(89.1%)	104(85.2%)	0.236
Regular	115 (30.4%)	39(31.9 %)		Yes	41(10.8%)	18(14.7%)	
Not regular	23(6%)	6(4.9 %)		**Deficit**			
Mean RBS	190.8±(105.1)	220.8±(127.6)	0.010	Normal	337(89.1%)	104(85.2%)	
Hyperlipidemia				Dysarthria	4(1 %)	2(1.6%)	0.618
No	249(65.8%)	85(69.6%)	0.438	Right hemiplegia	25(6.6%)	11(9 %)	
Yes	129(34.1%)	37(30.3%)		Left hemiplegia	12(3.1 %)	5(4 %)	
duration				**Duration**			
No hyperlipedemia	249(65.8%)	85(69.6%)	0.388	Normal	337(89.1%)	104(85.2%)	
First discovered	119(31.4%)	34(27.8%)		< 2 years	22(5.8%)	5(4%)	0.081
< 2 years	6(1.5%)	1(0.8 %)		2-5 years	15(4 %)	12(9.8 %)	
2-5 years	4(1 %)	1(0.8 %)		> 5 years	4(1 %)	1(0.8 %)	
> 5 years	0	1(0.8 %)		**Treatment**			
Smoking				Normal	337(89.1%)	104(85.2%)	
Nonsmoker	266(70.3 %)	93(76.2%)	0.211	No ttt	22(5.8 %)	9(7.3%)	0.765
Smoker	112(29.6%)	29(23.7 %)		Antiplatelet	21(5.5 %)	9(7.3%)	
SI				**OCP**			
Nonsmoker	266(70.3 %)	93(76.2%)		Male	198(52.3%)	68(55.7 %)	
X smoker	6(1.5%)	2(1.6%)	0.468	Non	176(46.5%)	53(43.4 %)	0.624
Stop smoker	13(3.4 %)	2(1.6%)		Yes	4(1%)	1(0.8%)	
Mild smoker	36(9.5 %)	13(10.6%)		**Drug abuse**			
Moderate smoker	38(10 %)	6(4.9%)		No	366(96.8 %)	113(92.6 %)	0.044
Severe smoker	19(5 %)	6(4.9 %)		Yes	12(3.1%)	9(7.3%)	
Cardiac				**Type/drug abuse**			
Not cardiac	259(68.5 %)	90(73.7 %)	0.288	Non	366(96.8 %)	113(92.6 %)	
Cardiac	119(31.4%)	32(26.2%)		Cannabis	5(1.3 %)	2(1.6 %)	0.074
IHD				Opium	7(1.8%)	7(5.7%)	
No IHD	275(72.7 %)	89(72.9 %)	0.851				

2-Urine analysis: acidic PH was reported in 99.4% of patients without AKI versus 24.4% in patients with AKI (P-value=0.421). Casts was reported in 1.6% of patients without AKI versus 6.5% in patients with AKI (P-value= 0.004). Crystals was reported in 26.5% of patients without AKI versus 48.3% of patients with AKI (P-value= 0.000). Cox was the most prevalent crystal and reported in 3.1% of patients without AKI versus 5.7% of patients with AKI. Trace of albumin in urine was reported in 1% of patients without AKI versus 5.7% of patients with AKI (P-value= 0.002). Hematuria was more severe in patients without AKI with mean RBC's in urine 3.82±5.9 versus 9.47±7.1 in patients with AKI (P-value= 0.000).
3-Electrolytes: the mean Na level was 139.6±6.6 in patients without AKI versus 134.9±6.3 in patients with AKI (P-value= 0.000). The mean K+ was 4.2±1.6 in patients without AKI versus 4.2±.9 in patients with AKI (P-value= 0.688). The mean Ca^{++} was 9.1±.5 in patients without AKI versus 8.5±.8 in patients with AKI (P-value= 0.000).
4-Liver enzymes: the mean AST was 32.30±38.8 in patients without AKI versus 39.49±43.3 in patients with AKI (P-value= 0.085). The mean ALT was 31.71±30.6 in patients without AKI versus 46.98±58.9 in patients with AKI (P-value= 0.000).
5-Coagulation profile: the mean prothrombin concentration was 92.9±12.2 in patients without AKI versus 21.5±1.9 in patients with AKI (P-value= 0.2).
6-Complete blood picture (CBC): the mean RBC's was 4.275±0.623 in patients without AKI versus 4.210±0.635 in patients with AKI (P-value= 0.321). The mean WBC's was 10.6±0.98 in patients without AKI versus 13.4±6.19 in patients with AKI (P-value= 0.000). The mean Platelets was 293.45±81.5 in patients without AKI versus 287.02±71.8 in patients with AKI (P-value= 0.436).
7-ESR: the mean 1st hr ESR was 12.826±0.6 in patients without AKI versus 27.20±18.4 in patients with AKI (P-value= 0.000). The mean 2^{nd} hr ESR was 46.92±22.6 in patients without AKI versus 53.98±27.5 in patients with AKI (P-value= 0.005).

Radiological findings:

U/S kidney: Echogenic grade (I) kidney on U/S was reported in 7.4% of patients without AKI versus 59.1% in patients with AKI (P-value= 0.000).
CT brain: Cerebral infarction was reported in 68% of patients without AKI versus 56.5% in patients with AKI while cerebral hemorrhage was reported in 31% of patients without AKI versus 41% in patients with AKI but hemorrhagic infarction was reported only in patients without AKI (0.7%). Multiplicity of cerebral infarction was reported in 9.7% of patients without AKI versus 7.3% in patients with AKI (P-value= 0.423).
Distribution of infarction: PACI was reported in 41% of patients without AKI versus 31.1% in patients with AKI, next lacunar infarction was reported in 16% of patients without AKI versus 5.7% in patients with AKI, then POC was reported in 6% of patients without AKI versus 5.7% in patients with AKI and finally TACI was reported in 5.5% of patients without AKI versus 14% in patients with AKI.
Intraventricular extension: IV was reported in 5.8% of patients without AKI versus 18.8% in patients with AKI (P-value= 0.000).
Site of ICH: The most prevalent site of cerebral hemorrhage was reported in basal ganglia (15% of patients without AKI versus 18% in patients with AKI) next parietal hemorrhage was reported in 12% of patients without AKI versus 17.2% in patients with AKI then brain stem was reported in 1% of patients without AKI versus 5% in patients with AKI then subarachnoid hemorrhage was reported only in of patients without AKI (1.5%) then intraventricular hemorrhage was reported in 0.8% of

patients without AKI finally cerebellar hemorrhage was reported in 0.5% of patients without AKI versus 0.8% in patients with AKI.

Midline shift: ML shift was reported in 17% of patients without AKI versus 36.8% in patients with AKI (P-value= 0.000).

Hydrocephalus: reported in 5.2% of patients without AKI versus 15.5% in patients with AKI (P-value= 0.000).

DISCUSSION

Our study was done on 500 patients presented with acute stroke within the first 48 hrs after onset and admitted to the Neurology department-Sohag University Hospital, Al-Helal Hospital and Sohag General Hospital.

Prevalence of renal impairment in stroke patients:

AKI is a common complication after acute stroke, more than one fourth of patients (26.7%) developed AKI in the first 2days after the ictus[9]. Reduced eGFR on admission reported in 26.3% of stroke patients[13]. Almost one-third (28.08%) of acute stroke patients presented with moderate or severe renal dysfunction[9]. A similar high proportion of patients who presented within 48h of ictus had renal dysfunction despite the differences in the risk profile of patients[14]. AKI is an independent prognostic factor for mortality after stroke and was present in 14.29% of stroke patients[15]. The prevalence of renal impairment (creatinine> 1.2 mg) in our series about 24.4%. Our findings not only reinforce the results of previous studies but also provide additional data on predictors of renal impairment. The reasons of differences in previous studies may be due to different baseline characteristics of participants, different methods to evaluate renal function and different classification of renal dysfunction.

Clinical characteristics and risk factors of both groups of patients:

Age and renal impairment: AKI developed more frequently in older persons, with a higher creatinine/lower GFR at baseline[15-17]. Our study found that renal impairment on admission more common in older than younger age.

Sex and renal impairment: AKI occurrence was strongly associated with male gender[17]. Our study found that renal impairment on admission in men was slightly more frequent than in women (13.8% versus 10.6% respectively).

Predictors of renal impairment in stroke patients:

The independent predictors of reduced eGFR were age, gender, hematocrit on admission, history of hypertension, history of diabetes, and NIHSS scores upon admission, among which hypertension and diabetes were modifiable factors[13]. Our study found that the predictors of renal impairment were age, conscious level, presence of speech abnormality, hypertension, hyperuricemia, RHD, drug abuse, presence of casts, crystals and albumin in urine analysis, elevated ALT enzyme, leucocytosis and high ESR With this issue is important and has a significant impact on short term outcome of stroke, but studies are lacking.

SUMMARY AND CONCLUSION

The study was done on 500 patients admitted to the Neurology department of Sohag university hospital, Alhelal hospital and Sohag general hospital presented by stroke within the first 48 hours. Patients with a history of renal disease or receiving dialysis for chronic renal failure were excluded. Patients were subjected to detailed medical and neurological evaluation. Stroke severity assessed by NIHSS, Glasgow coma scale and MRCS of power. CT brain is done for all patients

and laboratory studies including serum urea, creatinine, calculated creatinine clearance, uric acid, electrolyte assessment, random blood sugar, liver functions test, coagulation profile, complete blood count and erythrocyte sedimentation rate. Our study found that the prevalence of renal impairment (creatinine> 1.2 mg) in our series 24.4% and its predictors were age, conscious level, presence of speech abnormality, hypertension, hyperuricemia RHD, drug abuse, presence of casts, crystals and albumin in urine analysis, elevated ALT enzyme, leucocytosis and high ESR.

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الملخص العربى

دراسة معدل انتشار القصور الكلوى الحاد على مرضى السكتة الدماغية الحادة

المقدمة

تعتبر السكتة الداغية ثالث اكبر سبب يؤدى الى الوفاة فى الدول الصناعية بعد امراض القلب والاورام الخبيثة. والقصور او الفشل الكلوى الحاد قد يحدث مع مرضى السكتة الدماغية مما يكون له دور تنبئى فى مدى الاعاقة او الوفاة التى قد تحدث لمريض السكتة الدماغية خاصة اذا كان مصحوب ببعض الامراض الاخرى مثل ارتفاع السكر بالدم مع العلم بان الابحاث فى هذا المجال تعد قاصرة الى حد كبير.

الهدف من البحث:-

هو توضيح معدل انتشار القصور الكلوى الحاد فى مرضى السكتة الدماغية الحادة ويشتمل هذا البحث على 500 مريض بالسكتة الدماغية الحادة تم اختيارهم من المرضى المحجوزين بقسم الأمراض العصبية بمستشفى سوهاج الجامعي مستشفى الهلال ومستشفى سوهاج العام

المرضى و طرق البحث:-

1. تاريخ مرضى مفصل وفحص اكلينيكى كامل مع عمل مقياسى: (مقياس درجة السكتة الدماغية NIHSS ومقياس الاعاقة modified Rankin scale)
2. اشعة مقطعية على المخ
3. اشعة تليفزيونية على البطن
4. وظائف كلى وتشمل
   - أ- يوريا
   - ب- كرياتنين
   - ت- حمض البوليك

5. معدل الالكتروليت بالدم وتشمل صوديوم وبوتاسيوم وكالسيوم
6. سكر عشوائى بالدم
7. وظائف كبد
8. معدل تخثر الدم
9. بعض الفحوصات المعملية الاخرى وتشمل
    1) صورة دم كاملة
    2) سرعة ترسيب

النتائج

لقد اظهرت هذه الدراسة ان مرضى السكتة الدماغية الاحياء يكون لهم نسبة كرياتنين اقل من امثالهم الذين توفوا مع العلم بان هناك عوامل اخرى تحدد النتيجة النهائية لمرضى السكتة الدماغية الحادة مثل درجة الوعى ونوعية وشدة السكتة الدماغية ومن هنا يتضح التاثر الكبير لمرضى السكتة الدماغية بالفشل الكلوى ليس فقط على المدى القصير(شهر او اقل) بل ايضا على المدى البعيد

الاستنتاج

اهمية تحديد وظائف الكلى لمرضى السكتة الدماغية وذلك لاهمية الفشل الكلوى وتاثيره على النتيجة النهائية للسكتة الدماغية.