

Study of clinical profile of stroke patients and correlation of clinical stroke scores GREEK score, SIRIRAJ score, ALLEN score in differentiating stroke subtypes.

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Abstract:

Background: Most common cause of mortality worldwide after coronary artery disease is Stroke. It is the commonest cause of disability in adults. Its management depends mainly on differentiating stroke into two subtype's i.e ischemic or hemorrhagic stroke. CT brain is gold standard investigation for distinguishing stroke subtypes. Its use in resource poor settings is delayed because of cost and unavailability, hence delaying the treatment. Clinically it is difficult to diagnose stroke subtypes. Various clinical stroke scores have been developed by combining symptoms, risk factors and lab parameters.

Materials and Methods: We conducted a prospective interventional study to compare efficacy of clinical stroke scores GREEK SCORE, SIRIRAJ SCORE, ALLEN SCORE in differentiating ischemic and hemorrhagic stroke with CT/MRI brain, to compare clinical profile, risk factors, mortality between stroke subtypes. Data was collected from 200 inpatients admitted to in Department of Internal Medicine Basaveshwara Teaching and General Hospital attached to M.R Medical College Kalaburgi. Data was analyzed using SPSS software version 26. Sensitivity, Specificity, PPV, and NPV for these score were tested.

Results: Our study revealed that incidence of ischemic stroke is 83.5% and hemorrhagic stroke is 16.5%. Most common age group involved in ischemic stroke is 51-60 years, in hemorrhagic stroke it is 41-50 years. Hypertension, Type 2 DM, tobacco smoking are risk factors. Mortality is more in hemorrhagic stroke (48 vs 16.7%). Sensitivity, specificity, PPV, NPV, Diagnostic accuracy of Greek score in differentiating hemorrhagic stroke are 81.82%, 90.42%, 62.79%, 96.18% and 89%, Siriraj stroke score in diagnosing hemorrhagic stroke are 87.88%, 92.81%, 70.73%, 97.48% and 92% and Allen score in diagnosing hemorrhagic stroke are 84.85%, 96.41%, 82.35%, 96.99% and 94.50% respectively. We conclude that Allen score and Siriraj stroke score has better specificity and diagnostic accuracy for diagnosing hemorrhagic stroke than Greek score.

Conclusion: Siriraj stroke score and Allen score are better than Geek score in identifying hemorrhagic stroke because of higher sensitivity, specificity and negative predictive value. Disadvantage of Allen score is that it can be calculated only after 24hrs.

Key Word: Greek score, Siriraj stroke score, Allen score, Validity

Date of Submission: 10-01-2023

Date of Acceptance: 27-01-2023

I. Introduction

Most common cause of mortality worldwide after coronary artery disease is Stroke. It is the commonest cause of disability in adults. Its incidence is increasing in developing countries like India. Lifetime risk of developing stroke after 55 years is 1 in 5 in woman and 1 in 6 in men¹. Incidence rate of stroke annually in rural population is more than urban population. Prevalence rate of Stroke in India varies between 40-470/100000 population. Stroke is defined as focal neurological deficit that results from decreased perfusion of the brain⁴. It is due to occlusion or rupture of blood vessels supplying brain. Stroke has 2 main subtypes' ischemic and hemorrhagic⁵. 85% of strokes are due to ischemic, reminder are hemorrhagic⁴. Stroke Mortality rate is higher in India compared to western countries.² Most common age group involved is between 60-70 years, Males are commonly affected than females. M:F ratio 2:1³. Risk factors most commonly seen are hypertension, hypercholesterolemia, tobacco smoking etc.Management depends mainly on differentiating stroke into two subtype's i.e. ischemic or hemorrhagic stroke. CT Brain or MRI brain is done to differentiate stroke subtypes. It is very difficult to diagnose ischemic or hemorrhagic stroke clinically. Clinical stroke scores are developed by combining various clinical parameters to find stroke subtype. They are GREEK SCORE, SIRIRAJ SCORE and ALLEN SCORE.CT Brain is gold standard to classify stroke, but due to availability and cost issues it cannot be used universally, especially in resource poor rural settings⁵. Our aim is to study clinical features,

risk factors, radiological features, mortality between two stroke subtypes, compare and determine accuracy of clinical stroke scores: Greek score, Siriraj stroke score and Allen score in differentiating stroke subtypes and correlate with CT/MRI Brain

II. Material And Methods

This prospective interventional study was carried out on inpatients of Department of General Medicine at Basaveshwara teaching and general hospital, attached to M.R. Medical College Kalaburgi from 1st March 2021 to 31st August 2022 with diagnosis of acute stroke.

Study Design: Prospective interventional study

Study Location: Basaveshwara Teaching and General Hospital attached to M.R Medical College Kalaburgi, a tertiary care teaching hospital

Study Duration: 1st March 2021 to 31st August 2022

Sample size: 200 patients.

Sample size calculation: Sample size is calculated by using WHO software OPENEPI. According to AHA statistical update 87% of stroke cases are ischemic and keeping confidence interval 95%, power 80% prevalence difference 10, sample size comes to be 180 which was rounded off to 200

Subjects & selection method: Study was performed on inpatients admitted with diagnosis of acute stroke to Department of General Medicine Basaveshwara Teaching and General Hospital attached to M.R Medical College Kalaburgi after applying inclusion and exclusion criteria.

Inclusion criteria:

1. Acute stroke: Patients whose neuro deficit lasted for more than 24 hours and CT scan showed either cerebral infarction or intra-cerebral hemorrhage
2. Aged \geq 18 years

Exclusion criteria:

1. Stroke due to tumors, trauma, infections
2. Patient presenting after 72 hours of onset
3. Pure subarachnoid hemorrhage
4. Patients who had insufficient data to calculate scores

Procedure methodology

After approval from institutional ethics committee, study was started. Written informed consent was taken. Then inclusion and exclusion criteria were applied and study population selected i.e. acute stroke cases either ischemic or hemorrhagic. Following details of patient were recorded: age, gender, hypertension, diabetes, smoking, alcohol consumption past history of stroke, TIA, IHD, Rheumatic heart disease, peripheral arterial disease, clinical symptoms :onset of deficit, progression, neurological deterioration within the first 24 hours, vomiting, headache blood pressure, Glasgow Coma Scale, pupil and plantar response, neck stiffness, level of consciousness on admission, 3hrs and 24hrs after admission and basic laboratory investigations like ECG, WBC count, FBS, CT/MRI Brain. All these data entered in a Performa. Clinical stroke scores are calculated using formulas given in Table 1 and results are entered.

Allen's score :It was formulated by physicians of United Kingdom. It consists of following clinical parameters⁶

1. Onset with Symptoms of Loss of consciousness, headache, vomiting
2. Level of consciousness after 24 hrs
3. Plantar response
4. Diastolic BP
5. Atheroma markers : Diabetes
6. Hypertension
7. History of stroke or TIA
8. Heart diseases

Greek stroke score was formulated by a team of physicians from Athens, Greece⁷. It consists of 4 parameters, conscious level on admission, neurological deterioration, history of vomiting and WBC count. All these parameters are taken immediately on admission

Siriraj stroke score is formulated at Siriraj hospital and medical school, Bangkok. Variables that are used in the formulation of this score are as follows consciousness on admission, diastolic B.P, headache, vomiting and presence of atheroma markers⁶

Table 1
Greek score

Neurological deterioration within 3hrs from admission	6
Vomiting	4
TLC >12000	4
Decreased level of consciousness	6

Greek score	Diagnosis
Less than 4	Infarct
4 to 11	Equivocal
More than 11	Hemorrhage

Siriraj score

Variables	Clinical features	Score
Level of consciousness	Alert	0
	Drowsy/stupor	1
	Coma	2
Vomiting	No	0
	Yes	1
Headache	No	0
	Yes	1
Atheroma Markers (diabetes mellitus, angina, intermittent claudication)	None	0
	One or more	1
Diastolic BP	mmHg	
Constant		-12

<-1 =Ischemia, -1 to +1= Equivocal >+1= Hemorrhage

Table 2: Allen score

Symptoms	Score
Onset .LOC,Headache,vomiting,neck stiffness	
None or 1	0
2 or more	+21.9
Level of consciousness(24hrs after admission)	
Alert	0
Drowsy	+7.3
Unconsciousness	+14.6
Plantar response	
Flexor or single extensor	0
Both extensor	+7.1
DBP	DBP*0.17
Atheroma markers like DM, Angina, intermittent claudication	
None	0
1 or more	-3.7
HTN	
No	0
Yes	-4.1
H/O Stroke or TIA	
Absent	0
Present	-6.7
Heart diseases	
None	0
Aortic/mitral murmurs	-4.3
Cardiac failure	-4.3
Cardiomyopathy	-4.3
Atrial fibrillation	-4.3
Cardiomegaly	-4.3
MI within past 6 months	-12.6
Constant	-12.6

>24=Hemorrhage <4=Ischemia
4 to 24 = Equivocal

Statistical analysis

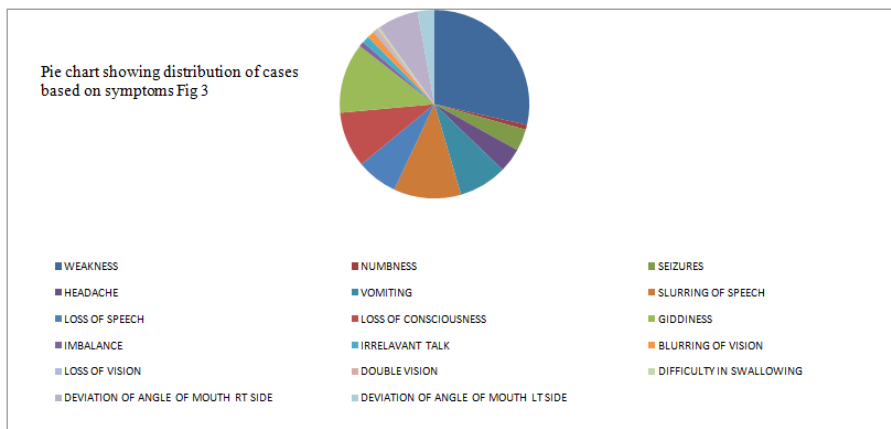
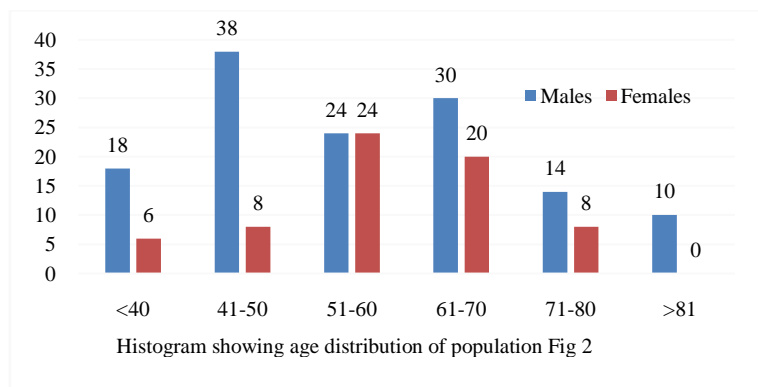
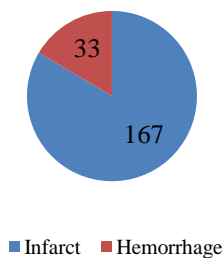
Variables like age, gender, symptoms, co morbidities, habits, etc are grouped into tables and test of significance (Chi-square test) applied and if $p < 0.05$ then it is statistically significant, Results of three stroke scores are calculated and compared with CT/MRI brain. Sensitivity, Specificity, Positive predictive value, Negative predictive value and diagnostic accuracy in diagnosing ischemic and hemorrhagic stroke are calculated. Results of all these scores are compared with one another and with other studies.

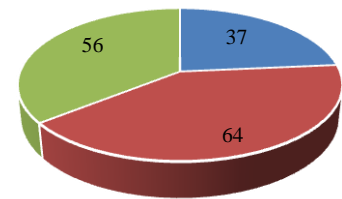
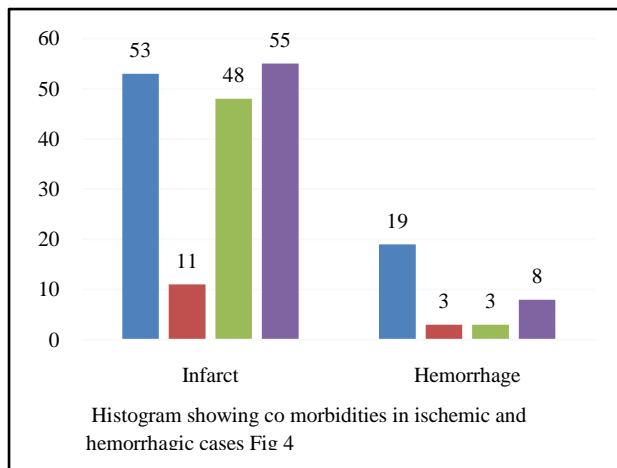
III. Results

Our study included 200 stroke patients, out of which 134 are males and 66 are females, M:F ratio is 2.03:1. This study included patients of age >18 years, least age involved is 28 years and highest age involved is 97 years and more common age group involved is 51-60 years with median age of 55.88 ± 17.447 years (Fig 2). Out of 200 patients 167 had ischemic stroke and 33 had hemorrhagic stroke based on CT/MRI brain (Fig 1). In present study patients most commonly had hemiparesis (43%), hemiplegia (26%), giddiness (29%), slurring of speech (28%) and loss of consciousness (23%) symptoms (Fig 3). Symptoms like headache (69%), vomiting (60%), loss of consciousness (51%) and seizures (21%) are commonly seen in hemorrhagic stroke patients and statistically significant association ($p < 0.05$) In present study out of 167 ischemic stroke patients, 64.24% (112) of cases had co-morbidities, either HTN, DM or both 31% (53) of cases had only HTN, 6.5% (11) had only DM, both HTN and DM were present in 28.7% (48) and neither of them were present in 32.93% (55) of cases. Out of 33 hemorrhagic stroke patients, 75.75% (25) of cases had co-morbidities, either HTN, DM or both. Only HTN in 57.5% (19) of cases, only DM in 9.09% (3), both HTN and DM are present in 9.09% (3) and No co-morbidities were present in 24.24% (8) of cases (Fig 4). Alcohol consumption (18.5%), tobacco chewing (28%),

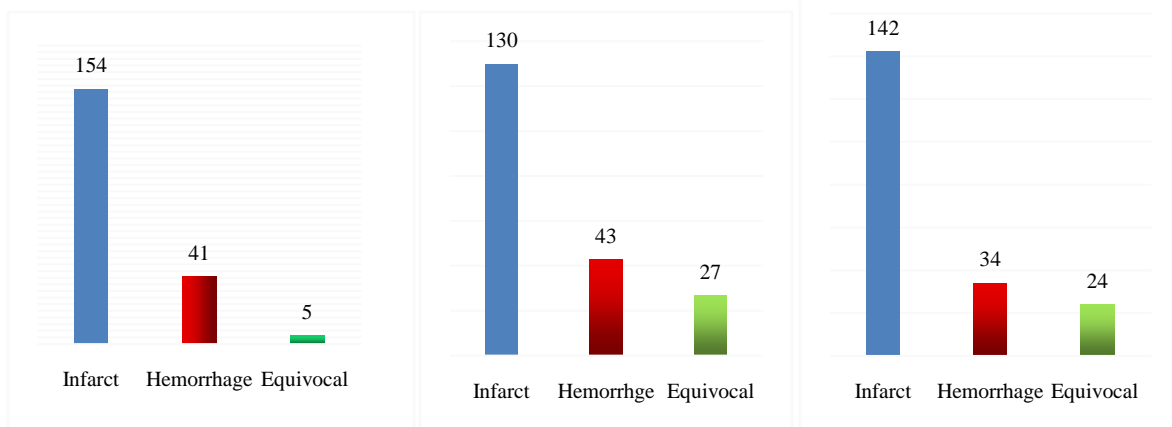
smoking (32%) are common habits in our study (Fig 5) and smoking had statistically significant association with stroke patients ($p < 0.05$ Fischer exact test). Common sites involved in hemorrhagic stroke are midbrain 14 cases (42%) (thalamus, putamen, caudate), lobes 8 (24%), cerebellum 6 (18%), pons 5 cases (15%). Our study had mortality of 44 cases (22%), more in hemorrhagic stroke (48%) compared to ischemic stroke (16.7%). Out of these 44 cases 18 (40%) are posterior circulation stroke. According to Siriraj stroke score (Fig6) 154 were ischemic, 41 were hemorrhagic stroke and 5 were equivocal, Greek score showed that 130 were ischemic, 27 were equivocal and 43 were hemorrhagic stroke. Allen stroke score showed following results 142 were ischemic, 24 were equivocal and 34 were hemorrhagic stroke. On comparison of each score with CT/MRI brain, results were as follows Siriraj stroke score had sensitivity of 91.62% with 95% confidence interval of 86.33% to 95.34% and specificity of 96.96% with 95% confidence interval of 84.24%-99.92% in diagnosing ischemic stroke. Positive predictive value is 99.37% and negative predictive value is 69.58% and diagnostic accuracy is 92.51% in diagnosing ischemic stroke. Siriraj score had a sensitivity of 87.88% with 95% confidence interval of 71.80% to 96.60% and specificity of 92.81% in diagnosing hemorrhagic stroke with 95% confidence interval of 87.78% to 96.23%. Positive predictive value is 70.73%, negative predictive value 97.48% and accuracy of this score in diagnosing hemorrhagic stroke is 92.0%. Greek score had a sensitivity of 77.84% with 95% confidence interval of 70.94% to 83.32% and specificity of 100% in diagnosing ischemic stroke with 95% confidence interval of 89.42% to 100% Positive predictive value of 100%, negative predictive value of 47.14% and accuracy of this score in diagnosing ischemic stroke is 81.50%. It had sensitivity of 81.82% with 95% confidence interval of 64.54% to 93.02% and specificity of 90.42% in diagnosing hemorrhagic stroke with 95% confidence interval of 84.91% to 94.42%. Positive predictive value of 62.79% and negative predictive value of 96.18% and accuracy of this score in diagnosing hemorrhagic stroke is 89.0%. Allen score had a sensitivity of 85.03% with 95% confidence interval of 78.70% to 90.07% % and specificity of 100% with 95% confidence interval of 89.42% to 100% in diagnosing ischemic stroke Positive predictive value of 100% and negative predictive value of 56.90% and accuracy of this score in diagnosing ischemic stroke is 87.50%. It had a sensitivity of 84.85% with 95% confidence interval of 68.10% to 94.89% and specificity of 96.41% with 95% confidence interval of 92.34% to 98.67% in diagnosing hemorrhagic stroke. Positive predictive value of 82.35% and negative predictive value of 96.99% and accuracy of this score in diagnosing hemorrhage is 94.50%.

Pie chart showing CT/MRI brain findings Fig 1





■ Tobacco ■ Smoking ■ Alcohol
Pie chart showing distribution of population based on habits Fig 5



Histograms showing results of Siriraj score, Greek score, Allen score respectively Fig 6

SSC	CT/MRI Brain		Total
	Ischemia	Hemorrhage	
Ischemia	153	1	154
Hemorrhage	12	29	41
Equivocal	2	3	5
Total	167	33	200

GSC	CT/MRI Brain		Total
	Ischemia	Hemorrhage	
Ischemia	130	0	130
Hemorrhage	16	27	43
Equivocal	21	6	27
Total	167	33	200

ASC	CT/MRI Brain		Total
	Ischemia	Hemorrhage	
Ischemia	142	0	142
Hemorrhage	6	28	34
Equivocal	19	5	24
Total	167	33	200

IV. Discussion

First step in management of stroke is ascertaining the stroke subtype, which determines the treatment. CT brain the gold standard investigation to look for hemorrhage in brain. CT/MRI will not be available in resource poor areas and its cost also hinders use in poor patients hence delays treatment. Clinical stroke scores are simple and help in differential diagnosis. This study's population size was 200, most common stroke is ischemic 167 (83.5%) whereas hemorrhagic stroke constitutes 33(17.5%), males are more commonly affected M:F ratio (2.03:1), age group commonly affected is 51-60 years with median age of 55 years. In the study by Jeyaraj Durai Pandian et al²² M:F ratio is 2:1 and ischemic stroke constitutes 83.6% which are comparable to our study. In the present study age, gender are not statistically associated between stroke subtypes. In our study, Hypertension, type 2 DM, hypercholesterolemia are risk factors associated with stroke subtypes. Hypertension was present in 57.25% of hemorrhagic stroke patients, smoking, alcohol consumption and tobacco chewing are other risk factors which is comparable to study by Jeyaraj Durai Pandian et al. In the present study smoking is commonly seen in stroke patients 32% which is statistically significant. In present study headache (69%), vomiting (60%), seizures (50%) and loss of consciousness (21%) are commonly seen in hemorrhagic stroke patients and also statistically significant. Case fatality rate(22%) of our study is similar to Jeyaraj Durai Pandian et al. Greek score is usually applied to identify hemorrhagic stroke, present study conducted in MRMC Kalaburagi showed Greek score has sensitivity of 81.82% and specificity of 90.42% in diagnosing hemorrhagic stroke. In T Berhe et al study, which included 91 patients by stroke diagnosis 42 are ischemic stroke and 49 (47%) are hemorrhagic stroke (53%) whereas in present study proportion of ischemic stroke is 83.5% (167) and hemorrhagic stroke is 16.5% (33).The proportion of hemorrhagic stroke is less in our study compared to T Berhe et al study. T Berhe et al study showed that Greek score has sensitivity, specificity, PPV, NPV of 77.8%, 89.3%, 87.5%, 80.6% respectively in diagnosis of hemorrhagic stroke, whereas present study has sensitivity, specificity, PPV, NPV of 81.82%, 90.42%, 62.79%, 96.18% respectively. In our study sensitivity of Greek score in diagnosing hemorrhagic stroke is higher and specificity is similar when compared to study of T Berhe et al.⁸. When compared to original Greek score, sensitivity and specificity of Greek score in diagnosing hemorrhage is less.

In present study sensitivity of Siriraj stroke score in diagnosis of ischemic stroke is 91.62%. Huang et al, Hong Kong showed its sensitivity is 78 %.. Pongvarin et al showed its sensitivity is 93%⁹. Hawkins et al, Auckland showed its sensitivity is 61 %¹⁰. Kochar et al, Bikaner showed its sensitivity of is 73%¹¹. Badam et al, India study showed its sensitivity is 52 %¹² in diagnosing ischemic stroke respectively. Sensitivity of Siriraj score in diagnosing ischemic stroke in present study conducted in B.T.G.Hospital Kalaburagi (91.62%) is comparable to Pongvarin et al, Wadhvani et al studies., and had higher sensitivity compared to Badam et al, India, Huang et al, Hong Kong, Hawkins et al, Auckland studies. Present study showed Siriraj score had specificity of 96.96% in diagnosing ischemic stroke, we will compare with other studies, in Kochar et al study, Bikaner it was found to be 80%¹¹. Glen et al, New Zealand showed specificity of 70%¹³, Badam et al, India showed specificity of 82 %¹². In Hawkins et al study, Auckland the specificity of 74%¹⁰ for diagnosing infarct respectively. Our study showed that Siriraj stroke score had higher specificity when compared to other studies in diagnosing ischemic stroke. Present study showed that sensitivity of Siriraj score in detecting haemorrhagic stroke was 87.88%. Let us compare it with various other studies conducted worldwide. The sensitivity of Siriraj score for detecting haemorrhage in Pongvarin et al study, Bangkok was found to be 89%⁶. In Hawkins et al study, Auckland it was 48%¹⁰ In Hui et al, Hong Kong study the sensitivity was 91%¹⁴. In Badam et al study conducted in India it was 44%¹². In Kochar et al study conducted at Bikaner the sensitivity was found to be 85%¹¹. On comparison it shows that present study, Siriraj score has higher sensitivity in detecting hemorrhage. The specificity of Siriraj stroke score in diagnosing haemorrhagic stroke in Celani et al, was 94%. In Hawkins et al study it was 85 %¹⁰. In Kochar et al study conducted at Bikaner, the specificity of the score is 90 %¹¹. In Hui et al it was 91%¹⁴ and Badam et al, the specificity of the score is 88 %¹². In present study its specificity was 92.81% in diagnosing hemorrhagic stroke which is similar to the studies mentioned above.

Present study showed that sensitivity of Allen score in detecting ischemic stroke was 85.03%. Let us compare it with various other studies conducted worldwide. In our study sensitivity and PPV of Allen score in diagnosis of ischemic stroke is higher (85.03%, 100%) as compared to study by Clifford C. Mwita et al (70%)¹⁵, study by Hawkins et al (78%, 86%)¹⁰ and study by Sandercock PA et al (78%, 95%)¹⁶. sensitivity of Allen score in diagnosis of ischemic stroke is lesser in present study when compared to study by Kochar et al 91%¹¹. Present study showed that specificity of Allen score in detecting ischemic stroke was 100%. In our study specificity of Allen score in diagnosis of ischemic stroke is higher (100%) as compared to study by Clifford C. Mwita et al (79%)¹⁵, study by Hawkins et al (70%)¹⁰, study by Sandercock PA et al (81%)¹⁶ and study by Kochar et al 60%¹¹.

Present study showed that sensitivity of Allen score in detecting hemorrhagic stroke was 84.85% In our study sensitivity of Allen score in diagnosis of hemorrhagic stroke is higher (84.85%) as compared to study by Clifford C. Mwita et al (54%)¹⁵, study by Kochar et al (60%)¹¹, study by Sandercock PA et al (78%)¹⁶ study by .Celani MG et al (38%)¹⁶ study by Badam et al (81%)¹² and study by Huang JA et al (67%)⁹. In our study specificity of Allen score in diagnosis of hemorrhagic stroke is higher (96.41%) as compared to study by Clifford C. Mwita et al (89%)¹⁵, study by Kochar et al (91%)¹¹, study by Sandercock PA et al (81%)¹⁶, study by Badam et al (76%)¹² and lesser as compared to study by Huang JA et al (100%)⁹, study by Kochar et al (60%)¹¹

V. Conclusion

Siriraj stroke score and Allen score are better than Geek score in identifying hemorrhagic stroke because of higher sensitivity, specificity and negative predictive value. Though clinical stroke scores have better sensitivity lack specificity in detecting hemorrhage. Disadvantage of Allen score is that it can be calculated only after 24hrs. Due to low specificity of clinical stroke scores and complications associated with incorrect use of anticoagulants in hemorrhagic stroke, clinical stroke scores should not be used to diagnose stroke subtype and combining other parameters with these scores to increase specificity may be helpful.

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