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Role of Alberta Stroke Programme Early Computed Tomography Score (PC- ASPECT) in Predicting Functional Outcome of Patients with Posterior Circulation Stroke - A Prospective Observational Study

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Abstract: ***Objective**: 1) To investigate the unfavourable outcome predictors of posterior circulation stroke. 2) To compare the PC-ASPECTS with respect to functional outcome prediction using Modified Rankin Scale and NIHSS (National institute of health stroke scale) 3) To identify the optimal cut-off point for the PC-ASPECTS for predicting favourable and unfavourable functional outcomes. **Sample Size**: Favourable functional outcome prediction in posterior circulation acute ischemic stroke has been observed in 64% from the previous study. Considering the 95% level of confidence interval (Z=1.96) with 10% precision (d=0.1) the minimum required sample size is –*

$$n = \frac{(Z\alpha_{/2})^2 \times p \times (1-p)}{(d)^2}$$

$$n = \frac{(1.96)^2 \times (0.64) \times (1-0.64)}{(0.1)^2} = 88.51 \cong 89$$

Therefore, the minimum required sample for the study is 89. Article considered for the sample size calculation: "Predicting functional outcomes of posterior circulation acute ischemic stroke in first 36 h of stroke onset" by Sheng-Feng Lin. Statistical Analysis Plan: All the qualitative parameters like sex, complaints, risk factors, etc, represented with frequencies and percentages. Quantitative parameters like Age, NIHSS score, PC Aspect score, etc., represented with Mean with standard deviation. To find the association between qualitative factors we used Chi-Square test for measure of association. To find the relation between NIHSS, MRS, PC Aspects scores we used Pearson's correlation. To compare mean difference we used unpaired t-test. P value less than 0.05 considered as significance. Data entered in Ms. Excel and Analyzed by using SPSS 19.0v. Conclusions and Results: 1) It was observed that 50 (55.6%) patients were in the age group of 60 years and above followed by 35 (38.9%) in the age group of 46-60 years. 2) Males were affected more i.e. 72 (80%) compared to the female patients 18 (20%). 3) Most observed co-morbid condition was diabetes in 56(62.2%) patients followed by hypertension in 55(61.1%) patients and smoking in 44(48.9%) patients. 4) Among the study participants 44(48.9%) were smokers. 5) It was observed that the symptoms of headache were present among 62 (68.9%) patients followed by weakness in 57 (63.3%), altered consciousness in 52 (57.8%) and vomiting in 46 (51.1%). 6) Most of the patients were having score 2 according to Modified Rankin scale after 4 weeks follow up. Score 2 seen in 34 (37.8%) patients followed by score 1 in 27(30%), score 3 in 18 (20%), score 4 in 9(10%) and score 5 in 2 (2.2%) patients. 7) In our study the mean age is 63.3 years, NIHHS score is 10, PC-ASPECT is 7.2 and modified Rankin scale score is 2. 8) The correlation of PC-ASPECT, NIHHS and modified Rankin score was observed. 9) The mean NIHHS is 17.43 for PC-ASPECT score <7 score, mean NIHHS is 7.81 for PC-ASPECT score >7 and above. 10) The mean modified rank in score is 3.52 for PC-ASPECT score <7, mean modified rank in score is 1.75 for PC-ASPECT score >7. 11) So our conclusion is that patients with low value of PC-ASPECT score (<7), present with higher value of NIHSS score and have higher value of Modified Rankin score- unfavourable outcome. And the patients with high value of PC-ASPECT score (>7), present with lower value of NIHSS score and low value of Modified Rankin score- favourable outcome. Inference: The present study concludes that the PC-ASPECTS and baseline NIHSS help physicians to predict an unfavourable outcome, both individually and in combination. In addition to the effect of aging, gender, co-morbidity like hypertension, diabetes, addiction factors like smoking a PC-ASPECTS of ≤ 7 was the strongest predictor of unfavorable outcomes in our univariate and multivariate models. The functional outcomes were assessed at day 30 according to the Modified Rankin Scale (MRS), a standardized functional outcome assessment tool.

Keywords: PC-Aspects, CT-Brain, Modified Rankin Scale, NIHSS Score and Stroke.

Abbreviations: NCCT- non contrast computed tomography; PC-ASPECTS (posterior circulation Alberta stroke programme early CT SCORE)

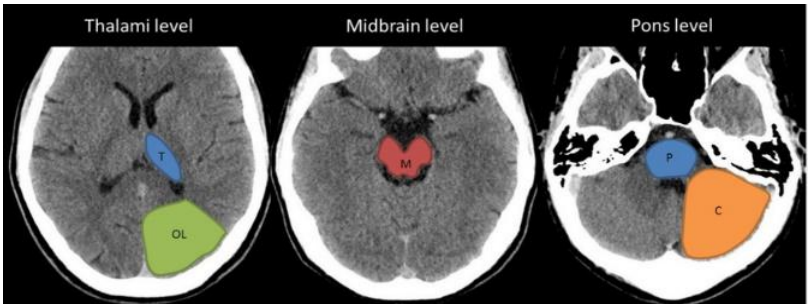
1. Introduction

Posterior circulation infarction accounts for 20% or more of all acute ischemic stroke cases. Acute basilar artery occlusion (BAO) is the most devastating form of posterior circulation infarction, and has a mortality rate of approximately 80%. Patients with Posterior circulation acute ischemic stroke has varied clinical presentations with symptoms of transient neurological attacks of nausea, vomiting, dizziness, and vertigo, vision loss, moderate to severe symptoms of headache, altered consciousness, bulbar signs of slurred speech and dysphagia, weakness, sensory dysesthesia, and ataxia. However, patients with posterior circulation stroke may exhibit a delayed time to presentation, compared with patients with anterior circulation stroke. Until now, no reliable method has been established for predicting the functional outcome of posterior circulation ischemic stroke.

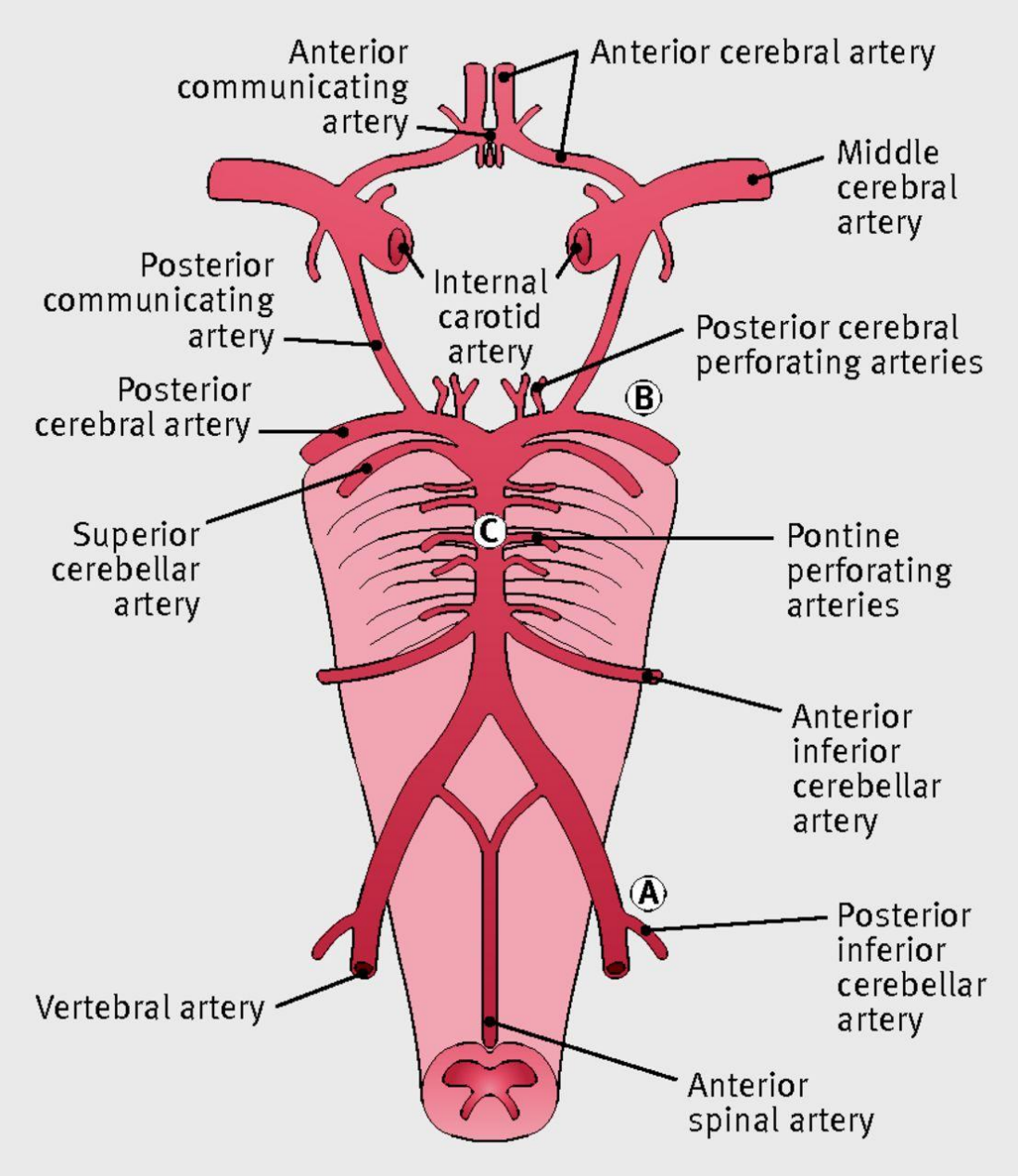
Routine examinations for patients with stroke include clinical assessment and brain imaging.(23)In regional community hospitals and large medical center hospitals, non- contrast brain computed tomography (CT) remains the most widely performed brain-imaging technique because it rap- idly detects hemorrhage, is readily available, and saves time, which are crucial for early management of patient. Despite being widely used, non-contrast CT is not the optimal method of comprehensively assessing posterior circulation infarction. Patients with posterior circulation acute ischemic stroke exhibit varied clinical presentations and functional outcomes.(1)

Transient isolated brainstem symptoms (eg, isolated vertigo, dysarthria, diplopia) are not consistently classified as transient ischaemic attacks (TIAs) and data for prognosis are limited. If some of these transient neurological attacks (TNAs) are due to vertebrobasilar ischaemia, then they should be common during the days and weeks preceding posterior circulation strokes. We aimed to assess the frequency of TNAs before vertebrobasilar ischaemic stroke.(5)

Similar to ASPECTS, posterior circulation Alberta stroke program early CT scores (PC-AS- PECTS) allots 10 points to assess early ischemic changes on computed tomography imaging. These 10 points provide semi quantitative estimates of the region of posterior circulation infarction, which include each side of the cerebellum (1 point), occipital lobe (1 point), Thalamus (1 point), Pons (2 point), and Midbrain (2 point).



Unlike anterior circulation stroke with a consensus ASPECTS of <6 as a robust predictor of unfavorable functional outcomes (UFO) and a relative contraindication of endovascular treatment, studies of posterior circulation infarction have demonstrated a discrepancy when predicting outcomes using baseline PC-ASPECTS. To address this issue, we performed a study to deter- mine whether baseline PC-ASPECTS effectively discriminate between unfavorable and favor- able outcomes.



Key clinical features of posterior circulation infarction according to anatomical location and vascular territory affected 12171822

Lateral medulla (intracranial vertebral artery infarct, also known as Wallenberg syndrome)
Nystagmus, vertigo, ipsilateral Horner's syndrome, ipsilateral facial sensory loss, dysarthria, hoarseness, and dysphagia
Contralateral hemisensory loss in the trunk and limb—pain and temperature

Medial medulla
Ipsilateral tongue weakness and later hemiatrophy of the tongue
Contralateral hemiparesis of the arm and leg
Hemisensory loss—touch and proprioception

Pons
Hemiparesis or hemisensory loss, ataxic hemiparesis, dysarthria, horizontal gaze palsy
Complete infarction causes "locked-in syndrome" with quadriparesis, loss of speech, but preserved awareness and cognition, and sometimes preserved eye movements

Top of the basilar (distal basilar occlusion)
Somnolence, confusion (from thalamic infarction)
Bilateral loss of vision, unawareness or denial of blindness (from bilateral occipital infarction)
Posterior inferior cerebellar artery
Truncal ataxia, vertigo (limb ataxia may occur, especially if the inferior cerebellar peduncle is affected)

Posterior cerebral artery
Contralateral homonymous hemianopia (from occipital infarction)
Hemisensory loss—all modalities (from thalamic infarction)
Hemi-body pain—pain (usually with a burning quality) down one side of the body (face, arm, and leg) as a result of thalamic infarction
If bilateral, may have poor visual-motor coordination, inability to understand visual objects (7)

Posterior Circulation Supply

Posterior Cerebral Artery (PCA)
- Posterior choroidal arteries

Basilar Artery
- Superior Cerebellar Artery (SCA)
- Anterior Inferior Cerebellar Artery (AICA)
- Posterior Inferior Cerebellar Artery (PICA)

2. Materials and Methods

Study Design and Patient Population

1) **Data Source:** Study of 90 patients who are referred to the Department of Radio- diagnosis with clinical symptoms and signs characteristic of posterior circulation acute ischemic stroke and who underwent CT brain within 36 h of stroke onset. A study assessed the PC-ASPECTS with imaging performed within 36 hr.
2) **Study Design:** Prospective observational study
3) **Our inclusion criteria included**
   a) Patients presented with clinical symptoms and signs characteristic of posterior circulation acute ischemic stroke and who underwent CT brain within 36 h of stroke onset. A study assessed the PC-ASPECTS with imaging performed within 36 hr.
   b) Cases who had given consent.
4) **Our exclusion criteria included**
   a) Patients with intracranial hemorrhage, subarachnoid hemorrhage, subdural hemorrhage, epidural hemorrhage, and venous territory infarction and those with both anterior and posterior circulation ischemic stroke.
   b) Pregnancy
5) **Ethical Justification for Study:** The study was carried out only after approval by Institutional Ethical Committee of this tertiary care institute.
6) **Image Acquisition:** All images were obtained as per standard of care protocols. Computed Tomography scans were done by Siemens 128 slice CT machine in GMC Nagpur.
7) **Image Interpretation:** The neurologic imaging characteristics of acute posterior circulation infarct were evaluated and PC-ASPECT score was calculated by the institution's four radiologists. (Two junior residents and two radiologists of 25 years experience).

We reviewed the electronic medical records to extract clinical, laboratory, and demographic data.

Modified Rankin scale:

The scale runs from 0–6, running from perfect health without symptoms to death.

0	No symptoms
1	No significant disability. Able to carry out all usual activities, despite some symptoms.
2	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
3	Moderate disability. Requires some help, but able to walk unassisted.
4	Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
5	Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
6	Dead

The study was conducted in a tertiary care hospital, in the Department of Radio-diagnosis.

NIHSS Scoring			
Scale Item	Coma	Difficult or Confused	Tips
1a LOC Responsiveness	2 - for some movement 3 - Flaccid or no movement	0 - if awake, alert	Can usually tell score by greeting
1b LOC Questions	2	1 - ET tube, trauma, severe dysarthria; 2 - Aphasia,stupor, confusion	Score initial response; pt may write answers.
1c LOC Commands	2	2 - if unable to understand or follow the commands	You are not testing grip strength. May pantomime if pt doesn't respond to command; ok if impaired by weakness
2 Best Gaze	0 if normal eye movement noted	0 if patient able to track your movements	Coma - hold eyes open and turn head side-to-side. Confused - Make eye contact and move to other side of bed
3 Visual	0 if blinks to visual threat 3 if no blink in any field 3 if blind due to any cause	0 if blinks to visual threat 3 if no blink in any field 3 if blind due to any cause	Three ways to test - finger counting, finger movement or threat; test in 4 quads of each eye separately
4 Facial Palsy	3	If patient is verbal, observe for facial droop. If confused and nonverbal, use noxious stimulation to elicit grimace	Check NLF in advance; score 1 for minor asymmetry on smiling; score 2 major for asymmetry of smile; score 3 for absence of movement in upper **and** lower face
5a, 5b Motor arm	3 for no effort against gravity 4 for no movement at all	If unable to follow directions, use observation to score. Is the patient using the arm?	**UN**testable only with amputation or fusion.
6a, 6b Motor leg	3 for no effort against gravity 4 for no movement at all	If unable to follow directions, use observation to score. Is the patient moving the leg?	**UN**testable only with amputation or fusion.
7 Limb ataxia	0	0 if unable to follow directions	Absent if paralyzed or unable to understand. **UN**testable only with amputation or fusion
8 Sensory	2	Use pinprick and observe patient's reactions if patient unable to cooperate	Ask pt, "can you feel this, can you feel this, and does it feel the same on each side"; (do not ask if sharper/duller)
9 Best Language	3	Choose score for stupor/limited cooperation: 2 - listener carries burden of communication; 3 - garbled or mute AND not following commands	Best language and COMPREHENSION; describe scene, name objects and read phrases. If blind, place object in hand and have patient describe
10 Dysarthria	2	1 - Difficult to understand (regardless of cause), 2 - speech not understandable, garbled	Listen to their words; if they can't read - have them repeat words or listen to the words they do say **UN**testable only with physical barrier
11 Extinction and Inattention	0	Score only if present	Looking for lack of awareness with double tactile/visual stimulation

NATIONAL INSTITUTES OF HEALTH stroke scale

CATEGORY	STROKE SCALE	SCORE
1a. Level of consciousness Alert, Drowsy, etc	0 Alert; 1 Drowsy; 2 Stuporous; 3 Coma	
1b. LOC Questions Month, age	0 Answers both correctly; 1 Answers one correctly; 2 Incorrect	
1c. LOC Commands Open/close eyes, make a fist & let go	0 Obeys both correctly; 1 Obeys one correctly; 2 Incorrect	
2. Best Gaze Eyes open - pt follows examiner's fingers or face.	0 Normal; 1 Partial gaze palsy; 2 Forced deviation	
3. Visual Introduce visual stimulus/threat to pt's visual field quadrants. Cover 1 eye and hold up fingers in all 4 quadrants.	0 No visual loss; 1 Partial hemianopsia; 2 Complete hemianopsia; 3 Bilateral hemianopsia	
4. Facial Palsy Show teeth, raise eyebrows and squeeze eyes tightly shut.	0 Normal; 1 Minor; 2 Partial; 3 Complete	
5.a Motor Arm - Left Elevate extremity to 90 degrees and score drift/movement. Count to 10 out loud and use fingers for visual cue.	0 No Drift; 1 Drift; 2 Can't resist gravity; 3 No effort against gravity; 4 No Movement NT = Amputation, joint fusion	
5.b Motor Arm - Right Elevate extremity to 90 degrees and score drift/movement. Count to 10 out loud and use fingers for visual cue.	0 No Drift; 1 Drift; 2 Can't resist gravity; 3 No effort against gravity; 4 No Movement NT = Amputation, joint fusion	
6.a Motor Leg - Left Elevate extremity to 30 degrees and score drift/movement. Count to 5 out loud and use fingers for visual cue.	0 No Drift; 1 Drift; 2 Can't resist gravity; 3 No effort against gravity; 4 No Movement NT = Amputation, joint fusion	
6.b Motor Leg - Right Elevate extremity to 30 degrees and score drift/movement. Count to 5 out loud and use fingers for visual cue.	0 No Drift; 1 Drift; 2 Can't resist gravity; 3 No effort against gravity; 4 No Movement NT = Amputation, joint fusion	
7. Limb Ataxia Finger to nose, heal down shin	0 Absent; 1 Present in one limb; 2 Present in two limbs	
8. Sensory Pin prick to face, arms, trunk, and legs - compare sharpness side to side	0 Normal; 1 Partial loss; 2 Severe Loss	
9. Best Language Name items, describe picture, and read sentences. Don't forget glasses if they normally wear them.	0 No aphasia; 1 Mild to moderate aphasia; 2 Severe aphasia; 3 Mute	
10. Dysarthria Evaluate speech clarity by pt reading or repeating words on list.	0 Normal articulation; 1 Mild to moderate dysarthria; 2 Near to unintelligible or worse NT = Intubated or other physical barrier	
11. Extinction and Inattention Use information from prior testing or double simultaneous stimuli testing to identify neglect. Face, arms, legs, and visual fields.	0 No neglect; 1 Partial neglect; 2 Complete neglect	

NT = Not Testable acceptable as noted above

Score	Stroke Severity
0	No stroke symptoms
1-4	Minor stroke
5-15	Moderate stroke
16-20	Moderate to severe stroke
21-42	Severe stroke

TOTAL =

Saebo

3. Discussion

Our study demonstrated that the PC-ASPECT score determination by non-contrast CT brain helps to determine the functional outcome of the patient.

The effect of co-morbidity like diabetes, hypertension and smoking on PC-ASPECT score.

The relation between NIHHS score, Modified Rankin scale and PC-ASPECT score in prediction of functional outcome of patient.

In our study we came to conclusion that the patients with lower PC-ASPECT values presented with high NIHSS score and also have higher value of Modified Rankin score after 4 weeks follow up.

The PC-ASPECTS and baseline NIHSS help physicians predict an unfavourable outcome, both individually and in combination. In addition to the effect of aging, gender, co-morbidity like hypertension, diabetes, addiction factors like smoking a PC-ASPECTS of ≤ 7 was the strongest predictor of unfavourable outcomes in our univariate and multivariate models.

A large percentage of patients with a PC-ASPECTS score of ≤ 7 had unfavorable outcomes.

The age stratification analysis results reveal that 55.6% patients were in the age group of 60 years and above.

The patients had a clinical presentation that included symptoms of dizziness, vertigo, neck pain, headache, and signs of Horner syndrome. Although these symptoms and signs are necessary for an acute stroke diagnosis, the NIHSS scoring system does not provide a score for them. Because the NIHSS is weighted more toward anterior circulation symptoms and signs, the PC-ASPECTS or MRI is more suitable for the diagnosis and assessment of posterior circulation ischemic stroke, particularly in older patients who may not be able to adequately describe their symptoms. Therefore a combination model of the PC-ASPECTS and baseline NIHSS had an additive effect because the PC-ASPECTS is more powerful in detecting unfavorable outcomes.

For patients with basilar artery occlusion, According to our review of the relevant literature, for patients with small artery occlusion in the posterior circulation, no study has investigated whether the PC-ASPECTS is suitable for functional outcome prediction with CT as an imaging modality.

In conclusion, both the PC-ASPECTS and NIHSS help clinicians predict functional outcomes. The PC-ASPECTS is more reliable than the NIHSS in minor stroke prediction. We determined that the combination of the PC-ASPECTS and NIHSS has an addictive effect in predicting the functional outcomes of patients with posterior circulation stroke.

The functional outcomes were assessed at day 30 according to the modified Rankin Scale (MRS) , a standardized functional outcome assessment tool with the following score ranges: 0–2, no symptoms to slight disability; 3–5, moderate to severe disability; and 6, death. Patients with MRS scores of 0–2 and 3–5 were categorized into the favourable and unfavourable outcome groups, respectively. MRS score of 0–2 should be selected as a favorable outcome because the ability to perform complex activities of daily life was the major consideration. (10)

The patient with co-morbidity have a low value of PC-ASPECT and higher value of NIHHS score and have higher value of Modified Rankin score, same applies to patient with abusive habit like smoking.

So our conclusion is that patients with low value of PC-ASPECT score (<7), present with higher value of NIHSS score and have higher value of Modified Rankin score- unfavourable outcome. And the patients with high value of PC-ASPECT score (>7), present with lower value of NIHSS score and low value of Modified Rankin score- favourable outcome.

Tables and Figures

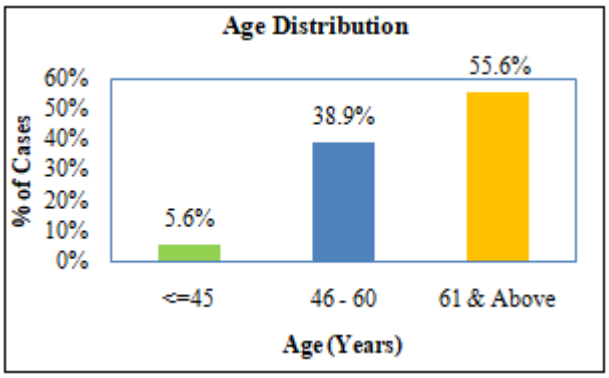


Chart 1: Age-wise distribution of study participants

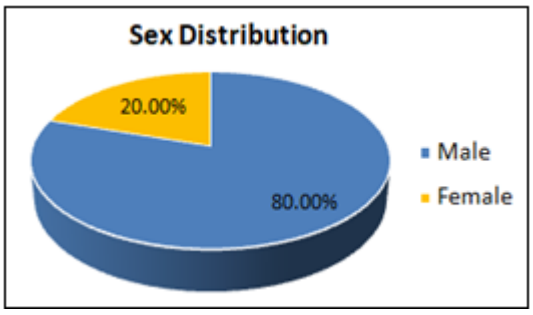


Chart 2: Gender-wise distribution of study participants

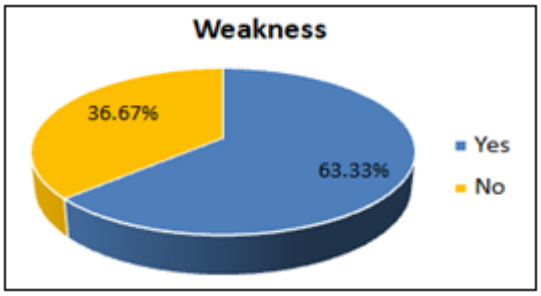
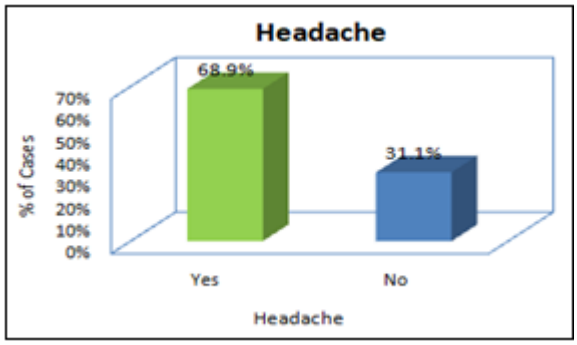
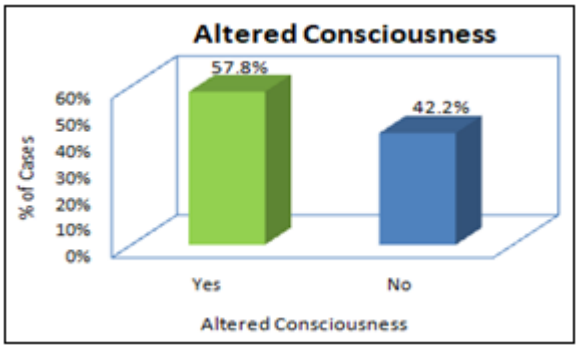


Chart 3: Symptom wise distribution of study participants





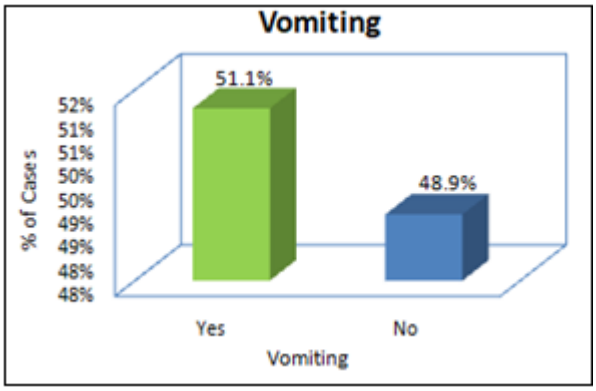
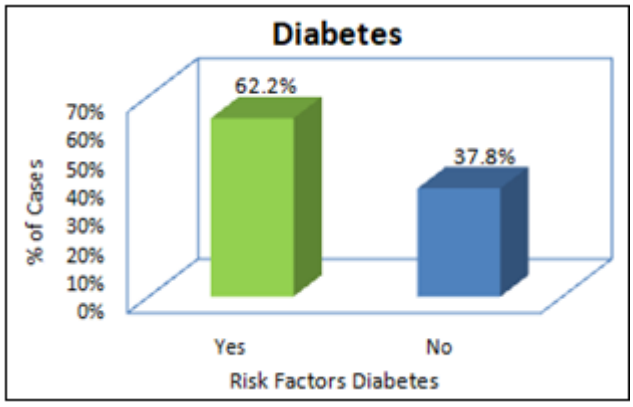
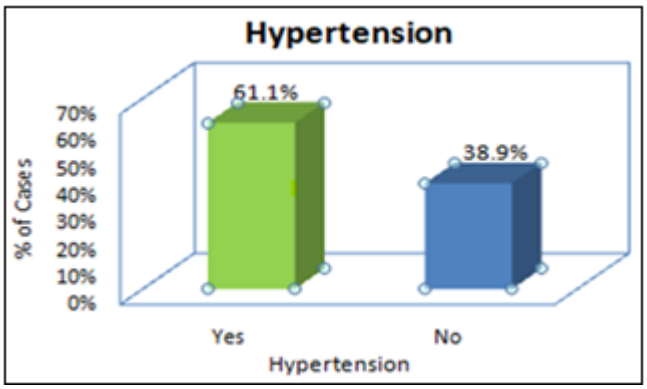
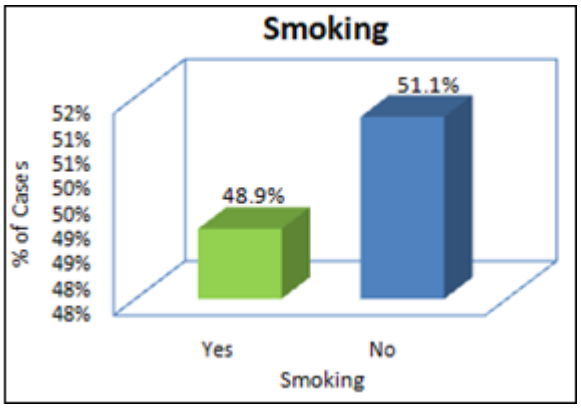


Chart 4: Study participants with associated comorbidity







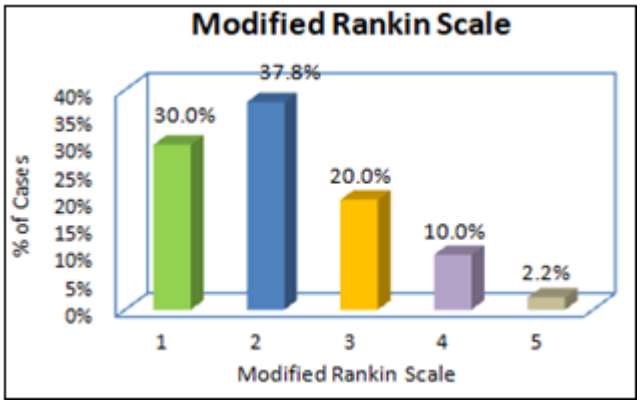


Chart 5: Modified Rankin score of study participants

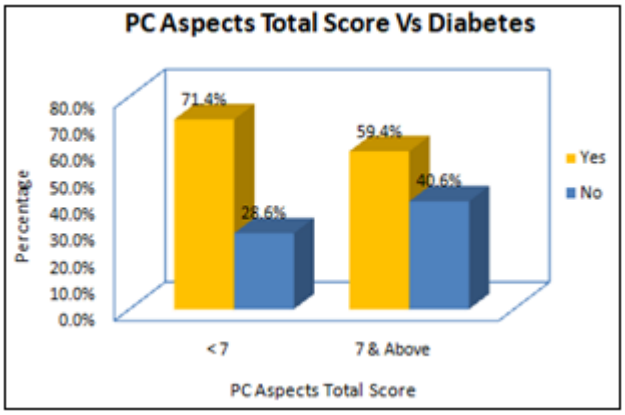


Chart 6: The effect on PC ASPECT score in patients with Co-morbidity like diabetes.

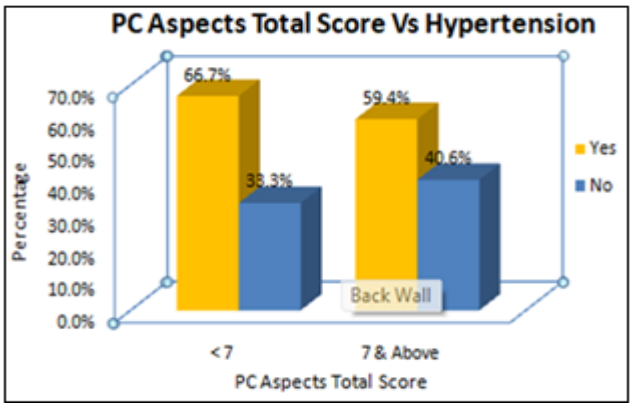


Chart 7: The effect on PC ASPECT score in patients with Co-morbidity like hypertension.

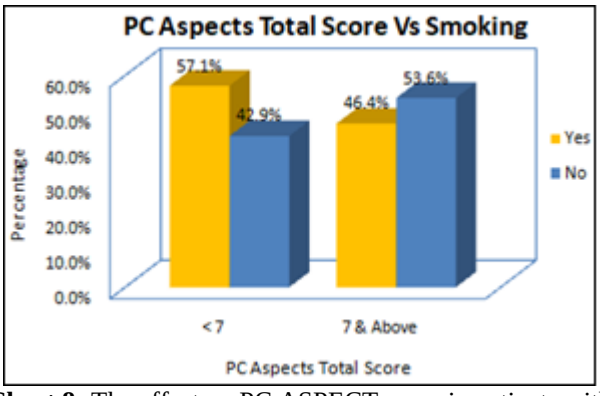


Chart 8: The effect on PC ASPECT score in patients with addiction like smoking.

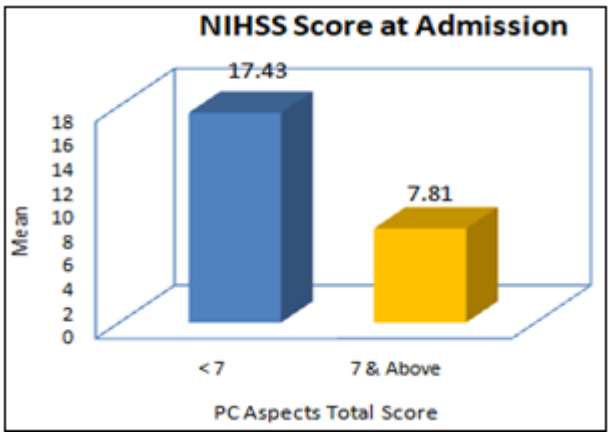


Chart 9: The comparison between PC-ASPECT SCORE and NIHSS score

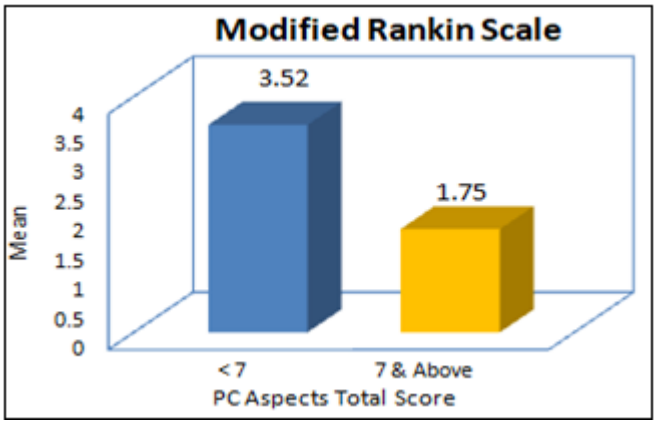


Chart 10: The comparison between PC-ASPECT score and Modified Rankin score.

Case 1

Reveals ill defined hypo density of average attenuation 22HU involving right occipital lobe s/o acute non-hemorrhagic right PCA territory infarct.

Case 2

Reveals hyperdense basilar tip due to acute thrombotic occlusion. Grey-white matter differentiation is preserved. The midline and posterior fossa structures are otherwise normal.

Case 3

Acute non-hemorrhagic lacunar infarct seen involving left thalamus.

Case 4

Reveals ill defined hypo density of average attenuation 28 HU involving midbrain s/o acute non-hemorrhagic brainstem infarct.

Case 5

Reveals ill defined hypo density of average attenuation 26 HU involving pons and right cerebellar hemisphere s/o acute non-hemorrhagic posterior circulation infarct

Case 6

Reveals ill defined hypo density of average attenuation 27 HU involving left cerebellar hemisphere s/o acute non-hemorrhagic left posterior inferior cerebellar artery (PICA) territory infarct.

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1) Department of Radiodiagnosis, Government Medical College, Nagpur
2) Department of Medicine and all Other Clinical Departments, Government Medical College, Nagpur

Conflicts of Interest Statement: None

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