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ARTICLE

ASPECTS correlates with Scandinavian Stroke Scale for predicting early neurological impairment

Correlação do ASPECTS com a escala Escandinava de AVC para predizer comprometimento neurológico precoce

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ABSTRACT

Objective: To investigate the correlation between the Alberta Program Early CT Score (ASPECTS) and the Scandinavian Stroke Scale (SSS) for the evaluation of neurological impairment in patients with acute stroke. **Method:** 59 patients with a first acute ischemic stroke were evaluated. The ASPECTS were evaluated by 2 neurologists at admission and by another neurologist after 48 hours. The NIHSS and SSS was applied to determinate stroke severity. Correlations and agreements were analysed statistically by Spearman and Kappa tests. **Results:** ASPECTS was correlated with National Institute of Health Stroke Scale (NIHSS) at admission ($r = -0.52$; $p < 0.001$) and SSS ($r = 0.50$; $p < 0.001$). The ASPECTS and SSS items were most correlated with arm ($r = 0.52$; $p < 0.001$) and hand ($r = 0.49$; $p < 0.001$) motor power, and speech ($r = 0.51$; $p < 0.001$). The SSS of 25.5 shows sensitivity (68%) and specificity (72%) when associated with ASPECTS ≤ 7. **Conclusion:** The SSS can predict worst neurological impairment when associated with lower values of ASPECTS.

Keywords: stroke, neuroimaging, outcome measures, scales.

RESUMO

Objetivo: Investigar a relação entre o *Alberta Program Early CT Score* (ASPECTS) e a *Scandinavian Stroke Scale* (SSS) para avaliação da incapacidade neurológica de pacientes na fase aguda do acidente vascular cerebral (AVC). **Método:** 59 pacientes com diagnóstico de primeiro AVC foram avaliados. O ASPECTS foi avaliado por 2 neurologistas na admissão e por outro neurologista após 48 horas. O National Institute of Health Stroke Scale (NIHSS) e SSS foram aplicadas para determinar a gravidade do AVC. As correlação e concordâncias foram analisadas estatisticamente pelos testes de Spearman e Kappa. **Resultados:** ASPECTS foi correlacionado com o NIHSS na admissão ($r = -0,52$; $p < 0,001$) e SSS ($r = 0,50$; $p < 0,001$). O ASPECTS e os itens do SSS que mais se relacionaram foram força do braço ($r = 0,52$; $p < 0,001$), da mão ($r = 0,49$; $p < 0,001$) e fala ($r = 0,51$; $p < 0,001$). A pontuação da SSS de 25,5 mostrou sensibilidade (68%) e especificidade (72%) quando associado ao ASPECTS ≤ 7. **Conclusão:** A SSS pode predizer pior incapacidade neurológica quando associado a baixos valores do ASPECTS.

Palavras-chave: acidente vascular cerebral, neuroimagem, medidas de desfecho funcional, escalas.

In Brazil as well as worldwide, stroke is among the leading causes of the functional disability and death in the adult population[1,2,3,4,5]. The increasing importance of imaging studies in recent years has led to the appearance of objective scales for evaluation of severity, such as the Alberta Program Early CT Score (ASPECTS), which subdivides the territory of the middle cerebral artery (MCA) into ten standardized regions evaluated by cranial CT[6,7].

The ASPECTS is a precise and practical method for evaluating stroke in the acute phase and is indicated especially in the first 6 hours after the initial event to detect early changes in the hyperacute phase and predict the possibility of haemorrhagic transformation, by outlining the severity of the ischemic area[8,9,10]. Recently we validated the SSS for the Brazilian population and found it useful for evaluating severity in stroke patients in our country[11]. This study aimed to investigate the

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correlation between the ASPECTS and the Scandinavian Stroke Scale (SSS) to evaluate the severity of neurological deficit in Brazilian patients with acute stroke involving the middle cerebral artery (MCA), to relate each item on the SSS scale with ASPECTS and to identify whether there is some cutoff value of SSS that maximizes the sensitivity and specificity of the severity in a worst neurological impairment. The first hypothesis of the study is that lower values of ASPECTS are positively correlated with lower SSS values, especially with specific items from the scale that evaluates the MCA territory.

METHOD

The study is a prospective series of cases that includes 59 individuals, of both sexes, admitted to the Stroke Unit of the Botucatu Medical School in the period from March to December of 2012 with a diagnosis of ischemic stroke – confirmed by clinical examination and noncontrast CT scan – in middle cerebral artery territory confirmed by the classification of BAMFORD[12], and excluding patients with ischemic stroke in the anterior or posterior cerebral artery territory, haemorrhagic stroke, prior stroke, presenting a modified Rankin Scale (mRS) score prior to admission ≥ 1, previous diagnosis of dementia or patients that were eligible for and received any type of treatment by cerebral reperfusion therapy (intra-arterial or intravenous).

At the admission in the stroke unit, the first procedure was clinical attention by means of neurological examination and National Institutes of Health Stroke Scale (NIHSS) by neurovascular physician of the Stroke Unit; then a noncontrast CT scan was obtained for clinical procedures and determination of the ASPECTS by 2 neurologists from the stroke team at admission independently. The new evaluation was applied after 48 hours by another expert neurologist to determine the neurological impairment severity through NIHSS[13], and the quantitative severity of paralysis and incapacity according to SSS[11]. These scales were applied without knowledge of the previous ASPECTS value at admission and performed by a neurologist certified in these scales. The study was approved by the Ethics Committee on Human Research of our Institution and all the patients or their guardians signed terms of free and informed consent to be included.

Statistical analysis

The concordance between the 2 neurologists for ASPECTS scoring at admission was evaluated by the Kappa coefficient. The relation among SSS, NIHSS and ASPECTS was assessed by the Spearman correlation and linear regression model considering the potential confounders (age, sex, topography of lesion and NIHSS at admission). The test of Shapiro-Wilk was performed to indicate whether the linear regression was adequate. The correlation between the items SSS and ASPECTS was measured by means of the Spearman correlation. The cutoff value of SSS that maximizes the sensitivity and specificity of the severity of the worst neurological impairment was estimated by constructing ROC curves using the ASPECTS. Significance was set at p less than 0.05. Statistical analyses were performed using the software SPSS v.15.0.

RESULTS

Based on the exclusion criteria, 151 individuals had been excluded from the study: 42 patients received a cerebral reperfusion therapy, 14 presented previous diagnosis of dementia, 28 had a prior stroke, 38 presented haemorrhagic stroke, 8 had an ischemic stroke in posterior cerebral artery territory, 12 had an ischemic stroke in anterior cerebral artery territory and 9 presented a mRS > 1 at admission. The 59 studied patients were comprised of 17 males and 42 females, with mean age of 66 years. The concordance between the 2 neurologists for ASPECTS was – Kappa coefficient = 0.706; $p < 0.001$. The ASPECTS values ranged from 5 to 10 (median = 9), NIHSS varied from 0 to 25 (median = 8); after 72 hours the NIHSS values ranged from to 0 to 31 (median = 6), while SSS varied from 4 to 58 (median = 34). At admission, the higher the ASPECTS, the lower the NIHSS values, -r = -0.56. After 48 hours the ASPECTS score was negatively correlated with NIHSS (-0.52) but positively related to SSS (r = 0.50).

Table 1 shows that ASPECTS accounts for 63.5% of the SSS variability. For each unit of increase in ASPECTS, there is a corresponding rise of 1.57 points in the SSS median considering the potential confounders. The p-value (p = 0.17) obtained by the Shapiro-Wilk test signifies that the adjustment was appropriate.

The correlations between ASPECTS and SSS items (Table 2) were assessed for consciousness (r = 0.23; p = 0.082), eye movements (r = 0.23; p = 0.074), arm motor power (r = 0.52; $p < 0.001$), hand motor power (r = 0.49; $p < 0.001$), leg motor power (r = 0.33; p = 0.010), orientation (r = 0.28; p = 0.031), speech (r = 0.51; $p < 0.001$), facial palsy (r = 0.21; p = 0.108), gait (r = 0.18; p = 0.167) and maximal score (r = 0.50; p = 0.001).

The Scandinavian Stroke Scale score of 25.5 shows sensitivity and specificity of 68% and 72%, respectively, when associated with ASPECTS ≤ 7 for the worst neurological impairment (Figure 1). Among the items on the Scandinavian Stroke Scale, speech presented sensitivity and specificity, respectively, of 72% and 78% (Figure 2).

DISCUSSION

In the present study, the ASPECTS values have demonstrated a closer association with the severity scales to identify neurological deficit and acute-phase outcome. The medical literature reports that low ASPECTS values were correlated with a high NIHSS score and a reduced long-term functional capacity[14,15,16].

Table 1. Adjusted regression model to explain the median SSS score as a function of the ASPECTS score considering the potential confounders.

Variable	β	ep	p	95%IC	
Constant	33.14	12.61	0.013	7.45	58.83
ASPECTS	1.57	1.03	0.136	-0.52	3.66
Age (years)	-0.09	0.12	0.469	-0.33	0.15
Sex (male)	5.74	3.30	0.091	-0.98	12.46
Topography (left side)	5.44	3.39	0.118	-1.46	12.34
NIHSS at admission	-1.61	0.29	0.000	-2.19	-1.03

R^2 = 63.5%; Residue analysis: p = 0.178 (Shapiro-Wilk); ASPECTS: Alberta Program Early CT Score; SSS: Scandinavian Stroke Scale; NIHSS: National Institute of Health Stroke Scale.

Table 2. Correlation between ASPECTS scale score and SSS items in acute phase of stroke.

Scale	Items	r	p-value
SSS	Consciousness	0.23	0.082
	Eye movements	0.23	0.074
	Arm, muscular strength	0.52	0.000
	Hand, muscular strength	0.49	0.000
	Leg, muscular strength	0.33	0.010
	Orientation	0.28	0.031
	Speech	0.51	0.000
	Facial paralysis	0.21	0.108
	Movement	0.18	0.167
	Total score	0.50	0.000

SSS: Scandinavian Stroke Scale; ASPECTS: Alberta Program Early CT Score; r: Spearman correlation.

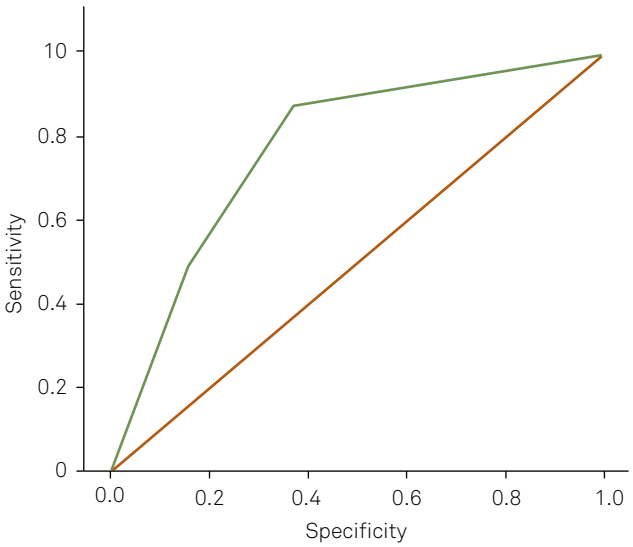

Figure 1. Sensitivity and specificity of total Scandinavian Stroke Scale score with ASPECTS values.

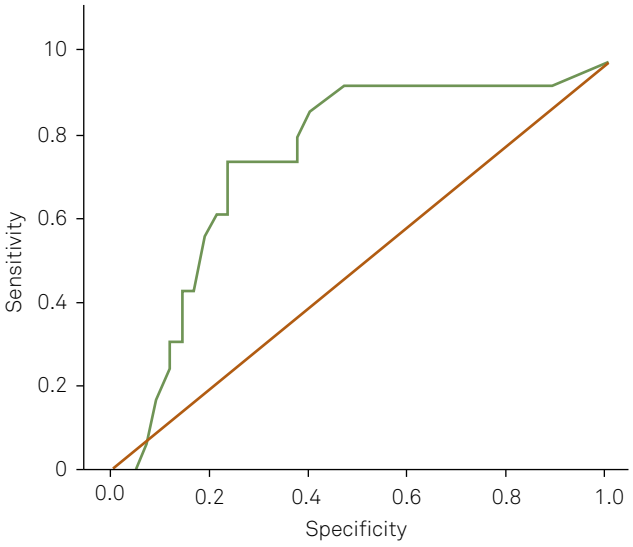

Figure 2. Sensitivity and specificity of speech item on Scandinavian Stroke Scale with ASPECTS values.

The kappa coefficient presented between the two neurologists in our study shows moderate results. The interagreement concordance values of ASPECTS change with a clinical experience, but is highly recommended for the clinical practice in neurovascular[8]. In study to analyses the interagreement confiability of ASPECTS to intra-arterial stroke treatment selection, the coefficient of correlation was 0.77, and when ASPECTS was dichotomized in ≤ 7 or > 7, the value was 0.53[17]. These findings suggest that the ASPECTS is dependent evaluator and the concordance rate in our study is in agreement with the international studies.

The NIHSS is the principle scale utilized in the acute phase for its specific items that define the neurological severity and predict the prognosis starting at the admission of the patient[7,13]. In our study, we observed a strong association between the ASPECTS scores and NIHSS values at admission into the stroke unit, which reflects the relation between the ischemic area and severity of neurological deficit.

Diverse authors report that ASPECTS is closely associated with the functional outcome of the dichotomous approach (> 7 vs. ≤ 7), having limited performance when only its value is evaluated in isolation to define the prognosis[7]. In our study, we observed a mild association between ASPECTS values and the scales of evaluation the neurological impairment in the acute phase of stroke[18,19]. For each ASPECTS score increase at hospital admission, there was a 1.5-point improvement in SSS, a determinative indicator in the neurological impairment after the acute phase of stroke.

The highest correlation of ASPECTS with the SSS items was with the upper limbs (strength of the arm and hand) and speech. Diverse studies emphasize that the territory irrigated by the MCA presents greater cortical representation for the hand and speech, given that brachial paresis, global aphasia and comprehension disorders are found with greater frequency in infarcts in these territories[20,21].

The SSS is currently utilized to predict the severity of the neurological impairment[22,23,24]. When ASPECTS was associated with total SSS score, it was observed that the values below 25.5 presented higher sensitivity and specificity for scores ≤ 7, a finding demonstrating that values below this endpoint should not be considered alarming from the neurological and

functional point of view, with this association being demonstrated in a manner unreported by the literature.

Limitations arising in our study included not delimiting confounding factors for acute-phase outcome such as levels of glycaemia and haemoglobin, as well as its small sample size of patients. Despite the limits of the study, ASPECTS represents a useful system for detecting the ischemic area, besides being a consistent predictor of prognosis. Given that cranial tomography is performed in Brazil and several other countries on the majority of acute-phase stroke patients, ASPECTS must be proposed as a tool for objective evaluation due to its low cost and high benefit. However, we emphasize the need for extensive training with the scales and the interpretation of images by the stroke team.

In conclusion, the Scandinavian Stroke Scale showed better sensitivity and specificity when associated with lower values of ASPECTS, especially in speech, for predicting worst early neurological impairment, while the SSS demonstrated correlation with speech and upper-limb functions during the acute phase of a stroke involving the middle cerebral artery.

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