Computed Tomography Angiography spot sign



Wada et al. in 2007 first reported Computed Tomography Angiography spot sign as a predictor for hematoma expansion in spontaneous intracerebral hemorrhage ¹⁾, which was considered to be related to continuous bleeding ²⁾. ³⁾.

Compared with previously reported predictors for hematoma expansion on non-enhanced CT, such as blend sign, black hole sign and heterogeneous density, CTA spot sign has better predictive accuracy for hematoma expansion ^{4) 5) 6)}.

The spot sign may therefore be useful to select patients for future surgical trials.

Initial clinical status and spot sign were associated with intraoperative aneurysm rupture (ioAR) during microsurgical clipping of ruptured aneurysms. However, there was no difference regarding clinical outcome and complications of the two groups ⁷⁾

Hotta et al., retrospectively assessed 323 consecutive patients with spontaneous ICHs admitted to the hospital between April 2009 and March 2012 and who underwent CTA on admission.

In 80 patients (24.7 %), spot signs were demonstrated on CTA source images. Multivariate analysis revealed two independent factors correlated with presence of the spot sign: age and hematoma volume (p < 0.05 each). The presence of spot sign was associated with unfavorable outcomes at discharge and hematoma growth after admission (p < 0.05 each). Adverse events related to CTA occurred in 17 patients (5.2 %), including transient renal dysfunction in 16 patients and allergy to contrast medium in one patient. All adverse events completely resolved within 1 week.

Presence of the spot sign indicated the possibility of hematoma growth and unfavorable outcomes. A small number of adverse events occurred in association with CTA, but without any permanent deficits. Given the potential benefits and risks, they believe that CTA performed at admission in all patients with ICH is beneficial to improve the outcomes⁸.

No evidence suggested that patients with ICH and a spot sign specifically benefit from intensive BP reduction $^{9)}$.

Initial computed tomography angiography (CTA) was conducted within 6h after ictus. Satellite sign on non-enhanced CT and spot sign on CTA were detected by two independent reviewers. The sensitivity and specificity of both satellite sign and spot sign were calculated. Receiver-operator analysis was conducted to evaluate their predictive accuracy for hematoma expansion.

This study included 153 patients. Satellite sign was detected in 58 (37.91%) patients and spot sign was detected in 38 (24.84%) patients. Among 37 patients with hematoma expansion, 22 (59.46%) had satellite sign and 23 (62.16%) had spot sign. The sensitivity and specificity of satellite sign for prediction of hematoma expansion were 59.46% and 68.97%, respectively. The sensitivity and specificity of spot sign were 62.16% and 87.07%, respectively. The area under the curve (AUC) of satellite sign was 0.642 and the AUC of spot sign was 0.746. (P=0.157)

The results suggest that the satellite sign is an independent predictor for hematoma expansion in spontaneous ICH. Although spot sign has the higher predictive accuracy, satellite sign is still an acceptable predictor for hematoma expansion when CTA is unavailable ¹⁰.

Systematic review

18 studies were pooled into the meta-analysis, including 14 studies of first-pass CTA, and 7 studies of combined CT modalities. In evaluating the accuracy of spot sign for predicting HE, studies of first-pass CTA showed that the sensitivity was 53% (95% CI, 49%-57%) with a specificity of 88% (95% CI, 86%-89%). The pooled positive likelihood ratio (PLR) was 4.70 (95% CI, 3.28-6.74) and the negative likelihood ratio (NLR) was 0.44 (95% CI, 0.34-0.58). For studies of combined CT modalities, the sensitivity was 73% (95% CI, 67%-79%) with a specificity of 88% (95% CI, 86%-90%). The aggregated PLR was 6.76 (95% CI, 3.70-12.34) and the overall NLR was 0.17 (95% CI 0.06-0.48).

Spot signs appeared to be a reliable imaging biomarker for HE. The additional detection of delayed spot sign was helpful in improving the predictive accuracy of early spot signs. Awareness of our results may impact the primary ICH care by providing supportive evidence for the use of combined CT modalities in detecting spot signs ¹¹.

Case series

2016

Morotti et al.performed a retrospective analysis of PPH cases obtained from a prospectively collected cohort of consecutive ICH patients who underwent CTA. CTA first-pass readings for spot sign presence were analyzed by two trained readers. Baseline and follow-up hematoma volumes on non-contrast CT scans were assessed by semi-automated computer-assisted volumetric analysis. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive and negative likelihood ratio, and accuracy of spot sign for prediction of in-Hospital mortality were calculated.

49 subjects met the inclusion criteria of whom 11 (22.4 %) showed a spot sign. In-Hospital mortality was higher in spot sign-positive versus spot sign-negative subjects (90.9 vs 47.4 %, p = 0.020). Spot

sign showed excellent specificity (95 %) and PPV (91 %) in predicting in-Hospital mortality. Absolute hematoma growth, defined as parenchymal and intraventricular hematoma expansion of any amount, was significantly higher in spot sign-positive versus spot sign-negative subjects (13.72 \pm 20.93 vs 3.76 \pm 8.55 mL, p = 0.045).

As with supratentorial ICH, the CTA spot sign is a common finding and is associated with higher risk of hematoma expansion and mortality in PPH. This marker may assist clinicians in prognostic stratification ¹².

2014

Han et al. conducted a retrospective review of all consecutive patients who were admitted to the department of neurosurgery. Clinical data of patients with ICH were collected by 2 neurosurgeons blinded to the radiological data and at the 90-day follow-up.

Multivariate logistic regression analysis identified predictors of poor outcome; we found that hematoma location, spot sign, and intraventricular hemorrhage were independent predictors of poor outcome. In-Hospital mortality was 57.4% (35 of 61) in the CTA spot-sign positive group versus 7.9% (10 of 126) in the CTA spot-sign negative group. In multivariate logistic analysis, we found that presence of spot sign and presence of volume expansion were independent predictors for the in-Hospital mortality of ICH.

The spot sign is a strong independent predictor of hematoma expansion, mortality, and poor clinical outcome in primary ICH. In this study, we emphasized the importance of hematoma expansion as a therapeutic target in both clinical practice and research ¹³.

2012

PREDICT (predicting haematoma growth and outcome in intracerebral haemorrhage using contrast bolus CT) was a multicentre prospective observational cohort study. We recruited patients aged 18 years or older, with ICH smaller than 100 mL, and presenting at less than 6 h from symptom onset. Using two independent core laboratories, one neuroradiologist determined CTA spot-sign status, whereas another neurologist masked for clinical outcomes and imaging measured haematoma volumes by computerised planimetry. The primary outcome was haematoma expansion defined as absolute growth greater than 6 mL or a relative growth of more than 33% from initial CT to follow-up CT. We reported data using standard descriptive statistics stratified by the CTA spot sign. Mortality was assessed with Kaplan-Meier survival analysis.

We enrolled 268 patients. Median time from symptom onset to baseline CT was 135 min (range 22-470), and time from onset to CTA was 159 min (32-475). 81 (30%) patients were spot-sign positive. The primary analysis included 228 patients, who had a follow-up CT before surgery or death. Median baseline ICH volume was 19·9 mL (1·5-80·9) in spot-sign-positive patients versus 10·0 mL (0·1-102·7) in spot-sign negative patients (p<0·001). Median ICH expansion was 8·6 mL (-9·3 to 121·7) for spot-sign positive patients and 0·4 mL (-11·7 to 98·3) for spot-negative patients (p<0·001). In those with haematoma expansion, the positive predictive value for the spot sign was61% (95% Cl 47-73) for the positive predictive value and 78% (71-84) for the negative predictive value, with 51% (39-63) sensitivity and 85% (78-90) specificity[corrected]. Median 3-month modified Rankin Scale (mRS) was 5 in CTA spot-sign-positive patients, and 3 in spot-sign-negative patients (p<0·001). Mortality at 3 months was 43·4% (23 of 53) in CTA spot-sign positive versus 19·6% (31 of 158) in CTA

spot-sign-negative patients (HR 2·4, 95% CI 1·4-4·0, p=0·002).

These findings confirm previous single-centre studies showing that the CTA spot sign is a predictor of haematoma expansion. The spot sign is recommended as an entry criterion for future trials of haemostatic therapy in patients with acute ICH ¹⁴.

2007

Wada et al. prospectively studied 39 consecutive patients with spontaneous ICH by computed tomography angiography within 3 hours of symptom onset. Scans were reviewed by 3 readers. Patients were dichotomized according to the presence or absence of the spot sign. Clinical and radiological outcomes were compared between groups. The predictive value of this sign was assessed in a multivariate analysis.

Thirteen patients (33%) demonstrated 31 enhancing foci. Baseline clinical variables were similar in both groups. Hematoma expansion occurred in 11 patients (28%) on follow-up. Seventy-seven percent of patients with and 4% without hematoma expansion demonstrated the spot sign (P<0.0001). Sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratio for expansion were 91%, 89%, 77%, 96%, and 8.5, respectively. Interobserver agreement was high (kappa=0.92 to 0.94). In patients with the spot sign, mean volume change was greater (P=0.008), extravasation more common (P=0.0005), and median hospital stay longer (P=0.04), and fewer patients achieved a good outcome (modified Rankin Scale score <2), although the latter was not significant (P=0.16). No differences in hydrocephalus (P=1.00), surgical intervention (P=1.00), or death (P=0.60) were noted between groups. In multiple regression, the spot sign independently predicted hematoma expansion (P=0.0003).

The computed tomography angiography spot sign is associated with the presence and extent of hematoma progression. Fewer patients achieve a good clinical outcome and hospital stay was longer. Further studies are warranted to validate the ability of this sign to predict clinical outcomes ¹⁵.

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