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Validating a threshold of ocular gaze deviation for the prediction of acute ischaemic stroke

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AIM: To determine a threshold at which the degree of ocular gaze deviation (OGD) on axial imaging is highly specific for the prediction of acute ischaemic stroke.

MATERIALS AND METHODS: A retrospective analysis of 517 patients who had received MRI with diffusion-weighted imaging (DWI) for suspected acute stroke was performed. The degree of OGD was measured in all patients and the presence and location of infarction determined. The difference in OGD between groups was compared using the independent *t*-test for normally distributed data and the Mann–Whitney test for non-normal data. The sensitivity and specificity for degrees of OGD in the prediction of acute infarction was calculated using a receiver operating curve (ROC) analysis.

RESULTS: The imaging of 448 patients meeting the inclusion criteria was reviewed. Acute infarct was demonstrated in 34.8% (n=156). There was a significant difference in the degree of OGD between patients with an acute infarct and those without evidence of acute ischaemia ($p<0.001$). ROC curve analysis for OGD demonstrated area under the curve (AUC) = 0.619 with increasing degrees of OGD more specific for acute infarct. OGD >11.95° had a sensitivity of 17% and specificity of 95.9% in predicting acute infarction.

CONCLUSION: Significant OGD>11.95° has a high specificity for acute infarct. This threshold may provide a helpful additional sign in the detection of subtle acute infarct, particularly on axial CT brain imaging.

Introduction

Ocular gaze deviation (OGD) was first described by Jean Louis Prevost in 1865[1] when he observed that patients with hemiplegia had eyes that were deviated towards the damaged cerebral hemisphere. Subsequent studies have examined the frequency, clinical features,[2–5] and lesion locations[6–9] associated with OGD in acute stroke, with the incidence of OGD reported in approximately 20% of acute hemispheric infarcts.[9,10,13,14] Previous studies looking at the clinical significance of OGD have shown that the observation of eye deviation on axial CT has been shown to improve the detection of acute ischaemic stroke[12] and to be associated with severe clinical symptoms, poor outcome, and increased mortality.[13]

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Supratentorial lesions causing OGD typically reflect dysfunction in cortical areas involved in the control of the frontal eye fields, spatial attention, and eye movements.[9,10] These lesions classically cause ipsilateral gaze deviation, and has been more commonly reported in right hemispheric infarcts.[9] Infratentorial infarcts involving the cerebellum and pons may also induce OGD but have been less frequently studied.[11] Contraversive shift of eye deviation from the lesional side to the contralateral side in hemispheric stroke may indicate emerging mass effect on thalamic mediated circuits and the corticopontine projection within the internal capsule.[14]

The assessment of OGD may be confounded by incidental variations in gaze direction[15] and the threshold at which OGD becomes a significant observation has not yet been defined in patients with suspected acute infarction. The purpose of the present study was, therefore, to determine whether a general threshold of radiologically determined gaze deviation on axial brain imaging for suspected acute stroke could be defined, which may provide a useful additional sign in the prediction of acute infarction.

Materials and methods

Case identification

Five hundred and seventeen consecutive patients with suspected acute stroke patients presenting at our institution were identified between 1 December 2011 and 31 March 2012 were selected (Fig 1). The present inclusion criteria included[1]: retrievable stroke protocol MRI brain on admission acquired within 24 h of presentation[2]; no previously demonstrated intracranial disease[3]; no non-ischaemic intracranial disease identified on the study examination[4]; axial imaging of the orbits unobscured by movement artefact or patient position. Sixty-nine patients were excluded due to newly identified non-ischaemic disease or image degradation by artefact. Patients were not given any instructions as to where to direct their gaze during the examination and no features of the layout of the MRI suite were identified which would direct a patients gaze either leftwards to rightwards. Both supratentorial and infratentorial lesions were included, as infarct in both these regions may result in OGD.[9–11,14]

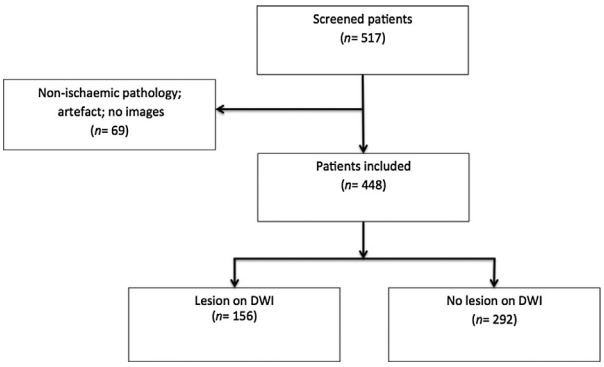

Figure 1 Study cohort.

MRI interpretation

MRI studies were obtained on a 1.5 T Symphony MRI machine (Siemens, Erlangen, Germany) or 1.5 T Achieva MRI system (Phillips, Andover, USA), using an eight-channel neurovascular phased-array coil. The standardized stroke protocol included T2 axial turbo gradient and spin-echo and diffusion-weighted axial (DWI) sequences. DWI was performed with a single-shot echo planar imaging (EPI) spin-echo sequence: 108 ms echo time, 90° flip angle, 230 × 230 mm field of view, 192 × 192 matrix, 19 sections, 5 mm sections thickness, 1.5 mm gap, scan acquired in three directions at B = 0, B = 500, and B = 1000. Axial T2-weighted brain MRI sequences were used for the detection of ocular gaze orientation.

OGD was then calculated for each globe by drawing three intersecting lines (Fig 2); line A was drawn anteroposteriorly through the midline, line B was drawn 90° perpendicular to line A, and further lines were drawn through the long axis of each lens. OGD, leftwards or rightwards, was recorded for both globes by measuring the angle formed by the intersection of these lines. The average OGD was calculated for each patient (right globe OGD + left globe OGD)/2).[10] Patients were excluded if movement artefact precluded the identification of the midline or long axis of the ocular lenses.

Statistical analysis

Statistical analysis was performed using SPSS for Windows, version 20. Normality was assessed visually with histograms and using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The difference in OGD between groups was also compared using the independent *t*-test for normally distributed data and the Mann–Whitney test for non-normal data. (These are different statistical tests, both of which were performed.) A p-value of <0.05 was considered statistically significant.

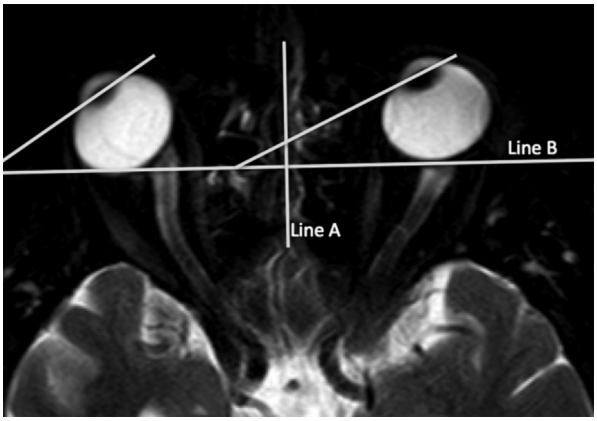

Figure 2 Measurement of OGD. Line A is drawn through the midline. Line B, is drawn perpendicular to line A. Lines are then drawn through the long axes of both lenses to create angles with line B from which the average OGD may be calculated.