Published in final edited form as:

J Stroke Cerebrovasc Dis. 2018 June ; 27(6): 1466–1470. doi:10.1016/j.jstrokecerebrovasdis.2017.12.035.

The Sustained DeyeCOM Sign as a Predictor of Large Vessel Occlusions and Stroke Mimics

Kevin S. Attenhofer, MD¹, Lovella Hailey, MS, ANP-BC, CNS¹, Melissa Mortin, MS, APRN, ANP-BC¹, Karen S. Rapp, RN, BSN, CCRC¹, Kunal Agrawal, MD¹, Branko Huisa-Garate, MD¹, Royya Modir, MD¹, Dawn M. Meyer, PhD, RN, FNP-C, FAHA¹, Thomas M. Hemmen, MD, PhD¹, and Brett C. Meyer, MD¹

¹University of California at San Diego (UCSD) Stroke Center

Abstract

Introduction—Rapid imaging in acute stroke is critical and often occurs before full examination. Early, reliable exam findings clarify diagnosis and improve treatment times. The DeyeCOM sign has been described as a predictor of ischemic stroke. In this study, we evaluate a sustained DeyeCOM sign on serial computed tomography scans in prediction of large vessel occlusion.

Methods—We retrospectively reviewed 46 acute stroke patients between April and June 2017 from the University of California, San Diego Stroke Registry who had both computed tomography and computed tomographic angiography as part of their acute work-up. A DeyeCOM(+) sign was defined as a conjugate gaze deviation on imaging of at least 15°. DeyeCOM(++) was defined as sustained gaze deviation on both scans.

Results—Three groups of patients were observed: DeyeCOM(++), non-sustained gaze deviation, and no gaze deviation (DeyeCOM(—)). All DeyeCOM(++) patients (8/8, 100%) had large vessel occlusion. Of those with non-sustained gaze deviation, 2/7 (29%) had large vessel occlusion. No DeyeCOM(—) patients (0/31, 100%) had large vessel occlusion. The specificity and sensitivity of DeyeCOM(++) for large vessel occlusion was 100% (CI .90–1.0) and 80% (CI .44–.97). The specificity and sensitivity of DeyeCOM(—) for absence of large vessel occlusion was 100% (CI .69–1.0) and 86% (CI .70–.95).

Conclusions—DeyeCOM(++) had 100% specificity for large vessel occlusion while DeyeCOM(—) had a 100% specificity for absence of large vessel occlusion. Sustained DeyeCOM, whether positive or negative, is a strong predictor of ultimate diagnosis that could lead to quicker endovascular treatment times.

Keywords

CT; CTA; acute ischemic stroke; neuroradiology; large vessel occlusion

Corresponding Author: Kevin S. Attenhofer, MD, 200 West Arbor Drive, Medical Offices North, 3rd floor, Suite 3, San Diego, CA 92103, Phone: 225-603-5926, Fax: 619-543-7771, kattenhofer@ucsd.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

INTRODUCTION

Early identification of anterior circulation large vessel occlusions (LVOs) in stroke has become increasingly important in the evolving fields of acute stroke and endovascular therapy(1). As time is of the essence in acute ischemic stroke (AIS)(2), some centers have moved to a “pit-stop” triage algorithm where patients are only briefly assessed prior to computed tomography (CT)(3). This improves door to imaging times, but results in less physical examination data being available prior to CT.

Obtaining as much information as quickly as possible is essential in triaging acute stroke. Prevost’s sign is conjugate gaze deviation in acute stroke(4–6). Gaze deviation is included in the National Institute of Health Stroke Scale (NIHSS) Score and other scales(7). Gaze deviation may be appreciated on imaging as the DeyeCOM sign(8), and may be the first evidence found of a patient having a cortical deficit.

The DeyeCOM sign has shown good specificity for AIS(8). Due to the brevity of CT, a false positive DeyeCOM sign may be noted for many reasons including alternate etiologies (intracerebral hemorrhage (ICH), seizure)(9), chance, or volitional gaze towards a point of interest. Many institutions include immediate CT based vessel imaging (CTA) immediately following the CT. In this analysis, we assessed whether the DeyeCOM sign is associated with large vessel cortical stroke etiologies, and if its absence is correlated with non-stroke etiologies. We further assessed whether the presence of sustained gaze deviation on both CT and CTA has a higher correlation with final diagnosis.

METHODS

We retrospectively reviewed 50 consecutive patients from our IRB approved stroke code registry between April 2017 and June 2017. Assessed patients included acute stroke code activations, with CT and CTA performed at our center, and where scans had both orbits’ lenses included on the images. All patients were scanned on a helical, multi-detector CT scanner with 320 detector rows (Toshiba Aquilion One, Toshiba American Medical Systems). NCCT protocol consists of a collimation of 32×0.5 mm, at a voltage of 120 kV and a current of 240 mA. CTA protocol consists of a bolus of 75 ml of iodinated contrast at 4 ml/sec, using a collimation of 80×0.5 mm, at a voltage of 120 kV and a current of 200 mA, and reconstructed into 2 mm images. CTA was performed immediately following NCCT as per our UCSD protocol with a median time of 5.5 minutes between start of NCCT scan and start of CTA. All images were reviewed on Agfa IMPAX software (v.6.6.1.3525). Axial images were reviewed for presence of a DeyeCOM sign by a single reviewer. Though previous reports have demonstrated that evaluation without formal measurements is equally as reliable as the caliper method(10), we chose to use the caliper method to mitigate against any bias that would come from the more global assessment technique.

Angle of gaze deviation was measured using IMPAX caliper tool. As with our prior publications(8), a midline was created through the nasal septum and occiput, then a perpendicular line was created. Subsequently, a line was drawn through the longest diameter of the lens. This line intersected with the perpendicular line to create an angle, which was

measured as the angle of gaze deviation (See Figure 1). As previously reported(8), cases with conjugately deviated gaze with angles > 15 degrees in each eye on NCCT were noted to be DeyeCOM(+). The absence of conjugate gaze deviation on NCCT was noted to be DeyeCOM(−). If gaze deviation was seen on both NCCT and CTA, they were DeyeCOM(++). Figure 2 notes the cohorts of sustained DeyeCOM finding on CT and then CTA (DeyeCOM(++)), absence of DeyeCOM finding on CT and then CTA (DeyeCOM(−−)), and non-sustained DeyeCOM finding (either DeyeCOM(+-) or DeyeCOM(-+)). Presence of anterior circulation LVO (terminal ICA, M1, or M2 as reported by local neuroradiology service) and final diagnosis were recorded for each patient. Final diagnosis categories included AIS with anterior LVO, AIS without LVO, seizure, or stroke mimic. Sensitivity, specificity, true positive, and false positive rates were determined [(DeyeCOM(++)) vs DeyeCOM(−−), DeyeCOM(++)) vs Other, DeyeCOM(−−) vs Other]. Baseline characteristics and treatment times were compared between cohorts. Fisher's Exact test was used for categorical variables and the Mann-Whitney U test was used for continuous variables.

RESULTS

Fifty consecutive cases were initially collected. Four patients were excluded from final analysis as both CT and CTA were not available. Eight patients had sustained gaze deviation on both NCCT and CTA (DeyeCOM(++)). All 8 were diagnosed with AIS with anterior LVO. The specificity and sensitivity of DeyeCOM(++)) for anterior LVO was 100% (CI .90–1.0) and 80% (CI .44–.97) when compared with all other included patients [DeyeCOM(++)) vs All Other]. Seven patients had non-sustained gaze deviation (2 were found to have AIS with anterior LVO, 2 were diagnosed with seizure, 2 were diagnosed with AIS without LVO, and 1 was a stroke mimic). The remaining 31 patients had no gaze deviation on either NCCT or CTA [DeyeCOM(−−)]. Of these 31 patients, none were diagnosed as AIS with anterior LVO. Their diagnoses included 15 with AIS without LVO, 15 were stroke mimic, and 1 was seizure. The specificity and sensitivity of DeyeCOM(−−) for absence of anterior LVO was 100% (CI .69–.10) and 86% (CI .70–.95) when compared with all other included patients [DeyeCOM(−−) vs All Other].

Baseline characteristics were comparable between cohorts, with no significant difference in age, sex, or comorbid conditions (Table 1). There were no differences in acute treatment times. DeyeCOM(++)) patients had higher NIHSS compared to DeyeCOM(−−). Patients with non-sustained DeyeCOM had an average NIHSS of 12.5, only significant when compared to DeyeCOM(−−) (12.5 vs 4.2, $p=0.006$). Patients in the DeyeCOM(++)) population were also older overall, with an average age of 80.8 years compared to 61.3 for DeyeCOM(−−) ($p=0.009$). Average age for non-sustained DeyeCOM was 74.8 years, not significantly different from DeyeCOM(++)) or DeyeCOM(−−).

DISCUSSION

In this small cohort of patients, the DeyeCOM sign was again demonstrated to be associated with anterior circulation LVO AIS ($p<0.001$). The sustained DeyeCOM sign noted on both NCCT and CTA has now also been shown to be even more highly associated with diagnosis of AIS ($p=0.014$) and anterior circulation LVO AIS ($p<0.001$) (Table 2). DeyeCOM(++))

patients had a much higher NIHSS, which is not surprising given that Prevost's sign is scored on the subsequent NIHSS as well. This is further supported by the association between DeyeCOM(+++) and anterior LVO stroke, where LVOs are generally more severe than other strokes and non-strokes(11). DeyeCOM(---) patients had the lowest mean NIHSS (4.2) reflecting the heterogeneous population of stroke mimics and small lacunar strokes. DeyeCOM(+) patients tended to be slightly younger than DeyeCOM(-) patients. The reason for this not known. Sustained DeyeCOM positive patients in this study were older. The reason for this is speculative, but may simply be due to a general prevalence of older patients having a higher likelihood of having either a stroke or LVO stroke.

As importantly, our analysis also sought to assess the utility of the absence of DeyeCOM(++) sign. In this small study, DeyeCOM(---) patients were never found to have an anterior LVO. Given the relatively larger and more heterogeneous DeyeCOM(---) population, it is better suited to suggest that the negative predictive value of DeyeCOM(---) for AIS with anterior LVO is very high. In this study it was 100%.

This study has numerous limitations with the most pronounced being that this assessment is limited by a small sample size. The relatively low number of seizure patients and absence of ICH or intracranial tumors in this cohort may lead to an underestimation of false positive DeyeCOM signs. It is important to note that these alternate diagnoses can often be accounted for in clinical practice and baseline imaging so the utility of the DeyeCOM sign is still likely extremely high. Even with the inclusion of these patients, the positive predictive value for central nervous system pathology is very high and for LVO stroke is high. Our analysis is also limited by its retrospective, single reviewer, single center design. The reviewer was not blinded to final diagnosis (though scoring was generally done before assessing the chart for diagnosis). This is why the caliper method was utilized as an objective and reproducible measurement (as opposed to the global assessment done in our other publication(10)), to mitigate this potential unconscious bias.

The sustained DeyeCOM(---) and DeyeCOM(+++) signs are strong predictors of final diagnosis. Clinical practitioners may be reassured that DeyeCOM(---) patients likely do not have anterior LVO. These results should also support practitioners' confidence that DeyeCOM(+++) patients likely reflect anterior LVO stroke and are unlikely to be a mimic. These findings have important clinical and endovascular pathway implications that should be included in clinical decision-making even before full neurologic examinations are possible in a stroke code. As "time is brain(2)" this information obtained early may save time in the stroke assessment and treatment pathway. This DeyeCOM sign can be rapidly obtained during an acute stroke evaluation and potentially lead to quicker endovascular treatment times. Further comparisons in this dataset are ongoing and testing of DeyeCOM in a larger prospective assessment is needed.

Acknowledgments

STUDY FUNDING: This study was supported by the Vascular Neurology Fellowship Program, UCSD Stroke Center, Department of Neurology and Neurological Sciences, University of California, San Diego.

Research reported in this publication was partially supported by the National Institutes of Health, under award number NIH 5U10NS086535. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

DISCLOSURES: B.C. Meyer- NINDS U10 Funding (5U10NS086535) & Speaker's Bureau, Genentech

References

1. Berkhemer OA, Fransen PS, Beumer D, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med*. 2015; 372:11–20. [PubMed: 25517348]
2. Saver JL. Time is Brain – Quantified. *Stroke*. 2006; 37:263–266. [PubMed: 16339467]
3. Rai AT, Smith MS, Boo S, et al. The ‘pit-crew’ model for improving door-to-needle times in endovascular stroke therapy: a Six-Sigma project. *Journal of NeuroInterventional Surgery*. 2016; 8:447–452. [PubMed: 26863106]
4. Tijssen CC. Conjugate deviation of the eyes in cerebral lesions. *Bull Soc Belge Ophtalmol*. 1989; 237:245–258. [PubMed: 2486111]
5. Goodwin JA, Kansu T, et al. Vulpian's sign: conjugate eye deviation in acute cerebral hemisphere lesions. *Neurology*. 1986; 36:711–712. [PubMed: 3517695]
6. Prévost MJL. Deviation des yeux et de la tête dans quelques cas d'hémiplégie. *Gazette Hebdomadaire de Médecine et de Chirurgie*. 1865; 41:649–650.
7. Carrera D, Campbell BC, Cortés J, et al. Predictive value of modifications of the prehospital rapid arterial occlusion evaluation scale for large vessel occlusion in patients with acute stroke. *J Stroke Cerebrovasc Dis*. 2017 Jan; 26(1):74–77. [PubMed: 27720525]
8. Coffman CR, Raman R, Ernstrom K, et al. The “DeyeCOM Sign”: predictive value in acute stroke code evaluations. *J Stroke Cerebrovasc Dis*. 2015 Jun; 24(6):1299–1304. [PubMed: 25891758]
9. Schwartz KM, Ahmed AT, Fugate JE, et al. Frequency of eye deviation in stroke and non-stroke patients undergoing head CT. *Neurocrit Care*. 2012; 17:45. [PubMed: 22565634]
10. Spokoyny I, Chen JY, Raman R, et al. Visual Determination of Conjugate Eye Deviation on Computed Tomography Scan Predicts Diagnosis of Stroke Code Patients. *J Stroke Cerebrovasc Dis*. 2016 Dec; 25(12):2809–2813. [PubMed: 27576212]
11. Heldner MR, Hsieh K, Broeg-Morvay A, et al. Clinical prediction of large vessel occlusion in anterior circulation stroke: mission impossible? *J Neurol*. 2016 Aug; 263(8):1633–40. [PubMed: 27272907]

Figure 1.
Non-contrast axial CT scan with calipers creating two angles, one for each eye. Right eye is deviated 18.1 degrees from midline. The left eye is deviated 16.3 degrees.

Figure 2.
Algorithm for cohort classification.

Table 1

Baseline Characteristics of DeyeCOM(++) vs DeyeCOM(---)

	DeyeCOM(++) n=8	DeyeCOM(---) N=30	Overall N=46	p-value
Age	80.75	61.3	65.4	0.009
Male	5 (62.5%)	19 (63.3%)	28 (62.2%)	1.00
Diabetes	2 (25.0%)	4 (13.3%)	8 (17.8%)	0.587
Hypertension	6 (75.0%)	19 (63.3%)	28 (62.2%)	0.689
Hyperlipidemia	4 (50.0%)	9 (30.0%)	15 (33.3%)	0.487
Epilepsy	1 (12.5%)	1 (3.3%)	2 (4.4%)	0.381
Atrial Fibrillation	2 (25.0%)	4 (13.3%)	8 (17.8%)	0.587
Initial NIHSS	18	4.17	7.08	<0.001

Table 2

Rates of Stroke vs. LVO stroke, first in DeyeCOM+ and DeyeCOM–, then DeyeCOM(++) and Other, and finally DeyeCOM(–) and other. In this instance, “other” is defined as all other study patients.

	DeyeCOM+	DeyeCOM–	p-value
Stroke	10	17	p=0.184
LVO	9	1	p=<0.001
	DeyeCOM(++)	Other	p-value
Stroke	8	19	p=0.014
LVO	8	2	p=<0.001
	DeyeCOM(–)	Other	p-value
Stroke	15	12	p=0.058
LVO	0	10	p=<0.001