Morphometric and Volumetric Comparison of Symptomatic and Asymptomatic Chiari Malformation Type I

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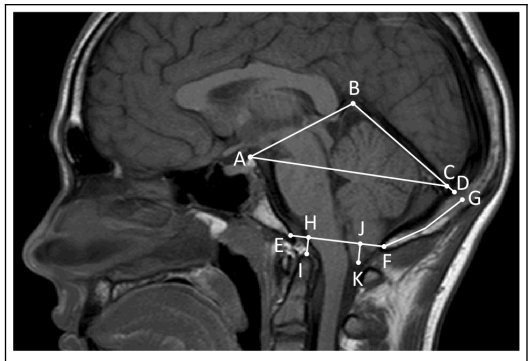
Introduction

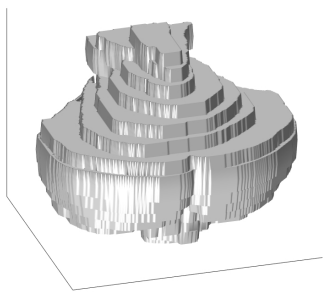
Chiari malformation type I (CMI) is typically defined by a cerebellar tonsil position 5 mm or more below foramen magnum. Low cerebellar tonsil position is a frequent incidental finding, even in asymptomatic individuals. Non-specific symptoms such as headache and neck pain are common in those with low tonsil position and in those with normal tonsil position, leading to uncertainty regarding appropriate management for many patients with low tonsil position and non-specific symptoms. Since cerebellar tonsil position is not strictly correlated with typical CMI symptoms, we sought to determine if other 2D morphometric or 3D volumetric measurements on MRI could distinguish asymptomatic from symptomatic CMI patients.

Methods

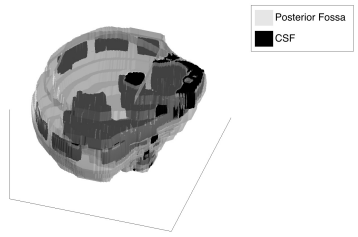
We retrospectively analyzed 102 pediatric patients from the University of Michigan clinical CMI database. All patients had cerebellar tonsil position at least 5 mm below foramen magnum. 51 symptomatic and 51 asymptomatic patients were matched for age at diagnosis, sex, tonsil position, and tonsil morphology. Five 2D anatomic MRI measurements and four 3D volumetric measurements of posterior fossa and CSF sub-



Sagittal MRI indicating morphometric landmarks and lines. Clivus-tentorium distance (AB), tentorium length (BD), clivus -torcula line (AC), McRae's line (EF), supraoccipital length (FG), basilar impression (HI), tonsil position (JK).



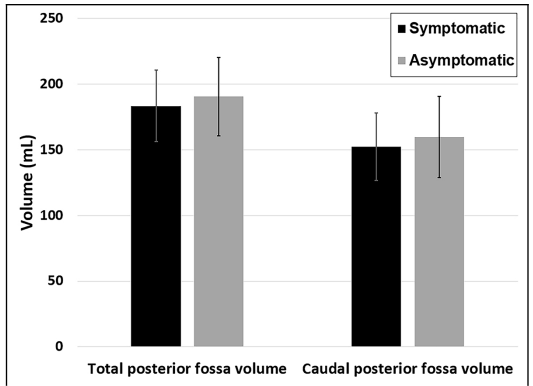
Three-dimensional illustration of total posterior fossa volume.



Three-dimensional illustration of caudal posterior fossa volume (gray) and CSF volume (black).

Results

There were no significant differences observed between symptomatic and asymptomatic CMI patients related to basilar impression (-5.9 mm vs. -7.0 mm; p=0.026), tentorium length (50.3 mm vs. 51.0 mm; p=0.537), supraoccipital length (39.4 mm vs. 42.6 mm; p=0.055), clivus-tentorium distance (52.0 mm vs. 52.1 mm; p=0.964), clivus-torcula distance (81.5 mm vs. 83.3 mm; p=0.257), total posterior fossa volume (PFV; 183.4 mL vs. 190.6 mL; p=0.250), caudal PFV (152.5 mL vs. 159.8 mL; p=0.256), fourth ventricle volume to caudal PFV ratio (0.0140 vs. 0.0136; p=0.649), or CSF volume to caudal PFV ratio (0.071 vs. 0.061; p=0.138).



Results graph comparing mean total posterior fossa volume (left) and caudal posterior fossa volume (right) between symptomatic patients (black) and asymptomatic patients (grey). Errors bars equal standard deviation.

Conclusions

No significant differences were observed in 2D morphometric and 3D volumetric measurements between the asymptomatic and symptomatic pediatric CMI groups, for whom tonsil position and morphology were matched. None of the additional measurements could predict symptom status after accounting for the matched variables. Further study will be necessary to establish if any imaging test can reliably distinguish symptomatic from asymptomatic pediatric CMI.