

## A morphometric assessment of type I Chiari malformation above the McRae line: A retrospective case-control study in 302 adult female subjects

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### Purpose

Traditional radiographic identification of CMI relies on the measurement of the cerebellar tonsils in relation to the foramen magnum with or without associated abnormalities of the neuraxis. The primary goal of this retrospective study was to comprehensively assess morphometric parameters above the McRae line in a group of female CMI patients and normal controls.

### Methods

Twenty-nine morphological measurements were taken on 302 mid-sagittal MR images of adult female CMI patients (n = 162) and healthy controls (n = 140). All MR images were voluntarily provided by CMI subjects through the Chiari 1000 and control participant images were obtained through the Human Connectome Project and a local hospital system. Custom software was developed to maximize speed, accuracy and repeatability.

### Results

The foremost discovery from the analysis was the reduced heights of structures in the posterior fossa of this group of adult female CMI patients in relation to the McRae line compared to healthy controls. Fastigium height, pons height, corpus callosum height, clivus length, and PCF height were all reduced in CMI patients compared to controls with effect size measures indicating moderate and large effects for each measure. CMI patients also demonstrated wider basal and Boogard angles, which combined provide evidence for the horizontal angulation of the clivus as a reliable morphological characteristic of CMI. The third cluster of reliable group differences centered around the odontoid process, which suggested a substantial extension of the odontoid process into the spinal canal. In all, 14 different measures were found to be different.

### Conclusions

Mid-sagittal morphometric comparisons of more than 300 MR images of adult female CMI patients and control participants yielded a multitude of reliable group differences between morphological structures above the McRae line. These findings clustered into three categories; the lowering of PCF structures in relation to the FM, the sharper angulation of the clivus in relation to the odontoid process, and the retroflexion of the odontoid process. Due to the large sample size and sample control utilized in the current study, these results have strong implications for morphological characteristics of CMI that have previously been viewed as contentious.

