Predictive accuracy of standard computed tomography scanning in the diagnosis of Chiari malformation Type I in children

MIRZA N. BAIG, M.D., PH.D.,1 ALI RAZA, M.S.,2 MOUMEN ASBAHI, B.S.,1 AND SCOTT ELTON, M.D.1

1Division of Pediatric Neurosurgery, Department of Neurological Surgery, Columbus Children’s Hospital and The Ohio State University Medical Center, Columbus, Ohio; and 2Clinical Education Centre, Royal Prince Alfred Hospital and University of Sydney, New South Wales, Australia

Object. In this study, retrospective data analysis was performed to analyze the utility of head computed tomography (CT) scanning in the diagnosis of Chiari malformation Type I (CM-I) in the pediatric population.

Methods. The authors conducted a retrospective review of radiology charts describing head CT results obtained at Columbus Children’s Hospital between January 2004 and January 2005. The records were searched for the key words “Chiari,” “cerebellar ectopy,” or “tonsillar ectopy.” The exclusion criteria included patients with previously known Chiari malformation Type I or Type II or those who had undergone follow-up magnetic resonance (MR) imaging at other institutions. Head CT and MR images for the remaining patients were reviewed to verify accuracy.

Results. Of the 72 patients with suspicious findings of tonsillar ectopy on CT, only 37 (51.4%) had MR imaging findings consistent with CM-I. The tonsillar ectopy in these patients ranged from 3 mm to 17 mm below the foramen magnum.

Conclusions. The authors’ findings indicate that incidental standard CT scans of the head have limited value in identifying CM-I. (DOI: 10.3171/PED-07/11/400)

KEY WORDS • Chiari malformation Type I • computed tomography • diagnosis • imaging • pediatric neurosurgery

MAGNETIC resonance imaging is the preferred neuroimaging modality for the diagnosis of CM-I. Sagittal views are especially useful in measuring the tonsillar displacement with respect to the foramen magnum.1,3,5 Computed tomography scanning of the head, however, is performed far more frequently in children than MR imaging for a multitude of reasons. As part of the workup, radiologists routinely comment on the position of the cerebellar tonsils in relation to the foramen magnum. Based on suspicious CT findings, the radiologist may recommend further studies such as MR imaging of the brain to elucidate the location of the tonsils, visualize the neuroanatomy, and further confirm the possible diagnosis of Chiari malformation. We analyzed the clinical usefulness and diagnostic yield of incidental CT scans in the diagnosis of Chiari malformations. It is important to quantify this usefulness so that the best decisions can be made concerning the use of valuable and limited resources (such as MR imaging machines), when time and cost are at issue.

We performed a retrospective study of patients at the Children’s Hospital in Columbus, Ohio from January 2004 to January 2005. Radiology records of head CT results were searched for any of the following key words: “Chiari,” “cerebellar ectopy,” or “tonsillar ectopy.” The resulting records were reviewed, and patients with a previously known diagnosis of Chiari malformation and those who did not undergo follow-up MR imaging at the Children’s Hospital were excluded. The MR imaging results obtained in the remaining patients were reviewed to assess the predictive value of incidental CT scans in diagnosing Chiari malformations.

Clinical Material and Methods

We searched radiology records of head CT scan results obtained at Children’s Hospital in Columbus between January 2004 and January 2005 for the key words “Chiari,” “cerebellar ectopy,” or “tonsillar ectopy.” The search yielded 951 records containing one or more of the key words. We then excluded patients who had previously received a diagnosis of Chiari malformation Type I or II. This refinement

Abbreviations used in this paper: CM-I = Chiari malformation Type I; CT = computed tomography; MR = magnetic resonance.
Utility of CT scanning in the diagnosis of CM-I resulted in 94 cases in which the radiologist had identified incidental findings of tonsillar ectopy, cerebellar ectopy, or a questionable Chiari malformation, and recommended follow-up MR imaging of the brain if clinically warranted for further investigation.

We further checked to see if MR imaging of the brain had been performed at our institution. Twenty-two of 94 patients did not match this criterion and were excluded from further analysis. Magnetic resonance images obtained in the remaining 72 patients were reviewed for findings of CM-I.

Results

Although there were no specific words that the radiologists consistently used to describe their findings on CT scans, the word “ectopy” was usually accompanied by other words such as “suspicious” and “if clinically warranted.” The head CTs were read by a number of radiologists and were performed for a wide variety of clinical indications. The diagnostic workup for Chiari malformation does not typically include CT scanning because MR imaging is the standard. The majority of CT scans with dictations of Chiari findings were obtained in patients with Chiari findings already recognized from previous imaging studies. Of the 72 patients with suspicious findings of tonsillar ectopy on CT, only 37 patients (51.4%) had MR imaging results consistent with CM-I. The tonsillar ectopy in these patients ranged from 3 mm to 17 mm below the foramen magnum.

The positive predictive value, which is the ratio of true positives to combined true and false positives (that is, the proportion of patients with positive test results who received the correct diagnosis), is 51.4%. We were unable to perform a sensitivity or specificity analysis because we selected only patients with CT findings suggestive of CM-I.

Discussion

Arnold–Chiari malformations are currently described to be of four different types.2 Chiari malformation Type I is characterized by the caudal descent of the cerebellar tonsils and may or may not be associated with the presence of a syrinx; a degree of medullary descent and buckling of the lower medulla may also be present. Herniation of the tonsils more than 5 mm below the foramen magnum on MR imaging is considered diagnostic.1 The Type II malformation is more extensive and is usually associated with meningocoele; a syrinx in the medulla or spinal cord may or may not be present. Type III is uncommon and involves caudal displacement of the cerebellum and brainstem into a high cervical or occipital meningocele. Type IV consists of only cerebellar hypoplasia.

Chiari malformation Type I commonly goes unnoticed until problems arise in adolescence or adulthood. The presentation of CM-I in adulthood includes a wide range of features: raised intracranial pressure, headache, progressive cerebellar syndrome, syringomyelia, and various signs of involvement of the lower cranial nerves and medulla, including dysphagia.4 The clinical symptoms in children are nearly identical to those seen in adults; however, the degree of tonsillar ectopia and presence of syrinx are more likely to be symptomatic.5

The preferred neuroimaging modality for the diagnosis of Chiari malformations is MR imaging. We studied the predictive value of CT head scans in identifying incidental CM-I in the pediatric population. Our results indicate that casual observations of Chiari malformations made on head CT scans have only a 50% predictive value when verified on MR imaging, indicating that standard CT scans of the head have limited value in identifying CM-I. The case can be made that if clinical findings are suggestive of Chiari malformation, the patient should undergo MR imaging directly rather than intermediary CT. This would not only save time and expense, but also eliminate unnecessary radiation exposure from CT scanning.

Conclusions

We reviewed head CT scans obtained over the year from January 2004 to January 2005 to identify the incidence of CT findings suggestive of CM-I. Of the 951 patient charts identified from our key word search results, 94 CT scans were noted by radiologists as suspicious for incidental findings suggestive of CM-I. Of these, 72 patients underwent MR imaging of the brain at our institution to rule out CM-I, and, in a review of these results, only 37 patients (51.4%) had positive Chiari malformation findings. This study further confirms that conventional head CT scans have no role in identifying “suspicious” CM-I findings. In addition, further investigation with brain MR imaging should only be undertaken when clinically warranted.

References


Accepted July 27, 2007.
Address correspondence to: Scott Elton, M.D., 700 Children’s Drive, Columbus, Ohio 43205. email: eltons@chi.osu.edu.