# LETTER TO THE EDITOR

## To The Editor

## Two Curious Cases of Complete Cerebellar Agenesis

**Keywords:** brain plasticity, cerebellum

Complete cerebellar agenesis is an extremely rare condition characterized by the complete absence of cerebellar tissue. Only a small number of cases have been reported, with varying motor and cognitive deficits. We describe two newly identified cases: a middle-aged woman, incidentally found to have complete cerebellar agenesis after presenting with back pain, and an older man who presented with headaches and functional decline.

This 55-year-old female accountant described several years of worsening back pain and muscle spasms (Case 1). She was diagnosed with cerebral palsy at the age of 2, when she was noted to have impaired motor function and developmental delay, but had never undergone cranial imaging. She had a life-long history of impaired balance, with numerous falls resulting in fractures.

Examination demonstrated horizontal gaze nystagmus bilaterally, and a flat, hoarse, and dysarthric voice. The cranial nerve exam was otherwise normal. Strength and sensation were normal. She had bilateral dysmetria and dysdiadokinesis. Her gait was wide-based with a tendency to fall forward. She had severe thoracolumbar paraspinal muscle spasm.

CT of the head revealed CSF density in the posterior fossa and thinning of the brainstem (Figure 1a, 1b). MRI confirmed complete cerebellar agenesis (Figure 1c–1f). The pons was hypoplastic, with a bowtie appearance due to lack of input from the cerebellar peduncles. MRI spine was normal.

Her pain was felt to be muscular, relating to truncal instability and overwork of paraspinal muscles in compensation, and she was referred to physiatry for ongoing follow-up.

This 70-year-old male retired mechanic presented to his local emergency department with a 3-month history of headaches and longer history of functional decline and worsening balance (Case 2). He described balance and coordination troubles dating from childhood, with falls, inability to keep up with peers, and lifelong profound dysarthria. He was taken out of school by his mother after grade 5, and always felt aspects of his health were hidden from him. He grew up in an era that pre-dated CT and MR imaging, and never underwent any cranial imaging.

On examination, he was profoundly dysarthric, and had bilateral horizontal gaze nystagmus. The remainder of his cranial nerve exam was normal. Strength and sensation were normal. He had dysdiadochokinesis and profound dysmetria bilaterally, and a markedly ataxic gait, with a wide-based stance and forward tilt.

CT showed an apparent complete absence of cerebellar tissue, thinning of the brainstem and absent cerebellar peduncles (Figure 2a). MRI confirmed complete cerebellar agenesis, pontine atrophy and a small midbrain (Figure 2b, 2c). The posterior fossa appeared normal in size and shape. MR angiography demonstrated the absence of any cerebellar arteries (Figure 2d, 2e).

His presentation was considered to be in keeping with this congenital structural defect, and he required no ongoing follow-up.

These two cases highlight interesting presentations of cerebellar agenesis and its downstream effects, as well as the plasticity of the nervous system and level of functionality that individuals can attain.

In 2015, Yu et al. presented a new case of complete cerebellar agenesis, together with a summary of all published living cases of primary cerebellar agenesis.[1] They found eight reported cases, describing patients with varying levels of motor deficits, aphasia, ataxia, and mental development. Reviewing the literature, we identified additional nine cases (Table 1). Five were in infants, one terminated in utero, and four with other intracranial anomalies.[2–5] One case was discovered incidentally at autopsy in a 38-year-old, who had a cognitive delay but was otherwise functionally normal.[6] Another case identified a 17-year-old with mild cognitive impairment, who had moderate ataxia and dysmetria, but was functionally independent.[7] The most recent report from Gelal et al. in 2016 identified two more cases of cerebellar

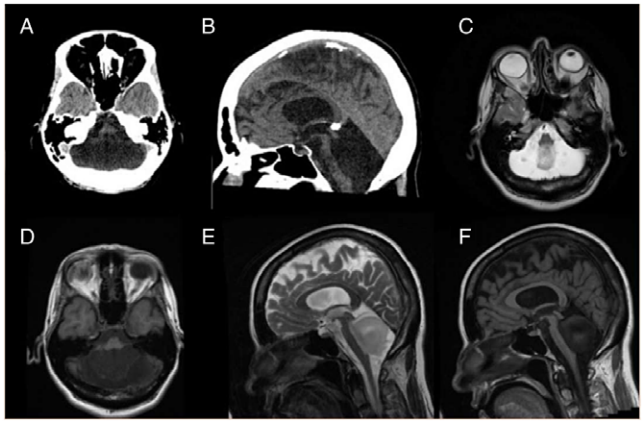


***Figure 1:*** *(a) and (b) CT showing CSF density in posterior fossa, thinning of the brainstem. (c–f) MRI confirming complete cerebellar agenesis, hypoplastic pons with bowtie appearance due to lack of input from cerebellar peduncles.*

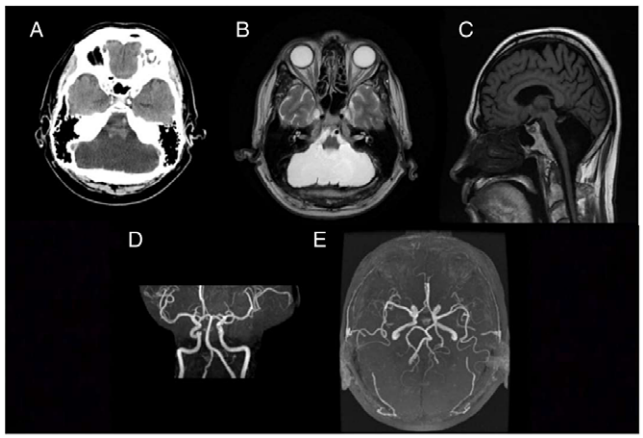


***Figure 2:*** *(a) CT showing complete absence of cerebellar tissue, thinning of brainstem, absent of cerebellar peduncles. (b) and (c) MRI confirming complete cerebellar agenesis, pontine atrophy and small midbrain. (d) and (e) MR angiography demonstrating absence of any cerebellar arteries.*



https://doi.org/10.1017/cjn.2021.199 Published online by Cambridge University Press

**Table 1: Summary of published cases of primary cerebellar agenesis**

| Author | Age/gender | Neurologic impairment | Imaging/notes |
|---|---|---|---|
| Yoshida and Nakamura 1982 (Yu et al. paper) | 4 months/female | Motor, cognitive impairments | Total absence |
| Sener and Jinkins 1983 (Yu et al. paper) | 58 years/female | Normal | Subtotal absence |
| Sener 1995 (Yu et al. paper) | 6 years/– | Motor impairments, aphasia, and ataxia | Moderate cerebellar symptoms |
| Sener 1995 (Yu et al. paper) | –/– | Motor impairments, aphasia, and ataxia | Moderate cerebellar symptoms |
| Van Hoof and Wilmink 1996 (Yu et al. paper) | 46 years/male | Spasticity, mild cognitive impairment, dysarthria, and ataxia | Total absence, confirmed with surgery |
| Velioglu et al. 1998 (Yu et al. paper) | 22 years/male | Motor and cognitive impairment, dysarthria, and ataxia | Subtotal absence |
| Deniz et al. 2002 (Yu et al. paper) | 7 years/female | Motor and cognitive impairment, dysarthria, and ataxia | Total absence |
| Timmann et al. 2003 (Yu et al. paper) | 59 years/female | Motor and cognitive impairment, dysarthria, and ataxia | Total absence |
| Yu et al. 2015 | 24 years/female | Mild cognitive impairment, moderate motor deficits | Total absence |
| Huissoud et al. 2009 | 23 weeks/female | – | Total absence, pregnancy terminated at 25 weeks |
| Gupta et al. 2007 | 10 weeks/female | – | Total absence, other intracranial anomalies (callosal agenesis) |
| Leech et al. 2007 | 38 weeks/- | – | Total absence, with arrhinencephaly |
| Hamilton et al. 1994 | Term infant/female | – | Total absence, microcephaly, other congenital anomalies, died after birth |
| Hamilton et al. 1994 | 24 weeks/female | – | Total absence, other congenital anomalies, terminated at 24 weeks |
| Leestma et al. 2000 | 38 years/male | Mild cognitive and motor impairments | Near total absence, incidental finding post-mortem |
| Titolimano et al. 2005 | 17 years/male | Mild cognitive impairment, moderate ataxia, and dysmetria | Total absence |
| Gelal et al. 2016 | 61 years/male | Moderate motor and cognitive impairment, dysarthria, and ataxia | Near total absence |
| Gelal et al. 2016 | 26 years/female | Mild motor and cognitive impairments, dysmetria, and dysarthria | Near total absence |
| Leck et al. (2021) | 64 years/female | Mild motor and cognitive impairments, dysarthria, ataxia | Total absence |
| Leck et al. (2021) | 70 years/male | Moderate motor and cognitive impairments, dysarthria, ataxia | Total absence |

agenesis in adult living patients, again with the variable extent of impairment.[8] Both of those patients underwent diffusion tensor imaging, with tractography showing no fibers from the brainstem to any posterior fossa tissue but unaffected supratentorial white matter tracts.[8]

Other, more common congenital conditions affecting the cerebellum may present with similar clinical findings or imaging. Dandy-Walker malformations are diagnosed based on the triad of i) complete or partial agenesis of the vermis, ii) cystic dilatation of the fourth ventricle, and iii) enlarged posterior fossa.[1] They may also be accompanied by callosal agenesis and other CNS abnormalities, with variability in the clinical presentation based on the severity of abnormality, though commonly with hydrocephalus and macrocephaly.[1]

Chiari malformations are divided into four subtypes: type I involving elongation of the cerebellar tonsils through the base of the skull; type II involving herniation of the cerebellar vermis, brainstem, and fourth ventricle through the foramen magnum (associated with lumbosacral myelomeningocele); and type III associated with herniation of cerebellum and brainstem through an occipital encephalocele.[1] Type IV is an extremely rare condition characterized by the loss of cerebellar development, hypoplasia, and decreased size of the cerebellum, often equated with primary cerebellar agenesis.[1] However, complete cerebellar agenesis is differentiated from the vanishing cerebellum seen in Chiari IV, as there are no scattered remnants of cerebellar tissue, a normal sized posterior fossa, and no abnormalities in surrounding structures.[9]



https://doi.org/10.1017/cjn.2021.199 Published online by Cambridge University Press

Patients with cerebellar agenesis typically have impairment of equilibrium, gait, and inability to direct complex, learned movements, emphasizing the role of the cerebellum in motor development. A behavioral pattern termed cerebellar cognitive affective syndrome describes the cognitive deficits seen in acquired cerebellar lesions, namely, executive and visuospatial disorders, expressive language disorders, and blunted affect.[10] A study of patients with congenital cerebellar malformations revealed a similar pattern of cognitive and affective difficulties, with heterogeneity in clinical phenotype highlighting the variation in neural reorganization processes.[10]

Our cases are remarkable for their age at presentation: with no imaging available when they were young, they received a diagnosis of cerebral palsy, never questioned until they sought medical attention many years later. While the pathology inherently does not seem to be life-limiting, the older age of our patients is a feature of the age they were referred to neurosurgery, highlighting how both attained remarkable levels of functionality and, now at 64 and 70, respectively, they represent two of the oldest patients known to be living with this condition.

## Disclosures

The authors have no conflicts of interest to declare.

## Statement of Authorship

EL and GEP were both involved in the conceptualization of the manuscript. EL did the initial writing of the manuscript, with oversight and editing provided by GEP. Both were involved in editing the reviewer comments and both approved the final submission of manuscript.

*Erika Leck*
*Division of Neurosurgery, Department of Surgery, Dalhousie University, Halifax, Nova Scotia, Canada*

*Gwynedd E. Pickett*
*Division of Neurosurgery, Department of Surgery, Dalhousie University, Halifax, Nova Scotia, Canada*

*Correspondence to*: Erika Leck, QEII Health Sciences Center, Halifax Infirmary, 1796 Summer Street, Halifax, NS B3H 3A7, Canada. Email: erika.leck@gmail.com

## References

1. Yu F, et al. A new case of complete primary cerebellar agenesis: clinical and imaging findings in a living patient. Brain. 2015;138:e353.
2. Huissoud C, Rudigoz R-C, Bisch C, et al. Complete cerebellar agenesis: a very rare abnormality of the posterior fossa. Ultrasound Obstet Gyneocol. 2009;33:730–31.
3. Gupta A, Malik GK, Gupta A, Saksena S, Gupta RK. MR demonstration of complete cerebellar and corpus callosum agenesis. Pediatr Neurosurg. 2007;43:29–31.
4. Leech RW, Johnson SH, Brumback RA. Agenesis of cerebellum associated with arrhiencephaly. Clin Neuropathol. 1997;16:90–7.
5. Hamilton RL, Grafe MR. Complete absence of the cerebellum: a report of two cases. Acta Neuropathol. 1994;88:258–61.
6. Leestma JE, Torres JV. Unappreciated agenesis of cerebellum in an adult: case report of a 38-year-old man. Am J Forensic Med Pathol. 2000;21:155–61.
7. Titomanlio L, et al. Cerebellar agenesis. Neurology. 2005;64:E21.
8. Gelal FM, et al. Clinical and MRI findings of cerebellar agenesis in two living adult patients. Ann Indian Acad Neurol. 2016;19:255–7.
9. Tekin D, Uysal S, Iyigun O. Primary cerebellar agenesis-Chiari IV malformation. O.M.U. Tip Dergisi. 2002;19:213–6.
10. Tavano A, et al. Disorders of cognitive and affective development in cerebellar malformations. Brain. 2007;130:2646–60.



https://doi.org/10.1017/cjn.2021.199 Published online by Cambridge University Press