

OCCASIONAL PAPER**Cerebellar agenesis revisited****C. A. R. Boyd**

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New clinical and employment information, together with over-looked previously published information, on a patient (H.C.) is reviewed. H.C., who died at the age of 76 in 1939, was found, by chance during anatomical dissection, to lack a cerebellum. This synthesis challenges an unusual and interesting account of cerebellar agenesis published in *Brain* in 1994 by Glickstein (see also Glickstein, 2006), in which the allegedly 'bogus' oral history of this individual's motor skills was held to have led to 'medical myth making'. Part of the burden of the 1994 paper was to show that 'cerebellar agenesis is always associated with profound motor deficits'. Glickstein therefore focussed on an apparent 'exception' to this conclusion, concerning the brain of a single case, H.C., who died 70 years ago, who 'had given rise to an oral tradition alleging that normal movement is possible despite total cerebellar agenesis'. Glickstein (1994) concludes 'despite an oral tradition to the contrary there is absolutely no evidence about the motor capacities of this man during his life'. Rather remarkably, an extensive history of this individual has become available, its significance becoming noted only this year; this complements and adds to a previous brief history published on H.C. (and not mentioned in the 1994 paper; see below). The new evidence includes the death certificate stating the man's occupation to have been 'manual labourer' with all the implications relevant to his supposed incapacity. The written historical record thus confronts the alleged 'myth'. It is interesting to note how medical records on an undoubtedly very ordinary citizen were recorded in London in the 1930s (before the NHS was set up in 1949) and how they could be made accessible to clinical colleagues in east London in the middle of World War II blitz bombing of the capital.

The new information: the 'Boyd folder' and its contents

The new information is contained in an ageing brown cardboard folder headed (in handwriting) 'Cerebellum: hypoplasia and aplasia' and signed J.D. Boyd at the bottom of the front cover. The handwriting is certainly that of Boyd and there is thus no doubt of the provenance of the folder. [Boyd was the Professor of Anatomy in Cambridge (until his death in 1968) where he had moved from the London Hospital Medical School in 1951; see Boyd and Boyd (2009)]. The 'Boyd folder' contained:

- (i) a 'compliment' slip from Mr Northfield (London Hospital Whitechapel E1) dated 6 July 1939;
- (ii) a typed page (foolscap) headed with the name of the subject (hereafter 'H.C.') and his age at death (76). This contained a detailed case summary including a 'Clinical History'. It discloses that the individual had been admitted to a South London Hospital (Tooting Bec Hospital) in June 1930, aged 67, with a diagnosis of osteitis deformans and a secondary dementia. He stayed in this hospital for 9 years until his death from 'myocardial degeneration and auricular degeneration' on 15 March 1939. On admission he was noted to have cardiac enlargement with an apex beat detected in the 6th intercostal space (left ventricular hypertrophy) and incipient right heart failure [with (tender) hepatomegaly on clinical examination]. He was also found to have a squint in his right eye. The social history describes

him as 'single'. The notes contained a record of his (subsequent) assessment by a neurologist, Dr. Jacobson, who described him as 'a simple man with some hearing loss and slow slurred speech; he has a fair memory for recent and remote events concerning himself, but with limited general knowledge. There is no hallucination or delusions nor emotional defect. He is clean in his habits and able to attend to his person. He is able to get around unassisted'. The following year (1931) he developed delusions and his memory became defective. He remained 'useful and active' on the ward until 1934; in 1936 he developed auricular fibrillation and peripheral oedema; in 1937 his condition was generally stationary although he then had 'dysarthria and right external strabismus, with sluggish pupils but both plantar reflexes remained flexor';

- (iii) a death certificate on H.C. (dated 15 March 1939, the day of his death) stating that he died from 'myocardial degeneration and auricular fibrillation';
- (iv) twelve photographic prints (together with a scale bar) of the post-mortem brain; and negatives for these prints. One is reproduced here as Fig. 1. Nine others can be found in the online supplementary material;
- (v) three sets of notes (all in Boyd's handwriting):
 - (a) a single sheet entitled 'A case of neocerebellar atrophy by J.D. Boyd'. This is virtually identical to that printed in the *Journal of Anatomy* (*vide infra*);
 - (b) a single sheet entitled 'Kappers, Huber & Crosby (1936) Nervous System of Vertebrates & Man Vol 1 p 810' this concerns the origin of the pons and refers to the work of , His (1891) and Essick (1907, 1912); and
 - (c) five sheets (held together by tag) headed 'Two cases of hypoplasia in Pontoneocerebellarius S. Koster Acta psychiatrica et neurologica scandinavica 1, 47 (1926)'. This includes a précis of these earlier cases and substantial discussion of how they might fit with the earlier literature and with Boyd's own views as an embryologist on cerebellar development and phylogeny.

It is probably the second of these [Boyd Folder item (ii)] that is most relevant to any re-interpretation of the position taken by Glickstein (1994). Clearly, detailed clinical evidence is available and this new material needs to be incorporated into what was published regarding the abilities of H.C. during his lifetime. Regarding the gross anatomy of this individual's brain, an image – taken from the preserved organ in 1994, allegedly still on display at that time in the School of Anatomy in Cambridge – has already been published (Glickstein, 1994; his Fig. 1); and in that review the brain anatomy is also described (Glickstein additionally and imaginatively arranged for an MRI scan of the brain to be carried out at the Institute of Neurology; his Fig. 2). Although not acknowledged in the 1994 paper (perhaps because the publication, *Proceedings, Anatomical Society of Great Britain and Ireland*, while present as an integral part of the *Journal of Anatomy* and thus available as hard copy in many libraries, had not been placed on any electronic database), the anatomical findings made were in fact described at a meeting of the Anatomical

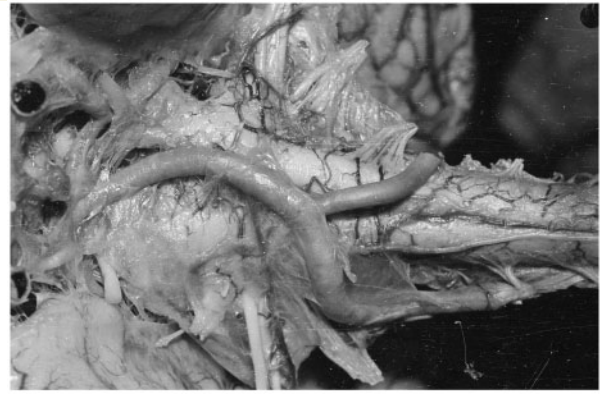


Figure 1 Reproduction of a black and white photograph from the Boyd folder showing the intact brain stem and basilar arterial territory of H.C.'s brain, following its removal from the skull by Mr Northfield, a neurosurgeon at the London Hospital. Glickstein (1994) recounts the discovery of the absent cerebellum as occurring in the dissecting room of the Anatomy Department of the London Hospital Medical School during a post graduate surgical examination. In the Boyd folder the handwritten note reads: 'cerebellar peduncles are very reduced in size; the pons is absent and the pyramidal tract can be identified at the surface of the ventral aspect of the brain stem as far as their decussation. No definite olive can be identified. A few tortuous fibres cross the pyramid superficially just behind the midbrain. The posterior fossa is well formed at the tentorium and is normal in position and development. The arachnoid lined the posterior fossa so as to form an enormous cisterna magna'.

Society of Great Britain and Ireland held at the Royal College of Surgeons in April 1940: and this was published (Boyd, 1940), the normal procedure continuing despite wartime conditions. In the ensuing discussion (recorded by A.E. Cave), the doyen of 20th century neurohistologists, W.E. Le Gros Clark, commented that in cats congenital absence of cerebellum was also found; and suggested that given the remarkable absence of the pons, particularly the pre-trigeminal pontine area, a histological study of the medial thalamic nucleus (looking for evidence of atrophy or gliosis) could be of particular interest (a point, perhaps, still worth pursuing). The report itself describes the subject as aged 76 at his death and details the appearance of the brain describing it as discovered by chance in the dissecting room. This published anatomical description fits well with the observations made some 50 years later by Glickstein (1994); thus the cerebellum is represented solely by a small nodule of nervous tissue, presumed to be palaeocerebellar; the pons is absent and the olive cannot be identified. However, the posterior fossa was well formed and the tentorium normal in position; no obvious changes were noted in the cerebral cortex. There is thus no controversy regarding the absence of most of the cerebellum, including all of the neocerebellum in this individual. Figure 2 shows a new MRI scan, made courtesy of the Wolfson Brain Imaging Centre, where all these features can readily be noted. Additionally the published report also provides clinical information on the individual immediately prior to death. At this stage, it is clear that there were indeed clinical signs

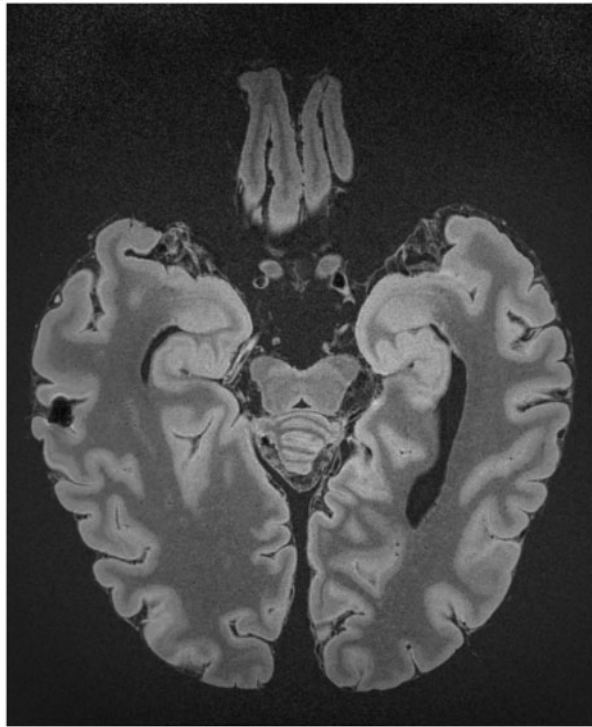


Figure 2 Oblique transverse section through brain of H.C. studied by MRI. Anterior is towards the top of the image, posterior towards the bottom. Note the complete absence of cerebellar hemispheres and the vestigial 'vermis' in the midline immediately posterior to the midbrain which lacks evidence of pons or pontine tracts. The two internal carotid arteries and the associated optic nerves lie well anterior to the midbrain structures. Image courtesy of the Wolfson Brain Imaging Centre, Cambridge. Photographic images of the intact brain that are shown in Supplementary Figures 1–9 complement this MRI; these photographs taken in 1939 show the brain stem and the complete absence of the neocerebellum.

including right external strabismus, slow and slurred articulation and an unsteady gait – all compatible with a variety of motor pathologies not excluding abnormal cerebellar function. However the new material in the 'Boyd folder' places this clinical evidence in the context of neurological deterioration over the last nine years of the individual's life; and, furthermore, contains a critical piece of new evidence, the death certificate of H.C., including his 'occupation'. From this it is clear that he had employment, that he was able to work in a manual job and that his working life was not curtailed by his cerebellar agenesis. None of this tells us his neurological status during the working part of his life; nor does it tell us anything about his motor development (although the absence, from the fairly substantial medical and social history contained in the Hospital Record at the time of his admission in old age, of any note of previous medical history may shed light albeit only indirectly). Taken together, a consensus seems to emerge, namely that adults may lead independent lives and have gainful employment dependent on motor skills in the absence of a cerebellum. However, the intellectual and the fine motor skills of such individuals may often be outside normal limits.

Conclusions

In man, cerebellar agenesis is compatible with a normal life span; and is also compatible with non-institutionalized life, including employment. In such patients there are almost certainly motor deficits that detailed clinical neurological examination may elicit. There may be other additional deficits [e.g. behavioural *cf.* Arcudi *et al.* (2000) and Leestma and Torres (2000)]. The making and keeping of detailed medical records of patients whose anatomical brain abnormality emerges only after death must be unusual; but it is clearly beneficial, as here, in allowing evidence to shed light on the genesis and interpretation of alleged medical 'myth making'. Sociologically, it seems fascinating that H.C.'s medical records in wartime London were so readily accessed and are found to be so detailed. Biologically, it appears that developmental plasticity within the nervous system is remarkable [*cf.* Gardner *et al.* (2001)], but perhaps never quite perfect, a conclusion that concurs with that made by Brodal (1969): 'a particular feature which contributes to making the diagnosis of cerebellar lesions difficult is the remarkable compensation which occurs...'. However nothing is known of the mechanism of compensation despite its great importance in clinical neurology'. Progress is now being made in understanding cell and molecular aspects of cerebellar morphogenesis (e.g. Millen and Gleeson, 2008); a future challenge will be to explore mechanisms for such functional compensation.

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Supplementary material

Supplementary material is available at Brain online.

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