

## The Irish Phineas Gage: Frontal Lobe Traumatic Brain Injury

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### Abstract

#### **Presentation**

We describe the clinical case of a gentleman who suffered a traumatic brain injury, following a fall on a building site. He was impaled with an iron rod through his left temple, sustaining significant injury to his frontal lobe.

#### **Diagnosis**

Frontal lobe traumatic brain injury with resultant behavioural change and cognitive impairment, which is discussed in detail in the manuscript and supplementary material.

#### **Treatment**

Emergency neurosurgical intervention, with removal of the rod and haematoma evacuation.

#### **Discussion**

Phineas Gage remains the archetypal example of frontal lobe dysfunction in medical education. A previously placid, mild-tempered railway foreman, Gage's frontal brain injury irrevocably changed his personality and engendered much interest in the functions of the frontal lobes. We describe Gage's modern-day Irish counterpart.

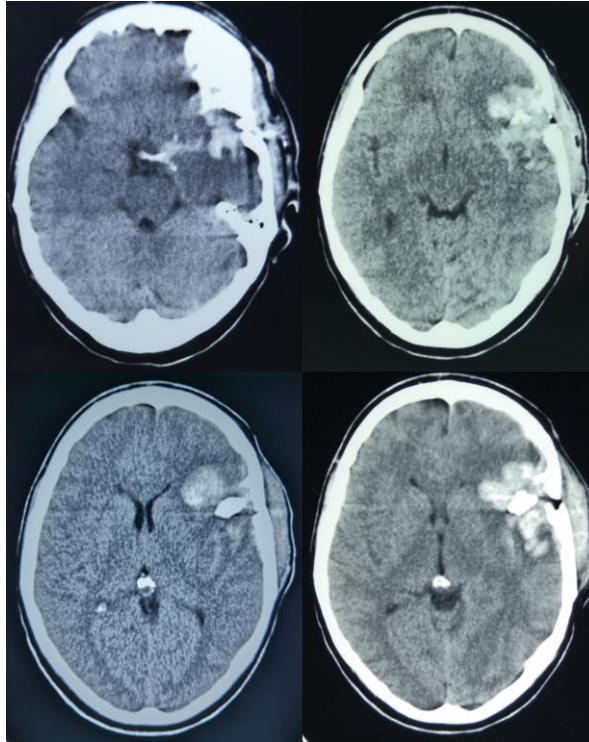
### Introduction

Phineas Gage was a 25-year-old railway foreman, a "shrewd businessman with a well-balanced mind"<sup>1</sup>. In 1848, an accidental explosion caused a 3cm-wide tamping rod to be propelled upward through Gage's facial bones and frontal skull, causing predominant left frontal lobe injuries (The Boston Crowbar Case)<sup>2,3</sup>.

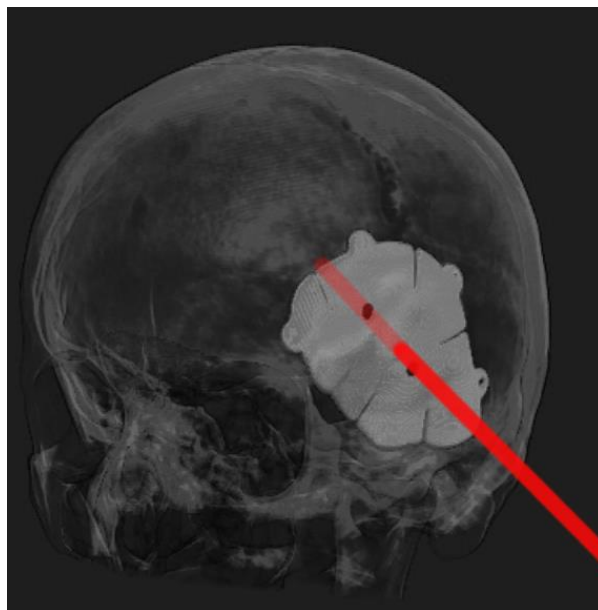
Gage recovered physically, but psychological deficits rendered him unable to resume his former position as a foreman. Harlow, Gage's physician commented that the equilibrium between his intellectual faculties and animal propensities seemed to have been destroyed<sup>1</sup>. Previously a favourite of his peers, Gage now displayed deference for colleagues, was profane, impatient, obstinate and despite devising many plans, was unable to proceed with any of them<sup>3</sup>; his friends commented that "Gage was no longer Gage"<sup>4</sup>.

## Case Report

Our patient, a 46-year-old right-handed carpenter, was injured in Ireland in 2006 after falling 2.5m from a scaffolding and becoming impaled on a 1.5cm diameter steel foundation rod which penetrated the left side of his temple, causing left fronto-parietal and temporal lobe damage. He was transferred to hospital with the steel rod in situ, which required surgical removal and evacuation of surrounding parenchymal haematoma. Acute imaging (Figure 1) and post-operative imaging (Figure 2) are shown below.



**Figure 1:** Initial non-contrast CT brain shows acute haemorrhage in the dorsolateral frontal lobe, a corresponding bone defect and significant extra-axial oedema. The path of the iron bar looks to pass medially and rostrally following penetration of the skull.



**Figure 2:** Volume rendered CT image of our patient showing our impression of the trajectory of the iron bar traversing the skull (titanium plate also visible).

He made a good physical recovery but subsequently was a changed man. Previously affable and gregarious, he became paranoid, irritable, short-tempered; he found it difficult to socialise and withdrew from society. He displayed poor concentration and memory and like Phineas 165 years ago, lost his job. He readily insults people and shows no remorse or empathy. He was forced to move out of the family home and became estranged from his longtime partner.

Neuropsychological examination performed ten years following the accident showed pervasive deficits consistent with frontal lobe injury. He assumed an overfamiliar manner, reflecting poor social awareness. He performed poorly on focused testing of cognitive skills considered sensitive to frontal lobe dysfunction, including mental abstraction, social reasoning, organisational functioning and sustained application of mental effort. Disproportionate executive functioning deficits were observed, with poor mental application to tasks, poor self-monitoring skills, defective abstraction, planning, organizational and strategic functioning and cognitive inflexibility, reflecting predominant dorsolateral prefrontal injuries.

## **Discussion**

Post-mortem examination of Gage's skull and detailed digital reconstructions of the rod's trajectory have confirmed that most of the cerebral damage occurred in the left frontal lobe, and the loss of over 10% of frontal white matter volume resulted in major disruption to the white matter connectome.<sup>3,8</sup>

Frontal sub-cortical circuits determine many facets of human behaviour. Damage to these can produce dramatic neurobehavioral syndromes, yet they are rarely formally assessed during routine neurological consultations<sup>6</sup>. Many different symptom groups are referable to frontal lobe injury, which generally predominantly localise to one of three frontal distinct regions. These include the dorsolateral prefrontal (heteromodal cortex) syndrome, which in isolation produces executive and learning dysfunction; the orbitofrontal and medial frontal (paralimbic) syndrome which manifests as personality changes and social disinhibition; and the anterior cingulate syndrome (the least studied of the three), which in isolation produces apathy and mutism (abulic syndrome)<sup>6</sup>. Isolated circuitry lesions have been reported, including Penfield who described executive dysfunction without personality change (heteromodal syndrome) in his sister following surgical treatment of an oligodendroglioma<sup>9</sup>. In practice however (as seen with Phineas, our patient, and more commonly in neurodegenerative disease) overlap is common. In the absence of accompanying physical deficits however, such frontal neurobehavioural and neuropsychiatric syndromes can be overlooked, or misinterpreted as personality traits.<sup>6,7</sup>

Our patient's frontal lobe injuries produced a clinical syndrome strikingly akin to that of Phineas Gage. This Irish modern-day doppelganger serves as a reminder to clinicians about the story of Phineas Gage and his unique contribution to the study of frontal lobe function.

### **Declaration of Conflicts of Interest:**

The authors declare that they have no conflict of interest.

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