The Reversal Sign: An Ominous Imaging Finding

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Keywords

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A 60-year-old man was admitted with anoxic brain injury after surviving a cardiopulmonary arrest in an apartment fire. The patient's initial rhythm was pulseless electrical activity and an estimated 45 minutes elapsed until return of spontaneous circulation. The patient had also suffered carbon monoxide poisoning, (carboxyhemoglobin of 35% on 100% supplemental oxygen), severe inhalation injury, and multiple first- and second-degree burns to face and extremities. A noncontrast head computed tomography (NCCT) on admission (Figure 1A and B) showed inversion of the normal relative densities of gray and white matter with gray matter exhibiting lower attenuation than the white matter, a pattern known as the "reversal sign."¹⁻³ Care was withdrawn on the third day of admission when patient met brain death criteria.

Discussion

Reversal sign findings on NCCT are variable and can include decreased density of cerebral cortical gray matter associated with a relative decrease or loss of the gray–white matter interface. These density changes can progress to complete reversal of the cortical gray/white matter densities (Figure 1A) with relative preservation of normal to high density of the central structures (Figure 1B) and cerebellum (often referred to as "white cerebellum sign").¹⁻³ However, these 2 signs are not required to coexist.⁴ The reversal sign represents severe anoxic–ischemic brain injury and can be seen in global cerebral ischemia, including carbon monoxide poisoning.¹⁻³ Proposed pathophysiologic explanations of decreased gray matter attenuation include edema and tissue destruction, while increased white matter density may be the result of distension of medullary veins.³ In our case, there was relative preservation of the density of the bilateral thalami but not cerebellum and all central gray structures, which reflects the variable imaging presentations of global anoxic injury. Such density preservation is not completely understood but thought to be a combination of relatively decreased susceptibility to hyperglycemia and hypoxia when compared to cortical gray matter,¹ the presence of malignant edema, and mechanical

Figure 1. The reversal sign represents severe anoxic–ischemic brain injury and can include diffuse, symmetric bilateral reversal of the gray and white matter density relationship on noncontrast head computed tomography (NCCT; A) and relative preservation of normal to high density of central structures, such as the bilateral thalami in this case (B).

factors such as relatively increased blood flow to central structures as transtentorial herniation occurs.³ However, it is important to note the classic presentation of carbon monoxide hypoxic brain damage involves bilaterally symmetric low attenuation in the globus pallidi,⁴ with the exact pathophysiologic mechanisms causing this pattern of damage rather than the "reversal sign" seen in our case remain uncertain.

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Nonetheless, regardless of etiology and pathophysiology, the “reversal sign” is usually associated with poor prognosis and irreversible brain injury.¹⁻³

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