

16. Diffuse Axonal Injury

Diffuse axonal injury (DAI) is the most common parenchymal injury occurring in trauma, and results from acceleration-deceleration or rotational force injuries. In these injuries, force differentials in adjacent areas of brain result in axonal sheering. DAI is staged by lesion location. Stage 1 lesions have the best prognosis and occur in the lobar white matter, usually at the gray-white matter junction (Fig. 16.1 A, B). Stage 2 lesions involve the corpus callosum (Fig. 16.1 C, black arrow), most commonly in the splenium and posterior portions. This pattern is related to the relatively narrow anterior falx which allows for transient hemispheric herniation in lieu of axonal sheering. Stage 3 DAI is the most severe form and involves the brainstem (Fig. 16.1 D, black arrow), most frequently the midbrain and superior pons. The appearance of DAI on conventional MR is initially related to tissue swelling and edema. Thus, areas of axonal injury appear somewhat hypointense on T1WI and hyperintense on T2WI and FLAIR scans (Fig. 16.1 A, C). Such lesions are classically described as ellipses with long axes paralleling the direction of axonal fibers. While T2WI are sensitive to DAI, the high SI of nearby CSF may make lesions that are near sulci or the ventricular system much less evident. Thus, FLAIR is the FSE sequence of choice for detection of DAI. The appearance of hemorrhagic DAI on MRI is variable, specifically depending upon the stage of blood products (See Ch. 8). Because of the increased sensitivity to susceptibility effects, GRE T2WI (Fig. 16.1 B, D) must be obtained when DAI is suspected. GRE is used primarily to detect blood products, which are seen as areas of low SI (Fig. 16.1 B, D), due to the presence of deoxyhemoglobin acutely. High

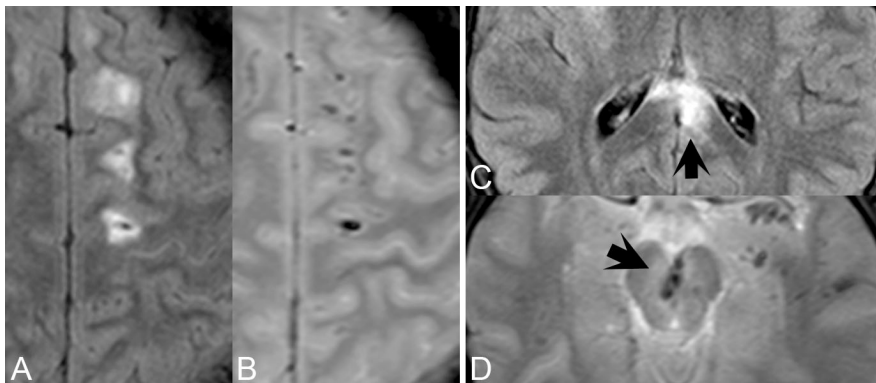


Fig. 16.1

sensitivity to hemosiderin also enables improved detection of chronic DAI with GRE: lesions remain hypointense for years with GRE after they have become inapparent on FSE MRI. DWI is less sensitive to DAI than the aforementioned sequences but may detect mild

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shear injuries that are otherwise inapparent. DAI lesions demonstrate restricted diffusion within the first 2-3 weeks of injury. Diffusion tensor imaging may demonstrate decreased diffusion along white matter tracts (anisotropy) in the setting of DAI, correlating with axonal disruption/shearing (loss of integrity).