# Concussions and Their Potentially Short-term and Long-term Adverse Effects: What Can MRI Tell Us?

RTS 2

## What is a concussion?

Despite the different definitions that exist, generally a concussion is defined as a mild traumatic brain injury (mTBI) induced by an impulsive force transmitted to the head resulting from a direct or indirect impact. It has been said that all concussions are mild TBIs, though all mTBIs are not concussions.[1]

Clinical presentation is complex (see Figure 1) and severity of this injury varies. The majority of the post-mTBI symptoms are resolved spontaneously within days to a few weeks. However, in about 30% of mTBI patient's postconcussion symptoms (PCS) persist over a period of several months or longer.[1]

Physicians commonly approach concussion management in a systematic manner (see Figure 2). This methodology typically doesn't include, nor benefit from imaging. The real benefit from initial and subsequent imaging comes retrospectively. When magnetic resonance imaging (MRI) scans of subjects with a history of concussion were compared to the scans of subjects with no history of concussive injury, it was evident that there is correlation between cognitive deficits and neuroimaging findings. Suffering from repeated concussions, a single concussion, or even several sub-concussive injuries, has the potential to manifest damage in the way of gray matter volumes, cerebral blood flow, white matter microstructures and ventricular enlargement.[2,4]

## Role of MRI

MRI is most commonly used for evaluating mTBI because of its superior soft tissue contrast and its multimodal nature that can provide anatomical, structural, functional, physiological and metabolic information. MRI also has the ability to detect subtle pathology in mTBI even when the clinical symptoms appear to return to normal values.[1] Although there are many MRI-based techniques, diffusion tensor imaging (DTI) has shown significant promise in identifying underlying neuropathology in mTBI and can be used to calculate cerebral blood flow, gray matter volume, white matter microstructure through fractional anisotropy and mean diffusivity.[2]

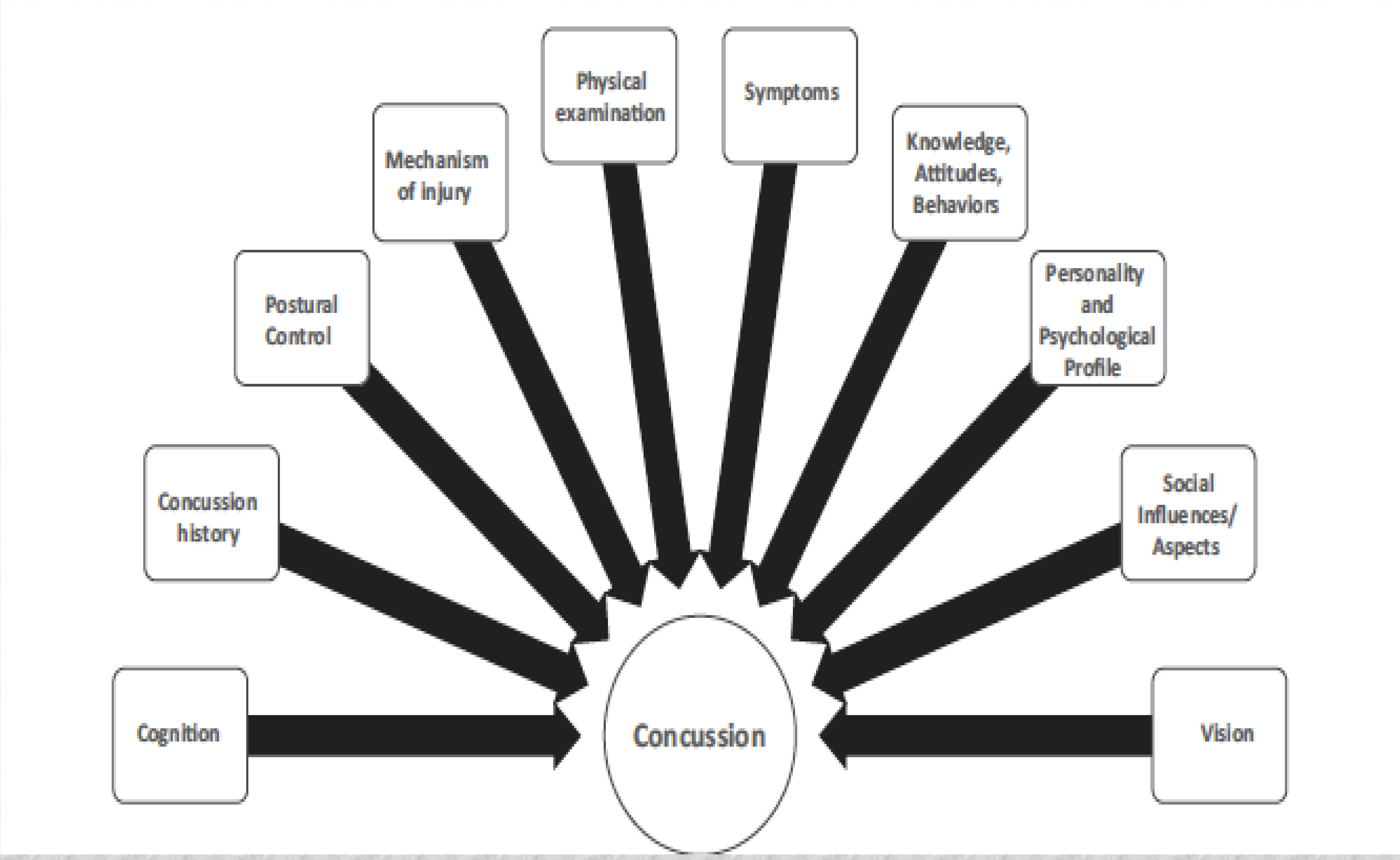


**Figure 1.** The complexity of concussion.[1]

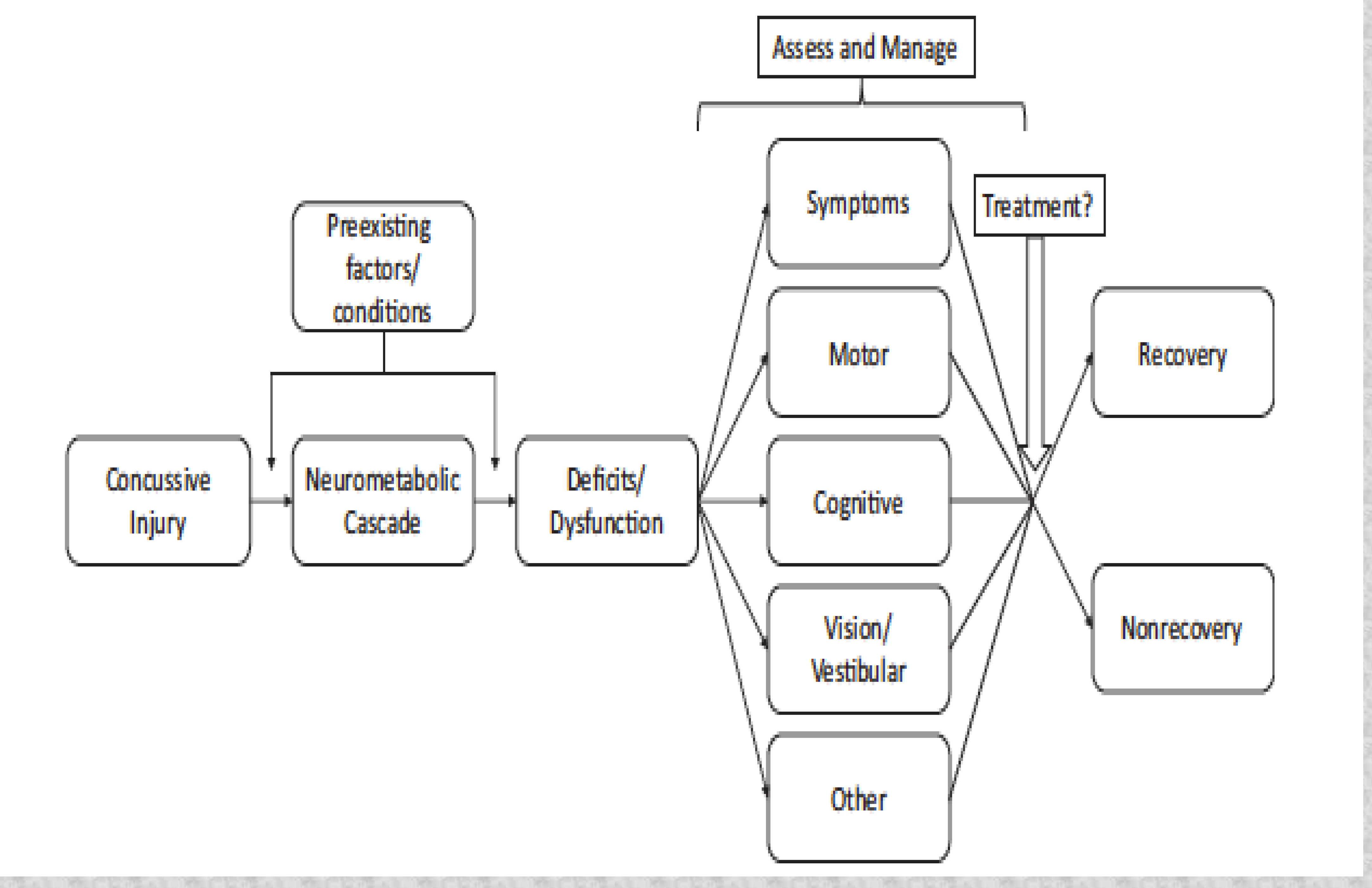


**Figure 2.** Progression of concussion management. Visual representation of the systematic style of management widely accepted and adopted by physicians.[1]

## Role of MRI cont'd

Within DTI sequences, changes in the microstructure of brain tissue can be assessed via altered fractional anisotropy (FA) and mean diffusivity values. Fractional anisotropy measures the directionality of water diffusion and mean diffusivity to ultimately compute total water diffusion in the brain's white matter. Decreased anisotropy values and elevated mean diffusivity are potential indications of an abnormality and can be interpreted suggestive of some ongoing recovery and/or reorganization in the brain that can continue for quite some time after the initial injury (see Figure 3).[3]

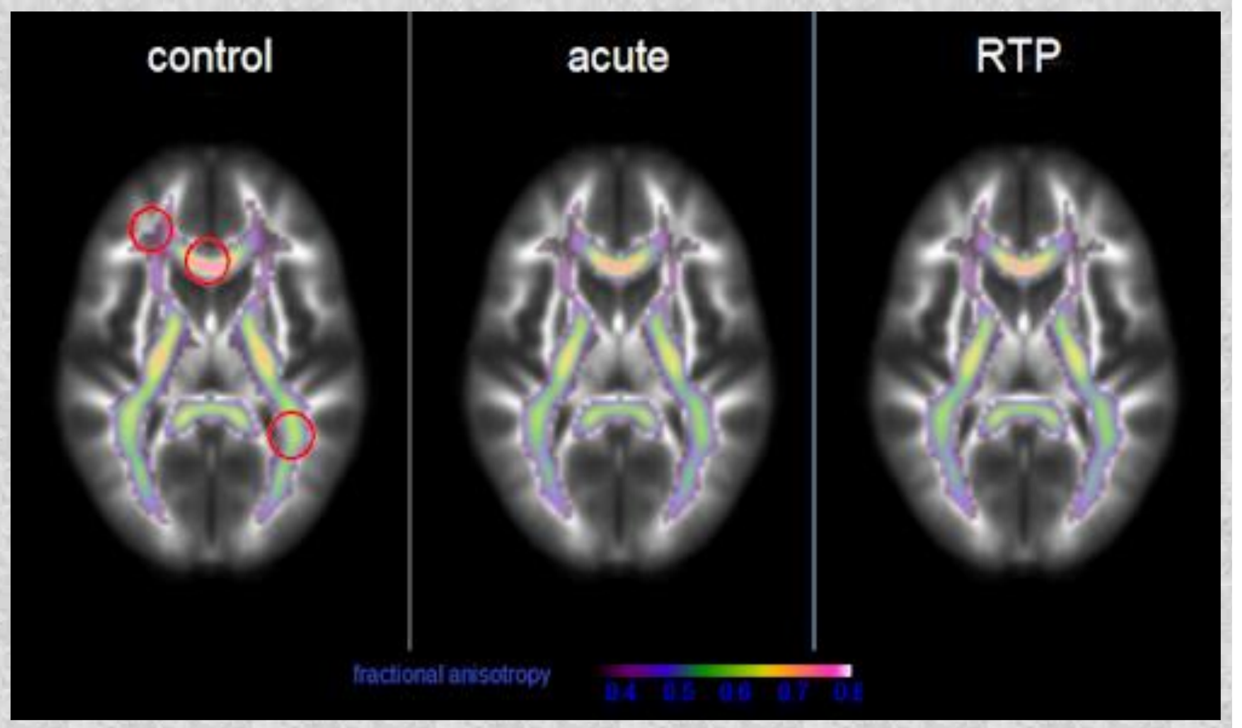


**Figure 3.** MR images show mean fractional anisotropy in white matter for control subjects compared with concussed athletes after their injury (acute) and when they were clinically cleared to return to play (RTP). Red circles indicate areas of significant concussion effects.[3]

## References


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