Post-Concussion Syndrome Due to Traumatic Brain Injury (TBI)

Traumatic brain injury (TBI) has become a major public health concern worldwide for both civilian and military populations. At least 10 million new head injuries occur annually worldwide, and these account for a high mortality rate of deaths in young adults.

TBI is defined as damage to the brain resulting from external mechanical force, such as rapid acceleration or deceleration, impact, blast waves, or projectile penetration. The major causes of TBI in high income countries are motor vehicle crashes (50%), falls (38%) and violence (including attempted suicide) (4%).

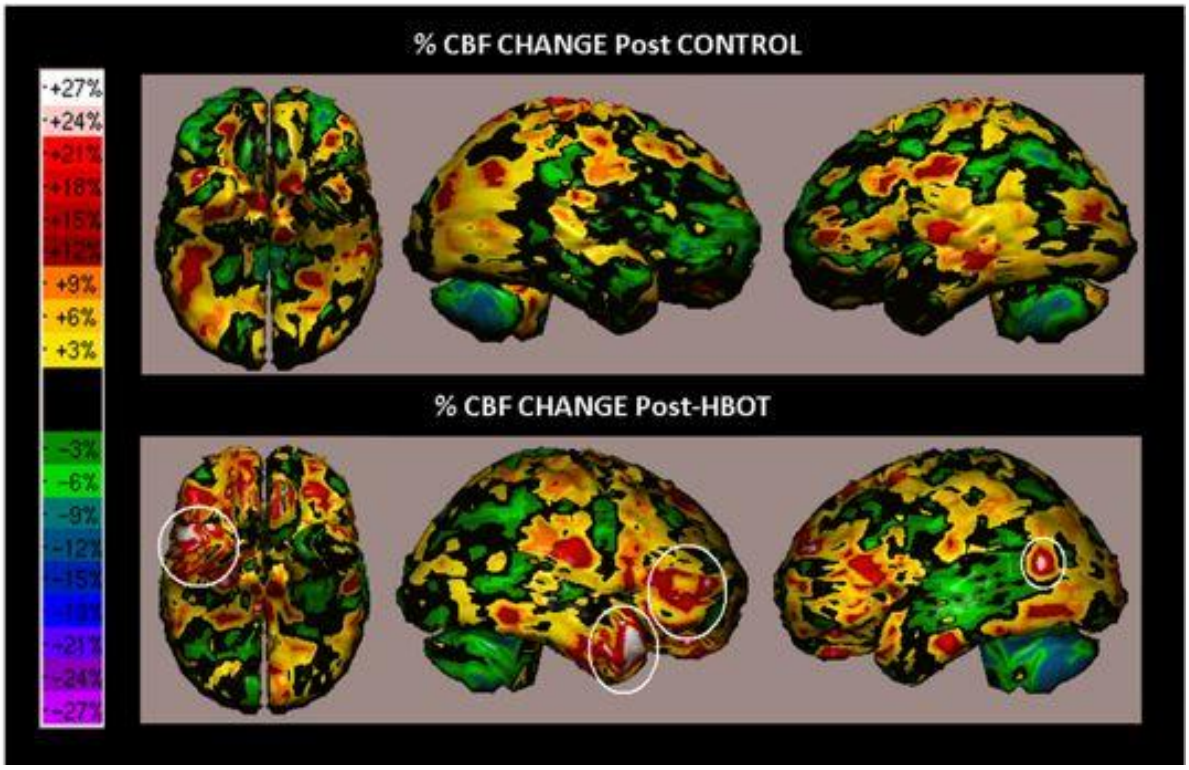
The pathophysiology of brain injury has primary and secondary components. The injury that occurs at the moment of impact is known as the primary injury. Primary injuries can involve a specific lobe of the brain or can involve the entire brain. During the impact of an accident, the brain crashes back and forth inside the skull causing bruising, bleeding, and tearing of nerve fibers. After the initial impact occurs, the brain undergoes a delayed trauma – it swells – pushing itself against the skull and reducing the flow of oxygen-rich blood. This is called secondary injury, which is often more damaging than the primary injury.

TBI classification is usually based on severity, anatomical features of the injury, and the cause of the injury: mild/ moderate/ severe. Patients with moderate-severe TBI survivors usually suffer from significant physical disability on top of cognitive, psychological and emotional impairments 3. Post-concussion syndrome (PCS) is a set of symptoms succeeding mild TBI in most patients. The PCS symptoms include headache, dizziness, neuropsychiatric symptoms (including behavioral and mood changes, confusion), difficulty balancing, fatigue, changes in sleep patterns and cognitive impairments (including memory, attention, concentration and executive functions disorders) 4,5. PCS may continue for weeks or months, most patients recover but up to 25% of the patients may experience prolonged PCS in which the symptoms become chronic 6-9.

Currently, there is no effective treatment/metabolic intervention in the daily clinical practice for post TBI patients with chronic neurological dysfunction. During the subacute-chronic phase, patients participate in intensive rehabilitation programs that aim to improve independent function and quality of life, mostly by helping the patients to adapt to their disabilities. Rehabilitation includes a multidisciplinary approach that may include physiotherapy, speech and language therapy, cognitive rehabilitation therapy, medications and others 10. However, several systematic reviews found limited evidence to support the efficacy of rehabilitation programs 11.

Hyperbaric Oxygen Therapy and Chronic Brain Damage

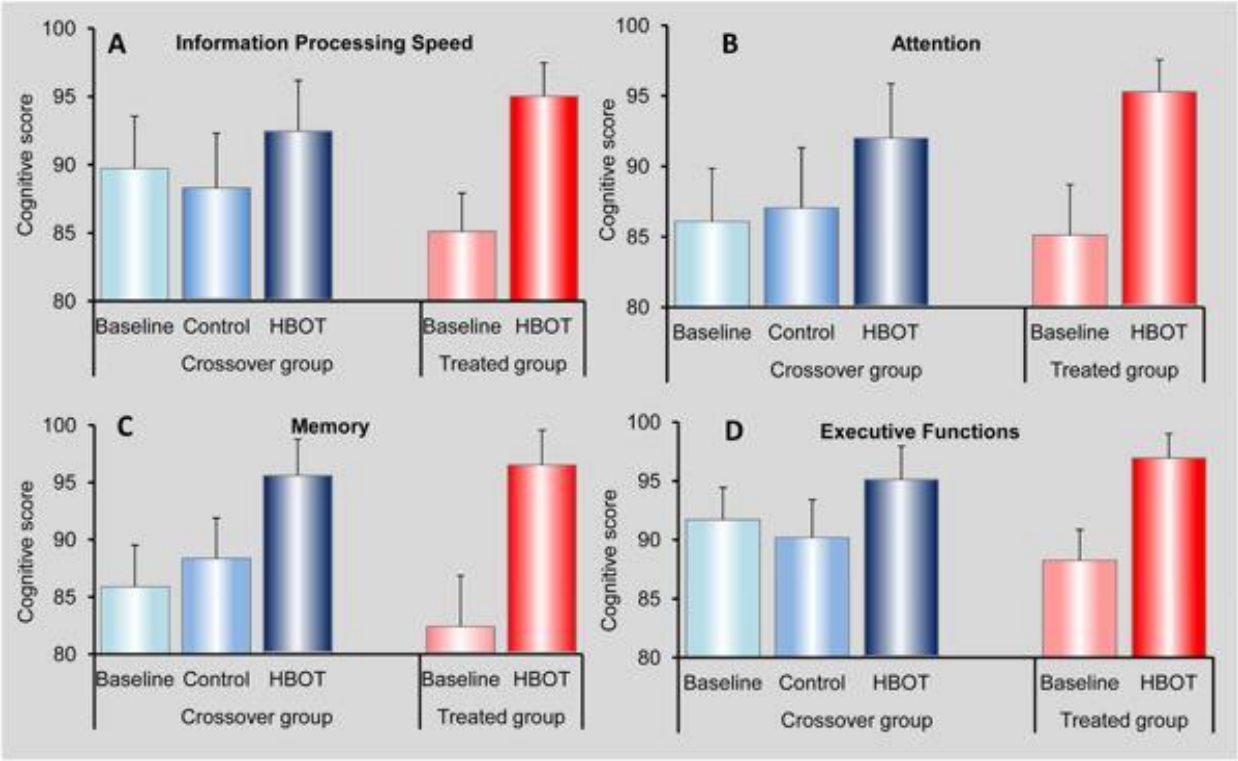
Hyperbaric Oxygen Therapy (HBOT) is used for chronic and urgent medical conditions associated with tissue hypoxia. There is growing data on physiological effects of HBOT on different injured tissue, including the brain, using different models of pre-clinical (animal) as well as clinical studies in humans. Recently, clinical studies in the Shamir (Asaf-Harofeh) Medical Center evaluated the effect of HBOT on patients suffering from neurological deficiencies. In these studies, it was found that HBOT can induce neuroplasticity in stunned/wounded brain regions (metabolic dysfunction) even years after the acute insult. These brain regions can be visualized by metabolic imaging of the brain, performed by SPECT analysis combined with MRI. In the regions where there is SPECT/MRI mismatch, HBOT can reactivate, initiate regeneration and induce neuroplasticity that is correlated with the related clinical symptoms.



The results are of a patient suffering from mild TBI and post-concussion syndrome. These SPECT images demonstrate significant improvement of metabolism in the localized significant changes (white circles) in the in the right temporal pole and in the right dorso-lateral area., in comparison to the baseline SPECT. HBOT SPECT findings correlate positively with the patient's improved cognitive function.

TBI and HBOT Research

Recently, clinical studies in the Shamir Medical Center evaluated the effect of HBOT on patients suffering from neurological deficiencies due to mild TBI. In the randomized controlled study “Hyperbaric Oxygen Therapy Can Improve Post Concussion Syndrome Years after Mild Traumatic Brain Injury – Randomized Prospective Trial” 12, it was found that HBOT can induce neuroplasticity and improve both cognitive impairments and quality of life even years after the acute insult. The HBOT treated group showed significant improvements in all cognitive domains (memory, attention, executive function, information processing speed and motor) and EQ-5D (quality of life score) compared to the controlled group. Moreover, the control group, was later crossed and received HBOT, gaining similar neurological and quality of life improvements.



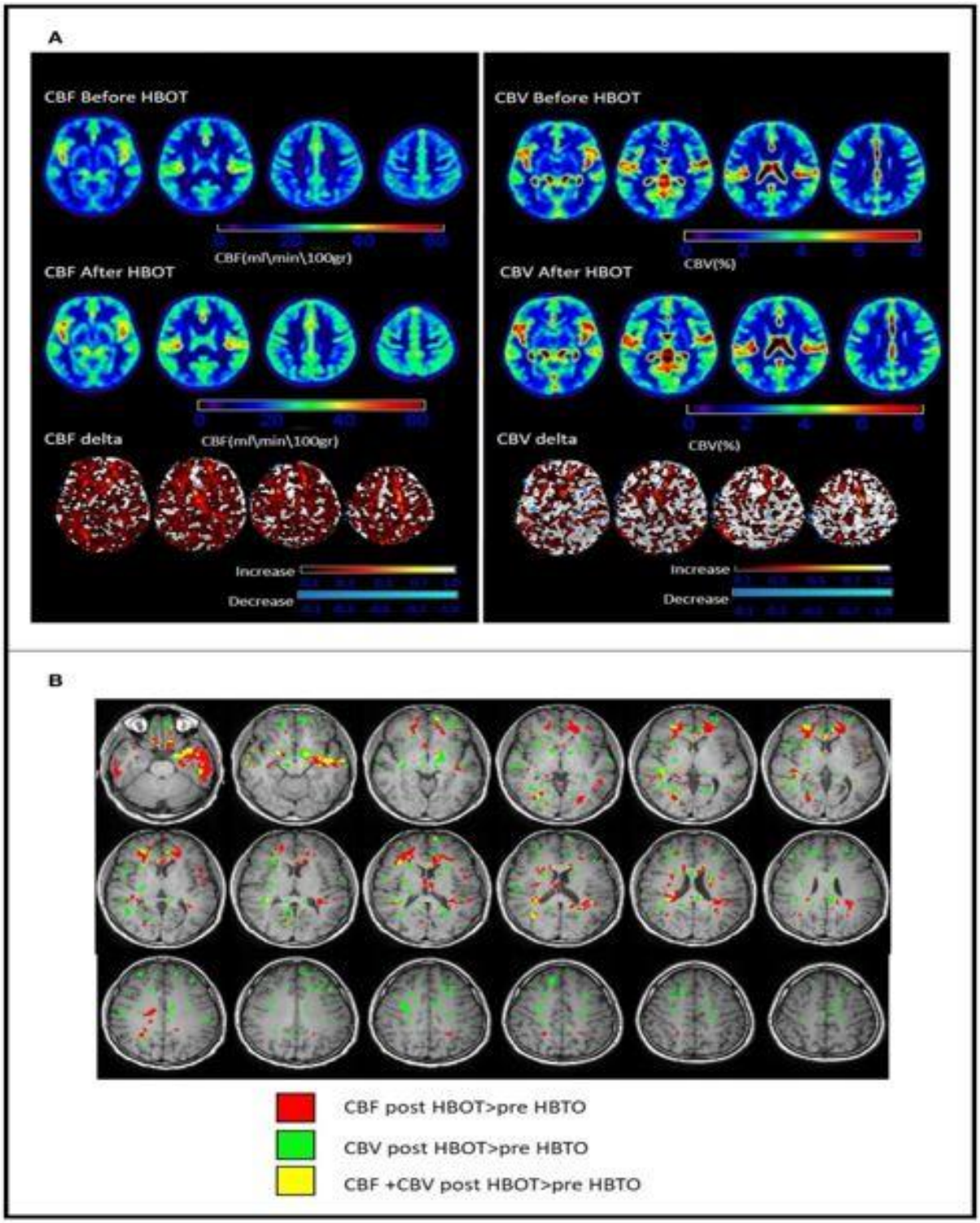
In the latest research headed by Dr. Amir Hadanny and Dr. Shai Efrati the team evaluated the effects of HBOT on the world's largest cohort of TBI patients treated with HBOT– see; “Effect of hyperbaric oxygen therapy on chronic neurocognitive deficits of post-traumatic brain injury patients: retrospective analysis”13.

A retrospective analysis was conducted on 154 patients who were treated with HBOT for TBI (>3 months) between 2008-2017 at the Sagol center.

Research Results:

- Significant improvements in all cognitive domains post HBOT even in the late chronic stage.
- The clinical improvements were achieved regardless of the severity of TBI – mild/moderate/severe.
- The clinical improvements were well correlated with increased activity in the relevant brain areas.

For the first time in humans, it was demonstrated that the clinical improvement correlates with significant increased cerebral blood flow (brain perfusion) and the generation of new blood vessels in the brain (angiogenesis). In addition, there was a significant regeneration at the level of the microstructure of the brain (neurogenesis).



Treating TBI: Sagol Center Recommended HBOT Protocol

Phase I Medical Assessment

The process begins with a comprehensive medical, physiological, cognitive, and imaging evaluation assessment. The tests are conducted by trained medical staff including: Physicians, Neuropsychologists, Physiotherapists, Physiologists, Nurses and more.

The evaluation also includes metabolic/functional brain imaging: brain perfusion MRI + brain microstructure (DTI) and brain SPECT in addition to neurocognitive tests and physical therapist assessment.

Phase III HBOT Protocol

60 Daily consecutive sessions / 5 days per week / 2 ATA / 100 Oxygen for 90min with air breaks of 5 minutes every 20 minutes/ total session time 120min.

Throughout the treatment period rehab training will be provided to patients by the professional cognitive and physiological professionals.

Phase III Post-HBOT Assessment

At the end of the treatment the evaluation and tests done at baseline will be repeated for an objective evaluation and future recommendations.

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