Osteopathy in the Cranial Field as a Method to Enhance Brain Injury Recovery: A Preliminary Study

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INTRODUCTION

Traumatic brain injury (TBI) represents a significant clinical burden. The majority of cases are mild TBIs that result largely from sports-related impacts, falls, car crashes and exposure to explosive devices.

A potential treatment strategy for TBI is the use of osteopathy in the cranial field (OCF). One therapeutic principal of OCF is movement of cerebrospinal fluid (CSF). The discovery of the lymphatic system of the central nervous system provides an opportunity to enhance brain fluid dynamics through the use of OCF and other lymphatic techniques. OCF disperses the CSF through the lymphatic system and helps to regulate lymphatic tissue fluid flows of the body, and thus may act as a method to enhance fluid flow within the brain.

Evidence on the clinical efficacy of OCF is heterogeneous and insufficient to draw definitive conclusions. Studies have found that the quality of life and global health were improved when OCF was used for children with cerebral palsy and others have reported on change in pain, sleeping habits, gross motor function, and autonomic nervous system function.

The overarching goal of this work is to determine if OCF can be useful as a treatment for TBI. The hypothesis is that OCF combined with a lymphatic pump will enhance fluid flow within the brain allowing for better clearance of toxic molecules.

METHODOLOGY

Osteopathy in the cranial field

Figure 1. Male adult rats were used to determine blood-brain-barrier (BBB) permeability following OCF. Anesthetized rats were either treated with OCF therapy, touch only, or no treatment (sham). For OCF, fingers were used to place gentle pressure over the rats’ occiput, medial to the junction of the occiput and temporal bone and inferior to lambda thereby placing tension on the dural membranes in the area of the 4th ventricle. This light pressure was used to discourage the flexion phase of the primary respiratory mechanism and was held until the operator felt the tissue relax and subsequent improvement in the freedom of motion of the primary respiratory mechanism which should in turn lead to enhanced lymphatic drainage (CV4 technique).

Lymphatic pump technique

Figure 2. After OCF, Lymphatic Pump Technique (LPT) was performed. LPT consisted of the operator pressing the abdomen of the anesthetized animal with the thumb on one side and index finger and middle finger on the other side of the medial sagittal plane. The fingers were placed bilaterally, caudal to the ribs. Pressure was exerted medially and cranially to compress the lower ribs until sufficient resistance is produced against the diaphragm to increase intrathoracic pressure, then the pressure was released. Compressions were administered at a rate of approximately one per second for the duration of approximately one minute of treatment. Top: touch treatment, bottom: LPT treatment.

Blood-brain-barrier permeability

Figure 3. After OCF and LPT, EB solution was injected intravenously via the tail vein. After a 12-hour period, intracranial perfusion with saline occurred and brains were collected, weighed and homogenized. Supernatants from each brain was measured at 620 nm using a 96-well plate reader.
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RESULTS

Figure 4. There was no significant difference (p=0.9) in the concentration of Evan’s Blue dye in either the blood or brain homogenates between all groups. This suggests that OCF does not cause BBB disruption in naive animals.

DISCUSSION

A large percent of Veterans have been exposed to TBIs during their tours of duty. It is known that blast exposure triggers an acute inflammatory response within the brain that persists within a subpopulation of individuals. Post injury impairment of glymphatic function likely exacerbates the injury due to accumulation of both normal metabolic waste as well as other toxic metabolic waste products. OCT may serve as a therapy to facilitate the mitigation of both the acute and chronic neuroinflammation. One possible explanation for the health benefit provided by OCF would be that the manipulation enhances the flow of CSF within the brain thereby enhancing the removal of the metabolic waste. The basic knowledge gained from these studies will build a foundation for designing effective noninvasive treatment options for TBI patients.

CURRENT WORK

Influences of OCF on CSF flow

Figure 5. Labeled dextran molecules (tracers) were delivered into the cisterna magna of anesthetized male rats, followed by one session of OCF after ten minutes. One hour following the OCF session, rodents were transcardially perfused and fixed with 4% paraformaldehyde to visualize penetration of fluorescent CSF tracers into the brain parenchyma. Brains were collected, sectioned and conventional fluorescence microscopy was used to measure tracer levels. Results indicated that flow of the small molecular weight tracer was elevated in OFT-treated animals.

Effects of OCF following Repeated Blast TBI

Figure 6. The Advanced Blast Simulator (ABS), located in the Center for Injury Biomechanics at Virginia Tech, consists of a gas compression chamber (driver), a transition chamber, testing chamber, and end-wave eliminator. A mesh sling, designed to minimize wave hindrance, suspends and immobilizes the anesthetized animals within the test section of the driver, thereby enabling exclusive focus on primary blast injuries resulting from the pressure changes. A high-speed camera records the specimen in the testing chamber during blast. Blast pressures are measured and depicted with pressure magnitudes (kPa) expressed over specific times (msec) at specimen location.

Figure 7. Behavioral and neuropathological assessments were conducted to determine the effects of OCT as a treatment for blast TBI. Open Field Tests (OFT) are a behavioral assessment was conducted two and seven days following injury. This test can help measure anxiety-like behaviors typically seen following neurotrauma. Astrocyte reactivity and BBB compromise will be investigated as these are consequences of blast injury.