Omega-3 Fatty Acid Ingestion as a TBI Prophylactic

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ABSTRACT

Given the hazardous nature of combat operations and training exercises (e.g. airborne operations) conducted by the United States military, servicemembers are at high risk for sustaining a traumatic brain injury (TBI). Since the beginning of the Iraq and Afghanistan wars, almost a quarter of a million servicemembers have sustained a TBI.[1] A large number of TBIs are a result of the concussive forces generated by improvised explosive devices (IED). A smaller number are a result of penetrating head wounds. Others may be caused by activities resulting in powerful acceleration, deceleration, or rotational forces. Therapies for treating TBI thus far have been limited.

Much of the research conducted to date has focused on post-injury pharmacological interventions.[2] Additionally, better protective equipment could help in preventing TBIs; however, these issues are outside the scope of this paper. A relatively new area of research is investigating prophylactic measures taken to lessen the effects of TBI. One such measure involves nutritional interventions and their effects on TBI severity. Therefore, the purpose of this paper is to elucidate the potential benefits of omega-3 fatty acid intake as it relates to TBI severity.

The pathophysiology of TBI can be divided into two distinct phases, the details of which can be found in the review by Werner and Engelhard.[3] Briefly, the first stage involves the brain tissue damage resulting from a violent force, which in turn, may cause a disruption or imbalance between cerebral blood flow (CBF) and brain cell metabolism. Low CBF and high metabolism leads to cell ischemia and high CBF paired with low metabolism leads to hyperemia, both of which result in negative clinical outcomes.[3] The second stage of TBI involves a disruption in cellular ion exchange (e.g., Ca^{2+}, Na^{+}, K^{+}) as well as a series of events that lead to cellular necrosis and apoptosis (i.e., inflammation, increased reactive oxygen species, vasoconstriction, etc.) It is in the second stage where nutritional factors may have a positive influence on clinical outcomes.

Previous research has shown positive outcomes in trauma patients who are fed immune-enhancing formulas that include omega-3 fatty acids.[4] While such research has not been done specifically for TBI patients and the results cannot be directly attributed to omega-3s alone, the positive outcomes are encouraging. Furthermore, newer research has investigated the relationship between omega-3 intake before injury and recovery from TBI. In a study by Wu and colleagues rats were fed one of two diets – a regular diet or a diet supplemented with omega-3 fatty acids – for four weeks and then given a TBI via a Fluid Percussion Injury (FPI).[5] The rats receiving the omega-3 supplemented diet had reduced oxidative damage and less learning disability than the rats that were not fed omega-3s.[5]

The likely mechanism of action of omega-3 fatty acids on TBI deals with one of the hallmarks of acute neural injury – neuroinflammation. Following acute neural trauma, prostaglandins, leukotrienes, thromboxane, and other pro-inflammatory factors are markedly increased.[6] The inflammatory process produces reactive oxygen species (ROS), which in turn lead to cellular apoptosis.[6] To a certain degree, the release of such pro-inflammatory factors offers a protective effect. However, too much of an inflammatory response can have a negative effect on outcomes and potentially lead to death. In contrast to such pro-inflammatory factors, omega-3 fatty acids possess anti-inflammatory properties and may aid in inhibiting an overly inflammatory response and reduced ROS production resulting from neural trauma.[7]

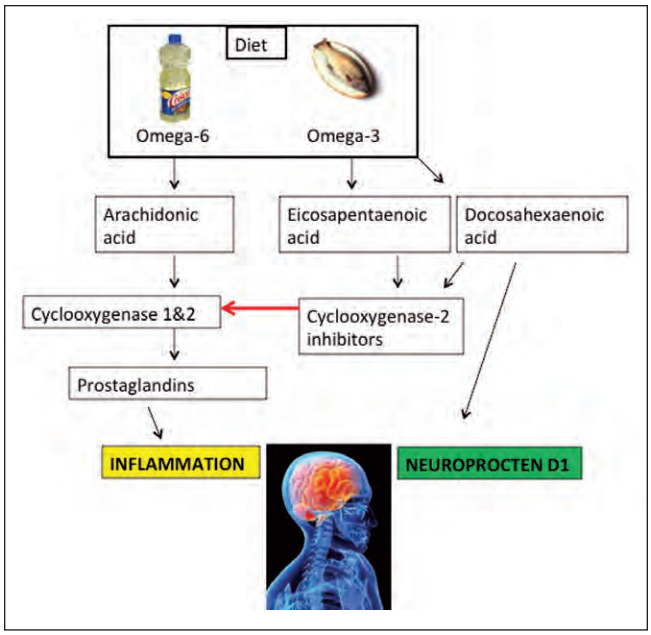
Docosahexaenoic acid (DHA) is a type of omega-3 fatty acid proposed to have beneficial effects on health. A great source of DHA in the diet is the consumption of omega-3 fatty acids. Furthermore, it has been clearly demonstrated that brain membrane ratios of omega-3

to omega-6 can be manipulated via dietary intake, which has been shown to influence neurotransmission and prostaglandin formation.[6] Consuming a diet high in DHA offers the potential for mediating pro-inflammatory chemicals associated with neural trauma and in turn protect the brain from TBI.[6]

We hypothesize that the SOF Warrior diet may have an effect on the cascade of chemicals released after TBI. The mental health and livelihood of a Warrior can come down to what they put at the end of their fork and knife. Although specifics for omega-3s consumption and protection against TBIs have yet to be specifically defined, animal studies suggest specific doses for cognitive health.

An omega-3 fatty acid dose of 4 grams per day (800mg of DHA) has been shown to increased vigor, reduce anger and anxiety, and reduce reaction time in sustained attention tests.[8] It is prudent to suggest that this amount be set as a goal currently for neuroprotection since it has demonstrated positive potential to improve brain performance and health. As further research is conducted with omega-3s and TBIs that amount might change. The goal of 4 grams of omega-3s per day might be challenging for many athletes since it equates to about 12 ounces of halibut or 9.6 ounces of anchovies.[9] Therefore, a dietary supplement might be needed to reach the 4g/d goal either as a standalone strategy or in combination with a high Omega-3 fatty acid diet. No serious side-effects were reported with omega-3 supplementation use in multiple studies[10] and omega-3 supplement intake has been shown to increase omega-3 fatty acid intake without increasing mercury intake.[11] Warriors need to ensure they make purchases through a reputable source and that the product contains at least 800mg of DHA in a 4 gram serving.

In the effort to improve the performance and ensure the safety of our SOF warriors we often focus significant time and energy in techniques and training to make our SOF warriors stronger and their bodies more resilient. The brain, the most important aspect of the Warrior, is often overlooked. The current average western diet has a ratio of pro-inflammatory Arachidonic acid (AA) to anti-inflammatory DHA of 15:1.[12] Since omega-6 fatty acids can compete with omega-3 fatty acids for absorption, the Western diet further compounds the lack of adequate omega-3 in the diet by potentially blocking some of the omega-3s that are consumed.[13] A more optimal ratio of AA to DHA would be 1:1.[12] The possible psychological benefits with mood disorders also support the potential for omega-3s as a TBI prophylactic as TBIs and post-traumatic stress disorders (PTSD) have some overlapping symptoms.[10] Furthermore, it is has been demonstrated that increasing omega-3 fatty acids is not only neurologically beneficial, but also beneficial to a multitude of disease states.[12,13]



Omega-6 and Omega-3 fatty acids roles in neuroinflammation and neuroportection

Omega-3 and Treatment of TBI Real World

Most examples of omega-3 as a treatment for TBIs to this point have involved animal models. However, there is a case report involving the lone survivor of the Sago Mine accident, he was treated with 21.2g/d of omega-3 fatty acids. The treating physicians attributed his recovery to the omega-3 fatty acids.[14] The results were so promising that one of the treating physicians, Dr. Julian Bailes, coauthored with COL Michael Lewis of the Defense and Veterans Brain Injury Center the article *Neuroprotection for the Warrior: Deitary Supplementation with Omega-3 Fatty Acids* were they make a similar argument for the consumption of omega-3 fatty acids at doses up to 4g/d.[15] Further research is needed to consider the multiple uses of omega-3 fatty acids for the Warfighter.[15]

Although further research is warranted, given the low risk to high reward of omega-3 fatty acid consumption it is advised for the SOF warrior to increase omega-3 fatty acid intake while simultaneously reducing omega-6 consumption in the diet. An increase can be achieved by consuming more marine based foods such as salmon, anchovies, and herring while a reduction in omega-6 reduction can be achieved by decreasing intake of "convenience foods" such as crackers, chips, and many of the fried foods served at fast food restaurants. While adjusting the diet should be the first step in improving the omega-3 to omega-6 ratio, dietary supplementation of omega-3s is also reasonable. In the quest for optimal performance and resiliency the SOF Warrior must realize that journey starts with the eating utensil in their hand.

References

1. Defense and Veterans Brain Injury Center. DoD Worldwide numbers for TBI. Available at: http://www.dvbic.org/TBI-Numbers.aspx. Accessed May 31, 2012.
2. Talsky A, Pacione LR, Shaw T, Wasserman L, Lenny A, Verma A, Hurwitz G, Waxman R, Morgan A, Bhalerao S. (2010). Pharmacological interventions for traumatic brain injury. *BCMJ*. Vol. 53, No. 1, January, February.
3. Werner C, Engelhard K. (2007). Pathophysiology of traumatic brain injury. *British Journal of Anasthesia*. 99(1): 4–9.
4. American Academy of Nutrition and Dietetics. Evidence Analysis Library. Critical Illness: Evidence-based Nutrition Practice Guideline 2012. Available at http://www.adaevidencelibrary.com. Accessed May 31, 2012.
5. Wu A, Ying Z, Gomez-Pinilla F. (2004). Dietary omega-3 fatty acids normalize BDNF levels, reduce oxidative damage, and counteract learning disability after traumatic brain injury in rats. *Journal of Neurotrauma*. October; 21 (10):1457–1467.
6. Tassoni D, Kaur G, Weisinger R, Sinclair A. (2008). The role of eicosanoids in the brain. *Asia Pac J Clin Nutr.* 17 Suppl 1:220–228.
7. Mills JD, Hadley K, Bailes JE. (2011). Dietary supplementation with the omega-3 fatty acid docosahexaenoic acid in traumatic brain injury. *Neurosurgery.* February, 68(2): 474–481.
8. Fontani G, Corradeschi F, Felici A, Alfatti F, Migliorini S, Lodi L. (2005). Cognitive and physiological effects of Omega-3 polyunsaturated fatty acid supplementation in healthy subjects. *European Journal of Clinical Investigation* [serial online]. November; 35(11):691–699.
9. Pennington J, Spungen J. Bowes and Church's Food Values of Portions Commonly Used. 18th edition. Lippincott Williams & Wilkins. 2005.
10. Ross B, Seguin J, Sieswerda L. (2007). Omega-3 fatty acids as treatments for mental illness: Which disorder and which fatty acid? *Lipids In Health And Disease*. September 18(6):21.
11. Melanson S, Lewandrowski E, Flood J, Lewandrowski K. (2005). Measurement of organochlorines in commercial over-the-counter fish oil preparations: Implications for dietary and therapeutic recommendations for omega-3 fatty acids and a review of the literature. *Arch Pathol Lab Med*. January; 129(1):74–77.
12. Farooqui A, Horrocks L, Farooqui T. (2007). Modulation of inflammation in brain: A matter of fat. *J Neurochem*. May 25, 2007;101(3):577–599.
13. Hibbeln J, Nieminen L, Blasbalg T, Riggs J, Lands W. (2006). Healthy intakes of n-3 and n-6 fatty acids: Estimations considering worldwide diversity. *Am J Clin Nutr.* June; 83(6 Suppl):1483S–1493s.
14. Roberts L, Bailes J, Dedhia H, et al. (2008). Surviving a mine explosion. *J Am Coll Surg*. 207(2): 276–83.
15. Lewis M, Bailes J. (2011). Neuroprotection for the warrior: Dietary supplementation with omega-3 fatty acids. *Mil Med*. October; 176, 10:1120–1127.

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