The Role of Mouthpieces in Reducing the Risk of Concussion

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With Minor Traumatic Brain Injury or MTBI (also known as concussion) reported to be of epidemic proportions in contact sports, awareness as well as methods of prevention and alleviation are an imperative mandate for the healthcare professions.

Concussion is defined as a complex pathophysiological process affecting the brain and induced by traumatic biomechanical forces. Concussion results in the rapid onset of impaired neurological function. Concussion may or may not involve loss of consciousness. The concussion symptom list now encompasses over 25 symptoms including dizziness, headache, blurring or other visual disturbances, amnesia, impaired balance and speech, wobbly gait, reduced cognition of surroundings understanding of verbal instruction and even vomiting. The acute clinical symptoms were previously thought to reflect functional disturbance only, but recent studies have shown long term neuropathological damage can result from repeated concussions. The brain is not an organ that can be conditioned to withstand repeated traumatic injury.

The primary cause of concussions is the brain itself being injured by banging against the inside of the skull during a moment of traumatic impact. Brain tissue is probably the softest biological material in the body and deforms easily in response to impulsively striking the inside wall of the hard bony skull. The brain normally floats in cerebrospinal fluid but striking the inside of the skull as a result of a traumatic impact can cause pathological damage. Repeated concussions before complete healing of previous ones have been shown to result in long-term neuropathological damage or even death.

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There are three distinct types of trauma that can initiate concussions in sporting activities —

1) Direct impact to the head or face

2) Trauma brought about by an impulsive blow specifically directed to the chin or mandible that forces the jaw into the brain

Concussions Can and Do Frequently Occur Without any Contact to the Head.
Robert Cantu | 2012

3) Traumatic body impact that causes a whiplash affect on the neck, resulting in the brain hitting the inside of the skull.

Biomechanical Differences such as Head Mass, Body Mass and Neck Strength may Explain Susceptibility to Concussion.
Epidemiology of Sport-Related Concussion
Daneshvar, Nowinski, McKee and Cantu | 2011

DIRECT HEAD IMPACT CONCUSSION
When a head is hit with substantial force it moves as a result of the impact. When it abruptly stops moving, the brain floating in a sac of cerebrospinal fluid inside the skull, may bang against the inside of the skull. The fragile brain tissue can become bruised or even tear if its location proximates the sharp bony ridges inside the skull. This type of concussion can occur at any lobe of the cerebrum. Bleeding, inflammation and swelling can result in damage to the brain tissue.
Jaw Impact

Jaw Impact Concussion

JAW IMPACT CONCUSSION
A traumatic blow to the chin or jaw can force the head of the mandibular condyle to perforate the thin superior surface of the glenoid fossa. The condyle is pushed through a thin wall of bone into the skull causing bruising and damage to the temporal lobe of the brain. This type of concussion is the least common of the three types and well-fitted, dual arch mouthpieces properly distract the condyles and provide excellent protection from temporal lobe concussion.

View from Inside of Skull Perf Left Glenoid Fossa

A View Inside the Cranial Vault

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NON-HEAD IMPACT CONCUSSION
Trauma to the chest and back of sufficient strength can cause whiplash of the head, resulting in concussion of the brain without a blow directly to the head. Delicate nerve cells in the cervical area are stretched, and along with damage inside the skull, can cause irreversible damage to the brain. When the head is more of a unit with the rest of the body, the resultant acceleration force from head impact is reduced. Neck strength mitigates rotational movement of the head from impulsive blows. Increased tone and strength of cervical muscles at the time of impact can reduce the risk of concussions. Neck strength can be increased with the correct mouthpiece fabricated in the correct maxillo-mandibular position to elicit facilitation.

![Image of hyperextension and hyperflexion with sprained or strained cervical tissues]

An illustration of the type of whiplash head movement that can result in a “non-head impact concussion”

FACILITATION AND INHIBITION
When a person gets a new computer they are initially blown away by its high speed performance. As the computer gets older most people notice that it no longer seems to perform as fast. Before one gets rid of it, the perception usually is that it is now way too slow. The hardware and the operating chip are the same as the day it was purchased. An older computer does not perform as fast because the hard drive is cluttered with superfluous software and data files that are no longer relevant or necessary and rarely used.

Human brains work in an analogous manner. The human brain has a finite number of neural circuits. When the brain’s circuitry is not cluttered, it performs at optimal speed and the term “facilitated” is used to describe its status. When the human brain circuits are overloaded with superfluous input, its speed and execution of function become reduced and we define this condition as “inhibited”.

The most important function of the back and neck in human beings is to support the head in an upright posture. Good posture is the least stressful position for proper head balance.

Maintenance of erect posture however, is a particularly difficult neurological task to accomplish because the head has an attached part that is almost constantly moving (the mandible) and necessitating constant counterbalancing by the back and neck. Talking, chewing and swallowing are the most complex human reflexes. Execution of these functions are performed with minimal movement of the head on the spinal column and require a tremendous amount of neurological circuitry. There are a large number of physiological, postural and structural issues that can clutter the brain’s circuitry and inhibit performance. Manual Muscle Testing (MMT) provides a window for measurement of neurological clutter.

The nervous system accomplishes regulation of muscle function at a subconscious level. Information provided within the muscle spindle cells and Golgi tendons generate signal outputs. Movement is generated by the premotor and motor cortex and sent to the reticular activating system, hypothalamus and limbic system.

Manual Muscle Testing (MMT) measures a muscle’s isometric response to changing pressure over a one to three second period; not the total or peak force the muscle can generate. A muscle is tested at either its most shortened position or in the middle of its range of motion. In isometric muscle testing no movement occurs. The muscle contracts but does not shorten. Isolation of a single muscle for testing is possible by specific positioning. MMT is a system of functional neurological assessment used to guide clinicians to therapeutic measures that facilitate optimal neurological, respiratory and postural functioning.

MMT, as described, is identical to standards of muscle testing utilized in physical medicine or disability determination, MMT is a method of assessing the status of neural function brought about in the Central Integrative State (CIS) of anterior horn motoneurons. The CIS is defined as the neurological summation of all excitatory inputs and inhibitory inputs. The functional isometric response of a skeletal muscle as demonstrated by MMT, via the CIS indicate nociceptive input elsewhere in the nervous system.

MMT is being used to assess which maxillo-mandibular position is most favored by the CIS. Based on its response to MMT, muscle status is said to be either inhibited or facilitated. Inhibited is the term describing the decreased ability to resist pressure over a one to three second test period. Facilitated describes the ability of the test muscle to resist increasing pressure over a one to three second period of time. Gains in facilitation occur only along the specific axis in which the muscle contracts.
It is worthy of emphasis that MMT does not measure strength or weakness and is not usually indicative of pathology or neuromuscular disease either. It is not logical to expect the elevator jaw muscles to exhibit maximal electromyographic activity in a maxillo-mandibular relationship with a vertical jaw position beyond freeway space and a protrusive jaw position anterior to edge-to-edge; yet this is often the position of maximal facilitation for a performance mouthpiece. Facilitation reflects the optimal summation of neurological inputs, and not merely muscle strength. Just like a computer that operates faster when its circuitry is not cluttered, human nervous systems work optimally with the least nociceptive input (read neurological clutter). A performance mouthpiece created in a position of facilitation enhances neurological, respiratory, circulatory, posture and muscle function.

BACKGROUND STORY

Sports mouthpieces were originally designed to accomplish two things: **protect the front teeth from trauma** and **prevent concussions from the jaw perforating the brain** as a result of trauma to the chin. There are several basic problems with existing athletic mouthpieces:

1. They are not built in a position of neurologic facilitation.
2. They occupy so much tongue space in the mouth that the wearer cannot talk clearly with the device in place.
3. Athletic mouthpieces are so bulky and take up so much tongue space that the user often needs to remove it to breathe optimally.
4. While some claim to increase strength they really do not increase strength.
5. With most athletic mouthpieces in place it is difficult to drink liquids.
6. Athletic mouthpieces are not comfortable enough for the user to allow them to remain in the mouth throughout the entire sporting event.

Above—**GoToGuard™ Contact Sport Model**

The upper component, an semi-hard impact resistant polypropylene copolymer can be made in many different colors. The lower component is in silicone-like material of medium-hard resilience. GoToGuard™ is available in Non-Contact Sport Models as well.

There are numerous mouthpieces that claim to enhance performance. The operative concept is that by enhancing muscle strength they can increase performance. There is significant controversy whether an oral appliance actually increases muscle strength. Strength does not necessarily reflect performance. Using electromyography, doctors can determine when a muscle is functioning at optimal levels and anatomically position muscles to function at the optimal electromyographic level, but placing a mouthpiece in the mouth cannot make a muscle stronger than it is when the mouthpiece is out. Facilitation and performance involves neurological coordination of vision, speed, timing, reflexes, hormone release, breathing and power, to name just some athletic variables.

The unique claims here are that this mouthpiece enhances neurological function by channeling the brain to establish the correct maxillo-mandibular relationship for optimal nervous system function. Moses' GoToGuard™ mouthpiece ultimately enhances performance by eliminating as much neurological clutter as possible. Whether by exercising and working out with a GoToGuard™, an athlete in a condition of facilitation can become stronger by improving on previous bests in a status of inhibition, still has to be scientifically established but certainly seems logical.

There is a complex interrelationship between breathing, head posture, tongue function, swallowing, the position of the teeth in the mouth and where they touch in function. Placing any device in the mouth changes the tongue posture, changes the shape of the airway and changes the posture of the head.

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What’s Wrong with these Pictures?

Mouthpieces BELONG in the MOUTH

WITH GoToGuard™

A. The open anterior design facilitates speech with the mouthpiece in place.

B. The unique thin upper component creates maximal space for tongue placement in the roof of the mouth and also enables clear speech.

C. Tongue positioning in the roof of mouth creates larger oral airway for better breathing.

D. With improved airway patency, the mouthpiece need not be removed for the user to breathe optimally.

E. Because it is so comfortable users do not feel an urge to repeatedly remove it during the sporting event.

F. The open anterior design permits the user to drink liquids with their GoToGuard™ in place.

G. Because head posture on the spinal column is improved it eliminates some degree of neurological clutter.

H. Because it is constructed in a maxillo-mandibular relationship that minimizes neurological clutter, it facilitates athletic performance.
on the spinal column. Oral appliances placed in the maxilla, especially those that contact the palate, take up space for the tongue, cause a lowered and retracted tongue position, reduce airway patency and alter normal swallow. The most important function of the back and neck in human beings is to support the head in an upright posture. The swallow is the most complex reflex activity the human nervous system performs. Ideally the tongue is in contact with the roof of the mouth during a swallow, the person is nose breathing, the lips are sealed and the teeth touch in a position of maximum occlusion all in order to brace the head on the spinal column so the head does not move during a swallow. These factors need to be considered in design of mouthpieces and have been in The GoToGuard™.

Breathing is a primal function necessary for survival. The respiratory central pathway of the brain maintains a patent airway and dominates reflex control of the oropharynx. It supersedes all other reflexes. Human beings are obligate nasal breathers. When nasal impedance or oxygen demands exceed a specific critical level, humans breathe through the mouth. The mouth however, is merely a backup alternative breathing organ. Oral devices are being used to successfully treat snoring, obstructive sleep apnea and upper airway resistance. By altering maxillo-mandibular positioning these successful oral devices also effect airway dilation. These principles also need to be applied to mouthpiece design and have been incorporated into The GoToGuard™.

THE EDGE CONFERRED BY USE OF GoToGuard™
The topic of oral devices is very complex. Among the many and varied functions that oral devices have been used with clinical success are:

- Splint the teeth, preventing movement
- Unload pressure on the TMJs from clenching and grinding of teeth
- Relieve muscle tension
- Stabilize the head and neck on the spinal column
- Protect the teeth from damaging themselves in parafunction
- Reduce nociceptive input to the brain
- Even the flow of cerebrospinal fluid around the brain
- Relieve pain from head, neck, face, jaws, neck and ear
- Improve head and body posture
- Improve airway patency
- Prevent perforation of the skull by the jaws, into the brain, as a result of trauma to the chin
- Improve athletic performance

The GoToGuard™ correlates a custom made mouthpiece with nervous system channeling to facilitate optimal physiologic activity. It is a method and device for registering the appropriate head, mouth, pharyngeal and body posture to facilitate optimal performance of physiologic movement, biomechanical balance, range of motion and airway patency for human beings. It provides a custom laboratory fabricated mouthpiece to establish this position of bio-neurologic facilitation. All of these functional improvements attributed to oral devices have the common link of being brought about by facilitation of neurologic control.

WHAT IS INNOVATIVE AND NOT OBVIOUS IN NeuroneX™ IS THE PROTOCOL CORRELATING THREE CO-FACTORS TO ESTABLISH THE DEVICE DIMENSIONS AND THE OPTIMAL CONSTRUCTION POSITION

1. Biofacilitation
Maximum performance of a muscle in response to Manual Muscle Testing (MMT) demonstrates low nociceptive input to the Central Integrative System (CIS) of the brain. The ability to maintain the test position against the pressure exerted in MMT is a measure of facilitation. Facilitation of a muscle being tested reflects low nociceptive input to the CIS.

What is also not obvious is that establishing the maxillo-mandibular position of facilitation for a performance mouthpiece appears to increase the resting tonus of all the neck muscles and stabilizes the head balance on the neck and back, making it more resistant to the whiplash effect of a traumatic blow.

The regulation of muscle function is accomplished at a subconscious level. Function and movement are generated by the premotor and motor cortex and sent to the reticular activating system, hypothalamus and limbic system. MMT is a method of assessing changes in muscle function brought about in the CIS of anterior horn motoneurons. MMT is a system of functional neurological assessment used to guide clinicians to therapeutic measures that restore optimal neurological, respiratory, balance and postural function.

Bite shims are plastic, arcuate-shaped wafers 1.5 mm thick that may be locked together to establish the correct vertical height. They are used for registration of the optimal maxillo-mandibular position of facilitation. This is a 3-dimensional position in which MMT and bite shims are utilized to establish the correct vertical, protrusive and lateral measurements. With use of these specific shims there is no lateral restriction of movement and the correct maxillo-mandibular relationship can be permanently recorded for custom fabrication of NeuroneX™.

3. THE MODIFIED CUSTOM MOUTHPICE A unique oral device whose modifications can have profound effects on such a diverse and wide range of human physiologic functions as athletic performance, concussion resistance, head posture, breathing, swallowing, speech tongue posture and ability to drink, all by reducing nociceptive neurological interference via a neurologically guided structural realignment of the head and neck.