

Research Article

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Controlling TMD Enhances Cognitive and Emotional Responsiveness

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ABSTRACT

Background: While previous studies have focused on cognitive improvement over time, they have not necessarily focused on mood changes. The goal of this study was to address pain relief, in particular the immediate response of pain relief.

Methods: The focus of this study was 25 chronic TMD patients suffering from craniofacial pain. Trigger point injections were given to alleviate this pain, after a neurocognitive assessment was completed. Patients were then given the Epworth Daytime Sleepiness Scale, Beck Depression Inventory (BDI), and a measure of memory (Three Words Three Shape Test) and processing speed (Symbol Search from the WAIS III) test. This was performed on a voluntary basis.

Results: Out of 25 participants, 4.2% reported a pain ranking of 1 (on a scale of 0 to 3), 37.5% reported a pain ranking of 2, and 58.3% reported a pain ranking of 3. In regards to the origin of pain, 75% reported that trauma was the origin, 16.7% reported that stress was the origin, and 8% reported that the origin was anatomical in nature.

Conclusions: This study has shown that you have a higher chance of immediate increase in cognitive function in terms of processing speed, however memory is not as receptive to immediate change. Craniofacial muscles are therefore less tense.

Practical Implications: Can there be an immediate improvement in brain function when pain is eliminated? Dentists who are specialists in treating TMD are proving to revert negative cognitive and emotional changes when TMD symptoms dissipate.

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Introduction

The purpose of this study was to assess the effects of pain on emotions as well as cognition. Chronic pain has been described as a personal experience given that individuals tend to react to and feel pain differently. Chronic pain takes on physical as well as psychological and social dimensions. When pain reaches the point of being chronic, cognition has been routinely impaired. There is a well-known spiral of the effects of pain, cognition and the emotional response of depression. All of this can result in poor sleep, which further exacerbates the pain.

According to the National Institute of Dental and Craniofacial Research most people with pain in the area of the jaw joint or muscles does not signal a serious problem. Generally, discomfort from these conditions is occasional and temporary, often occurring in cycles. The pain eventually goes away with little or no treatment. Some people,

however, develop significant, long-term symptoms [1].

Pain of the head and face is measurably different from pain in the rest of the body, both subjectively and in the brain. Studies have found that people rate head and facial pain as more severe, emotionally draining, and scary than pain elsewhere in the body. Compared to the extremities, pain in the face leads to greater activation of the amygdala, a key fear center of the brain.

The lateral parabrachial nucleus is an important node along a neural circuit that conveys pain signals between the spinal cord/brainstem and emotional centers higher up in the brain. The pathway is thought to encode the emotional aspects of pain, such as suffering and fear. This suggests the system is evolutionarily wired to respond to head and face pain more quickly and more intensely [2].

There are a multitude of studies in the literature regarding the effects of chronic pain on the brain and the potential amelioration of those effects slowly over a course of time as the chronic pain is appropriately treated. Pain from chronic temporomandibular

disorders not only similarly activates the effects of pain from other areas of the body, but can concomitantly alter brain activity due to multiple signs and symptoms of TMD that are additionally painful physically, emotionally and cognitively. Some of the often seen symptoms of TMD include:

Otalgia as a trigger point referral from the zygomatic fibers of the Masseter [3].

Dizziness as the tensor veli palatini muscle tightens and torques on the Eustachian tube [4].

Ear congestion as the anterior malleolar ligament positionally alters the malleus when pulled within the petro tympanic fissure when the temporomandibular meniscus moves. Partial or complete blockage of the Eustachian tube can cause popping, clicking, and ear fullness [5, 6]. Subjective hearing loss caused by the tensor tympani muscle pulling on the eardrum [7].

In the late 1970's, an eight-year-old girl arrived into my dental office. Her parents mentioned that she had slowly lost hearing in one ear and the ENT doctor could not figure out why since her ear was anatomically correct. I noticed that her previous dentist had extracted a deciduous mandibular molar causing the opposing maxillary tooth to extrude inferiorly. I proceeded to even out her occlusion as any dentist might do. Three weeks later she returned, ran up to me and hugged me. Her mother gave me a freshly baked cake and asked what I did to bring her hearing back. I read a textbook on Otolaryngology that simply stated the ear and the TM Joint both originate from Meckel's Cartilage and TMJ or ear symptoms often confuse each other. That was the 1970's information. We certainly have increased our knowledge since then.

These TMD signs and symptoms are routinely documented and treated by those in the dental field who expertly treat TMD. Dentists in this field are aware of negative emotional and cognitive changes in patients, which revert positively as the multiple TMD symptoms ameliorate and disappear over time.

When patients with chronic pain become stressed, cognition can be affected by the mechanisms involved in stress and create changes in brain structure and function. Chronic stress is well known to trigger a cascade of events impacting sympathetic nervous system activity, neuroendocrine response, and possibly immune system activity. The long-term impact of stress related to patients with chronic pain may manifest itself in brain behavior responses similar to that seen in the trauma population. It has been well documented that those individuals suffering from PTSD or chronic stress have reductions in brain volume and memory disturbance.

A study in the journal *Neurology* finds that people with higher levels of the stress hormone cortisol have subtle reductions in brain volume. The study also shows they also appear to have slight reductions in their performance on memory tests.

The study was carried out by researchers from Harvard Medical School; the National Heart, Lung, and Blood Institute; Boston University School of Medicine; the University of California, Davis, at Sacramento; and UT Health San Antonio.

The team looked at data from the well-known Framingham Heart Study, which has been following participants (and their offspring) since the 1940s. They focused on participants who were middle-aged (average age, 48), and healthy—none had any signs of cognitive decline.

The participants' cortisol levels were measured and correlated with their performance on tests of memory and cognition, as well as their brain volume via MRI.

It turned out that people who fell into the highest third of cortisol level had reduced volume in the frontal and occipital (back-most) lobes of the brain. They also showed changes to the white matter (the tracks of connections between neurons), which might signal poorer connectivity. But the behavioral results are at least as important: People with higher cortisol levels also performed worse on memory tests, like copying a shape that was presented to them, or being asked to recall a story after a 20-minute break.

The effect was stronger in women than in men, but it's not clear if this is because women are more stressed or more susceptible to the effects of stress [8].

All individuals experience pain differently. Chronic pain may be felt and yet scientifically remain unexplained making it a personal experience that is difficult to measure and understand. The fear of the unknown by these individuals easily increases stress and its multiple emotional, cognitive and physical sequelae. Some individuals are able to experience high degrees of pain, while others are more negatively affected. What is the anatomy of pain and why is cognition affected?

The International Association for the Study of Pain has published the following definition of pain, which reflects what has been learned about pain in the last four centuries, and primarily in the past half century. *Pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage"* [9].

From this long-standing definition, we can conceptualize easily that pain is a perception, in the same way that ocular and otologic sensations due to muscle pain and foreshortening are. Its significance is determined by the cerebral cortex in the same fashion as that of other activities there. It is activated and transmitted by sensitivity to chemical changes in the tissues. This *perception is real*, whether or not harm has occurred or is occurring, and other research has investigated and documented that facial pain creates a more severe proprioception of the pain. TMD is definitely in this anatomical region and this research investigates both cognitive and emotional consequences of TMD pain [10].

Review of the Literature: There is a significant relationship between depression and pain symptoms as well as pain and suicidal thoughts. Patients with long history of pain disorders also have increased depression and anxiety symptoms [11]. Chronic pain can be severe and intractable with detrimental consequences including psychological distress, job loss social isolation and highly comorbid with depression and anxiety. Pain serves as a warning depicting injury or disease that needs to be addressed. Chronic pain has no adaptive purpose and when severe or intractable it can become internalized, lodging itself in the core of the individual personal with lifelong effects. An increase in the number of pain locations and pain severity was associated with an increased risk of depression recurrence but not anxiety. Subthreshold depressive symptoms mediated the associations between pain and depression recurrence. This supports the existence of a mutually reinforcing mechanism between pain and depression. Chronic pain is highly comorbid with anxiety and depression. Comorbidity between chronic neck and back pain, and mood and anxiety disorders was noted in two recent large-scale population surveys [12].

Having a mood or anxiety disorder increases the odds of highly disabling and severely limiting pain. Anxiety and depressive symptoms are significantly associated with pain related disability and limiting pain with more severe symptoms having higher odds of highly disability and severely limiting pain. The presence of depression and anxiety are associated with pain symptom severity.

The presence of depression and anxiety or co-morbid depression and anxiety was associated with the chronic pain grade. Symptom severity was associated with more disability and severely limiting pain. Chronic pain is common in up to 70 percent of patients with depressive and anxiety disorders. Chronic pain and depression most likely have a bidirectional association, depression is a predictor of persistent pain and pain is a predictor of the persistence of depression. Pain can cause feelings of anxiety, which in turn can make one more sensitive to pain with the persistence of the pain experience as a consequence. Pain has a negative impact upon prognosis of psychopathology and psychiatric treatment outcome with pain leading to more treatment resistance [13].

Acute pain induces depressed mood and chronic pain is known to cause depression. Depression can adversely affect pain behaviors and independently induce long term plasticity in the central nervous system. Pain encompasses sensory cognitive and affective components; feeling of annoyance, sadness, anxiety, depression in response to noxious stimulus. In patients treated for depression the prevalence of chronic pain was reported to be 51 to 59 percent. In patients with chronic pain the mean prevalence of major depression is reported to be between 18 and 85 percent. Pain is a major risk factor for the development of depression. In a longitudinal cohort study with 12 year follow up pain as well as severity and chronicity of pain and was statistically significant associated with the onset of depression [14, 15].

Multiple studies have reported cognitive improvement as chronic pain is decreased, however, mood was not noted to be improved until recently. Research has indicated the impact of pain upon attention functioning. Studies have demonstrated reduced gray matter density in brain regions known to be part of the pain system, involving the attention areas of the brain, as well as abnormalities in blood flow and white matter tracks.

Purpose

This study is to see if there can be an immediate improvement in brain function when both acute and chronic pain are temporarily successfully eliminated quickly at its source with local anesthetic injections to primary and satellite trigger points and/or entrapment neuropathy areas in the head and neck.

Methods

The variables are pain, cognition or speeded processing, memory, depression, daytime fatigue or better sleep.

Pre and post neurocognitive assessment was completed on 25 patients suffering from chronic head and neck pain due to temporomandibular dysfunction.

Subjects were chronic TMD patients. Marcaine injections to the trigger points or entrapments neuropathy regions are within this scope of the practice of dentistry; Areas of pain were alcohol cleaned and the technique (originally utilized by Dr. Janet Travell on President Kennedy's trigger points and nerve entrapments) was provided to volunteer TMD pain patients. Patients completed a voluntary release to perform the study.

Patients were administered the Epworth Daytime Sleepiness Scale, Beck Depression Inventory (BDI) as well as a measure of memory (Three Words Three Shape Test) and processing speed (Symbol Search from the WAIS III) prior to and following the procedure.

Two different forms were used for the memory test to avoid a practice effect; however a practice effect cannot be ruled out on the symbol search (in terms of familiarity with the test).

The purpose of The Epworth Scale inclusion was to screen and not include those who snored heavily, choked while breathing, gasped upon awakening, or were told they stopped breathing when sleeping. OSA could easily alter pain perception.

The BDI is a well-known measure of depression. The BDI showed high reliability and good correction with measures of depression and anxiety as a source of detecting major depression in patients with medical conditions [16, 17]. The Three Word Three Shape Test is an easy "bedside" test for elderly patients to measure verbal and nonverbal memory within the same modality [17].

The Symbol Search is a subtest from the Wechsler Adult Intelligence Scale (WAIS-III) the older version is used for research purposes that measures processing speed [18, 19].

Results

There was improved mood seen on the faces of patients an hour subsequent to the doctor administering the injection and applying a heat pack while they relaxed Paired samples t-tests revealed that there was a highly significant difference from the pre and post testing for the BDI scores ($p=.000$) and the Symbol Search scores ($p=.001$). Scores for the Three Words Three Shapes task (recall and recognition) were not significantly different.

There were a total of 25 participants. Regarding pain ranking 1 participant or 4.2% reported a pain ranking of 1 (on a scale of 0 to 3), 9 participants or 37.5% reported a ranking of 2, and 14 participants or 58.3% reported a ranking of 3. Regarding origin of pain 18 participants or 75% reported that trauma was the origin, 4 participants or 16.7% reported that stress was the origin, and 2 participants or 8% reported that the origin was anatomical in nature.

Regarding sleep, a total of 4 participants or 17.4% responded positively to sleep ESS or OSA and 19 or 82.6% responded negatively.

A total of 8 or 33.3% of participants reported having received treatment for depression and 16 or 66.7% reported not having received treatment for depression. A total of 11 participants or 45.8% reported no previous injections, 3 participants or 12.5% reported one injection, 2 participants or 8.3% reported two injections, one participant or 4.2% reported three injections, one participant or 4.2% reported four injections, 3 participants or 12.5% reported five injections, 2 participants or 8.3% reported 6 injections, and 1 participant or 4.2% reported 10 injections.

Conclusions

We have shown from this study that you can have an immediate increase of normalized cognitive function seen on a measure of processing speed but not on the memory test. It is likely that memory is more complex and not as receptive to immediate change as the task of processing speed. The facial appearance was not as tense since the facial and jaw muscles were visually softened and their attitude and demeanor was more cordial as noted by the doctor and assistants.

The goal of this study was to address the immediate response of pain relief. Previous studies have focused upon cognitive improvement over time and have not documented change in mood.

Limitations of the Study: Only two neurocognitive measures were used. The study is a small sample of patients [20-39].

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