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The association between history of traumatic brain injury and rates of dental treatment, endodontic therapy, and caries risk: A records-based study

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Abstract

Introduction: Traumatic Brain Injury (TBI) is a prevalent health issue in the United States and even more prevalent amongst members of the armed forces. The purpose of this project was to evaluate the association between history of TBI and rates of dental treatment performed, endodontic therapy, and high caries risk.

Methods: This was a retrospective medical and dental records study. The first 100 of a chosen dental hygienist's patients in 2016 who were seen for dental prophylaxis appointments were chosen as subjects. Armed Forces Health Longitudinal Technology Application (AHLTA) and Corporate Dental System (CDS) records were used to gather information on these subjects including rank, age, gender, duty status, tobacco use, history of TBI, total number of dental procedures, total Dental Weighted Value (DWV), number of endodontic procedures, endodontic DWV, high caries risk categorization, total days dental fitness class 1, and total days dental fitness class 3. From these subjects, a "TBI group" and a "Non-TBI group" were formed. T-Test analyses were performed to compare these groups to each other in categories of total number of dental procedures, total DWV, total days dental fitness class 1, and total days class 3. Relative risks ratio analysis was used to compare these groups in terms of high caries risk categorization.

Results: Eight out of 100 subjects had a history of TBI. All TBI events were mild. Six subjects had 1 event, 1 had 2 events, and 1 had 4 events. The TBI group had a

statistically higher mean number of dental procedures ($P=0.00000025$) and mean total DWV ($P=0.0000062$) compared to the non-TBI group. No subjects from the TBI group had an endodontic procedure. The TBI group had lower mean days in dental fitness class 1 and more mean days in dental fitness class 3, but the results were not statistically significant. The TBI group had lower high caries risk categorization rates than the non-TBI group, but the results were not statistically significant.

Conclusions: Patients with a history of TBI had a significantly higher number of dental procedures performed and DWV generated compared to patients without a history of TBI.

Introduction

TBI is a prevalent health issue in the United States. In 2010, the Centers for Disease Control and Prevention (CDC) estimated that TBIs accounted for approximately 2.5 million emergency department (ED) visits, hospitalizations, and deaths in the United States, either as an isolated injury or in combination with other injuries (1). TBI was defined by a consensus panel of experts “as an alteration in brain function or other evidence of brain pathology, caused by an external force (2).” The functional consequences of TBI range from transient, reversible alterations in brain function to profound disability or death (3).

TBI is even more common for the members of the armed forces. According to the 2013 CDC, NIH, DoD, and VA Leadership Panel; from 2000 through 2011, 4.2% of the 5,603,720 who served in the Army, Air Force, Navy, and Marine Corps were diagnosed with a TBI (3). According to a Defense and Veterans Brain Injury Center (DVBIC)

analysis of surveillance data released by the Department of Defense (DoD), TBI cases peaked at 33,149 U.S. military personnel diagnosed in 2011 alone (4).

TBI may be associated with increased need for dental treatment, endodontic therapy, and caries risk because of two reasons. First, TBI has been shown to be associated with maxillo-facial injuries. In studies which included all facial trauma cases, the rates of concomitant brain injury ranged from 14% (5) to as high as 41.4% (6), and these numbers are even higher when involving facial fracture (7,8). As these two injuries are so commonly associated, clinicians should also suspect maxillo-facial injuries when a known TBI has occurred (6). Maxillo-facial injuries may also involve damage to teeth. This damage often requires various restorative dental procedures that may lead to root canal (endodontic) therapy if the pulp of the tooth is also damaged.

Second, TBI has been linked to a decline in general health, and this would likely include a patient's oral health. TBI has been associated to varying degrees with many health conditions. Two symptoms commonly associated with TBI of all severity levels are post-traumatic stress disorder and chronic headaches (9-13). Other common TBI symptoms include dizziness, balance problems, irritability, memory problems, and, in severe cases, motor impairment including paresis, ataxia, and postural instability. (10, 14)

The association between TBI and oral health remains largely unexplored. A 2017 systematic review of acquired brain injury and its association with oral health status showed that oral health had been noted as poor in acquired injury patients and that the quality of life related to oral health improved when oral hygiene interventions were

provided (15). This systematic review did not mention TBI specifically, but it stated that research in this area had largely been related to stroke.

The purpose of this study was to evaluate the association between a history of traumatic brain injury and rates of dental treatment performed, endodontic therapy, and high caries risk utilizing data regarding DWV, caries risk, procedure totals, and the days in specific dental fitness categories. DWV is a numerical value given to all dental procedures which is meant to correlate with the estimated cost if performed in a civilian dental office. Class 1 dental fitness category patients are those with a current dental examination who do not require dental treatment or reevaluation. Class 3 dental fitness category patients require urgent or emergent dental treatment (16). According to the US Army Health Readiness Center of Excellence, based on 5-year averages from 2013-2017, class 3 patients are 8 times more likely to experience a dental emergency than class 1 (17). Caries risk categorization is a tool that determines a patient's caries risk based on numerous factors, including hygiene, diet, and dental history (18).

Materials and Methods:

Subject Selection

This was a retrospective medical and dental records study approved by the Dwight D. Eisenhower Army Medical Center Institutional Review Board (Protocol #RHC-A-18-023). Subjects were selected using the systematic sampling approach known as the "100 Consecutive" method. To minimize bias, a hygienist was chosen because he or she would typically treat most patients at regular intervals regardless of number and types of other dental procedures performed. In this case, a dental hygienist was chosen

who had worked at an Army dental treatment facility at Fort Gordon, GA for many years. The first 100 of her patients presenting for dental prophylaxis appointments who met inclusion criteria beginning January 1st, 2016 were chosen as subjects.

Subjects were excluded if:

1. Medical/dental records for years 2016-2017 were incomplete (Service Member retirement, recent enlistment, etc.)
2. History of polytrauma. Polytrauma was defined as an objective and subjective categorization based on AHLTA codes and/or treatment notes that indicated an injury to the upper extremity that may physically limit oral hygiene.

Data Gathering

AHLTA and CDS were utilized to gather data on selected subjects in the areas of demographic information, military data, and basic health data. Specifically, for each subject, data was gathered in the following categories: last name, first name, last 4 numbers of social security number, rank, age, gender, and duty status. Data regarding patient tobacco use was gathered from AHLTA.

AHLTA was utilized to gather data on selected subjects in the areas of traumatic brain injury and polytrauma. Specifically, for each subject, data was gathered in the following categories: history of polytrauma, history of traumatic brain injury, number of occurrences, and most recent TBI, all categorized by severity.

Specifically the following AHLTA codes related to TBI were searched:

- z87.820: Personal history of traumatic brain injury
- DOD0101: Personal history of TBI, highest level of severity unknown
- DOD0102: Personal history of traumatic brain injury, highest level of severity mild

- DOD0103: Personal history of TBI, highest level of severity moderate
- DOD0104: Personal history of TBI, highest level of severity severe
- S06.0x0: Concussion without loss of consciousness
- S06.0x0a: Concussion without loss of consciousness, initial encounter
- S06.0x1: Concussion with loss of consciousness of 30 minutes or less
- S06.0x9: Concussion with loss of consciousness of unspecified duration
- S06.0x09a: Concussion with loss of consciousness, initial encounter

CDS was utilized to gather data on selected subjects in various dental categories. Specifically, for each subject, data was gathered in the following categories: history of maxillofacial surgery, number of endodontic procedures, DWV from endodontic procedures, total number of dental procedures, DWV from all dental procedures, high caries risk categorization, total days in dental classification category 3, and total days in dental classification category 1.

CDS codes were searched to gather data relating to the patient's history of maxillofacial surgery. A search for D7000-D7999 series codes was performed. Based on the specific codes and associated written notes, the research team determined if the patient had a history of maxillo-facial surgery from trauma within 3 months before or after TBI diagnosis.

CDS was also utilized to gather data regarding the total quantity and DWV of endodontic procedures. A search for D3000-D3999 codes was performed. All codes in this series were included.

Results:

From the first 159 patients seen for dental prophylaxis appointments by the chosen dental hygienist starting January 1st, 2016, 100 subjects met the inclusion criteria. The other 59 patients were excluded due to having incomplete medical and/or dental records for the calendar years 2016 and 2017. No patients were excluded due to

history of polytrauma. Among included subjects, 8/100 (8%) had a history of at least one TBI event prior to 2016. All TBI events were categorized as mild, and 6/8 of those subjects showed just one TBI event. One subject had a history of 2 TBI events, and one subject had a history of 4 TBI events. None of the 8 TBI subjects had a history of maxillofacial surgery within 3 months before or after TBI diagnosis.

Patient demographic, military, and basic health results

See tables 1 and 2 for patient demographic, military, and basic health results. T-test analysis showed that the TBI group had a significantly higher mean age than the Non-TBI group (P=0.00041). T-test analysis showed that while the TBI group showed a higher percentage of tobacco users than the Non-TBI group, these results were not significant (P=0.059).

Table 1.

	Subjects	Mean Age (years)	Gender		Current Duty Status		Military Rank				
			% Male	% Female	% Active Duty	% National Guard	% E1-E4	% E5+	% WO	% O1-O2	% O3+
Total	100	30.17	77	23	98	2	35	51	7	4	3
Non-TBI group	92	29.43	77.2	22.8	97.8	2.2	37	47.8	7.6	4.3	3.3
TBI group	8	38.63	75	25	100	0	12.5	87.5	0	0	0

Table 2.

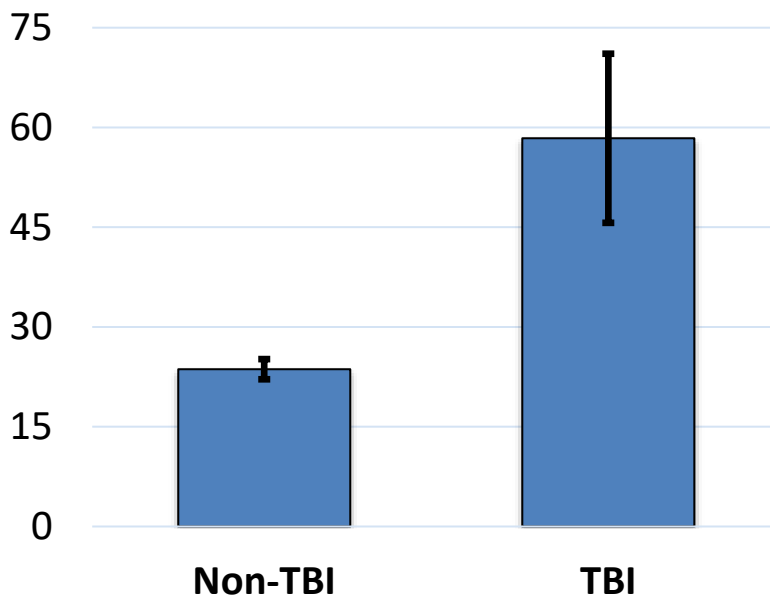
	Tobacco Use	Of Those Who Use Tobacco, % Who Use:					
		Less Than ½ Pack/Day	½ Pack/Day	Less Than 1 Pack/Day	1 Pack/Day	More Than 1 Pack/Day	Smokeless
Total	23	69.6	17.4	4.3	4.3	0	4.3
Non-TBI group	20.7	68.4	21	5.3	0	0	5.3
TBI group	50	75	0	0	25	0	0

TBI and Dental History Results

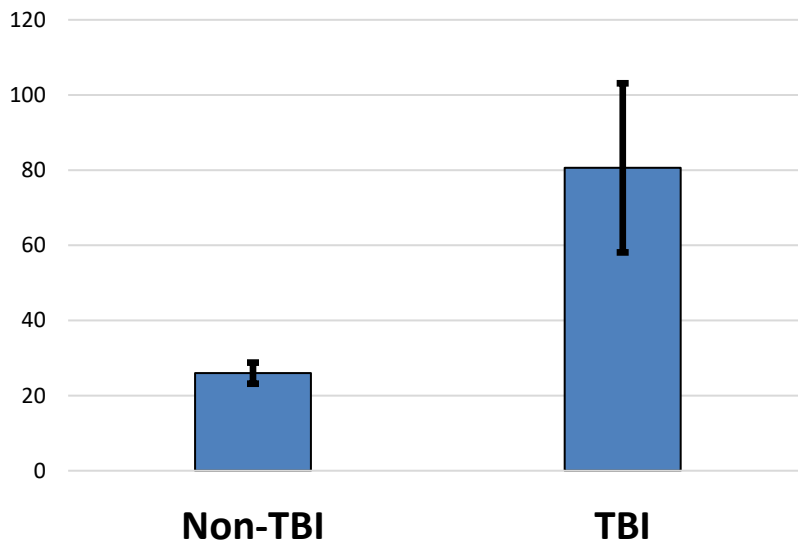
1. Non-TBI group vs TBI group: Total Dental Procedures/Total DWV (2016-2017)

	Non-TBI	TBI
Mean Total Procedures	23.65	58.38
Mean DWV	25.97	80.61

Mean Total Procedures



Mean DWV



T-test analysis showed that the TBI group had statistically higher mean number of dental procedures (P=0.00000025) and mean total DWV (P=0.0000062) compared to the non-TBI group.

2. Non-TBI group vs TBI group: Endodontic Procedures/ Endodontic DWV (2016-2017)

The mean number of endodontic procedures for the non-TBI group was 0.21, and mean DWV was 1.25. No endodontic procedures or endodontic DWV were found in the TBI group.

3. Non-TBI group vs TBI group: High Caries Risk Categorization

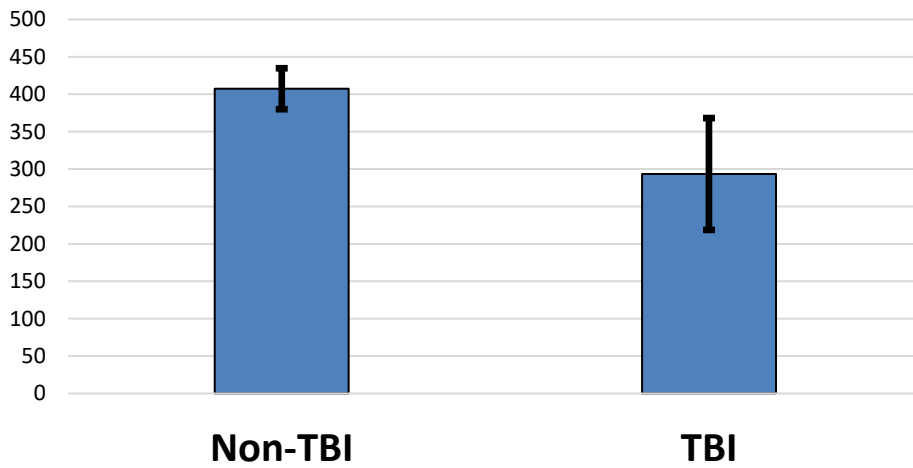
- a. Non-TBI group: 24/92 (26.1%) categorized as high caries risk
- b. TBI group: 1/8 (12.5%) categorized as high caries risk

Relative risks ratio statistical analysis performed, and this analysis showed the relative risk to be 0.48, which was not statistically significant (P: 0.44).

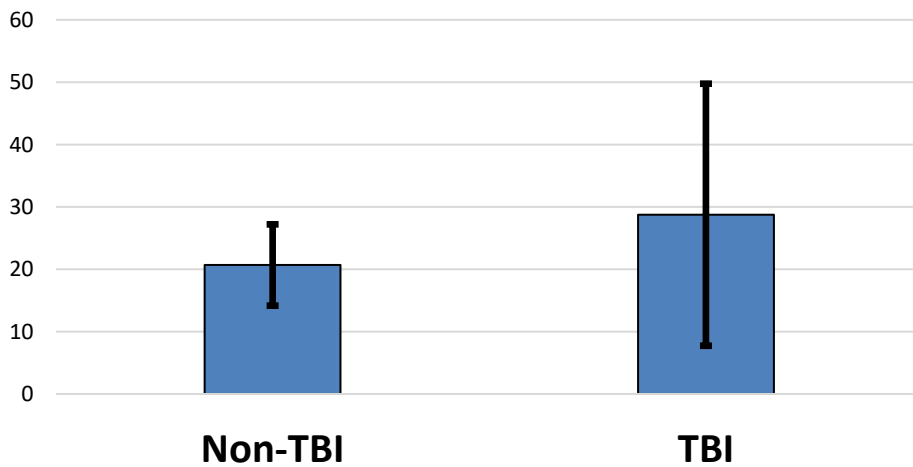
4. Non-TBI group vs TBI group: Mean Days Dental Class 1/ Mean Days Dental Class 3.

	Non-TBI	TBI
Mean Days Dental Class 1	407.3	293.4
Mean Days Dental Class 3	20.7	28.75

Mean Days Class 1



Mean Days Class 3



The TBI group showed less mean days classification 1 and more mean days classification 3, but T-test analysis showed that neither of these were statistically significant (days class 1 P: 0.24, days class 3 P: 0.73).

Discussion

The goal of this research was to explore the possible association between history of TBI and overall oral health as quantified by various dental record markers. A positive association was shown between history of TBI and the mean number of dental procedures and DWV. No other categories demonstrated such an association.

This research was limited in several ways. First, the number of subjects was only 100, and because of this, our TBI group amounted to only 8 subjects. As mentioned earlier, from 2000 through 2011, 4.2% of Service Members were diagnosed with a TBI. The 8% result we observed in our population is likely this high because of the TBI clinic located at Fort Gordon, GA. Nonetheless, only having 8 subjects in the TBI group resulted in limited power. Second, confounding factors exist which cannot be ignored. For example, the TBI group was significantly older and had higher tobacco use rates than the non-TBI group. It is not only possible, but likely, that these factors also influenced their oral health.

This was one of the first times that research looked into the association between the history of TBI and oral health. In one study, TBI patients who were given oral hygiene instruction after TBI had better plaque scores than TBI patients with no oral hygiene instruction (19). This seems likely to be true of any two groups, regardless of TBI diagnosis. In 2012, the University of Washington DECOD (Dental Education in the Care of Persons with Disabilities) Program put out an Oral Health Fact Sheet for Dental Professionals about Traumatic Brain Injury (20). In this fact sheet, they described the possible oral manifestations of TBI as the following:

- a. Oral/dental trauma from TBI or self-injurious behaviors
- b. Bruxism
- c. GERD (Gastro-esophageal Reflux Disease) in intubated patients
- d. Inadequate oral hygiene due to cognitive impairments, spasticity, and ataxia

Research on Service Members represented a unique opportunity for evaluating associations between TBI and oral health because the population has a higher-than-average TBI population, and their oral health is routinely monitored, addressed, and recorded. Our findings showed that the dental needs of the TBI population were different and greater than the Non-TBI population and would therefore benefit from being treated differently clinically. Routinely, Service Members are seen annually for dental exams and cleanings. We recommend patients with a history of TBI receive a dental exam and cleaning every 6 months. While on the surface more costly, this will proactively monitor for dental conditions which could have potentially greater long-term costs in terms of the DWV and number of procedures. This preventive measure could dramatically improve Service Member's oral health and quality of life and may also improve dental readiness. It is our hope that future research further explores the potential association between history of TBI and oral health and what it may mean, not only for Service Members, but anyone who has suffered a TBI event.

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