Traumatic dental injuries and attention-deficit/hyperactivity disorder: is there a link?

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Abstract – Traumatic dental injuries (TDIs) constitute a major cause of morbidity among children worldwide. Both TDIs and attention-deficit/hyperactivity disorder (ADHD) are prevalent conditions with similar male-to-female predominance and similar age of presentation. While the commonest causes of TDIs have been identified as playground or sports accidents, a well-known feature of ADHD is accident proneness. Violence, another significant risk factor for TDIs, is more likely to be observed in conduct disorder, a common comorbidity of ADHD. Also, both TDIs and ADHD have been found to be associated with left-handedness. The presence of multiple dental trauma episodes (MDTE), as well as increased risk for non-dental injuries in children with TDIs indicates an underlying persistent condition, which resembles ADHD. Higher point prevalence of mental distress at age 30, found to be associated with increased lifetime prevalence of TDIs, may also be taken as an evidence of a background developmental disorder persisting into adulthood with various comorbidities. In conclusion, this review combines the results of several studies and explains the significance of ADHD as an underlying and predisposing factor for TDIs. Increased awareness and close collaboration between different disciplines involved are essential.

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Dental trauma is one of the most serious oral conditions among children. Previous epidemiological and hospital-based studies worldwide have provided substantial information about the prevalence of traumatic dental injuries (TDIs) in children and adolescents, which indicates an important public dental health problem (1–5). Anterior teeth fractures, which account for the majority of cases, lead to both functional and aesthetic, therefore emotional consequences (2). Possible dental complications may include pulp necrosis, pulp canal obliteration, root resorption, tooth discoloration, loss of marginal alveolar bone and/or abscess formation (1, 3). The main causes of injury were described as falls and collisions with other children possibly experienced during sports and games (4, 5). Among the structural factors considered, incisor overjet of more than 3 mm and incompetent lips were described as significantly predisposing (6).

The Health Survey for England 1997 provided the initial data regarding the association between hyperactivity and major injuries affecting face and/or teeth (7). Following this, Sabuncuoglu et al. (8) found a significant association between attention-deficit/hyperactivity disorder (ADHD) and TDIs, and proposed an explanatory model. ADHD is the most common developmental psychiatric disorder, which affects up to 4–12% of all school-age children (9). According to DSM-IV (10), hyperactivity, inattentiveness and impulsivity, which are the core behavioral characteristics of this disorder must be evident by age 7 years and must have a minimum duration of 6 months. Based on the symptom presentation, ADHD may be coded as predominantly inattentive, predominantly hyperactive-impulsive and combined type (10). ADHD is three times more common in boys than in girls suggesting a neurobiological determinant of the disorder. ADHD is often associated with significant comorbidity such as learning disorders, conduct disorders and mood disorders and may persist into adulthood often with poor outcome.

Children with traumatized teeth may avoid laughing and smiling as a result of the subjective feeling of shame. Trauma to the face and teeth, and further treatment efforts have a negative impact on the psychological well-being of children. Since the second set of teeth is the set people are supposed to keep for the rest of their lives, it is important that they be in healthy condition.

This article has aimed to review the literature on TDIs from the ADHD perspective highlighting critical aspects, which may be indicative of the features of ADHD. Relevant subheadings have been required for a better understanding and comprehension of the topic.

Prevalence of TDIs and ADHD

Despite agreement on its importance, little agreement exists on the prevalence of TDIs among children. Prevalence rates of dental injuries vary from the lowest rate as 2.4% to the highest rate as 34% (2, 11). Several studies have reported prevalence rates between 10 and 25% (12–15). Differences in sampling technique and application of diagnostic criteria may be responsible for the broad range of findings in several studies.

The prevalence of ADHD among school-aged children has been estimated to be 3–5% (16). However estimates may go as high as 17.7% (17). Here, once again population rates may vary according to the population that is sampled, the diagnostic criteria, and diagnostic instruments that are used (17).

Given the great variations in the prevalence rates, it is impossible to reach categorical conclusions regarding the relationship between TDI and ADHD. Nonetheless, it appears that both TDI and ADHD are common health problems among children.

Gender distribution in TDIs and ADHD

Most previous studies reported higher levels of TDIs among boys than girls, which is consistent among all clinical or epidemiological studies (3, 15, 18, 19). Likewise, both clinical and epidemiological samples have revealed that ADHD is much more common in males. The male-to-female ratio ranges from 4:1 for the predominantly hyperactive-impulsive type to 2:1 for the predominantly inattentive type (16). So, we can conclude that the gender distribution is similar for both TDIs and ADHD.

Age of onset in TDIs and ADHD

As TDIs are much more prevalent in the pediatric age group, it would be wise to consider the possible developmental factors that might be involved.

ADHD is a persistent developmental problem that may change its manifestation from preschool through adult life. Although the preschool child with ADHD displays various symptoms, it is in elementary school that children with ADHD are first recognized. Core symptoms of ADHD, that is hyperactivity, inattentiveness and impulsivity, become fully manifest. In the course of ADHD in adolescence, there is clearly a decrease in gross motor hyperactivity, as well as impulsivity. However, core symptoms of ADHD may be present in a form that is seen in previous age groups because of changing developmental state, life circumstances and psychosocial factors.

The prevalence and incidence of traumatic injuries are reported to peak at 2–4 years of age and again at 8–10 years of age (3, 5, 20). The decrease between these two peaks is accounted by the exfoliation of primary teeth and eruption of permanent teeth (3). Although incidence rates fall during adolescence, adolescents do continue to experience dental injuries most often because of sports-related accidents.

Thus, it is apparent that developmental courses of TDIs and ADHD symptoms as complaints are in parallel. Even if it is argued that TDIs are related to age-appropriate childhood activity, that indicates the association of ADHD, which represents the high-end of the affected behaviors.

Incisor overjet as a risk factor for TDIs

Even though several researchers have identified incisor overjet as a risk factor for sustaining TDIs in children (6, 14, 20, 21), some studies have failed to provide supportive results (2, 22). Interestingly, having found statistically significant evidence of incisor overjet in TDIs also, Hunter et al. do not consider it as clinically significant and further, give special emphasis to the rougher nature of boys activities and their more active participation in sports as of greater importance than the magnitude of their overjet in determining TDIs (23).

Accidental TDIs and accident proneness in ADHD

The most common causes of TDIs have been identified as accidents in several studies (4, 21, 24). Playground accidents as falls and collisions experienced during games or sports account for the majority of the TDIs in childhood.

Previous research has suggested that an important feature of ADHD is accident proneness, which may occasionally put these children at risk from serious bodily injury (25, 26). This finding applies to numerous situations. Young people with ADHD have been found to be at greater risk of involvement

in driving accidents (27). Children with ADHD are also at higher risk of burn injuries, which is another life-threatening outcome (28).

Given these already existing data, there is substantial convergence between the ADHD model and causes of dental injuries in childhood. In addition, no other clinical condition has ever been mentioned as associated with accident proneness.

Violence in TDIs as a feature of conduct disorder, a common comorbidity of ADHD

Violence has been addressed as one of the important causes of dental injuries in previous studies. Caldas & Burgos found that in patients 1–59 years of age, injuries caused by violence peaked in the 6–15 years age group (29). Of the several studies conducted so far, the highest prevalence rate of TDI caused by violence was reported at 42.5% among Syrian children (30).

In terms of diagnostic definition, violent behaviors are more likely to be displayed in the course of conduct disorders, as reported in several studies (31–34). Of all the clinically referred children with ADHD, up to 30–50% may meet the criteria for conduct disorder (16). In DSM-IV (10), aggression towards others, bullying and often initiating physical fights are included among the criteria used to diagnose conduct disorder, which may be associated with TDIs, as well as non-dental injuries. Some studies have already shown that traumatic injuries are highly frequent in children and adolescents with conduct disorder (7, 35).

However, although the available data supports the ADHD background in TDI caused by violence, one should bear in mind that, some children with injuries may indeed be the victims of other children performing violent acts.

Left-handedness as a risk factor for TDIs may be suggestive of underlying ADHD

The poor motor skills of ADHD children increase the likelihood of traumatization (36). A recent study has identified left-handedness as a risk factor for TDI, such that 28.3% of left-handers and 11.7% of right-handers were found to have dental injuries in a sample of 2180 adolescents, at a significance level of 0.001 (19). In fact, this finding may also be supportive/indicative of the underlying ADHD, as an association between ADHD and non-righthandedness (ambidexterity or left-handedness) has been reported in previous studies. Yamamoto & Hatta (37) found higher frequency of non-righthandedness in children with Minimal Brain Dysfunction (former term for ADHD) relative to the normal controls. Recently, Reid & Norvilitis (38) have shown that ADHD is associated with anomalous laterality across domain, beyond non-righthandedness. This also seems to confirm the previous findings that patients with ADHD made more errors on a random letter cancellation than the comparison subjects, which indicated right hemisphere dysfunction (39).

In the light of these studies and our background knowledge of TDIs, we may rethink the data provided by Canakci et al. (19). First of all, although left-handedness was found to be significantly high among adolescents with TDIs, left-handed children account for only 21% of the children in the authors' sample. Thus, it would be wise to consider a general condition associated with left-handedness. What was the distribution of left-handed children with TDI with respect to sex, age groups, and history of trauma? Addressing these issues is important in order to determine the link between ADHD and TDIs. Although the authors themselves admitted that the reason for the increased risk of left-handedness remained unknown, it looks like that, the ADHD model may provide the explanatory insight.

Urinary catecholamines in ADHD and TDIs

Vanderas & Papagiannoulis (40) showed significant correlation of the incidence of dentofacial injuries with urinary epinephrine so that as the value of epinephrine increased the probability of sustaining a dentofacial injury rose. The authors concluded that children under emotional stress were more likely to sustain TDIs. From the diagnostic standpoint, so termed 'emotionally stressful states' may fall in the category of anxiety disorders, such as separation anxiety disorder, obsessive-compulsive disorder or social phobia, which possess no significant association with TDIs, according to a recent study (8). Although severe anxiety may manifest as motor hyperactivity, this presentation is quite uncommon among childhood anxiety disorders to be associated with TDIs. Furthermore, it was found that higher levels of urinary epinephrine correlated positively with measures of attention and negatively with observed restlessness, which therefore might be expected to lower the risk of traumatization (41, 42).

As the urinary epinephrine was found to be lower in ADHD children relative to controls in another study (42), the findings of Vanderas & Papagiannoulis (40), higher urinary catecholamines as a predictor of sustaining dental injuries contradict the ADHD perspective.

Multiple dental trauma episodes (MDTE) from the ADHD perspective

It is known that some children and adolescents are more likely to suffer from MDTE. The analyses of

the dental records of the 227 children revealed that 26% had suffered previous trauma to either primary or permanent teeth (43). Glendor et al. (44) found that in a random sample of 81 children with TDI, 41 had sustained MDTE in a follow up of 12 years. It was also determined that the risk of sustaining MDTE was eightfold for patients with their first trauma episode at 9 years of age compared with 12 years of age. The mean age for the first trauma episode was lower for patients with MDTE, compared with patients with single episodes.

It is now accepted that ADHD is a chronic condition that will persist over the life span, but with different manifestations. Thus, as the background risk factor persists, multiple trauma episodes may be expected. As noted above, in the course of ADHD in adolescence, there is clearly a decrease in gross motor hyperactivity, as well as impulsivity. This explains why the risk of sustaining MDTE is more likely to occur for the patients with their first trauma episode before the age of 9. Stimulant medications indicated in the treatment of ADHD can effectively control the symptoms and the associated risks. The main issue for many children who take these medications, however, relates to the fact that these drugs only reduce symptoms during the time they are taken and cessation of the medication will virtually always lead to a recurrence of symptoms and the associated risks. Thus, in children with ADHD, who comply well with a continuous medication regimen will be less likely to have MDTE. As stimulants are not indicated in preschool children, primary dentition will always remain vulnerable to traumas.

The association of TDIs with non-dental injuries, mental distress and alcohol consumption from the ADHD perspective

The increased lifetime prevalence of non-dental injuries in people with TDIs has been highlighted in only one study, which also found a significant association between mental problems and TDIs (45). That indicates again that a general and developmental condition must be taken into consideration, which may expose people to the risk of a wide array of accidents. Since ADHD is the most prevalent behavioral disorder associated with accidental injuries in children and adolescents, it is not surprising to find an elevated prevalence of both dental and non-dental injuries in subjects suspected of having ADHD (25, 26).

As used by Perheentupa et al. (45), the term 'mental distress' refers to a broad range of psychiatric disorders and in the authors' study, higher point prevalence of mental distress at age 30 was found to be related to increased lifetime prevalence of dental traumas. As TDIs peak in childhood, this interesting finding may be taken as an evidence of developmental psychopathology persisting into adulthood. Research has revealed that although ADHD has its onset in childhood, it may persist into adult age often with negative outcomes. Among the serious comorbidities associated with adult ADHD are antisocial personality disorder, mood and anxiety disorders and substance abuse disorders.

As the point prevalence of higher alcohol consumption was also found to be related to the increased lifetime prevalence dental traumas, the same interpretative approach applies again here. Studies have indicated that children and adults with ADHD are more vulnerable to alcohol dependence and possible negative consequences (46, 47).

Association between TDIs and ADHD

In a hospital-based matched case-control study (48), no relationship between TDIs and emotional symptoms, conduct disorder and hyperactivity was found on the Strengths and Difficulties Questionnaire in children aged 7–15 years old. Of particular interest, in a population based survey using the same instrument (7), hyperactivity was found to be significantly associated with the occurrence of major injuries affecting the face and/or teeth. The only clinical study, which explored the relationship between TDIs and ADHD has provided significant results (8). It should be kept in mind that the diagnosis of ADHD is a clinical diagnosis based on parent and child interviews, observations of the parent and child, behavior rating scales, physical and neurological examinations, and cognitive testing and the most reliable data in regard to research may be obtained in this way (17).

One study worthy of attention regarding the importance of methodological issues is reported by Blomqvist et al. (49). In that study, as children with ADHD comprised only 25% of the index sample, the analysis did not reveal any significant association between TDIs and ADHD.

Is low prevalence rate of TDIs related to higher rate of treatment for ADHD?

Both pharmacological and non-pharmacological therapies are used to treat children with ADHD. Psychostimulants, which include methylphenidate and amphetamine, are the drug of first choice in ADHD, with a well-established therapeutic efficacy. Recently, once-daily formulations of these medications have been introduced, which increase efficacy and compliance throughout treatment (50). One of the lowest prevalence rate of fractured incisal teeth, 2.4% among third graders in the US, might be

related to the higher rate of psychostimulant use in the treatment of ADHD in the US (2). Once the symptoms that we assume to be associated with accidents are under control, traumatic outcome may be expected to fall. With regard to burn injuries in children with ADHD, the accident preventive role of medications has been stressed (28, 51). Moreover, it may be thought that, since the day stimulants were available on the drug market, an unknown number of TDIs might have been prevented. Consequently, it means that an unknown amount of time-consuming and costly dental treatments have been prevented, provided that the medications have been effective in controlling the symptoms of ADHD and children have continued to take their medications.

Conclusion

It is important to note that, not all the children with ADHD sustain TDIs and not all the children with TDIs have ADHD. Caution is required in applying the theoretical evidence in clinical practice on an individual basis. Nevertheless, there is a very strong sense that a relationship exists, as provided by the information in this review. It looks as if, to some extent, different professions are dealing with different reflections of the same disorder. There has been so little contact between dental and child mental health professionals that opportunities have not arisen to exchange ideas, views and interpret different findings. The trainees of both professions learn so little about the curriculum of their counterparts during training. Thus the time is ripe to fill the gap of required knowledge in this field.

One of the causes of failure in recognition of TDIs as an associated condition in ADHD may be the exfoliation of traumatized primary teeth just before the elementary school age, when an increase in referrals for the concerns of ADHD symptoms is expected. Second, once the children with ADHD receive treatment and consequently their excess behaviors normalize, the risk for TDI drops as long as they adhere to treatment. Missing cases who never seek treatment for ADHD may be another cause of failure in the recognition of TDIs as an associated condition. Adolescents with ADHD are less likely to present to child psychiatry if they were not referred before, in their most troublesome years. Also, considering the dental trauma to be an insignificant event, children and their parents may not report the accidents to the child psychiatrist. Prompt dental treatment may restore the appearance of the fractured teeth before coming to the clinician's attention.

In Friedlander's review (52), dentists caring for children with ADHD are advised to be familiar with the manifestations of the disorder as well as knowledgeable about the basics of the disorder. However, no particular reference to dental traumas exists in that review. Thus, dental health professionals should assume greater responsibility for the psychiatric background of their patients, acquire relevant knowledge and refer suspected cases with TDIs to child psychiatrists experienced in this field. As two out of three people who have ADHD never receive a diagnosis or treatment, this will be of great value especially in identifying missing cases. For the child psychiatry field, the knowledge of the association between ADHD and TDI is an important contribution, which indicates close collaboration with pediatric dentists. Besides that, researchers should also focus on the association between TDIs and ADHD and refer to the issue wherever data indicates. Increased awareness and collaboration between dentists and child mental health professional will definitely improve the health and well-being of children.

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