



E-ISSN: 2707-4455
P-ISSN: 2707-4447
IJFM 2023; 5(1): 05-08
www.forensicpaper.com
Received: 09-10-2022
Accepted: 18-11-2022

Dr. Seema M
The Oxford Dental College,
Bengaluru, Karnataka, India

A new insight into forensic odontology through salivary amylase amongst neurodevelopmental disorders: A review

Dr. Seema M

DOI: <https://doi.org/10.33545/27074447.2023.v5.i1a.57>

Abstract

Over the last decade, Saliva is being chosen as an alternative to blood and urine. Whole saliva contains mixture of secretions. Saliva is usually deposited in bite marks found in many homicides, assault and other criminal cases. Saliva is often detected in the crime scene along with bite marks or lip prints where the oral cavity may have been involved. Cellular and serological analysis of the obtained saliva is of immense use in identification of the accused. One such component of saliva is Amylase testing. It has been used as a presumptive test for crime scene. Neurodevelopmental disorders (NDDs) are multifaceted conditions characterized by impairments. People with NDD are overrepresented in criminal populations and evaluating them for criminal responsibility can often be a complex task for forensic examiners. Salivary Amylase can be used as a tool to evaluate the mental health of the offender.

Keywords: Saliva, blood, urine, bite marks, Neurodevelopmental disorders

Introduction

Over the last decade, Saliva is being chosen as an alternative to blood and urine. Whole saliva contains mixture of secretions released from salivary glands, gingival crevicular fluid and also comprises of exfoliated oral epithelial cells and microorganisms. Saliva collection, considering as noninvasive method even by individuals with limited training. It also avoids the intrusion of private functions while collection under direct supervision, makes it a popular fluid for analysis in forensics. This gives an added advantage. Saliva is usually deposited in bite marks found in many homicides, assault and other criminal cases. Saliva is often detected in the crime scene along with bite marks or lip prints where the oral cavity may have been involved. Cellular and serological analysis of the obtained saliva is of immense use in identification of the accused^[1]. One such component of saliva is Amylase testing. It has been used as a presumptive test for crime scene saliva for over three decades, mainly to locate stains of saliva on the surfaces^[2].

Role of saliva in identification of a person

Analysis of Bite mark analysis encounters a lot of challenges, primarily because of the elastic and distortable nature of skin and also lack of good impression medium. Saliva usually gets deposited in bite marks found in many criminal cases including homicides and assault. Saliva which gets deposited during biting has received an important alternative focus in bite mark analysis in Forensics. It is difficult to collect saliva samples from stains from objects like cloth, paper or other inanimate objects and skin as it remains invisible and substrate on which saliva is deposited, mainly skin, cannot be submitted directly to extraction procedures^[1].

Literature review on association of neurodevelopmental disorder to crime

Neurodevelopmental disorders (NDDs) are multifaceted conditions characterized by impairments in cognition, communication, behavior and/or motor skills resulting from abnormal brain development. Intellectual disability, communication disorders, autism spectrum disorder (ASD), attention deficit/hyperactivity disorder (ADHD) and schizophrenia fall under the umbrella of NDD.

Corresponding Author:
Dr. Seema M
The Oxford Dental College,
Bengaluru, Karnataka, India

Currently, there are no biomarkers to diagnose NDD or to differentiate between them. Rather, these disorders are categorized into discrete disease entities, based on clinical presentation. This is problematic, as many symptoms are not unique to a single NDD, and several NDDs have clusters of symptoms in common^[3].

According to WHO, Autism Spectrum Disorders (ASD) included diverse group of conditions. They are characterized by some degree of difficulty with the social interaction and communication. Other various characteristics are atypical patterns of activities and behaviors including such as difficulty with transition from one activity to another and also a focus on details and with unusual reactions to sensations^[4]. Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and the presence of restricted interests and repetitive behaviors^[5].

Asperger's disorder (AD) and High Functioning Autism (HFA) are two high functioning subtypes of ASD. This includes individuals who have average to above average intelligence and tend to have normal speech and language development. They might display atypical development of social reasoning and intuitions. In of the recent research on the incidence of HFASDs in criminal settings that has been published in the past 10 years and it also highlights provocative associations between the deficits in individuals with HFASDs and violent crime^[6].

Literature has also indicated a higher prevalence of AD in maximum security hospitals including unique forensic profiles, potentially increased violent crime. Increased possible sexual offending and questions of exculpatory fitness among the law-breaking individuals with HFASDs have also been reported. They has also been found to be associated with psychiatric comorbidity with an infrequent history of illicit drug use, but a greater history of violent behavior. This doesn't conclude on suggestion towards HFASD diagnosis is sufficient to invoke mitigation. But these findings support the need to understand the characteristics of individuals with HFASDs that might contribute to law breaking and to use those characteristics to parse out legal and intervention driven policy recommendations. Researchers have also agreed on to that most individuals with HFASD are law abiding citizens who are more likely to be victims of crimes than committing them, but they are still seven times more likely to intersect with the criminal justice system than individuals without ASD^[6].

According to the literature it has also been shown that ASDs are known to be associated with an increased risk of aggression and challenging behavior. In a study conducted with 269 violent offenders, included assessment for prevalence of ASD, and previous externalizing problems and criminal history. Results showed that there was a very high prevalence of externalizing and antisocial behaviors in the history of these offenders. ASD offenders had significantly more often been diagnosed with a neurodevelopmental disorder^[7].

ASD offenders were overrepresented in crimes involving sex associated with a child victim. The results of the above study provided a very important knowledge of the developmental history of such offenders with ASD. Though this is a very small and atypical phenotype it poses significant challenges to the criminal justice system. More understanding is needed to prevent these individuals from

committing crimes but also to provide a fair judicial treatment, to assess exculpatory factors and improve our forensic treatment models^[8].

Currently ASDs are rapidly becoming one of the most pressing mental health and social problems. There is a need to understand the risks and consequences as the population increases and the age associated with the symptoms of these disorders and the presence of an increased number of adults in the community with ASD. Literature shows that violent crime behavior among the adults with HFASDs having supporting evidence of potential risk for aggression but not necessarily for criminal behavior. Other features like several core nondiagnostic features that includes theory of mind deficits, poor emotion regulation and impaired moral reasoning. This might interact to potentiate the commission of violent crime by an individual with HFASDs. It is also been emphasized as the way that affective and cognitive dimensions interact in producing vulnerabilities to violence^[9].

Similar to the non affected adults, individuals with ASDs have also show the entire range of sexual behaviors. However, due to the core symptoms of the disorder spectrum, including deficits in social skills, sensory hypo and hypersensitivities and repetitive behaviors, some ASD individuals may also develop quantitatively above average or non normative sexual behaviors and interests. Literature reviewing on Hypersexuality, paraphilic fantasies and behaviors, it is been proven to be more common in adult males with ASD than in neurotypical people. Researchers have also hypothesized that the restricted interests and repetitive behaviors commonly seen in ASD may transform into sexualized behaviors in the adulthood^[10].

Salivary Alpha Amylase in Neurodevelopmental Disorder

Over three decades, testing for Amylase has been used as a presumptive test for crime scene using saliva mainly to locate saliva stains on surfaces^[11]. In humans the digestion of dietary starch is initiated by salivary α -amylase. It is an endo enzyme that hydrolyzes the starch into maltose, maltotriose and oligosaccharides. 40 to 50% of human Salivary proteins accounts on Salivary amylase that alters the physical properties of starch. It is Important to know the quantity and enzymatic activity of salivary amylase that shows significant individual variation. By linking genetic variation and its consequent salivary enzymatic differences to the perceptual sequellae of these variations, it has been prove that AMY1 copy number relates to salivary amylase concentration and enzymatic activity level, which in turn account for individual variation in the oral perception of starch viscosity^[12].

Salivary alpha amylase (sAA) being the major enzymes in the oral cavity. Salivary alpha-amylase activity (sAA) and plasma noradrenaline (NA) concentrations are often considered to be surrogate markers of sympathetic activation in response to stress. sAA is a non invasive marker for stress of sympathetic activation^[13].

Literature shows that there is an association between changes in Salivary Amylase(SA) during exposure to a stressful stimulus and changes in blood norepinephrine or heart rate variability indices strongly suggests that SA is an accurate marker of sympathetic nervous system activity. SA is the principal saliva protein and is mainly secreted by the parotid glands. The autonomic nervous system plays a major

role in SA secretion. It also shows an association between changes in SA during exposure to a stressful stimulus and changes in anxiety state. There is a potential role for noninvasive, real-time, and point-of-care biomarkers such as salivary amylase (SA) to identify anxious patients and to target preoperative pharmacologic or non-pharmacologic interventions in these patients [14].

The results of a study on measurement of the basal and stress induced salivary alpha-amylase activity may help to understand autonomic nervous system disturbance in mental disorders. Differences in alpha-amylase activity between the youths with depression and among healthy subjects. Concretely, midday activity was lower in patients with depression and the diurnal increase in enzyme activity present in healthy subjects was absent in patients. Children and adolescents with depression exhibited lower values of alpha amylase activity and also a flatter morning to midday slopes which may indicate a disturbance of alpha-amylase daily rhythm. This motivates further studies on the relationship between sympathetic activation and mood disorders [15].

sAA is indeed a sensitive marker in both physically and psychologically induced arousal paradigms. Neuroendocrine markers such as salivary alpha amylase (sAA) and cortisol (CORT) play a very important role in establishing human responses to stressful events [16].

Recent reports related to emotions collected in conjunction with a museum exhibit on emotion (Goose Bumps!-The Science of Fear) presented additional data collected as part of study. They collected two commonly measured indices of emotional arousal, salivary cortisol and α -amylase, before and after participants had gone through a realistic fear challenge course as part of the exhibit. They found that α -amylase, but not cortisol, showed a highly specific increase only for those participants who endorsed both emotional arousal and negative valence. By contrast, the fear inducing course resulted in high arousal but positive valence in some participants no increase in α -amylase was measured. They concluded that salivary α -amylase is a promising biomarker for fearful experiences, and suggest that it is important to pay attention to positively valenced arousal that may be induced by fearful stimuli [17].

sAA was increasingly found in autistic children than in normal children. To quantify psychological stress and to distinguish eustress and distress a study conducted by using salivary amylase activity (SMA). Salivary glands not only act as amplifiers of a low level of norepinephrine, but also respond more quickly and sensitively to psychological stress than cortisol levels. Salivary amylase activity can be utilized as an excellent index for psychological stress as time course changes of the salivary amylase activity have a possibility to distinguish eustress and distress. However in dry chemistry system a method for quantification of the enzymatic activity still needs to be established that can provide with sufficient substrate in a testing tape as well as can control enzymatic reaction time. It makes it necessary to develop a method that has the advantages of using saliva, such as ease of collection, rapidity of response, and able to use at any time. Salivary amylase activity was measured using Kraepelin psychodiagnostic test as a psychological stressor. A significant difference of salivary amylase activity was recognized between the pre stress and mid stress periods [18].

Conclusion

Saliva is being chosen as an alternative to blood and urine. The importance of saliva as an investigative body fluid is increasing steadily over the years in forensic laboratories. Safety in its handling, the ease and noninvasive methods of saliva collection has gained popularity in the field of forensic testing for drugs of abuse. Use of saliva in the detection of drugs of abuse and inebriated drivers has gained popularity in recent years. Saliva is also an analytical tool in cases of heavy metal poisoning by reflecting the ionic imbalance and excretion of certain poisons through this route. Sex determination and individualization of accused in scenes of crime with the help of salivary exfoliated cellular examination and DNA profiling is proving to be of immense help in forensic investigations. Saliva is usually deposited in bite marks found in many homicides, assault and other criminal cases. Salivary Amylase can be used as a tool to evaluate the mental health of the offender. In cases of saliva derived from bite marks of unknown animals, species specific genetic profile can help in the identification of the animal in question.

Higher prevalence of malocclusion (overjet) and class III molar relationship is found in autistic children. Prevalence of oral habits like bruxism, tongue thrust and thumb sucking are significantly higher in patients with ASD. Besides teeth absence, other important occlusal parameters should be taken into account. When a tooth fails to register in a bite mark it does not necessarily mean that it is missing. It may be fractured, displaced or infra-occluded. These particularities are very helpful in identifying the biter [19].

There is a paucity of compiled literature on the role of saliva in forensic odontology prompting an extensive search for comprehensive update. This also requires laboratories that have automated settings for saliva as is routinely done for blood or urine. More research dedicated towards this particular innocuous body fluid should be aimed at for gaining detailed information in forensic sciences. Saliva is usually deposited in bite marks found in many homicides, assault and other criminal cases.

People with NDD are overrepresented in criminal populations and evaluating them for criminal responsibility can often be a complex task for forensic examiners. Individuals with NDD often make their way through the criminal justice system and forensic evaluators need to be familiar with relevant statutes [20]. Salivary Amylase can be used as a tool to evaluate the mental health of the offender, thus narrowing down the suspects and helping against the recidivism.

Conflict of Interest

Not available

Financial Support

Not available

References

1. Susmita Saxena, Sanjeev Kumar. Saliva in forensic odontology: A comprehensive update. *Journal of Oral and Maxillofacial Pathology: JOMFP*
2. Hedman J, Dalin E, Rasmusson B, Ansell R. Evaluation of amylase testing as a tool for saliva screening of crime scene trace swabs. *Forensic Sci Int Genet.* 2011 Jun;5(3):194-8. DOI: 10.1016/j.fsigen.2010.03.003. Epub 2010 Apr 8. PMID: 20457099.

3. Mullin AP, Gokhale A, Moreno-De-Luca A, Sanyal SJ, Waddington L, Faundez V. Neurodevelopmental disorders: mechanisms and boundary definitions from genomes, interactomes and proteomes. *Transl Psychiatry*. 2013 Dec;3(12):e329.
4. WHO. 2022 Mar 30.
5. Holly Hodges, Casey Fealko, and Neelkamal Soares. Autism spectrum disorder: definition, epidemiology, causes, and clinical evaluation. *Transl Pediatr*. 2020 Feb 9(Suppl 1):s55-65.
6. Monique Chiacchia JD. Mscjcriminal justice. *Autism Spectrum Disorder and the Criminal Justice System*; c2016 Apr 5.
7. Björn Hofvander, Sophie Bering, Eva Billstedt. Few Differences in the Externalizing and Criminal History of Young Violent Offenders With and Without Autism Spectrum Disorders. *Front Psychiatry*. 2019;10:911.
8. Matthew D Lerner, Omar Sultan Haque, Eli C Northrup, Lindsay Lawer, Harold J Bursztajn. Emerging Perspectives on Adolescents and Young Adults with High-Functioning Autism Spectrum Disorders, Violence, and Criminal. *Journal of the American Academy of Psychiatry and the Law Online*. 2012 Apr;40(2):177-190.
9. Daniel Schöttle, Peer Briken, Daniel Turner. Sexuality in autism: hypersexual and paraphilic behavior in women and men with high-functioning autism spectrum disorder *Dialogues Clin Neurosci*. 2017 Dec;19(4)381-393.
10. Hedman J, Dalin E, Rasmusson B, Ansell R. Evaluation of amylase testing as a tool for saliva screening of crime scene trace swabs. *Forensic Sci Int Genet*. 2011 Jun;5(3):194-8. DOI: 10.1016/j.fsigen.2010.03.003. Epub 2010 Apr 8. PMID: 20457099.
11. Mandel AL, Peyrot des Gachons C, Plank KL, Alarcon S, Breslin PAS. Individual Differences in AMY1 Gene Copy Number, Salivary α -Amylase Levels, and the Perception of Oral Starch. *PLoS ONE*. 2010;5(10):e13352. DOI:10.1371/journal.pone.0013352
12. Liubov Petrakova, Bettina K Doering, Jan-Sebastian Grigoleit. Psychosocial Stress Increases Salivary Alpha-Amylase Activity Independently from Plasma Noradrenaline Levels. *PLoS One*. 2015;10(8):e0134561.
13. Robert-Mercier T, Dehoux M, Longrois D, Guglielminotti J. Salivary Amylase as a Stress Biomarker. In: Preedy, V., Patel, V. (eds) *General Methods in Biomarker Research and their Applications*. Springer, Dordrecht; c2014. https://doi.org/10.1007/978-94-007-7740-8_31-1
14. Daniela Jezova, Jana Trebaticka, Katarina Buzgoova, Zdenka Durackova, Natasa Hlavacova. Lower activity of salivary alpha-amylase in youths with depression. <https://doi.org/10.1080/10253890.2020.1777975>
15. Van Stegeren AH, Wolf OT, Kindt M. Salivary alpha amylase and cortisol responses to different stress tasks: impact of sex. *Int J Psychophysiol*. 2008 Jul;69(1):33-40. DOI: 10.1016/j.ijpsycho.2008.02.008. Epub 2008 Mar 5. PMID: 18417235.
16. Tony W Buchanan, David Bibas, Ralph Adolphs. Salivary α -amylase levels as a biomarker of experienced fear. *Commun Integr Biol*. 2010;Nov-Dec 3(6):525-527.
17. Yamaguchi M, Kanemori T, Kanemaru M, Takai N, Mizuno Y, Yoshida H. Performance evaluation of salivary amylase activity monitor. *Biosens Bioelectron*. 2004 Oct 15;20(3):491-7. DOI:10.1016/j.bios.2004.02.012. PMID: 15494230.
18. Somaye Farmani, Shabnam Ajami, Neda Babanouri. Prevalence of Malocclusion and Occlusal Traits in Children with Autism Spectrum Disorders. *Clin Cosmet Investig Dent*. 2020;12:343-349.
19. Costa ST, Carvalho GP, Matoso RI, Freire AR, Junior ED, Prado FB, *et al*. Identification of Suspect by Bite Mark Analysis in a Dead Woman: A Case Report *Austin J Forensic Sci Criminol*. 2016;3(1):1049.
20. Jeffrey Guina, Camille Hernandez, Jay Witherell, Allison Cowan, David Dixon, Irina King, *et al*. Neurodevelopmental Disorders, Criminality, and Criminal Responsibility. *Journal of the American Academy of Psychiatry and the Law Online*; c2022 Jul. DOI: <https://doi.org/10.29158/JAAPL.210103-21>

How to Cite This Article

Seema M. A new insight into forensic odontology through salivary amylase amongst neurodevelopmental disorders: A review. *National Journal of Clinical Orthopaedics*. 2023;5(1):05-08.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.