

Platelet Serotonin Level and Impulsivity in Human Self-destructive Behavior: A Biological and Psychological Study

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ABSTRACT

Context: Suicide is a disease and a global public health problem. Suicidology has come to become a topic of study for intervention and research. The serotonin (5-hydroxytryptamine [5HT]) system has remained a prime area of investigation. The neurons and platelets display structural and functional similarities. Ninety-nine percent of 5HT is contained in platelets, which shares similar 5HT uptake and release mechanisms with 5HT neurons. **Aims:** This study aims to study human self-destructive behavior (HSDB). **Objectives:** Exploring the biological (serotonin levels in platelets) and psychological aspects (impulsivity) of attempted suicide or HSDB. **Settings and Design:** Thirty-one patients, above the age of 18 years, with a recent history of HSDB, were studied and given an International Classification of Diseases-10 diagnosis, after a detailed interview. **Subjects and Methods:** For the platelet 5HT estimation, blood samples were collected, and enzyme immunometric assay carried out. Detailed assessment of the impulsivity was done by the 25-item structured diagnostic interview for borderlines by Zanarini *et al.* **Statistical Analysis Used:** We obtained both categorical and continuous data. Chi-square test, Fisher's test, Student's *t*-test, and Pearson's product moment correlation were used. **Results:** Female subjects outnumbered males by 2:1. Major depression, adjustment disorder, personality disorder were predominant diagnoses. The mean platelet serotonin concentration for males = 57.3 ng/ml, that of females = 56.05 ng/ml ($P > 0.05$). Platelet 5HT levels were found to be negatively correlated with impulsivity scores ($P < 0.05$). **Conclusions:** Platelet serotonin levels in our study sample were quite low when compared with those reported in published literature. Low serotonin levels were inversely related to impulsivity, but only in males.

KEYWORDS: Human self-destructive behavior, impulsivity, serotonin

INTRODUCTION

Human self-destructive behavior (HSDB) runs counter to the fundamental drive to survive.^[1] Self-destructive behavior and nonfatal suicide attempts have been conceptualized as "Parasuicide."^[2] Attempted suicide is a suicidal act with nonfatal outcome, and the terms attempted suicide, parasuicide, and deliberate self-harm are used synonymously (WHO 1968). Further, a distinction is also made between self-destructive behavior (deliberate self-harm) where the intent is to inflict hurt to self and attempted suicide where the intent is to die but somehow turned unsuccessful.^[3] As suicides or suicidal attempts occur in almost all mental disorders including substance use and adjustment disorders as well as in stressful life situations, several workers veered toward the idea that suicide itself may be an entity in its own distinct psychological, social, and biological underpinnings.

Ever since Asberg *et al.*^[4] reported reduced concentration of 5-hydroxyindoleacetic acid (5HIAA) in the cerebrospinal fluid (CSF) of attempted suicides, brain serotonergic system has become the focus of attention as far as biological factors are concerned. Investigators from our country have not

explored this area with a measure of seriousness. Moreover, measuring the function of serotonin receptor in real time needs sophisticated technology like positron emission tomography.

The platelets in the blood are found to be similar to central nervous system neurons. The importance of intraneuronal serotonin levels can be realized from the fact that impaired tryptophan hydroxylase, a rate-limiting enzyme in serotonin synthesis has been described as a marker for suicide.^[5] However, it appears that actual level of serotonin in platelets has not been measured so far. In any case, no Indian investigator has addressed themselves to this particular area.

As far as the psychological factors are concerned, the trait of impulsivity has been noted as the common thread running through the psychiatric disorders across the board as well as in the seemingly healthy persons who resorts to suicidal

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How to cite this article: Dutta SE, Gupta S, Raju M, Kumar A, Pawar A. Platelet serotonin level and impulsivity in human self-destructive behavior: A biological and psychological study. *J Neurosci Rural Pract* 2017;8:199-203.

Access this article online	
Quick Response Code: 	Website: www.ruralneuropractice.com
	DOI: 10.4103/jnrp.jnrp_425_16

behavior. The concept of impulsivity covers a wide range of “actions that are poorly conceived, prematurely expressed, unduly risky or inappropriate to the situation and that often result in undesirable outcomes.”

In view of the gravity of the condition as such and also the implication for potential successful suicides, later on, it was considered that a study on platelet serotonin levels and impulsivity might yield information relevant to the primary prevention of completed suicide.

SUBJECTS AND METHODS

Setting

A single-centric, cross-sectional study was carried out on all persons above 18 years of age, who were brought to the casualty department of a tertiary care hospital in Pune, Maharashtra, during a 6-month period with a history of self-destructive behavior. As the department offers consultation-liaison services to all other specialties and general emergency services, we interviewed these patients once they were stabilized.

Methods

The investigators introduced themselves as doctors who were doing research on HSDB and solicited cooperation from the prospective candidates as well as the caretakers, after ensuring them of full confidentiality. Informed consent was obtained from all. Institution’s Ethical Committee approved the study. A standard psychiatry interview was conducted, and appropriate psychiatric diagnosis was given if any constellation of symptoms satisfied the criteria of International Classification of Diseases, diagnostic criteria for research (ICD-10-DCR).

Platelet serotonin estimation

Enzyme immunometric assay was carried out on the kit obtained from M/s Enzo Life Sciences, PA, USA. Blood samples were collected after informed consent under full aseptic conditions. The samples were labeled by alphanumeric code to maintain confidentiality. After collection of blood, it was centrifuged at 16000 ×g for 15 min, and the white buffy coat was collected. The platelets were washed twice using physiological saline and centrifuged at 2000 ×g for 10 min and again washed. Platelet pellet was resuspended using distilled water. Suspension thus obtained was frozen and thawed shortly before carrying final assay.

The samples were stored at -20°C before final estimation at the facilities provided at the Interactive Research School for Health Affairs, an autonomous research institute of the Parent University.

The structured interview for impulsivity is a 25 item structured interview that is taken out of the diagnostic interview for borderlines (DIB) by Zanarini *et al.*^[6] It has been translated and back translated into Marathi at Maharashtra Institute of Mental Health by Chitalkar and Phadke.^[7] Up to two marks can be given for each positive answer. The maximum score is 50.

Statistical analysis

We obtained both categorical and continuous data. Chi-square test was used to test the significance of categorical data.

Fisher’s test was used where Chi-square test could not be used. In case of continuous data Student’s *t*-test was used. Pearson’s product moment correlation was used for correlations. However, as the data were not balanced and platykurtic data were transformed into log 10 as per Holmes *et al.* 2006.^[8] Only percentages were used at places for drawing comparisons.

RESULTS

A total of 31 persons, who attempted suicide were investigated for this study. The sample consisted of 10 males and 21 females. The mean age of total sample was 30.6 years. There was no significant difference between mean ages of male and female patients ($t = 0.64, P = 0.05$).

There was no significant difference in the mean score of impulsivity between male (7.6) and female (4.39) patients ($t = 0.40, P = 0.05$). The mean platelet serotonin concentration for males was 57.3 while that of females was 56.05. The difference was not significant ($t = 0.11, P > 0.05$).

The sample could be broadly divided into ICD-10-DCR diagnosis of depression, adjustment disorder, personality disorder, miscellaneous categories, and suicidal patients with no diagnoses. The differences in the diagnostic categories was found to be statistically significant (Fisher’s exact test $P = 0.0037$) [Table 1].

Mean serotonin level of persons with miscellaneous diagnoses was found to be significantly low in comparison with that of those with no diagnoses ($t = 2.97, Df = 9, P < 0.025$). The difference between all other diagnoses was found to be not significant [Table 2].

Platelet Serotonin levels were found to be negatively correlated ($r = -0.37$) with impulsivity scores. The negative correlation was found to be statistically significant ($t = 2.173, Df = 29, P < 0.05$). Impulsivity is negatively correlated to platelet Serotonin ($r = -0.31$) in males which was found to be significant ($t = 2.27, Df = 8, P < 0.05$). However, in

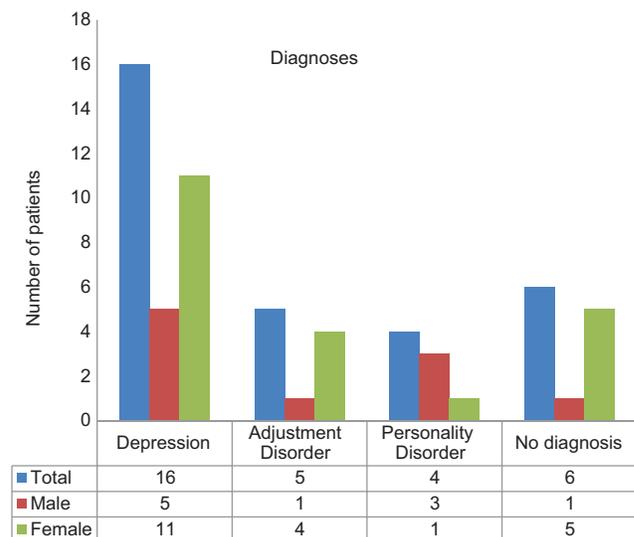


Table 1: International Classification of Diseases-10-diagnostic criteria for research diagnoses

female suicidal patients, no significant correlation between impulsivity and platelet serotonin levels was found ($r = 0.026$, $t = 0.12$, $P > 0.05$) [Tables 3 and 4].

DISCUSSION

Biology of suicidal behavior

In the past two decades, there has been a proliferation of studies on the neurochemistry of suicidal behavior. The impetus for these investigations came when Asberg *et al.* in 1976, first reported that low CSF 5HIAA levels were associated with suicidal behavior.^[4] Many investigators later replicated this finding. Identifying biological factors underlying HSDB has become very important area of investigation in recent time.

Platelet serotonin and suicide

Neurons and platelets display structural and functional similarities. In blood, more than 99% of 5-hydroxytryptamine (5HT) is contained in platelet.^[9] Platelets and central serotonergic neurons share many structural and functional similarities^[10,11] and offer a good opportunity to study central 5HT neurons from the periphery. In a recent review of suicide in India, Vijayakumar mentioned of the limited number of studies on the biology of suicide in our country.^[12] The present worker is not aware of any study in platelet serotonin in attempted suicide in India. Hence, a small venture to study platelet serotonin levels in attempted suicide is attempted on an exploratory observational design.

Epidemiology

Gender

Maharashtra is one of the leading suicide states of India. Among the completed suicides in our country, a male:female ratio of 65:35 has been reported.^[13] As far as attempted suicides are concerned a reverse trend has been reported by various workers.^[14-16] In India, Srivastava and Kulshreshtha reported male under 35 were at risk.^[16] While Lal and Sethi reported homemakers below 30 years of age were at risk.^[15] No official figures for suicide attempts are available. There is no epidemiological data on attempted suicides. In the present study, females outnumbered males by 2:1 which perhaps reflect the present trend.

Age

Globally, parasuicide is generally considered as a problem in the young (under 35 years) while suicide as a problem in the old.^[2] The mean age of the patients in the present study was 30.6 years. There was no difference in the mean age of male and female persons. Hence, it appears that mean age reflects the general trend. In India, even completed suicide appears to be a problem of young as 70.1% of suicide victims are below 44 years of age.^[13]

Human self-destructive behavior and psychiatric diagnosis

It is reported that 90%–94% of people who completed suicide had mental illness^[17,18] and mood disorders were reported in 45%–77% of suicides;^[19] the figures for suicidal attempts are not known. However, adjustment disorders and personality disorders reported to be more likely in suicidal attempts while mood disorder, psychosis, and substance use predominate in completed suicides.^[2] In the present study, 51% had depression that corresponds to Barraclough *et al.*^[19] and Bagadia *et al.*^[20]

Table 2: Platelet serotonin levels of the various diagnoses (ng/ml)

Depression (D) (n=16)	Personality Disorder (PD) (n=4)	Miscellaneous (M) (n=5)	No Diagnosis (n=6)
18	85	36	92
132	66	25	95
36	28	66	76
86	30	39	32
42		16	82
28			68
115			
72			
16			
34			
42			
36			
42			
74			
34			
56			

Mean=53.94 Mean=52.25 Mean=36.4 Mean=74.17
 D versus PD: $t=0.03$, $df=18$, $P>0.05$, D versus ND: $t=1.35$, $df=20$, $P>0.05$ (not significant) D versus M: $t=1.13$, $df=19$, $P>0.05$ (not significant), M versus ND: $t=2.97$, $df=9$, $P<0.025$ (significant).

Table 3: Impulsivity and platelet serotonin levels in males

Impulsivity score	Serotonin (ng/ml)
3	133
5	37
9	85
16	31
18	67
7	96
4	29
5	17
2	43
7	35

(Pearson product moment correlation) - $r=-0.31$, $t=2.27$, $df=8$, $P<0.05$ (significant)

In 19% of cases, no diagnoses could be made. In both sexes, the absence of psychosis and substance use is quite striking. Seventy-one percent of females had depression or adjustment disorder with depressed mood, while 50% of the males had a depression 25% of the females had no diagnosable disorder. Thirty percent of the males had a personality disorder, and 5% of males had no diagnosable disorder. In this way, attempted suicide seems to be similar to mood disorders in some ways and differ in other respects. The differences between male and female found to be significant ($P = 0.0037$).

Two putative factors are assumed to be underlying suicide. A common genetic factor predisposing for mental illness in general and an independent risk factor for suicide of which the biological factor may be related to the serotonergic system while the psychological factors were found to be impulsivity and aggression.^[1]

Table 4: Impulsivity and platelet serotonin levels in females

Impulsivity score	Serotonin (ng/ml)
3	19
2	93
2	37
4	87
5	43
3	26
2	77
13	116
2	73
11	33
3	67
3	35
3	38
2	83
2	40
3	37
7	43
12	29
3	75
2	69
5	57

(Pearson product moment correlation) - $r=0.026$, $t=-0.12$, $df=19$, $P>0.05$ (not significant)

Human self-destructive behavior and impulsivity

Impulsivity may be made up of several independent factors, and there is little unanimity what these factors are. There is no consensus on the best way to measure impulsivity.^[21] To circumvent the problem of translating and standardizing the Barrat Impulsiveness scale,^[22] we utilized the 25 items on impulsivity from the DIB^[6] that was translated into Marathi by Chitalkar and Phadke.^[7] These 25 items appear to give adequate coverage to tap various aspects of impulsivity. Norms for the scale obviously are not available. The possible maximum marks are fifty. The mean score for the study population was 5.45, and that of males and females were 7.6 and 4.39, respectively. However, the difference in the means was not significant. Among the diagnostic categories, personality disorder patients had the highest mean impulsivity score of 13, which was significantly high ($P < 0.001$) than other diagnoses. Personality disorder patients are known to have high impulsivity scores.^[9]

Human self-destructive behavior and platelet serotonin

The mean platelet serotonin levels of the total study samples were 51.3 ng/ml, which in males was 57.3 ng/ml, and in females, it was 56.05 ng/ml. Only one study has quoted platelet Serotonin levels in normal individuals. Ghosh correlated little finger length and platelet serotonin levels in 48 healthy subjects. He postulated that little finger length was related to neuroticism, which is known to be associated with depression and anxiety.^[11] In his study, serotonin levels in the males were 160.57 (nonneuroticism) and 86.38 (neuroticism). While in females, they were 182.76 (nonneuroticism) and 126.16 (neuroticism). The

platelet serotonin levels of the present study are lower than those reported by Ghosh.^[11] Perhaps, it can be understood from the fact that his sample consisted of healthy individuals. Comparison with platelet serotonin levels of Ghosh study brings out of the fact that all attempted suicides have low platelet serotonin levels. Walderhaug *et al.*^[23] reported reduced serotonin levels (by tryptophan depletion) caused increased impulsivity in healthy individuals and impulsivity is associated with suicidality.^[1] In the present study, no difference in platelet Serotonin levels between males and females was found.

Correlation of impulsivity and platelet 5-hydroxytryptamine

Contrary findings have been reported about the relationship between impulsivity and platelet serotonin levels.^[24-30] In the present study, platelet serotonin levels when compared with that of healthy normal patients of Ghosh study^[11] found to be quite low in the sample. The issue could have been put across more emphatically had there been a sample of healthy controls in this study. Platelet serotonin levels were found to be low in suicidal patients, and this corresponds to other studies.^[24-26,28] However, Askenazy *et al.* found elevated 5HT levels in platelets of suicidal attempt patients.^[27]

Given the low levels of platelet serotonin in the study sample and the reported association of impulsivity and suicidality^[31] an attempt was made to correlate the impulsivity scores with platelet serotonin levels. A significant negative correlation ($r = -0.32$, $t = 2.173$, $P < 0.05$) was obtained.

On analyzing if impulsivity associated with gender, it was observed that a significant negative association between platelet serotonin and impulsivity was present in males ($r = -0.31$, $t = 2.27$, $P < 0.05$) and not in females ($r = 0.026$, $t = 0.12$, $P > 0.05$). This divergent finding is not due to high serotonin content in females as found by Le Quan-Bui *et al.*^[32] because platelet serotonin levels in females were actually marginally higher in females in this study. It appears that low impulsivity scores (mean 4.39) in females in comparison to males (mean 7.60) have contributed to this gender specific correlation of impulsivity with platelet serotonin. The worker is not aware of any study showing similar finding.

Limitations

The present study is hospital based and will have limitations in generalizing the findings to the population. The study also suffers from a small sample size and observational design.

CONCLUSIONS

Platelets are known to be similar to central serotonergic neurons in many ways. The present study revealed low platelet serotonin levels in attempted suicide subjects. Low serotonin levels were inversely related to impulsivity, but not in female population.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Raju MS, Garg MK, Rajguru B, Srivastava K. Personality factor correlates of growth hormone and hypothermic response to buspirone challenge in suicidal soldiers. *Med J Armed Forces India* 2002;58:114-9.
- Caroll-Ghosh T, Victor BS, Bourgeois JS. Suicide. In: Hales RE, Yudofsky SG, editors. *American Psychiatric Publishing textbook of clinical psychiatry*, 4th edition. Edited by Hales RE, Yudofsky SC. Washington DC, American Psychiatric Publishing, 2003. p. 1457-83.
- Roy A. M.B. emergency psychiatry: Suicide. In: Sadock B, Sadock V, editors. *Comprehensive Textbook of Psychiatry*. 5th ed. II, 1414-1426, 1989. Baltimore: Lippincott Williams and Wilkins; 2000. p. 2031-40.
- Asberg M, Träskman L, Thorén P. 5-HIAA in the cerebrospinal fluid. A biochemical suicide predictor? *Arch Gen Psychiatry* 1976;33:1193-7.
- Nielsen DA, Virkkunen M, Lappalainen J, Eggert M, Brown GL, Long JC, *et al.* A tryptophan hydroxylase gene marker for suicidality and alcoholism. *Arch Gen Psychiatry* 1998;55:593-602.
- Zanarini MC, Gunderson JG, Frankenburg FR, Chauncey DL. The revised diagnostic interview for borderlines: Discriminating BPD from other axis II disorders. *J Pers Disord* 1989;3:10-8.
- Chitalkar Y, Phadke S. *Structured Clinical Interview DSM 3 R Borderline Personality Disorder*. Pune: Maharashtra Institute of Mental Health; 1991.
- Holmes D, Moody P, Dine D. *research methods for the biosciences*: Oxford University Press; 2010.
- Sneddon JM. Blood platelets as a model for monoamine-containing neurones. *Prog Neurobiol* 1973;1:151-98.
- Bianchi M, Moser C, Lazzarini C, Vecchiato E, Crespi F. Forced swimming test and fluoxetine treatment: *In vivo* evidence that peripheral 5-HT in rat platelet-rich plasma mirrors cerebral extracellular 5-HT levels, whilst 5-HT in isolated platelets mirrors neuronal 5-HT changes. *Exp Brain Res* 2002;143:191-7.
- Ghosh D. Platelet serotonin level and its correlation with finger length relation. *Indian J Psychiatry* 2008;50:253-6.
- Vijayakumar L. Indian research on suicide. *Indian J Psychiatry* 2010;52 Suppl 1:S291-6.
- National Crime Records Bureau. *Accidental deaths and suicides in India 2010*. New Delhi: National Crime Records Bureau, Ministry of Home Affairs; 2011.
- Schmidtke A, Bille-Brahe U, DeLeo D, Kerckhof A, Bjerke T, Crepet P, *et al.* Attempted suicide in Europe: Rates, trends and sociodemographic characteristics of suicide attempters during the period 1989-1992. Results of the WHO/EURO multicentre study on parasuicide. *Acta Psychiatr Scand* 1996;93:327-38.
- Lal N, Sethi BB. Demographic variables in a attempted suicide by poisoning. *Indian J Psychiatry* 1975;17:100-7.
- Srivastava S, Kulshreshtha N. Expression of suicidal intent in depressives. *Indian J Psychiatry* 2000;42:184-7.
- Robins E, Murphy GE, Wilkinson RH Jr., Gassner S, Kayes J. Some clinical considerations in the prevention of suicide based on a study of 134 successful suicides. *Am J Public Health Nations Health* 1959;49:888-99.
- Black DW, Winokur G. *Suicide and Psychiatric diagnosis in suicide over the life cycle*. Bluementhal SJ, Kupfer DJ, Washington D.C.: American psychiatric Press;1990;135-53.
- Barraclough B, Bunch J, Nelson B, Sainsbury P. A hundred cases of suicide: Clinical aspects. *Br J Psychiatry* 1974;125:355-73.
- Bagadia VN, Abhyankar RR, Shroff P, Mehta P, Doshi J, Chawla P, *et al.* Suicidal behaviour: A clinical study. *Indian Journal of Psychiatry* 1979;21:370-5.
- Evenden JN. Varieties of impulsivity. *Psychopharmacology (Berl)* 1999;146:348-61.
- Barrat ES. Anxiety and Impulsiveness relative to psychomotor efficiency. *Percept Mot Skills* 1959;9:191-8.
- Walderhaug E, Lunde H, Nordvik JE, Landrø NI, Refsum H, Magnusson A. Lowering of serotonin by rapid tryptophan depletion increases impulsiveness in normal individuals. *Psychopharmacology (Berl)* 2002;164:385-91.
- Mück-Seler D, Jakovljevic M, Pivac N. Platelet serotonin concentrations and suicidal behaviour in recurrent major depression. *J Affect Disord* 1996;39:73-80.
- Sperux-Varoquaux O, Alvarez JC, Berlin I, Batista G, Despierre PG, Gilton A, *et al.* Differential abnormalities in plasma 5-HIAA and platelet Serotonin concentrations in violent suicide attempters: Relationship with impulsivity and depression. *Life Sci* 2001;69:647-57.
- Mann JJ, McBride PA, Anderson GM, Mieczkowski TA. Platelet and whole blood serotonin content in depressed inpatients: Correlations with acute and life-time psychopathology. *Biol Psychiatry* 1992;32:243-57.
- Askenazy F, Caci H, Myquel M, Darcourt G, Lecrubier Y. Relationship between impulsivity and platelet serotonin content in adolescents. *Psychiatry Res* 2000;94:19-28.
- Kovacic Z, Henigsberg N, Pivac N, Nedic G, Borovecki A. Platelet serotonin concentration and suicidal behavior in combat related posttraumatic stress disorder. *Prog Neuropsychopharmacol Biol Psychiatry* 2008;32:544-51.
- Nenadic-Sviglin K, Nedic G, Nikolac M, Kozaric-Kovacic D, Stipcevic T, Muck Seler D, *et al.* Suicide attempt, smoking, comorbid depression, and platelet serotonin in alcohol dependence. *Alcohol* 2011;45:209-16.
- Müller-Oerlinghausen B, Roggenbach J, Franke L. Serotonergic platelet markers of suicidal behavior – Do they really exist? *J Affect Disord* 2004;79:13-24.
- Beck AT, Brown G, Berchick RJ, Stewart BL, Steer RA. Relationship between hopelessness and ultimate suicide: A replication with psychiatric outpatients. *Am J Psychiatry* 1990;147:190-5.
- Le Quan-Bui KH, Plaisant O, Leboyer M, Gay C, Kamal L, Devynck MA, *et al.* Reduced platelet serotonin in depression. *Psychiatry Res* 1984;13:129-39.