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EFFECT OF EXAMINATION STRESS ON MOOD, PERFORMANCE AND CORTISOL LEVELS IN MEDICAL STUDENTS

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Abstract : Stress produces definable mental and physiological reactions in the body. Mild stress is beneficial in cognitive tasks and performance but persistently high stress may lead to neuropsychiatric illnesses like anxiety and depression. Examinations act as stressor and activate hypothalamic-pituitary adrenal axis causing an increase in cortisol level, which is reflected in saliva. Present study was done on 35 medical students. Their mood parameters were assessed, using Depression Anxiety Stress Scale (DASS) scoring, and salivary cortisol levels using quantitative ELISA. Subjects were evaluated for mood parameters two times, one during relaxed state (with no examinations in preceding 2 weeks and in coming 2 weeks) and another during stressed state (on the day of viva voce examination). The levels of mood parameters and salivary cortisol were significantly raised during examination stress. The changes in stress level significantly correlated with change in levels of anxiety and salivary cortisol though there was no significant effect on the performance. Males and females showed similar changes in mood parameters. This study suggests that as examinations act as unavoidable stressors, the medical educators as well as students should be made aware of the negative consequences of stress faced during medical training. Efficient relaxation program as well as counseling services should be provided to stressed students so that they are able to cope better with examination stress.

Key words : salivary cortisol stress anxiety depression academic performance

INTRODUCTION

Stress is defined as “a physical or psychological stimulus that can produce mental or physiological reactions that may lead to illness”. Mild stress may be beneficial

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in cognitive tasks and performance while persistently high stress may lead to anxiety and depression, which are definable neuropsychiatric disease entities. Stress response is characterized by an increase in corticosteroid release. There are considerable individual differences in this response (1). Some individuals show persistent, large cortisol increases in response to stress while others show little or no such response (2). High versus low cortisol responders may actually represent two different groups, which may differ with respect to level of perceived stress and personality traits.

Several studies have documented that medical training causes high incidences of psychological distress among students (3) and academic examination has been considered as one of the most acute stressors as performance in examinations generally has future consequences on student's career. Cortisol concentration and its rates of excretion increase in students during periods of examination stress (4). This is in response to stress which increases HPA-axis activity with a subsequent rise in salivary cortisol level (5). Salivary cortisol measurement has been considered a valuable and convenient alternative to Plasma cortisol measurement. Apart from being noninvasive, it closely reflects the concentration of free, biologically active cortisol in plasma and is independent of the rate of saliva secretion (6). It also enables demonstration of the overdrive of HP A axis, assessment of which is helpful in subjects suffering from stress, anxiety and depression. Many studies have related stress, anxiety or depression with cortisol concentration. Performance has also been reported to be affected by levels of stress (4). Present study was undertaken to explore the effect of the oral examination on perceived levels of stress, depression, anxiety and salivary cortisol response in medical students.

MATERIAL AND METHODS

Study design

This was a longitudinal follow up study in which, subjects were assessed for stress parameters and cortisol levels at two times. One in the relaxed state (with no examinations in preceding two weeks and coming two weeks); another in the stressed state(on the day of viva voce examination).

Subjects

Thirty five medical students (21 males, 14 females) who were appearing in the first professional examination were recruited for the study after written informed consent. Students with the history of neurological or psychiatric disorders, taking medicines affecting emotional status and endocrinological profile, tendency of gingival bleeding or addicted to tobacco or alcohol were excluded. The study protocol was approved by the institutional ethics committee.

Stress parameters

Subjects were given a questionnaire of 42 items for scoring Depression, Anxiety and Stress (DAS) Scale, which has 14 questions each for assessing depression, anxiety and stress levels (7).

Saliva sample collection

Subjects were instructed in advance not to eat or drink anything except water one hour before saliva collection to minimize

possible food debris and stimulation of salivation. DAS scoring and salivary sample collection was done simultaneously. Salivary samples were collected at the same time of the day (between 10:30 am and 11:00 a.m.) both during relaxed state and stressed state. Samples were stored in the deep freezer at –80°C.

Salivary cortisol assay

Salivary cortisol was measured by ELISA (DiaMetrasrl) method. The intra assay variability was 7% and Inter-assay variability was 9.3%. ELISA of all the samples was done by the same person with technical expertise who was blinded for the results of scoring and performance.

Performance

The marks obtained in the viva voce of first professional physiology examination, which was conducted by external examiners was taken as performance. Examiners were neither aware about the study nor the students enrolled in that.

Statistical analysis

Data analysis was done using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). The normality of data was tested using Shapiro wilk test. All the data were expressed as mean±SD. The pre & post data was analyzed using Paired 't' test. Group comparison was done using one way analysis of variance. Correlation analysis was performed using Pearson correlation coefficient. A two-tailed (α=2), probability value less than 0.05 ($P<0.05$) was considered significant for all statistical tests applied.

RESULTS

Of the thirty five students enrolled in the study, 21 were males and 14 females with mean age of 20.4±1.59 years, height 162.9±9.8 cm and weight 54.22±9.8 kg.

Stress, anxiety, depression and salivary cortisol levels determined during relaxed state were compared to the levels observed on the day of examination. The levels of mood parameters as well as cortisol levels both were significantly raised during examination stress (Table I).

TABLE I: Comparison of different correlates during relaxed state and exams.

Variables	*Relaxed state (n=35)*	*Stressed state (n=35)*	*'P' value*
Heart rate (beats/min)	74±12	75±6.9	0.705
Systolic BP (mmHg)	117±6.2	118±9.5	0.076
Diastolic BP (mmHg)	77±5.2	78±9.7	0.218
Stress	12.08±5.4	15.31±4.9	0.0001**
Anxiety	9.4±4.3	12.6±3.8	0.0001**
Depression	7.4±4.5	9.05±4.56	0.001**
Cortisol (ng/ml)	2.65±1.67	5.08±3.05	0.0001**

Data presented are means±SD. *P<0.05; **P<0.01.

Mood parameters and stress response in males *versus* females

Mood parameters and salivary cortisol levels were compared between males and females (Table II). Males exhibited significantly higher baseline levels of anxiety as compared to females. Baseline levels of stress and depression are also higher but not significant statistically. Both males and females showed an increase in the level of stress, anxiety and depression during exams but the difference does not reach statistical significance. Both groups showed increase in

TABLE II: Comparison of different correlates in males and females during relaxed state and exams.

Parameters	*Relaxed state*		*Stressed state*		*'P' value*
	Males (n=21)	*Females (n=14)*	*Males (n=21)*	*Females (n=14)*	
Heart rate (beats/min)	74.76±12.6	72.86±11.4	76.12±7.2	73.21±6.3	0.7398
Systolic BP (mmHg)	117.81±5.8	115.86±6.8	119.62±8.3	115.57±10.9	0.4126
Diastolic BP (mmHg)	77.90±4.4	75.71±6.1	79.33±9.19	76.00±10.4	0.4823
Stress	13.33±4.6	10.21±6.1*	16.14±4.5*	14.07±5.3	0.0131
Anxiety	10.86±3.9*	7.21±4.1*#	13.52±3.3#	11.36±4.3	0.0002
Depression	8.24±4.8	6.21±3.8	9.95±4.9	7.71±3.6	0.1186
Cortisol (ng/ml)	2.48±1.5*#	2.92±1.9	5.02±3.1*	5.19±3.1#	0.0016

Data presented are means±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-Kramer test. The significantly different (P<0.05) groups are flagged with * and #.

cortisol levels in response to examination stress but only the response in case of males is statistically significant. The performance was not significantly different in the two groups (Percentile marks in males and females are 76.5±12.1 and 76.27±11.2 respectively).

Correlation between changes observed in different parameters

To determine whether the changes observed in mood parameters correspond to the changes in cortisol levels and performance in examination, bivariate correlation analysis was performed. The changes in stress level were found to correlate significantly with change in level of anxiety and cortisol in subjects (Table III). Performance correlated negatively with stress and anxiety level but it was not statistically significant.

TABLE III: Correlation analysis between changes observed in different parameters of DASS scale, serum cortisol and sores in examination.

Variables		*Correlation (r)*	*Significance (P value)*
Deltastress	DeltaAnxiety	0.4	0.016*
Deltastress	DeltaDepression	0.07	0.684
DeltaAnxiety	DeltaDepression	–0.004	0.983
DeltaCortisol	Deltastress	0.387	0.022*
DeltaCortisol	DeltaAnxiety	0.384	0.023*
DeltaCortisol	DeltaDepression	–0.163	0.531
Percentile Marks	Deltastress	–0.212	0.222
Percentile Marks	DeltaAnxiety	–0.22	0.213
Percentile Marks	DeltaDepression	0.28	0.108
Percentile Marks	DeltaCortisol	–0.06	0.733

*P<0.05; **P<0.01.

Low *versus* high cortisol responders

As there are inter individual variations for cortisol response, the subjects were divided as low and high cortisol responders by taking median split of the level of change (i.e. ~3 ng/dl in our study) in cortisol due to stress (Table IV). Low cortisol responders though, had higher baseline stress, anxiety and cortisol levels, but they showed significantly low response/change for perceived stress, anxiety and cortisol levels during examination stress as compared to high responders. There was no significant difference, observed in the performance of the two groups.

TABLE IV: Comparison of mood parameters and performance in high cortisol responders and low cortisol responders. Significance (P value) determined using students t test.

Variables	*Delta cortisol < 3 ng/mL (n=18)*	*Delta cortisol < 3 ng/mL (n=17)*	*'P' value*
Stress	12.2±6.25	11.9±4.6	0.880
Deltastress	2.1±2.9	4.5±3.4	0.029
Anxiety	9.94±4.9	8.82±3.7	0.455
DeltaAnxiety	2.22±2.5	4.34±3.0	0.031
Depression	7.33±4.7	7.5±4.5	0.901
DeltaDepression	2.1±3.3	1.17±1.6	0.327
Cortisol (relaxed)	3.13±1.6	2.14±1.6	0.081
Percentile Marks	76.7±11.6	76±11.9	0.878

Data presented are means±SD.

DISSCUSION

In this study, we evaluated changes in the level of stress, anxiety, depression and salivary cortisol among medical students due to viva voce examination and correlated it with their academic performance. Results show that viva voce examination leads to significant changes in the level of mood parameters and salivary cortisol. Changes in level of cortisol showed a significant correlation with that of stress and anxiety. Performance was negatively correlated with changes in level of stress and anxiety, but it was not statistically significant. Various studies both on animals and human studies have indicated that stress and glucocorticoids may impair memory and cognitive function (8, 9).

Studies have shown that written examinations may (10) or may not (4) cause increase in cortisol levels; however, oral examinations routinely elicit a cortisol response and feelings of stress (11), and have been shown to cause greater cortisol release and feelings of anxiety than written examinations (4). Shah et al. (2010) have also reported a negative correlation between perceived stress and academic performance, which was not significant (12). Authors suggested that only acute stressors may be responsible for affecting academic performance. Also the students who are striving hard to perform well in the exam may be stressed. Their Individual coping styles and skills along with their access to different forms of social support may play a role in negating the effect of stress on academic performance. Sansgiry et al. (2006) also found an insignificant negative correlation between academic performance and test anxiety (13). Authors suggested efficient counseling service in their institution as one of the causes for not getting a significant association between performance and test anxiety. According to them such programs are efficient in improving academic performance, which has also been supported by others (14).

Medical curriculum is stressful (3) and varied levels of stress have been reported amongst medical students and health care professionals (11). Vaidya and Mulgaonkar (2007) also found increased level of stress and anxiety among first year medical students and they found academic pressure to be most responsible for this (15). They could not get any correlation between stress, anxiety, depression and academic performance. Authors suggested that the students who perceive tests/exams as a burden experience it as stressful situations while for others, who consider exams useful, it may assist them in their learning. Previous studies have also reported that academics/exams are common sources of

stress among medical students (16, 17) and anxiety and stress due to examination has a negative effect on the performance (18). Baseline stress, anxiety, and depression were higher in males similar to the findings of other studies (19) and viva voce examination led to a significant rise of cortisol level in them which is in accordance with the findings of others (20). However, females showed a trend of increased salivary cortisol with stress though it was not significant. Females vary in their response to stress corresponding to the phase of their menstrual cycle. They have blunted responses in the follicular phase and increased responses similar to those of men in the late luteal phase (20). In our study we did not evaluate females according to their phase of menstrual cycle, which may be one of the causes for statistically insignificant rise in cortisol in females. Moreover, variations in cortisol response probably reflect differences in the ways male and female perceive or cope with specific psychosocial situations. Stressors such as public speaking and mental arithmetic provoke greater cortisol changes in males than in females (21).

In the present study basal salivary cortisol levels were not found to be related to basal levels of DASS scores. Bradtstadter et al., (1991) and Ockenfels et al, (1995) also reported no association in levels of cortisol and mood parameters in healthy subjects (22, 23). In studies by Schaeffer et al., (1984) and Linkowski et al. cortisol levels have been reported to be related to mood parameters but these studies were done in chronically distressed subjects or psychiatric patients (24, 25). A subgroup comparison of the students as low and high cortisol responders was done by taking a median split for the relative change in cortisol level during viva compared to baseline. We found that high cortisol responders were significantly more stressed (P=0.029) and anxious (P=0.031) during viva, though they had lower baseline values as compared to low responders. Thus students who perceived greater stress and anxiety during examination showed a significant rise in cortisol levels as reported in other studies (11, 26), though there was no difference in the performance of the two groups. Cortisol levels were raised on the day of viva voce which reflects the up regulated HPA axis in response to stress. Examination stress leads to mood changes, which effect cortisol level, both of which in turn may affect the academic performance of the subjects. Loft et al., (2007) in contrast reported a decrease in cortisol levels (27).

In the present study association was sought between anxiety, depression, stress, salivary cortisol and performance during professional viva voce examination. The results reveal that examinations act as an unavoidable natural stressor and lead to increased stress, anxiety and depression in students, consequently excite HPA axis, resulting in increased release of cortisol. Despite changes in mood and cortisol levels, performance was not affected significantly in this group of students. To an extent cortisol may be helpful in dealing with the increased demands of the body during stress, but an excessive and persistent increase may lead to various ailments. Due to certain limitations, we were not able to assess post examination changes in mood and cortisol level, which would have led us to the conclusion that whether these changes were

persistent or only for a short duration. This was the limitation of our study, which may be evaluated further on a larger sample size along with the various other factors, which may affect performance apart from mood changes and cortisol levels.

The medical educators as well as students should be made aware of the negative consequences of stress faced during medical training and an efficient relaxation program as well as counseling services should be provided to such stressed students to enhance their academic performance. Education system needs to develop better evaluation techniques which cause less distress among students and educators, need to develop and promote better support programs for struggling students for their well being.

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