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Original Article

Variations in adrenal hormones in law enforcement servicemen during a mission to local armed conflict

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Abstract. In a previous study, we reported changes in the adrenocorticotropic hormone (ACTH) and cortisol secretion in blood samples from law enforcement personnel during the mission to local armed conflict region. In the present study, we demonstrate those changes collectively with additional data on changes in the adrenaline and noradrenaline in the urine samples of the same individuals. The study was conducted on 48 male officers who were deployed to an army conflict teritory for a duration of 4 months. At the onset of the mission, there was a modest increase in all hormones corresponding to the general adaptation syndrome theory. As the mission started, significant increases were observed in the mean levels of the hormonal parameters in both serum and urine at different time points as compared to those before the mission. At first week of deployment, a sharp increase in the secretory activity of medulla and cortical adrenal gland was found and at the termination of the mission a dysfunction of hypophysis-adrenal gland regulation system was identified. These findings might lead to disturbances in interhormonal relationships and cause decreased stress tolerance in the relevant individuals.

Keywords: Law enforcement officer, adrenaline, noradrenaline, adrenocorticotropic hormone, cortisol, emergency condition

Introduction

The principal responsibility of any government is to secure safety of its citizens. Accordingly, every type of life activity has to be protected from potential conflict hazards.

The world community has entered into a new era in the 21st century, creating intensification of different political, ideological, religion, or economical conflicts and crises. Some factors with much impact on social transformation includes technological progresses and global environment changes [1-3].

In order to maintain law enforcement in different territories and secure the safety of citizens, special police squads are needed. The professional task of law enforcement officers occurs in extreme conditions and often in emergency situations. The service duties are in the range of medium security with hardware assistance, special equipment and different weapons [4, 5]. In addition, besides professional detrimental factors affecting an armed personnel who has been trans-located from another region, other factors such as specific climatologic and geographical environments of a combat territory are pivotal [6, 7]. These factors based on their severity and duration may create considerable health problems ranging from functional disorders to pathological conditions with permanent impairments [8, 9]. In such individuals, various functional changes occur in order to provide adaptation to those conditions. In fact, the endocrine system plays a major role in forming a compensatory regulatory mechanism to counter extreme impacts. In such response, activation of sympathoadrenal system plays a pivotal role [10, 11].

In a previous study, we reported changes in the adrenocorticotropic hormone (ACTH) and cortisol secretion in blood samples from law enforcement officers during the mission to local armed conflict area [12]. Subsequently, the aim of the present study was a comprehensive assessment of changes in ACTH, cortisol, adrenaline, and noradrenaline, secretions in both blood and urine samples from the same group of servicemen during a mission to the local armed conflict territory.

Materials and Methods

We studied 48 male officers (mean age: 28.28±0.51) from the Ministry of Home Affairs who were law enforcement servicemen. All subjects had a mission to an army conflict territory (North Caucasus) for the purpose of maintaining law enforcement. The duration of their mission was 4 months. In all cases, we measured the blood serum ACTH by radioimmunoassay (Cis bio International, Cedex, France) and cortisol by enzyme immunoassey (Monobind Inc, California, USA). In addition, the levels of adrenaline and noradrenaline in urine samples of all cases were measured using gass chromatography method with mass spectrometer detector. Statistical analysis of the data was performed using the SPSS 15.0 software. The mean and

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standard deviation (SD) was calculated for each measurement. To assess the universal distribution, Shapiro-Wilk normality test was applied. Comparative analysis of means was performed by Wilcoxon rank test. A P value less than 0.05 was considered as significant.

Results

Overall the results of our study showed that in all cases, the levels of the hormones examined were in the normal physiological range before the mission. However, significant increases were found in the mean levels of the hormonal parameters at different time points during the mission as compared to those before the mission.

The mean serum ACTH level was increased more than two-fold in the individuals at 14 days after mission as compared to before mission (Table 1). At 1 month after mission, the ACTH level was increased four-fold ($p<0.001$). At 2 months after mission, we found a subsequent ACTH rise but it was less significant when compared with the measurement at 1 month ($p=0.005$). At the time of termination of the mission, the mean ACTH level was decreased but it still remained higher than the level before mission ($p<0.001$).

The serum cortisol level changed during the combat mission with a different pattern from ACTH dynamics (Table 1). Particularly, at 14 days after the mission, the mean cortisol level increased as compared with before mission ($p=0.002$). However, it was decreased at 1 month ($p=0.006$) and 2 months ($p<0.001$) as compared with 2 weeks after the mission. The mean cortisol level at 1 and 2 months showed no statistical difference as compared to before mission ($p>0.05$). At the end of the mission (after 4 month), the cortisol level increased to a maximum level. The level was similar to that of the two weeks measurement but better than before the mission and those at 1 and 2 months ($p=0.05$ and $p=0.003$ respectively).

The dynamics of urinary catecholamine levels in law enforcement servicemen during combat mission had analogous features with serum ACTH and cortisol changes but with less statistical significance (Table 2). Urinary excretion of adrenaline in 2 weeks combatants was increased twice as compared with before the mission ($p<0.001$). At 1 month, this parameter remained similar to that at 2 weeks ($p=0.65$). At 2 months, urinary adrenaline concentration reached the highest level as comared with 2 weeks and 1 month measurements ($p=0.002$ and $p=0.02$ respectively). When the combat mission was over, the mean adrenaline level decreased, but it was higher than that of before the mission ($p=0.04$).

The analyses of urinary noradrenaline excretion showed an increase at 2 weeks after the mission (Table 2). At 1 month after the mission, unlike adrenaline, the noradrenaline level increased as compared to that at 2 weeks ($p=0.05$) and continued at a similar level at 2 months. When the combat mission was over, noradrenaline concentration decreased, but it was higher than that of before the mission ($p=0.003$).

Discussion

Suprarenal hormones play a leading role in the formation of adaptation response to environmental factors in humans [13]. Abnormality of adrenal regulatory function occurs during excessive and long-term exposure to harmful environmental agents and results in a decline in human performance and physical and mental suffering (distress). The principal manifestations of these abnormalities are hormonal hypersecretion, target cell resistance, and failure of feedback regulation mechanism [14, 15].

Various investigations have shown that combatants with first time experience of deployment to a mission have allostasis laboratory markers of increased ACTH and cortisol levels after the mission. The level reaches to a maximum after 2 weeks. At the end of combat mission, these parameters decrease but remain higher than those at the beginning of the mission. This is indicative of a homeostasis imbalance retention [16]. A number of studies demonstrate that persistence of high levels of catecholamine, ACTH and cortisol in combatants for more than 6 months predetermine a triggering pathogenic mechanism of posttraumatic stress disorder [17-19]

In our study, the serum ACTH level at 2 months after the combat mission was constantly increased. At the time of termination of the mission (after 4 month), it decreased, but still exceeded twice when compared with that of before the mission. With regard to the serum cortisol changes, in spite of a sharp increase after the first two weeks, a decrease of this hormone was observrved, although ACTH

TABLE 1
SERUM ADRENOCORTICOTROPIC HORMONE (ACTH) AND CORTISOL CHANGES AT DIFFERENT DURATIONS OF MISSION

Duration	ACTH (pg/ml)	Cortisol (nmole/l)
Before mission[a]	20.07±3.20	404.81±124.54
2 weeks[b]	55.80±15.68	489.25±112.46
1 month[c]	86.43±17.56	426.80±102.54
2 months[d]	96.60±17.18	407.82±101.66
4 months[e]	55.37±10.70	471.16±117.78

Values are mean±SD. Statistical significances: ACTH (a vs. b,c, d,e, and b vs. c,d, and c vs. e and d vs. e, $p<0.001$; b vs. e, $p<0.81$; c vs. d, $p<0.005$. Cortisol (a vs b, $p<0.002$; a vs. c, $p<0.35$; a vs. d, $p<0.89$; a vs. e, $P<0.003$; b vs. c, $p<0.006$; b vs. d, $p<0.001$; b vs. e, $p<0.44$; c vs. d, $p<0.37$; c vs e, $p<0.05$; d vs e, $p<0.006$.

TABLE 2
URINARY ADRENALINE AND NORADRENALINE CHANGES AT DIFFERENT DURATIONS OF MISSION

Duration	Adrenaline (nmole/day)	Noradrenaline (nmole/day)
Before mission[a]	83.01±18.63	160.35±38.85
2 weeks[b]	117.12±55.68	229.30±102.34
1 month[c]	122.80±67.56	275.68±121.58
2 months[d]	161.55±77.18	268.32±111.67
4 months[e]	91.32±57.62	193.61±66.05

Values are mean±SD. Statistical significances: Adrenaline (a vs. b,c,d, and d vs. e, $p<0.001$; a vs. e and a,c vs. e, $p<0.04$; b vs. c, $p<0.65$; b,c vs. d, $p<0.002$; b vs. e, $p<0.03$). Noradrenaline (a vs. b,c,d, and c,d vs. e, $p<0.001$; a vs. e, $p<0.03$; b vs. c,e, $p<0.05$; b vs. d, $p<0.07$; c vs. d, $p<0.76$).

was increased. Therefore, hormonal disbalance could be the first sign of disturbances in hypophysis-adrenal gland regulation system. At the end of mission, a dramatic cortisol increase was found, comparable with the first 2 weeks. In fact, this may predestine a derangement of adaptation process.

Catecholamine (adrenalitermine or noradrenaline) generated in adrenal medulla produces a short-term adaptation process. It has a catabolic effect and involves in almost all metabolisms. Catecholamine secretion is increased in stress conditions and extreme situations. The target cells and action mechanisms for adrenaline and noradrenaline are different though of common physiological effect. Thus, adrenaline (anamed as “fear hormone”) improves individual’s weakness resistance in initial stress time at high speed. The noradrenaline (named as “fury hormone”) act after adrenaline. Its blood secretion corresponds with aggression and promote muscle strength. Noradrenaline is potent as adrenaline effect [20, 21].

In our study, we found that at first two weeks after the combat mission, the urinary adrenaline and noradrenaline levels were increased in the military servicemen. This observation could be atttibuted to the natural adaptation process to environmental changes. Furthermore, at two months, the adrenaline level was increased but when the mission was over it was decreased. However, the adrenaline level remained higher than that before the combat mission. This observation could be due to a retardation of adaptation process and probably first sign of distress. Concerning the noradrenaline changes, there was a significant increase and prolonged duration of this hormone. From the physiologic point of view, this appears to be a normal individual’s response required for elongation of survival probability in stress situation. Similar results have been obtained in other investigations. Taken together, in the military servicemen during the armed mission a specific feature of catecholamine dynamics was observed which was attributable to adaptation process but in some cases with signs of distress. These hormonal imbalances could remain up to 6 month or more [22].

In conclusion, in combatants particularly special police squads that have acquired professional skills in extreme conditions and during the mission to local armed conflict territory, the secretory function of adrenal gland undergoes changes corresponding to the principles of general adaptation syndrome theory. At first week after the mission to military zone, a sharp increase is seen in the secretory activity of medulla and cortex of adrenal gland. At the termination of combat mission, signs of dysfunction in hypophysis–adrenal gland regulation system appear that may lead to disturbances in interhormonal relationships and thus weakening of stress tolerance.

The disturbance of endocrine regulation requires establishment of special measures to reduce it. The ultimate aim of these precautions is to provide increased resistance and capability to deal with extreme conditions in emergency case and prevention of mortality risk. These measures should include a long-range and clear-cut planning of combat missions, early diagnostics including laboratory tests for armed personnels to be deployed to harmful locations, special training (physical, psychological, preventive, etc.) for armed personnels who are going to work in extreme conditions and emergency situatiuons, and special medical rehabilitation measures that provide rapid restoration of the individual’s health after the termination of combat mission. .

Conflict of Interest

The authors declare no conflicts of interest.

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