

POST TRAUMATIC STRESS DISORDER AND RELATED FACTORS FOLLOWING ORTHOPEDIC TRAUMAS

Mohammad Reza Fayyazi Bordbar, Ali Reza Hootkani, Ali Akbar Samari

ABSTRACT

Objective: The purpose of this study was to determine the prevalence of posttraumatic stress disorder among patients visited following an orthopedic traumatic injury and to identify changes in vital signs and demographic variables associated with the disorder.

Design: Descriptive study.

Place and duration of study: The study was done on one hundred patients admitted to outpatient orthopedic clinic in Imam Reza Hospital (Mashhad, IRAN). The study was carried out during spring and summer of 2006.

Subjects and Methods: Upon admission, demographic information, pain intensity according to patient's sense, pulse rate, blood pressure were assessed and General Health Questionnaire-28 was filled for the patients. Then symptoms of PTSD were evaluated on the beginning and after one and three months follow up based on DSM-IV criteria. The initial data from the patients developing PTSD after one and three months were compared with those without the disease.

Results: After one month, 5 patients (8.3%) and after three months 6 patients (12.8%) had complete PTSD criteria and 10 patients (16.7%) after one month and 6 patients (12.8%) after three months developed subsyndromal PTSD. Presence of high pulse rate ($P=0.000$), high intensity of the tolerated pain ($p=0.000$), more somatization symptoms ($p=0.041$) and more anxiety symptoms ($p=0.039$) predicted the development of PTSD after one month and presence of high pulse rate ($P=0.000$), high intensity of the tolerated pain ($P=0.000$), high maximum blood pressure ($P=0.047$), more somatization symptoms ($P=0.019$) and more anxiety symptoms ($P=0.024$) predicted the development of PTSD after three months.

Conclusion: High Blood Pressure, pulse rate and pain as well as more anxiety and somatization symptoms upon experience of trauma may increase rate of PTSD in sever orthopedic patients.

Key words: PTSD, Orthopedic Trauma, GHQ-28, Blood Pressure, Pulse Rate, Pain.

INTRODUCTION

Psychiatric disorders following accidents are very common¹⁻⁴. Such disorders are not restricted to severe calamities like earthquake and accidents. One of the most common disorders of this kind is post traumatic stress disorder (PTSD)⁵.

In PTSD the patients reexperience the event in various ways. This could take the form of disturbing repetitive thoughts, recurrent nightmares of the accident or flashbacks of the accident, all of which are bothering for the patient. The patient attempts to avoid any matter,

object or individual reminding the related event. Sometimes the patient feels detachment from the community and inability to adapt and experiences emotional numbing. More important, the patient experiences hyperarousal that may show off with signs such as excitability, insomnia and changes in sleep cycle. These symptoms must at least have duration of one month for the diagnosis of PTSD.

Although the prevalence of PTSD after orthopedic traumas in different studies has been reported high, there is diversity in various statistics from different areas⁶⁻¹³. In a study in Los Angeles 25 percent of the patients experienced PTSD¹⁰. In another study in Germany 12 percent of the patients experienced PTSD after six months. Also 11 percent of the patients experienced symptoms of PTSD although they did not show full disease criteria². In another study in the United States on 580 patients with orthopedic traumas, 51 percents fulfilled the criteria of PTSD⁹. Also in another four month follow up of the orthopedic patients, the prevalence of PTSD was reported to be 23 percent⁸.

Mohammad Reza Fayyazi Bordbar, M.D. Assistant Professor of Psychiatry, Mashhad University of Medical Sciences

Ali Reza Hootkani, M.D. Assistant Professor of Orthopedics, Mashhad University of Medical Sciences

Ali Akbar Samari, Psychologist, Azad University of Kashmar, Ibn-e-Sina Hospital, Hor-e-Ameli Blv; Mashhad, IRAN

Correspondence:

Dr. Mohammad Reza Fayyazi Bordbar

PTSD in orthopedic patients causes specific problems for them that may be more destructive than their orthopedic trauma. It can also affect their orthopedic treatment so that the patient has no courage and incentive to maintain healing and take part in the therapy.⁹ Several reviews have been reported about the factors related to PTSD in such patients^{6-9,11,12,14-16}. In the Los Angeles study the frequency of PTSD was reported to be higher in women, elderly patients, the unemployed and single patients and those with recent mental problems¹⁰. Also in a study in Germany on 56 accident victims there was a direct relationship between PTSD and trauma intensity and work related problems⁹. But in the London study there was no relationship between trauma intensity and frequency of PTSD⁸.

In view of the lack of data on this disorder in Iran, the authors decided to evaluate the incidence of PTSD in severe orthopedic patients in a three month period and find the association with the various likely factors involved.

SUBJECTS AND METHODS

In a descriptive study with ex-post-facto design, one hundred patients admitted to the outpatient trauma clinic in Imam Reza hospital in Mashhad who fulfilled the study criteria were involved. Inclusion criteria were:

1. Severe orthopedic trauma (e.g.: bone fracture, dislocation, or ligament rupture).
2. Age between 15 and 50 years.
3. No history of previous anxiety disorder.

4. No history of severe orthopedic trauma.
5. No decrease in level of consciousness after trauma.
6. Mental and personal ability and willingness to take part in the study.

Patients taking part in the study were first examined and were given orthopedic therapy and were asked to fill a demographic questionnaire. Their pulse rate and blood pressure were also recorded. The intensity of the pain was evaluated using a scoring system from 1 to 5 according to the patient's sense of pain.

The patients were then visited in the psychiatry clinic and a General Health questionnaire-28 (GHQ-28) was completed. Within the next month the patients underwent orthopedic therapy and then were evaluated psychiatrically and the GHQ-28 was filled for them. The presence of PTSD was checked for them using psychiatric interview based on DSM-IV-TR. Their pain intensity, blood pressure and pulse rate was again recorded.

Unfortunately forty patients withdrew from the study and only 60 patients were left. Two months later (three months post trauma) only 47 patients yielded to the study and were subject to psychiatric interview for PTSD diagnosis. In each psychiatric interview symptoms of re-experience, avoidance, and numbing and hyperarousal were evaluated individually.

Finally, demographic data, pain experience, primary blood pressure, primary heart rate and symptoms of depression, anxiety, somatization and dysfunction according to GHQ-28 were compared between PTSD patients and those without this disorder using t-test, ANOVA and x square tests (Fig. 1).

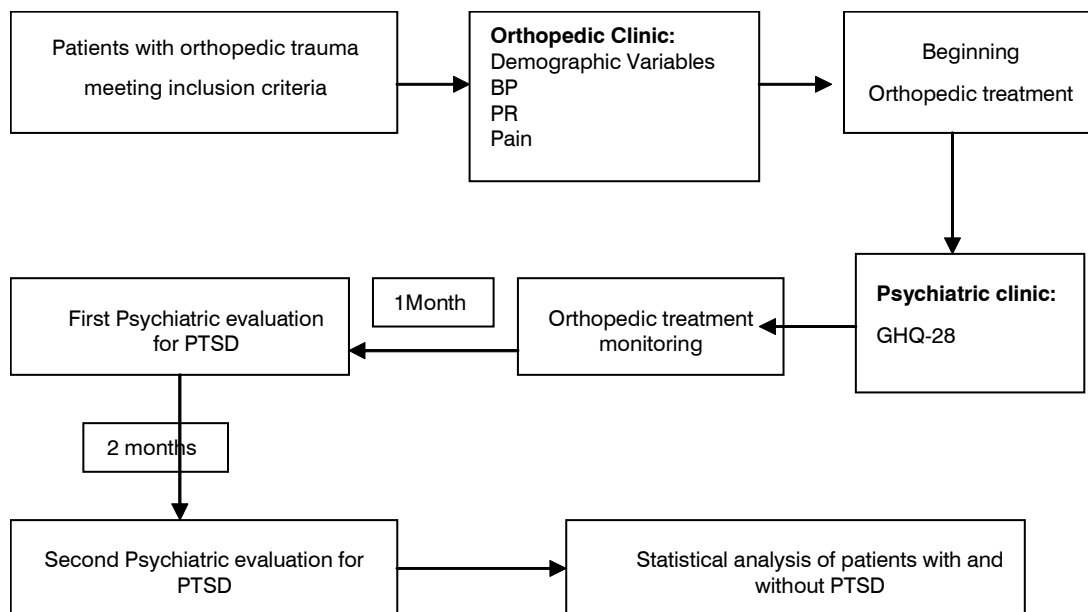


Fig. 1: Diagram of the study method

RESULTS

Out of sixty patients studied, 48 were men (80%), 38 were married (64.4%), 27 had junior high school diploma (45%), 41 were employed (69.5%) (Table 1). The average age of patients was 37.25 years with a standard deviation of 14.63 years.

In the beginning of survey, the mean of maximum blood pressure of the patients was 128.67 mmHg and the mean of minimum blood pressure was 84.16 mmHg. The pain experienced in a 1 to 5 scale was reported to be 3.166 for patients. The heart rate of the patients was on average 86.9 bits per second. Evaluation of the general health according to GHQ-28 in four dimensions showed that 13 patients (21.6%) meetinf the criteria for

somatization, 10 patients (16.6%) suffering from anxiety, 13 patients (21.6%) in dysfunction and 14 patients (23.3%) in depression had scores higher than the cut off point.

After one month post trauma, the mean of maximum blood pressure was 121.25 mmHg and the mean of minimum blood pressure was 79.67 mmHg. The pain experienced was scored 2.2 by the patients. The heart rate was 81.5 on average. The statistical analysis of the above changes according to the t-test showed significant changes in all parameters. Also the scores of GHQ test showed significant decline within one month in all dimensions except depression (Table 2).

Table 1
Demographic data of the patients with orthopedic trauma

Parameter		Number n=60	Percent %
Sex	Male	48	80
	Female	12	20
Marital status	Single	16	27.1
	Married	38	64.4
	Divorcee	5	8.5
Occupation	Employed	41	69.5
	Unemployed	8	13.6
	Housewife	10	16.9
	Illiterate	2	3.3
Education	Junior high school	27	45
	High school	25	41.7
	University degree	6	10

Table 2
Variations of blood pressure, heart rate, pain experienced and GHQ-28 scores one month after the traumatic experience

Parameter	Upon admission		1 month post trauma		t	P
	Average	Standard deviation	Average	Standard deviation		
Maximum blood pressure	128.67	8.43	121.25	7.74	5.91	0.000
Minimum blood pressure	84.17	7.20	79.67	7.47	3.68	0.001
Heart rate	86.90	11.34	81.48	8.42	2.30	0.000
Pain experienced	3.17	0.92	2.2	0.80	8.88	0.000
GHQ somatization score	5.63	3.84	4.03	2.90	3.79	0.000
GHQ anxiety score	5.03	3.49	3.90	3.13	2.77	0.007
GHQ dysfunction score	6.05	4.02	4.32	3.62	3.80	0.000
GHQ depression score	4.85	4.63	4.02	4.15	1.82	0.073

After one month, 5 patients (8.3%) out of 60 had complete PTSD criteria and their number increased to 6 (12.8%) out of 47 after three months (thirteen patients had withdrawn from the study group and their data was unavailable). Although 10 (16.7%) of the patients had some symptoms of PTSD after one month, and 6 patients (12.8%) after three months, but they did not meet all criteria (subsyndromal PTSD). Table 3 shows PTSD symptoms after one month and after three months in patients.

Patients having PTSD or subsyndromal PTSD after one month were compared with control group in demographic data, blood pressure, heart rate, level of pain experienced and general health according to GHQ-28 upon admission using ANOVA and X square tests. Based on this comparison the heart rate ($P=0.000$), level of pain experienced ($P=0.000$), somatization symptoms

($P=0.041$) and anxiety ($P=0.039$) according to GHQ-28 at the time of accident showed significant relation to emergence of PTSD symptoms one month later. The higher the value of these parameters was at the time of accident the higher the possibility of PTSD. Assessment of those experiencing PTSD symptoms three months post trauma showed that the maximum blood pressure ($P=0.047$), heart rate ($P=0.000$), pain experienced ($P=0.000$), somatization symptoms ($P=0.019$), and anxiety ($P=0.024$) according to GHQ-28 at the time of accident had a significant relationship with PTSD symptoms three months later ($P<0.05$). The higher was the value of these parameters, the higher the possibility of PTSD. Factors such as age, sex, education, occupation, minimum blood pressure, depression, and dysfunction based on GHQ-28 had no significant relationship with emergence of PTSD (Table 4). This comparison was made for the presence of individual PTSD symptoms and its rela-

Table 3

Prevalence of PTSD symptoms in patients with orthopedic trauma after one month and after three months

Symptoms of PTSD	One month		Three months	
	Number	Percent	Number	Percent
Without symptoms	45	75	35	58.13
Reexperience	10	16.7	9	15
Avoidance or Numbing	6	10	8	13.3
Hyperarousal	16	26.7	12	20
Subsyndromal PTSD	10	16.7	6	10
PTSD	5	8.3	6	10

Table 4

Comparison of demographic data, cardiac parameters, pain experienced and GHQ in patients experiencing PTSD after 1 and 3 months with control group

Variables	PTSD after three months			PTSD after one month		
	F	Chi-square	P	F	Chi-square	P
Age	0.351	—	0.705	1.723	—	0.190
Sex	—	4.917	0.86	—	0.876	0.645
Marital status	—	0.916	0.633	—	0.924	0.630
Occupation	—	2.056	0.358	—	0.277	0.870
Education	—	0.270	0.987	—	2.498	0.287
Maximum blood pressure	0.507	—	0.605	3.286	—	0.047
Minimum blood pressure	1.111	—	0.336	1.789	—	0.179
Heart rate	30.051	—	0.000	22.452	—	0.000
Pain	12.201	—	0.000	13.790	—	0.000
Somatization (GHQ)	3.379	—	0.041	4.361	—	0.019
Anxiety (GHQ)	3.446	—	0.039	4.055	—	0.024
Dysfunction (GHQ)	1.663	—	0.199	1.724	—	0.190
Depression (GHQ)	3.078	—	0.054	2.694	—	0.079

Table 5
Comparison of parameters according to presence or absence of reexperience and avoidance or hyperarousal, one and three months after trauma

Parameters	Significant level of relation between variables & PTSD symptoms					
	One month after trauma			Three months after trauma		
	Reexperience	Avoidant	Hyper-arousal	Reexperience	Avoidant	Hyper-arousal
Age	P=0.788	P=0.571	P=0.723	P=0.594	P=0.777	P=0.127
Sex	P>0.05	P>0.05	P=0.043	P>0.05	P>0.05	P>0.05
Marital status		P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Occupation	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Education	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Maximum blood pressure	P=0.636	P=0.170	P=0.640	P=0.424	P=0.187	P=0.932
Minimum blood pressure	P=0.650	P=0.374	P=0.462	P=0.260	P=0.370	P=0.078
Heart rate	P=0.000	P=0.004	P=0.000	P=0.000	P=0.000	P=0.000
Pain	P=0.000	P=0.001	P=0.000	P=0.000	P=0.000	P=0.000
Somatization (GHQ)		P=0.0891	P=0.022	P=0.007	P=0.129	P=0.005
Anxiety (GHQ)	P=0.030	P=0.341	P=0.004	P=0.131	P=0.188	P=0.008
Dysfunction (GHQ)	P=0.214	P=0.144	P=0.039	P=0.056	P=0.223	P=0.079
Depression (GHQ)	P=0.014	P=0.431	P=0.024	P=0.086	P=0.527	P=0.034

tionship with the mentioned criteria at the time of accident and the results are presented in Table 5.

DISCUSSION

In this study we attempted to evaluate the incidence of posttraumatic stress disorder following severe orthopedic traumas in a population of Iranian patients from the city of Mashhad. We also tried to determine the relationship between demographic data, some physiological symptoms like blood pressure, heart rate and pain intensity, and psychiatric symptoms such as anxiety and depression, somatization and dysfunction (according to GHQ-28) with PTSD incidence.

Our study showed that after one month, 8.3 percent of patients experienced full-criteria PTSD and 14.7 percent showed subsyndromal disorder. On the whole 25 percent of the patients experienced this disorder. General incidence of PTSD symptoms three months post-trauma did not show considerable change (25.5%) although the number of patients experiencing full PTSD criteria had increased within three months (12.7%). Our

study showed that there was no relationship between demographic data and PTSD. Some physiological symptoms such as patient's heart rate upon admission to the clinic (after one and three months) and maximum blood pressure at the time of admission (after three months) have a significant relationship with PTSD. Also the pain intensity experienced by the patient at the time of trauma can predict emergence of PTSD.

Based on the general health questionnaire, the intensity of anxiety and somatization symptoms following accident can also predict occurrence of PTSD symptoms especially reexperience and hyperarousal one and three months after the accident while depression and dysfunction can not predict PTSD.

Incidence of PTSD following orthopedic traumas has been measured in various studies. In a study in Kenya 13.3 percent of the patients experienced PTSD following traumas following car accidents according to DSM-IV criteria.¹⁷ While in a study in Turkey the incidence of this disorder following car clashes was estimated to be 30 percent. This study reported incidence of PTSD 17 per-

cent after six months¹⁸. Also in a study in Israel involving 74 car accident patients, 32 percent of them were reported to experience PTSD according to DSM-IV classification system after one year¹⁹.

Some Western countries have also reported the incidence of PTSD after orthopedic traumas in the same range. For example, a study in Germany examining 179 patients with trauma from car accidents after six months of follow up showed that 18.4% had PTSD according to interviews based on DSM-III-R²⁰. But in a study in Taiwan on 64 patients the high incidence of 82.8% based on Post-traumatic stress disorder reaction Index was reported after one and a half months²¹. Also in a study in the United States up to 51 percent of 580 patients with orthopedic traumas based on the civilian Mississippi Scale for posttraumatic stress disorder questionnaire experienced PTSD⁹.

The reasons for this big difference in the reports of PTSD are related to a number of factors. Maybe the most important reason is the way this disorder has been evaluated (e.g. using questionnaire or clinical interview). Also the time of survey and the country and its culture could be important.

One of the factors related to the presence of PTSD in orthopedic traumatic patients that can be used to predict this disorder is vital signs especially heart rate^{7,14-16,22}. In our study it was shown that the heart rate of patients upon admission has a significant relationship with PTSD symptoms after one and three months. Other studies have also been conducted in this regard. In one of the studies performed on 86 patients in Israel it was found that the heart rate upon admission (95.5 ± 13.9 against 83.3 ± 10.9 , $p < 0.001$, $t = 4.4$) and after one week (77.8 ± 11.9 against 72.0 ± 9.5 , $p < 0.03$, $t = 2.25$) can have a significant relationship with PTSD, although heart rate after one month and after four months in patients with PTSD had no difference with control group⁷. Two studies on children and adolescents have also shown the link between heart rate and potential PTSD incidence following orthopedic trauma. In one study 82 youngsters were evaluated whose primary heart rate had a significant relation with PTSD six weeks and two months later²². In another study 190 youth were examined in whom higher heart rate upon admission (109.6 against 99.7) could predict PTSD¹⁶.

It seems that severe physiologic response to trauma signals anxiety symptoms to be presented as PTSD in future. Our study especially showed that more intense pain experienced by the patient can increase the likelihood of PTSD. It appears that emotional problems cause more difficulties than physical problems⁹. Patients with PTSD face much more trouble than other patients. A study indicated that the duration of stay of patients with orthopedic trauma in hospital was longer for PTSD patients than other patients²⁰.

A number of studies have indicated that the presence of previous psychopathology or psychiatric symp-

toms such as anxiety and depression in patient early in the accident may increase the likelihood of PTSD^{19,21}. Our study only found a significant relation between anxiety and somatization symptoms with PTSD early in the trauma, while some studies have reported depression as a sign predicting PTSD symptoms. In our study the presence of depression after one month with $p = 0.054$ and after three months with $p = 0.079$ showed the relationship. It may be due to the number of samples, and future studies may prove this relationship as significant.

The relationship between demographic factors and PTSD incidence following orthopedic traumas has also been investigated. In a study it was indicated that most of PTSD patients (442.9%) were young¹⁷, while our study showed no significant relation between PTSD and age. Although in our study the relation of sex with PTSD could not be evaluated due to the low number of women, it has been shown in various studies that women have more susceptibility to PTSD following orthopedic traumas^{17,23}.

Due to small sample size and withdrawal of fifty percent of the subjects the results of this study can not be generalized to the whole society and those with orthopedic traumas. Our monitoring period was three months and this caused exclusion of those experiencing PTSD symptoms after this period of time (delayed PTSD). In our study only patients with severe orthopedic traumas were involved and we ignored the results of patients with milder traumas. Some studies have not mentioned any difference in PTSD incidence in patients with traumas of different intensities¹⁷ while the results can be generalized to those with milder traumas admitted to the hospital. We must note that some orthopedic patients are not referred to hospitals and are treated outpatient and there may be a difference between these two groups in PTSD incidence.²⁴ We propose a more comprehensive study with larger sample size involving a range of orthopedic patients and monitoring them for a longer period of time.

Acknowledgement: We must acknowledge the kind attention of the personnel of accident clinic and trauma ward of Imam Reza Hospital who collaborated in our research.

Research Fund: This research has done with financial support of the Vice Chancellor of Research of Mashhad University of Medical Sciences.

REFERENCES

1. Opalic P, Lesic A. Investigation of psychopathological state of patients depending on specific clinical characteristics of physical trauma. *Panminerva Med* 2002;44:11-7.
2. Nyberg E, Stieglitz RD, Frommberger U, Berger M. [Psychological disorders after severe occupational accidents]. *Versicherungsmedizin* 2003; 55:76-81.
3. Kuhn M, Ehlert U, Rumpf HJ, Backhaus J, Hohagen F, Broocks A. Onset and maintenance of psychiatric

- disorders after serious accidents. *Eur Arch Psychiatry Clin Neurosci* 2006;256:497-503.
4. Mason S, Turpin G, Woods D, Wardrope J, Rowlands A. Risk factors for psychological distress following injury. *Br J Clin Psychol* 2006;45 (Pt 2):217-30.
 5. Moore K, Thompson D. Posttraumatic stress disorder in the orthopedic patient (continuing education credit). *Orthop Nurs* 1989;8:11-9.
 6. Kupchik M, Strous RD, Erez R, Gonen N, Weizman A, Spivak B. Demographic and clinical characteristics of motor vehicle accident victims in the community general health outpatient clinic: a comparison of PTSD and non-PTSD subjects. *Depress Anxiety* 2006.
 7. Shalev AY, Sahar T, Freedman S, Peri T, Glick N, Brandes D, et al. A prospective study of heart rate response following trauma and the subsequent development of posttraumatic stress disorder. *Arch Gen Psychiatry* 1998;55: 553-9.
 8. Feinstein A, Dolan R. Predictors of post-traumatic stress disorder following physical trauma: an examination of the stressor criterion. *Psychol Med* 199; 21: 85-91.
 9. Starr AJ, Smith WR, Frawley WH, Borer DS, Morgan SJ, Reinert CM, et al. Symptoms of posttraumatic stress disorder after orthopaedic trauma. *J Bone Joint Surg Am* 2004; 86-A: 1115-21.
 10. Glynn SM, Asarnow JR, Asarnow R, Shetty V, Elliot-Brown K, Black E, et al. The development of acute post-traumatic stress disorder after orofacial injury: a prospective study in a large urban hospital. *J Oral Maxillofac Surg* 2003;61:785-92.
 11. Chen GH, Liu JH, Zheng JL. [Posttraumatic stress disorder (psychiatric injury) after road traffic accidents in forensic medicine: a primary study]. *Fa Yi Xue Za Zhi* 2006; 22:107-10.
 12. Hamanaka S, Asukai N, Kamijo Y, Hatta K, Kishimoto J, Miyaoka H. Acute stress disorder and posttraumatic stress disorder symptoms among patients severely injured in motor vehicle accidents in Japan. *Gen Hosp Psychiatry* 2006; 28:234-41.
 13. Schafer I, Barkmann C, Riedesser P, Schulte-Markwort M. Posttraumatic syndromes in children and adolescents after road traffic accidents—a prospective cohort study. *Psychopathology* 2006; 39:159-64.
 14. Kuhn E, Blanchard EB, Fuse T, Hickling EJ, Broderick J. Heart rate of motor vehicle accident survivors in the emergency department, peritraumatic psychological reactions, ASD, and PTSD severity: a 6-month prospective study. *J Trauma Stress* 2006;19:735-40.
 15. Rabe S, Dorfel D, Zollner T, Maercker A, Karl A. Cardiovascular correlates of motor vehicle accident related posttraumatic stress disorder and its successful treatment. *Appl Psychophysiol Biofeedback* 2006; 31: 315-30.
 16. Kassam-Adams N, Garcia-Espana JF, Fein JA, Winston FK. Heart rate and posttraumatic stress in injured children. *Arch Gen Psychiatry* 2005; 62: 335-40.
 17. Ongecha-Owuor FA, Kathuku DM, Othieno CJ, Ndetei DM. Post traumatic stress disorder among motor vehicle accident survivors attending the orthopaedic and trauma clinic at Kenyatta National Hospital, Nairobi. *East Afr Med J* 2004;8: 362-6.
 18. Ozaltin M, Kaptanoglu C, Aksaray G. [Acute stress disorder and posttraumatic stress disorder after motor vehicle accidents]. *Turk Psikiyatri Derg* 2004;15: 16-25.
 19. Koren D, Arnon I, Klein E. Acute stress response and posttraumatic stress disorder in traffic accident victims: a one-year prospective, follow-up study. *Am J Psychiatry* 1999;156: 367-73.
 20. Frommberger UH, Stieglitz RD, Nyberg E, Schlickewei W, Kuner E, Berger M. Prediction of posttraumatic stress disorder by immediate reactions to trauma: a prospective study in road traffic accident victims. *Eur Arch Psychiatry Clin Neurosci* 1998; 248: 316-21.
 21. Wang CH, Tsay SL, Bond AE. Post-traumatic stress disorder, depression, anxiety and quality of life in patients with traffic-related injuries. *J Adv Nurs* 2005; 52: 22-30.
 22. Nugent NR, Christopher NC, Delahanty DL. Emergency medical service and in-hospital vital signs as predictors of subsequent PTSD symptom severity in pediatric injury patients. *J Child Psychol Psychiatry* 2006; 47: 919-26.
 23. Fullerton CS, Ursano RJ, Epstein RS, Crowley B, Vance K, Kao TC, et al. Gender differences in post-traumatic stress disorder after motor vehicle accidents. *Am J Psychiatry* 2001; 158: 1486-91.
 24. Sanders MB, Starr AJ, Frawley WH, McNulty MJ, Niagaris TR. Posttraumatic stress symptoms in children recovering from minor orthopaedic injury and treatment. *J Orthop Trauma* 2005; 19: 623-8.