ORIGINAL ARTICLES

CAUSES OF CHEST PAIN IN SOLDIERS EVACUATED FROM HIGH ALTITUDE

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ABSTRACT

Objective: To find out causes of non-traumatic chest pain in soldiers evacuated from high altitude.

Study Design: A descriptive observational study.

Place and Duration of Study: The study was carried out at Combined Military Hospital Skardu, from April 2010 to Oct 2011.

Material and Methods: A total of 68 soldiers, evacuated from height, 8000 feet or more, with non-traumatic chest pain being the dominant complaint, were included in the study and evaluated thoroughly with examination, investigations including serial ECGs, cardiac enzymes, blood CP, x-ray chest PA view, at CMH Skardu. Patients with ECG abnormalities, positive ETT or enlarged cardiac size on x-ray, were transferred to AFIC Rawalpindi for echocardiography, coronary/angiography, electrophysiological studies and patients with radiological evidence of High Altitude Pulmonary Edema (HAPE) or Pulmonary Infarction were transferred to department of pulmonology, Military Hospital Rawalpindi for further investigations like Lung perfusion studies, pulmonary angiography, CT/MRI studies.

Results: Out of 68 soldiers, 20(29.41%) were diagnosed as having non-specific chest pain, 17(25%) acute mountain sickness and 10 (14.71%) pulmonary hypertension, right atrial or ventricular dilatation. Three (4.4%) had cardiac arrhythmias, 2(2.94%) had Ischemic heart disease and 1 (1.5%) had vavular heart disease. While 6(8.82%) were having respiratory tract infection, 5(7.35%) acid peptic disease, 2(2.94%) HAPE and 1(1.5%) had adjustment disorder and pulmonary infarction each. One (1.5%) patient had tight muscle bridge on the left anterior descending (LAD) artery.

Conclusion: Soldiers evacuated from high altitude with chest pain should be evaluated thoroughly to exclude disorders of cardiovascular and respiratory system as considerable ratios acquire significant disability while at high altitude.

Keywords: Causes, Chest pain, High Altitude.

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INTRODUCTION

Northern areas of Pakistan making border with India constitute the highest battle field in the history of mankind. Soldiers from both India and Pakistan actually reside at heights ranging up to 22000 feet throughout the year. At high altitude the composition of air remains same as at sea level but the barometric pressure falls, resulting in alveolar hypoxia and increased ventilation[1]. At high altitude cardiac output for a given work level is the same in acclimatized subjects as at sea level. Although the coronary blood flow is decreased but coronary arterial oxygen extraction is increased to maintain myocardial oxygen delivery[2]. Myocardial contractility is not impaired by severe hypoxia[3]. Due to alveolar hypoxia there is a decrease in systemic blood pressure while pulmonary arterial pressure is increased[4-6]. Hypobaric hypoxia causes vasoconstriction of pulmonary artery[7]. Polycythemia strenuous physical work and vaso-constrictive effects of cold further aggravate pulmonary hypertension leading to right atrial and right ventricular hypertrophy[8,9]. Prolonged stay at high altitude induces thickening of the pulmonary arteriolar walls[10].

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Living at very high altitudes (more than 17500 feet) at low PaO_2 brings changes in blood, cardiovascular system, respiratory system and emotional state, depending on multiple factors including age and ethnic origin of the individuals, duration of stay, altitude and associated illnesses. If individuals do not descend, most of the times it will make the body more vulnerable to develop thrombo-embolic phenomena, pulmonary hypertension, right heart failure, dilated cardiomyopathy, cardiac arrhythmias, polycythemia, progressive weight loss, psychological disturbances and anasarca. Evacuation from high altitude with chest pain is very common and this study was carried out to find frequency of various final diagnoses.

MATERIAL AND METHODS

This descriptive observational study was carried out at Combined Military Hospital Skardu, from April 2010 to Oct 2011. The study population, being serving soldiers, consisted of male only and was very heterogeneous as they belonged to all parts of the country.

Ethical Considerations

An informed consent was obtained from all the patients included in the study. All soldiers evacuated from altitude 8000 feet or more with major complaint of typical or atypical chest pain, alone or associated with other symptoms like shortness of breath, palpitation, headache, edema, pain epigastrium, nausea, vomiting, and dry or productive cough were included in the study. Soldiers with post trauma chest pain or major presenting complaints other than chest pain were excluded from the study.

On arrival at northern areas all the troops were physically evaluated. All these soldiers were physically healthy and their base line investigations including blood complete picture, Urine RE and ECG were normal. After acclimatization according to a set protocol they climbed to their respective posts at high altitude. They were evacuated from the posts to the field hospitals once they developed chest pain. At field hospitals (altitude between 2800-3000 meters) they were physically examined and investigated (CBC, urine RE, cardiac

Table-1: Description of x-ray chest, echocardiography and coronary angiography.

Investigation	Findings	No.	%
X-ray chest PA	Total	68	100%
	Normal	58	85.29%
	Cardio-magaly	5	7.35%
	Pulmonary Edema	2	2.94%
	Pneumonic Consolidation	2	2.94%
	Pulmonary Infarction	One	1.47%
Echocardiogram	Total	42	61.76%
	Normal	30	44.11%
	Pulmonary Hypertension or Rt Atrial or Ventricular Hypertrophy	10	14.70%
	Post MI moderate LV dysfunction	One	1.47%
	Anterior Mitral Leaflet Prolapsed with AR.	One	1.47%
Coronary Coronary Angiography	Total	25	36.76%
	Normal	21	30.88%
	Coronary Artery Disease	2	2.94%
	Aberrant origin of left coronary artery	One	1.47%
	Tight muscle bridge on the LAD and a systolic squeeze of 40%.	One	1.47%

enzymes, ECG and chest x-ray PA view) by the medical officer/medical specialist. After the initial management these patients were then evacuated to the base hospital at Skardu where a consultant physician evaluated them and additional tests (renal functions, blood sugar, lipid profile and plasma D-Dimer assays) were also done. Chest pain was diagnosed as "typical angina" if patient had all 3-criteria i.e., (1) the presence of sub-sternal chest pain (2) discomfort was provoked by exertion or emotional stress and (3) was relieved by rest and/or nitroglycerin. Chest pain was classified as atypical if 2 of the above criteria were present and non cardiac if it had ≤1 of the typical angina characteristics.

Patients with typical chest pain or persistent abnormalities in ECG or increased heart size in x-ray chest PA were transferred to Armed Forces Institute of Cardiology (AFIC) Rawalpindi for further evaluation by echocardiography, exercise tolerance test, coronary angiography and electrophysiological studies. All patients with pulmonary opacities on x-ray chest were transferred to Pulmonology Department of Military Hospital Rawalpindi for evaluation by lung CT or perfusion scan. Patients with retero-sternal burning or pain epigastrium aggravating on empty stomach or after meals with normal serial ECGs and x-ray chest were given trial of H_2 receptor blocker. If not relieved were evaluated by upper GI endoscopy. One patient required treatment by psychiatrist because of his non resolving symptoms in spite of symptomatic treatment with normal physical examination and investigations. All the observations including clinical features, investigation results and final outcome were recorded on already designed form.

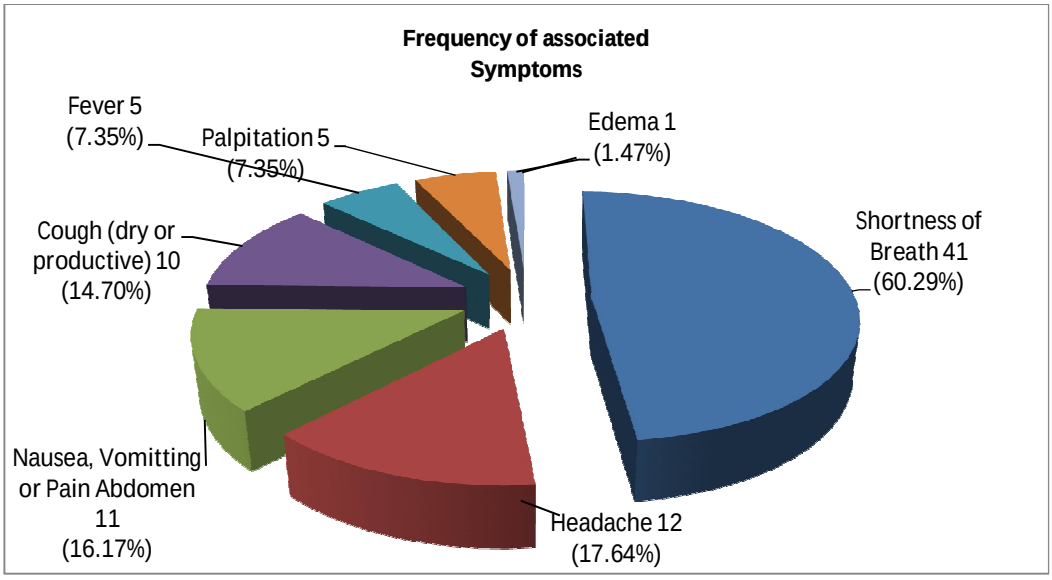

Figure-1: Frequency of associated symptoms.

Statistical Analysis

The data was compiled and analyzed by using SPSS software, version 20 and Microsoft Excel 2007.

RESULTS

Mean age of the patients was 29.81 (SD ± 7.18) years with a range of 20-50 years. The mean height at which the soldiers stayed was 13593.24 feet (SD ± 4260.931), with range from 8000 feet to 21000 feet. The mean stay of these soldiers at high altitude was 54.37 days (SD ± 57.011), range 4 to 210 days.

Out of 68 patients, 25 (36.76%) patients presented with typical chest pain while 43 (63.24%) patients presented with other than

typical chest pain. Detailed frequencies of other symptoms associated with chest pain are shown in fig-1.

The mean hemoglobin after evacuation from high altitude was 16.43 g/dl (SD ± 1.868), range being 11.60 to 23.10 g/dl. Cardiac enzymes and plasma D-Dimers were raised in 1 patient each. TLC was raised in 4 patients. ESR, peripheral blood film including platelets, fasting and random blood sugar, serum urea, creatinine, electrolytes and lipid profile were all within normal range.

A total of 28 (41.18%) out of 68 patients, had significant ECG changes. These changes were, (1) T-wave inversion in anterior or inferior leads or changes of right ventricular hypertrophy in 20(29.41%) patients, (2) a form of arrhythmia in 3 (4.41%) patients-atrial fibrillation with T inversion in inferior leads in 1, paroxysmal supra-ventricular tachycardia and right bundle branch block (RBBB) in 2nd and 1st degree atria ventricular (A-V) block with occasional premature atrial contractions in 3rd, (3) changes suggestive of acute anterior myocardial infarction in 2 (2.94%) patients, (4) 1 patient had $S_1Q_3T_3$ pattern in ECG.

Chest x-ray was done in all 68 patients. 9 (13.23%) patients had abnormal chest x-ray. details as shown in table-1.

ETT was done in 38 (55.88%) patients. It was normal in 21 (30.88% of total 68) and positive or inconclusive in 17 (25% of total 68) patients.

Echocardiogram was performed on 42(61.76%) and coronary angiogram was done in 25 (36.76%) patients. Details are shown in table-1.

Out of 68 soldiers, 20 (29.41%) were diagnosed as having non-specific/atypical chest pain and 17 (25%) had acute mountain sickness (AMS). Sixteen (23.53%) were found to have significant cardiac disease - and 9(13.23%) had disorders of respiratory system. Details of final diagnosis have been shown in fig-2.

DISCUSSION

High-altitude illnesses have profound consequences on the health of many unsuspecting and otherwise healthy individuals who sojourn to high altitude for recreation and work. The most common of these illnesses, which can present as low as 2,000 m, is AMS which is usually self-limited but can progress to the more severe and potentially fatal entities of high-altitude cerebral edema and high-altitude pulmonary edema[11]. Climbing up the mountains and daily activities at high altitude, where there is low partial pressure of O_2 in atmosphere, requires extreme exercise of muscles of respiration specially and other body muscles generally. This obviously causes fatigue and cramps of these muscles leading to myalgias and presentation as chest pain. The same was reflected in this study as non specific atypical chest pain most likely musculoskeletal is the most common outcome that is 29.4%.

The AMS is the most common presentation of high altitude sickness[11]. AMS affects 15 to 30% of Colorado resort skiers, 50% of climbers on Mount McKinley, 70% of climbers on Mount Rainier, and 25 to 50% of climbers who trek to the base of Mount Everest[12]. AMS in 17(25%) cases is the 2nd most frequent outcome in our study. Slightly lower ratio of AMS than non specific chest pain, in the present study, is the result of the sample characteristics.

Prolonged stay at high altitude leads to pulmonary hypertension and right ventricular hypertrophy, secondary polycythemia, finger clubbing, cyanosis and signs of right heart failure diagnosed as sub acute mountain sickness or chronic mountain sickness depending upon duration of stay and extent of changes[13]. Most commonly encountered ECG changes at high altitude include right-axis deviation and an R/S ratio equal to or greater than 1 in V1, with an R wave 0.5 mV or greater, right bundle branch conduction disturbances, increased T negativity in V1 and V2 and

increase in P wave amplitude in inferior leads[14,] Anand et al. reported T-wave inversions in leads V1-V6 in 21 patients due to pulmonary hypertension[16]. On the basis of these studies we consider that most of the ECG changes in our patients are due to pulmonary hypertension and right atrial or ventricular hypertrophy as also confirmed on echocardiography. This pulmonary hypertension and right atrial and ventricular hypertrophy comprises 3rd largest outcome in our study making 14.7% of the total.

Common problems of upper and lower respiratory tract infection and dyspepsia relieved by H_2 receptor blockers are also significant at higher altitude and were cause of chest pain in approximately 15% of patients. People at high altitude, especially those with AMS, show an increased incidence of infectious symptoms, such as coryza, cough, sore throat and diarrhea. But it is difficult to know if such symptoms represent a real increase in infection or just overlapping symptoms of high-altitude illness[17].

Another important outcome was diagnosis of cardiac arrhythmias and ischemic heart disease in 7.3% of cases. Arrhythmias may be a result of right atrial or ventricular hypertrophy and may become a cause of sudden death at high altitude.

HAPE is a serious and potentially life-threatening manifestation of altitude illness. Up to 15 % of travelers to altitudes over 2,500 m (8,202 ft) will develop HAPE, depending on the traveler's age and sex, and the rate of ascent[18]. It is more common in persons under 20 years of age[19]. The Lake Louise symposium proposed diagnostic criteria for HAPE. In the setting of a recent gain in altitude, at least two of the following symptoms must be present: dyspnea at rest, cough, weakness or decreased exercise performance, chest tightness or congestion. In addition, at least two of the following signs must be present: rales or wheezing in at least one lung field (usually the right middle lobe), central cyanosis, tachycardia or tachypnea[19,20]. A total of 2.9% of our patients who presented with chest pain were found to have HAPE.

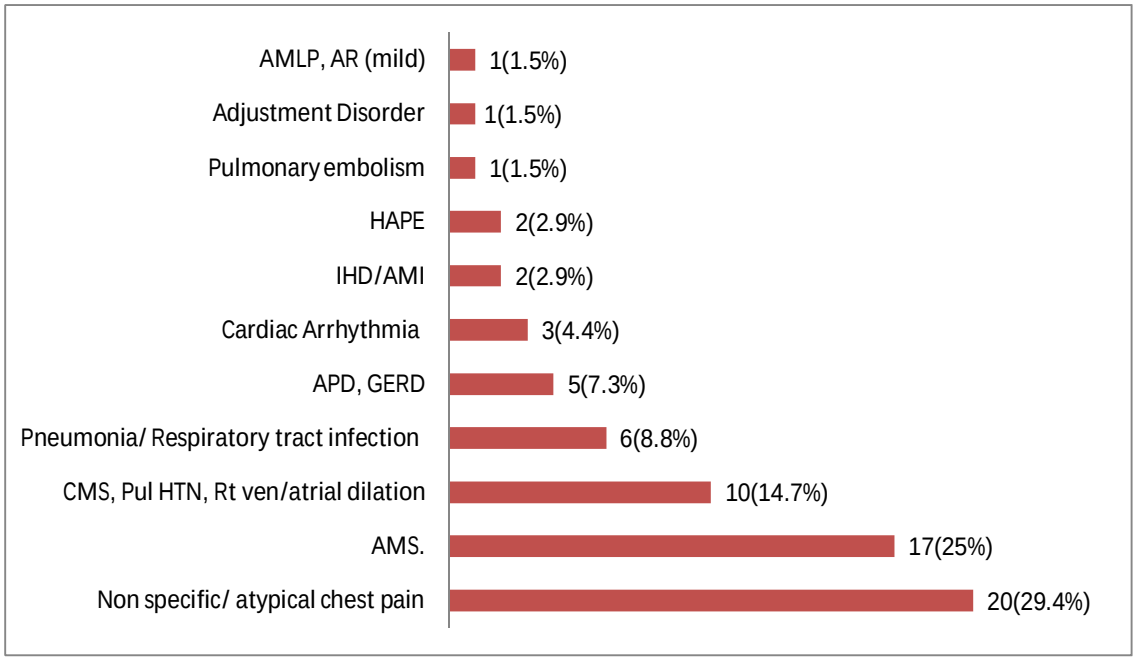

Figure- 2: Frequency of final diagnosis in patients evacuated from high altitude with chest pain.

Thrombotic events such as a pulmonary embolus, stroke and venous thrombosis are a greater danger at high altitudes than at sea level, probably because of the combination of dehydration, polycythemia, cold weather, constrictive clothing and prolonged periods of inactivity. At least one of our patients proved to be a case of pulmonary infarction. Doppler study of his leg veins showed thrombus in right femoral and popliteal veins which was the source of embolus.

One of our patients was diagnosed by a psychiatrist as having adjustment disorder. At 10000 to 14000 feet, many soldiers only experience feelings of diminished vigor, weariness, and increased sleepiness. However, clear psychiatric morbidity reflected as hostile behavior changes, thoughts of paranoia, depression, anxiety and obsessive-compulsiveness are more commonly observed at heights above 15000 feet[21]. High Altitude Medical Research Cell (HALMARC) studied psychiatric sequelae on high altitude exposure in soldiers deputed in Siachen area and observed that psycho-neurological changes were detected in "non-acclimatized" lowlanders after 96 hours ascent from 7600 feet to 14200 feet but cleared completely within 48 hours[22]. Similar high percentage of anxiety, depression and obsessive-compulsive disorder (OCD) amongst deployed soldiers has been reported in several other studies[23].

CONCLUSION

Soldiers evacuated from high altitude with chest pain very frequently have under lying significant medical disorder pertaining to cardio-vascular, respiratory and other body systems. Deployments after proper acclimatization according to protocols, education of the troops about high altitude illness and its prevention, can decrease the cases of acute high altitude illness. More over speedy evacuation to lower altitude at presentation along with early detailed evaluation and management at base hospital can decrease the morbidity and mortality in our troops due to high altitude illnesses.

CONFLICT OF INTEREST

The authors of this study reported no conflict of interest.

REFERENCES

1. West JB. The 1988 Stevenson Memorial lecture. Physiological responses to severe hypoxia in man. Can J Physiol Pharmacol 1989; 67: 3: 173-8.
2. Kaijser L, Grubbstrom J, Berglund B. Coronary circulation in acute hypoxia. Clin Physiol 1990; 10: 3: 259-63.
3. West JB. Limiting factors for exercise at extreme altitudes. Clin Physiol 1990; 10: 3: 265-72.
4. Oelz O, Maggiorini M, Ritter M, Waber U, Jenni R, Vock P, et al. Nifedipine for high altitude pulmonary oedema. Lancet 1989; 2:1241-4.
5. Grissom CK, Elstad MR. The pathophysiology of high altitude pulmonary edema. Wilderness Environ Med 1999; 10: 88-92.
6. Glaus TM, Tomsa K, Hassig M, Reusch C. Echocardiographic changes induced by moderate to marked hypobaric hypoxia in dogs. Vet Radiol Ultrasound 2004; 45: 3: 233-7.
7. Moudgil R, Michelakis ED, Archer SL. Hypoxic pulmonary vasoconstriction. J Appl Physiol 2005; 1: 390-403.
8. Barer GR, Bee D, Wach RA. Contribution of polycythemia to pulmonary hypotension in simulated high altitude rats. j physipol 1983; 336: 27-38.
9. Will DH, Reeves JT, Grover RF. Cold induced pulmonary hypertension in cattle. J Appl Physiol 1978; 45: 469-73.
10. Reeves JT, Robert F. Grover. Insights by Peruvian scientists into the pathogenesis of human chronic hypoxic pulmonary hypertension. J of Appl Physio 2005; 98: 384-9.
11. Schoene AU, RB SO. Illnesses at high altitude. Chest 2008;134: 2: 402
12. Bezruchka S. High altitude medicine. Med Clin North Am. 1992; 76: 1481–97
13. Jacqueline A N, Brent R W M. Altitude related illness. CMDT 2010; 36: 1417-1419.
14. Malconian M, Rock P, Hultgren H, Donner H, Cymerman A, Groves B et al. The electrocardiogram at rest and exercise during a simulated ascent of Mt. Everest (Operation Everest II). Am J cardiol 1990; 65: 22: 1475-80.
15. Karliner JS, Sarnquist FF, Graber DJ, Peters RM Jr, West JB. The electrocardiogram at extreme altitude: experience on Mt. Everest. Am Heart j 1985; 109: 505-13.
16. I.S Anand, R.M. Malhotra, Y. Chandrashekhar, H.K. Bali, S.S. Chauhan, S.K.Jindal, R.K.et al Adult subacute mountain sickness- a syndrome of congestive heart failure in man at very high altitude. Lancet 1990; 335: 561-5.
17. Murdoch DR. Symptoms of infection and altitude illness among hikers in the Mount Everest region of Nepal. Aviat Space Environ Med. 1995; 66: 148–51.
18. Staton GW Jr, Ingram RH Jr. Pulmonary edema. In: Rubenstein E, ed. Scientific American medicine. New York: Scientific American, 1993:14.
19. Hultgren HN. High-altitude pulmonary edema: current concepts. Annu Rev Med. 1996; 47: 267–84.
20. Dietz T. The Lake Louise consensus on the definition of altitude illness. Himalayan Rescue Association, Nepal. http://www.gorge.net/hra/us/AMS-LakeLouise.html (Accessed November 11, 1997).
21. Hallagan LF, Pigman EC. Acclimatization to intermediate altitudes. In: Encyclopedia of Sports Medicine and Science [Encyclopedia online]. [s.l]: Will Hopkins; 1998 [Cited 2006 Jul 22]. http://www.sportsci.org/encyc/altitaccl/altitaccl.html.
22. Ahmad M. Aslam M. Psychiatric problems at high altitude. Pak Armed Forces Med J 1994; 44(2): 57-60.
23. Brugger P, Regard M, Landis T, Oelz O. Hallucinatory experiences in extreme-altitude climbers. Neuropsychiatry Neuropsychol Behav Neurol; 1999; 12(1): 67-71.