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Case Report

Postural dysautonomia in response to head-up tilt in a military pilot aspirant: Aeromedical considerations

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ABSTRACT

Intolerance to orthostasis encompasses a group of responses on assumption of upright posture. One such response is postural dysautonomia. One of the types of postural dysautonomia is postural orthostatic tachycardia syndrome, which is characterised by an increase in heart rate of more than 30 bpm without hypotension along with other features of dysautonomia on attaining an erect posture, either actively or passively. This paper brings out a case of postural dysautonomia in a pilot aspirant in response to Head-up tilt (HUT) test. A 23-year-old female military pilot aspirant reported for evaluation of Syncope and Air Sickness. She gave a history of solitary episode of loss of consciousness on ground while preparing for an early morning sortie. She was diagnosed with a case of neurocardiogenic syncope and was put back to flying training. Subsequently, after about 2 months, she developed features of air sickness while flying and also could not tolerate preliminary motion sickness desensitisation at her unit. A thorough medical evaluation failed to reveal any neurocardiological abnormality. Before commencing the air sickness desensitisation protocol at the Institute of Aerospace Medicine, she was subjected to HUT during which she developed signs and symptoms suggestive of postural dysautonomia. A test retest assessment with repeat HUT and passive standing test revealed similar responses.

Keywords: Dysautonomia, Postural orthostatic tachycardia syndrome, Head-up tilt, Orthostatic stress, Pilot aspirant

INTRODUCTION

Dysautonomia is a broad terminology used to describe a number of physiological disturbances of the autonomic nervous system (ANS). Under non-stressful conditions, the two components of ANS - Sympathetic and Parasympathetic nervous systems are in balance. In the event of stress, the sympathetic response predominates and this leads to physical signs and symptoms. One of the stressful situations that the human body faces in day to day life is orthostasis. On assumption of upright posture, there is immediate shift of blood of 300–800 mL from upper body to lower body.[1] This pooling of blood is sensed as a decrease in blood volume and blood pressure at the cephalic end and it initiates an autonomic response mediated by cardiopulmonary (senses low blood volume), carotid and aortic (sense low blood pressure) baroreceptors. This triggers a compensatory mechanism by which the parasympathetic tone decreases and there is a surge of sympathetic discharge, thereby restoring blood circulation at the head level.[2] This response is considered physiological to the postural change and is evident by an immediate increase in heart rate (HR), slight reduction of systolic blood pressure (SBP) and slight increase or maintenance of diastolic blood pressure.[3] However, some susceptible individuals show abnormal responses to orthostasis. The abnormal responses to orthostatic challenge can vary from development of

persistent tachycardia, anxiety, and hypotension and can ultimately progress to pre-syncope or frank syncope.

This paper highlights a case of postural dysautonomia that was detected during evaluation of a female flying aspirant at the Institute of Aerospace Medicine (IAM), India.

CASE REPORT

A 23-year-old female military pilot aspirant reported to IAM for evaluation of Air Sickness and Syncope. She was undergoing her flying training at the Air Force Academy, Indian Air Force. One day, during her pre-flight preparation for an early morning sortie, the cadet was putting on her shoes and sitting on a chair. On getting up, she felt giddy and lost consciousness. It was a solitary episode of loss of consciousness without signs of convulsion. She was evaluated at her local unit hospital and was diagnosed as a case of neurocardiogenic syncope. Since confirmed diagnosis of neurocardiogenic syncope with a known precipitating event was established, she was not restricted from flying duties as per standard regulatory guidelines and she continued with her flying training.

Two months later, in a span of 4 days, she reported with nausea and vomiting on three occasions during her flying training. On all three occasions, the symptoms of nausea and vomiting appeared after she was subjected to aerobatic manoeuvres during her training sorties. She reported that she never developed any symptoms of motion sickness while traveling in vehicles on road or as a passenger in civil airlines. Before that she had undertaken about 20 h of flying on the same jet trainer aircraft (Pilatus PC7) flying routine flight handling sorties (with exposures up to 2.5 Gz) without any symptoms. She was referred to the local aeromedical training centre where she underwent Air Sickness desensitisation therapy. However, she was unable to complete the protocol due to persistent vomiting. Thereafter, she was referred to IAM for further evaluation and aeromedical disposal.

At IAM, the pilot aspirant was extensively evaluated for any cardiovascular or neurological abnormality. All routine investigations including electrocardiographic and electroencephalographic studies, magnetic resonance imaging (Brain), treadmill test and 24-h Holter study were within normal limits. Head-up tilt (HUT) test was carried out in view of her previous episode of syncope.

Immediately on exposure to 70° HUT, she developed tachycardia which persistently remained high even till 20 min of exposure. She also developed symptoms of tingling, numbness, shortness of breath, warmth and pain in the neck. The test was terminated at that point. The results of HUT were consistent with symptoms of postural dysautonomia as per the American College of Cardiology/American Heart Association/Heart Rhythm Society guidelines.[4] She was evaluated by Aviation Psychologist and was found to have high performance anxiety. Due to her exhibiting normal clinical condition on ground, she was deemed fit on ground by cardiologist and neurologist.

Before commencing her motion sickness desensitisation at IAM, the individual was fluid loaded with increased salt and water intake and a test retest assessment was carried out with repeat HUT and passive standing test. The results of both the tests were similar to the HUT response earlier in that she presented with persistent tachycardia without hypotension accompanied by xerostomia and pre-syncopal symptoms. Both the HUT responses are presented in [Table 1].

Protocol for HUT

The New Castle Protocol for HUT testing was used for evaluation of this patient.[5] There was continuous recording of Non-invasive Blood Pressure (NIBP), heart rate (HR), 12 leads electrocardiogram (ECG) and oxygen saturation during the entire duration of testing. The following were taken as end points of the test:

1. At the end of 45 min of tilt at 70°
2. In case of abnormal ECG rhythm, even if the subject is asymptomatic
3. In case SBP falls below 60 mm Hg
4. Severe pre-syncopal symptoms.

DISCUSSION

One way of evaluating the cardiovascular reflexes on orthostatic stress is by tilt table testing.[3] Postural orthostatic tachycardia syndrome (POTS) is characterised by persistent tachycardia of ≥30 beats/min (or absolute HR ≥120 beats/min) on assumption of upright posture from supine position (≥40 beats/min for those between 12 and 19 years age) with subjective symptoms of dysautonomias such as diaphoresis, tremulousness, palpitation, fatigue and xerostomia in absence of orthostatic hypotension [Table 2]. These signs and symptoms have to be persistent for at least 6 months if a person were to be labelled as a case of POTS.[6] However, some guidelines do not mention the time duration of symptoms for diagnosis of POTS. The symptoms are provoked by orthostatic challenge and relieved by lying down. The symptoms of POTS can be absent on active standing due to 'skeletal muscle pump' brought about by the contraction of lower limb muscles when a person stands, thereby increasing the venous return and arterial blood pressure. During passive standing such as in HUT, however, the skeletal muscle pump does not function and blood tends to pool in lower limbs, thus activating the reflex baroreceptor mechanism of cardiovascular system.[7] This case report talks about a case in which the symptoms of dysautonomia were established during evaluation in HUT.

Table 1: Responses to 70° HUT.

	TIME (min)	HUT 1			HUT 2		
		SBP (mm Hg)	DBP (mm Hg)	HR (/min)	SBP (mm Hg)	DBP (mm Hg)	HR (/min)
Horizontal	0	105	68	81	111	66	94
	2	105	68	80	104	61	79
	4	106	65	88	101	63	77
	6	107	68	82	108	68	82
	8	107	68	84	106	62	72
	10	106	64	87	109	63	75
	Mean	**106**	**66.83**	**83.67**	**106.5**	**63.83**	**79.83**
70° HUT	0	106	64	107	119	72	111
	2	119	75	113	117	73	103
	4	113	80	120	114	73	112
	6	109	72	118	112	70	115
	8	113	74	126	110	72	115
	10	118	76	111	110	71	123
	Mean	**113**	**73.5**	**115.83**	**113.67**	**71.83**	**113.17**
	12	132	78	129	115	77	126
	14	119	69	120	116	74	128
	16	123	68	136	119	74	120
	18	132	87	137	115	74	114
	20	115	62	140	117	79	123
	Mean	**124.2**	**72.8**	**132.4**	**116.33**	**75.33**	**122.33**
	22**	118	60	140	116	74	123
	24	107	68	106			
	26	92	62	138			
	28*	85	64	131			
Horizontal	0	99	61	89	111	68	95
	2	114	60	85	110	66	90
	4	107	57	80	110	65	83
	6	106	61	84	108	66	81
	8	106	66	78	113	71	83
	10	107	66	80	109	70	88
	Mean	**106.5**	**61.83**	**82.67**	**110.17**	**67.67**	**86.67**

*1st HUT Run terminated at 28th min of HUT as the individual developed signs and symptoms of pre-syncope. **2nd HUT Run terminated at 22nd min of HUT as the individual developed symptoms of dysautonomia (dryness of mouth, tingling and numbness in extremities, warmth, neck pain and shortness of breath). SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, HUT: Head-up tilt

Clinical significance

POTS is considered to be a variant of neurocardiogenic syncope caused due to dysautonomia. In patients with documented POTS, the symptoms usually are relieved with fludrocortisone, beta-blockers, or combinations.[8] The clinical significance of POTS lies in its close overlap with neurally mediated syncope. The symptoms are elicited by brain hypoperfusion and sympathetic excitation.[8] Although the instant case had an element of anxiety which could also elicit similar response, patients with POTS frequently do have increased anxiety and somatic hypervigilance. Excessive heart rate during orthostasis is not secondary to anxiety but is considered to be a physiological response to maintain arterial pressure during venous pooling. Exercise training and improving physical conditioning are strategies often utilised for these patients.

This case encompasses three different conditions which produce overlapping and interrelated clinical manifestations – syncope, air sickness and postural dysautonomia. The aeromedical concerns pertaining to each condition in this case are discussed:

Syncope

The aircrew aspirant had no history of symptoms of orthostatic intolerance during ground training. The single episode of syncope was associated with her standing up after tying shoelaces. The impeded venous return due to raised intra-abdominal pressure and the baroreceptor loading due to head down position (while tying the shoe laces) support the diagnosis of neurocardiogenic syncope due to a known precipitating cause. As per the extant aeromedical guidelines, neurocardiogenic syncope with a known precipitating cause

Table 2: Diagnostic criteria for postural orthostatic tachycardia syndrome.

Guidelines	Diagnostic criteria
2017 ACC/AHA/HRS Guidelines[4]	A clinical syndrome is usually characterised by all of the following: 1) Frequent symptoms that occur with standing (e.g., light headedness, palpitations, tremulousness, generalised weakness, blurred vision, exercise intolerance and fatigue); and 2) An increase in heart rate of ≥30 bpm during a positional change from supine to standing (or ≥40 bpm in those 12–19 y of age); and 3) The absence of OH (>20 mm Hg reduction in systolic blood pressure). Symptoms associated with POTS include those that occur with standing (e.g., light headedness, palpitations); those not associated with particular postures (e.g., bloating, nausea, diarrhoea, abdominal pain); and those that are systemic (e.g., fatigue, sleep disturbance, migraine headaches). The standing heart rate is often >120 bpm.
Grubb *et al*.[9]	POTS is defined as ongoing symptoms of orthostatic intolerance (>6 months duration) accompanied by a heart rate increase of at least 30 beats/min (or a rate that exceeds 120 beats/min) observed during the first 10 min of upright posture or HUTT occurring in the absence of other chronic debilitating disorders. Symptoms may include fatigue, orthostatic palpitations, exercise intolerance, light headedness, diminished concentration, headache, near syncope and syncope.

ACC/AHA/HRS: American College of Cardiology/American Heart Association/Heart Rhythm Society, POTS: Postural orthostatic tachycardia syndrome, HUTT: Head-up tilt test

does not preclude any aircrew from carrying out flying duties. Hence, she was considered fit on this account.

Air sickness

She developed symptoms of motion sickness during aerobatic manoeuvres. Considering her training and flying history, she was labelled as a case of Air Sickness. The aerobatic manoeuvres in-flight lead to a combination of vestibular and cardiovascular orthostatic challenges; hence, differentiating the symptoms due to orthostatic dysautonomia and air sickness could be difficult in air. However, she could not complete the air sickness desensitisation therapy where only vestibular challenge is simulated, which indicates an element of Motion Sickness in the mix of events. The evidence of high performance anxiety in the individual is also contributory to her inability to complete the motion sickness desensitisation therapy.

Postural dysautonomia

The individual showed dysautonomic responses to HUT and passive standing tests. The results of HUT meet two of three criteria for POTS as per American College of Cardiology (ACC) guidelines (persistent tachycardia for a period without orthostatic hypotension). She also developed signs of pre-syncope in the end which resulted in termination of the run in the first HUT testing. However, as per other standard guidelines, these responses should persist for more than 6 months before labelling the individual with POTS.[9] In view of no symptoms during routine ground training and in general handling sorties, the interpretation of these orthostatic challenge tests need to be considered carefully in an asymptomatic individual, especially in light of the sensitivity and specificity of the test itself. A study carried out by Plash and Diedrich on 15 POTS individuals and 15 healthy controls showed that while 10 min tilt correctly identified 93% of the POTS patients, it also identified 60% of the normal controls as having orthostatic tachycardia (sensitivity 93%, specificity 40%). A 30-min tilt identified 80% of healthy controls as having orthostatic tachycardia.[10] Thus, the pre-test probability of having POTS in this individual is considered low. However, the symptoms of vomiting in air anyway meant that she could not fly till she became desensitised to aerobatic challenges. It was hence decided that she would be observed for a period of 6 months and reevaluated for cardiovascular, vestibular and autonomic systems. However, the individual could not be reevaluated as she was not considered fit to complete her flying training and hence she did not report to the aeromedical evaluation centre (IAM).

Follow-up

Patients with postural dysautonomia are mainly managed with physical reconditioning and sustained postural training exercises, they need to be followed up regularly. However, as brought out earlier, IAM is an aeromedical evaluation centre where aircrew or aircrew aspirants are mostly referred from hospitals for assessment of flying fitness. Since, this case was disqualified from flying, follow-up was not possible.

CONCLUSION

The case report describes an aircrew who was evaluated for air sickness and syncope and developed signs of postural dysautonomia while being subjected to orthostatic challenge in the form of HUT. However, the challenge remains whether one should consider the dysautonomic response as aeromedically significant, especially in view of no clinical compromise being evident during daily routine physical activities.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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