Assessing POT Syndrome with Wearable Sensors and AI: A Case Study

Bhairavi ugale[1], Susmita Paul[2], Anmol Saxena[3]

[1]BPT, Head of Clinical researcher, Ashva wearable technologies pvt ltd, Bangalore, Karnataka.
[2] MPT consultation physiotherapist padmanaban's movementology academy.
3 Founder and CEO, Ashva Wearable Technologies Pvt Ltd, Bangalore, Karnataka, India.

How to cite this article: Bhairavi ugale, Susmita Paul, Anmol Saxena.Assessing POT Syndrome with Wearable Sensors and AI: A Case Study. Indian Journal of Physiotherapy and Occupational Therapy/Volume 18 No. 2, April-June 2024.

Abstract

Background: POTS affects younger people between the ages of 15 and 45, with a clear female predominance (80%). Dizziness, weakness, a quick heartbeat, and palpitations upon standing are the most frequent complaints. Additionally, patients frequently describe headaches, "brain fog," dyspnea, gastrointestinal problems, and musculoskeletal pain in addition to physical deconditioning and decreased exercise ability.

Objective:- fitnees assessment of neurological symptoms along with musculoskeletal symptoms.

Results - fitknees assessment shows significant changes in static balance, dynamic balance and gait parameter.

Key Words: wearable sensors, POTS

Introduction

According to extensive population-based studies, 15% to over 20% of people experience dizziness (including vertigo) on an annual basis. About one-fourth of complaints of dizziness are due to vestibular vertigo, which has a 5% 12-month prevalence and a 1.4% yearly incidence. It is two to three times more common in women than in men, and its incidence increases with age.[1] Vertigo is a common, painful, and disturbing condition that has drawn more and more interest from the medical and scientific fields. Because of how it affects people on a daily basis, it is crucial to comprehend its underlying causes, make a precise diagnosis, and employ efficient management techniques. In order to better understand the complicated balancing systems of the human body and to create more effective interventions and treatments for people who experience vertigo, scientists and medical experts are always trying to understand the complexities of the condition.[1]

POTS affects younger people between the ages of 15 and 45, with a clear female predominance (80%). In wealthy nations, the prevalence is between 0.2% and 1.0%. Immunological stressors such as viral infection, vaccination, trauma, pregnancy, surgery, or psychological stress are frequently responsible for the start of POTS.[2-4]

POTS is a condition characterized by an excessive increase in heart rate (tachycardia) when moving from a lying down to a standing position.

Corresponding Author: Bhairavi Ugale, BPT, Head of Clinical researcher, Ashva wearable technologies pvt ltd, Bangalore, Karnataka.

E-mail: bhairavi.ashva@gmail.com

Submission date: October 26, 2023 **Revision date:** Dec 7, 2023 **Published date: May 2 , 2024**

It frequently causes symptoms including light-headedness, weariness, and occasionally muscle weakness. Although POTS predominantly affects the cardiovascular and autonomic nervous systems like Dizziness, weakness, a quick heartbeat, and palpitations upon standing are the most frequent complaints. Additionally, patients frequently describe headaches, "brain fog," dyspnea, gastrointestinal problems, and musculoskeletal pain in addition to physical deconditioning and decreased exercise ability.

Thus, when assessing some of these neurological conditions, it becomes difficult for the therapist to know exactly where the case is and how to quantify the measures. Some of the tests used in the clinic have limitations. This is where artificial intelligence comes into play. The test methods that are modified by the AI make it easy for the therapist to focus on the part that needs more focus.

PATIENT HISTORY AND OBSERVATION

An 38 year old female was complaining of giddiness, discomfort while traveling since five years She also started to experience nausea and discomfort. This episode she experienced only after traveling for a while. The symptoms started to occur even at home while performing daily activities like descending the stairs, even while cooking. The symptoms started to increase after a period of time. The symptoms were at their peak before the outbreak of the pandemic, She struggled when she was in the sunlight. She also had difficulty performing fast movements like fast walking, and turning activities.

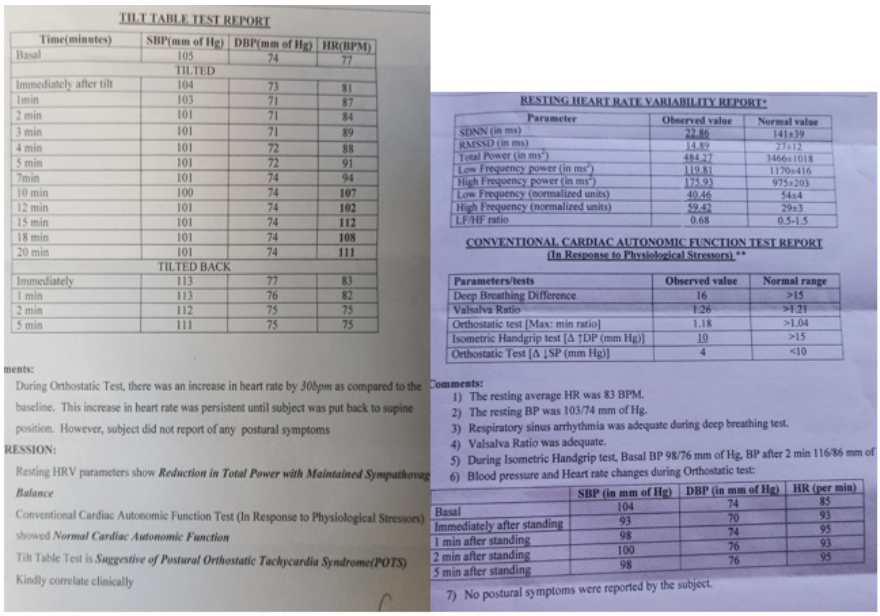
The feeling of sudden giddiness when forward bending and getting up suddenly from lying. She also had complaint of pain on the whole right side of her face. Considering it to be a migraine, she had undergone a lot of diagnostic tests. An increase in the rate was often seen. Symptoms of dysautonomia were also mentioned by her. Neurological tests were also carried out to confirm the same. For the atomic function testing, it showed that she was actually suffering from Postural Orthostatic Tachycardia Syndrome. The investigations done recently showed that she was suffering from vertigo, which causes the headaches for which she was taking medications as well. Along with the medications, the doctor also suggested she wear compression stockings.

On observation, she had rounded shoulders. Slightly slouched back posture.

MEDICAL DIAGNOSIS: Postural Orthostatic Tachycardia Syndrome

PHYSIOTHERPAY DIAGNOSIS: POTS is associated with lower limb muscular weakness, imbalance, and vertigo.

INVESTIGATIONS



TILT TABLE TEST REPORT

Time(minutes)	SBP(mm of Hg)	DBP(mm of Hg)	HR(BPM)
Basal	105	74	77
TILTED			
Immediately after tilt	104	73	81
1min	103	71	87
2 min	101	71	84
3 min	101	71	89
4 min	101	72	88
5 min	101	72	91
7min	101	74	94
10 min	100	74	107
12 min	101	74	102
15 min	101	74	112
18 min	101	74	108
20 min	101	74	111
TILTED BACK			
Immediately	113	77	83
1 min	113	76	82
2 min	112	75	75
5 min	111	75	75

ments:

During Orthostatic Test, there was an increase in heart rate by *30bpm* as compared to the baseline. This increase in heart rate was persistent until subject was put back to supine position. However, subject did not report of any postural symptoms

RESSION:

Resting HRV parameters show ***Reduction in Total Power with Maintained Sympathovag Balance***

Conventional Cardiac Autonomic Function Test (In Response to Physiological Stressors) showed ***Normal Cardiac Autonomic Function***

Tilt Table Test is ***Suggestive of Postural Orthostatic Tachycardia Syndrome(POTS)***

Kindly correlate clinically

RESTING HEART RATE VARIABILITY REPORT*

Parameter	Observed value	Normal value
SDNN (in ms)	22.86	141±39
RMSSD (in ms)	14.89	27±12
Total Power (in ms²)	484.27	3466±1018
Low Frequency power (in ms²)	119.81	1170±416
High Frequency power (in ms²)	175.93	975±203
Low Frequency (normalized units)	40.46	54±4
High Frequency (normalized units)	59.42	29±3
LF/HF ratio	0.68	0.5-1.5

CONVENTIONAL CARDIAC AUTONOMIC FUNCTION TEST REPORT (In Response to Physiological Stressors) **

Parameters/tests	Observed value	Normal range
Deep Breathing Difference	16	>15
Valsalva Ratio	1.26	>1.21
Orthostatic test [Max: min ratio]	1.18	>1.04
Isometric Handgrip test [Δ ↑DP (mm Hg)]	10	>15
Orthostatic Test [Δ ↓SP (mm Hg)]	4	<10

Comments:

1) The resting average HR was 83 BPM.
2) The resting BP was 103/74 mm of Hg.
3) Respiratory sinus arrhythmia was adequate during deep breathing test.
4) Valsalva Ratio was adequate.
5) During Isometric Handgrip test, Basal BP 98/76 mm of Hg, BP after 2 min 116/86 mm of
6) Blood pressure and Heart rate changes during Orthostatic test:

	SBP (in mm of Hg)	DBP (in mm of Hg)	HR (per min)
Basal	104	74	85
Immediately after standing	93	70	93
1 min after standing	98	74	95
2 min after standing	100	76	93
5 min after standing	98	76	95

7) No postural symptoms were reported by the subject.

Fig 1 & 2

Fig 1- The tilt table test reports shows that during the orthostatic test the heart rate increased by 30bpm compared to the baseline. Resting heart rate variability showed reduction in total power with sympathovagal balance. The tilt table test is indicatory for postural orthostatic tachycardia syndrome.(POTS)

Fig 2- The reports mentioned in this test are resting heart rate variability and conventional cardiac autonomic function test. Resting heart rate and blood pressure was measured for the patient. All the parameters were measured accordingly.

PHYSIOTHERAPY TREATMENT

STRENGTH TRAINING - Both upper and lower limbs with therabands

NEUROMUSCULAR TRAINING

BALANCE TRAINING - single stand with eyes open and eyes closed

Progressing with bosu ball and wobble board

Result

Active proprioception test

To examine the patient's proprioception, an active proprioception test is carried out. to determine whether the patients' proprioception is affected by the disorder. The patient is instructed to flex their knee at a predetermined angle that has been specified; this angle is known as the target angle. The person is now required to reach the predetermined angle while completing the test three times with their eyes closed. The proprioception in this situation is unaffected if the person is able to achieve the established target angle.

Static balance

Fig 3 represents graph for static balance.

1. The test can be performed with both eyes open and eyes closed.
2. When the patient performs the test with with eyes open at ease then only proceed to eyes closed.
3. For this patient the test was performed with eyes closed.
4. The individual was asked to maintain balance on single leg at least was 30 secs.

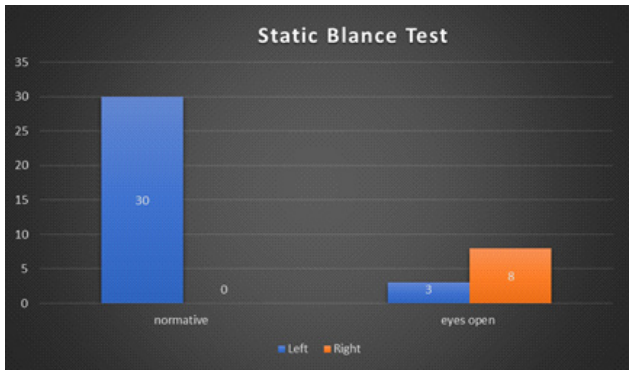


Fig. 3

DYNAMIC BALANCE

Fig 4 represents graph for dynamic balance.

The test was performed without any support

The longer it takes to complete the test, the greater the risk of falling.

For this individual the time taken to perform the test is more then normative so the chances of fall are more.

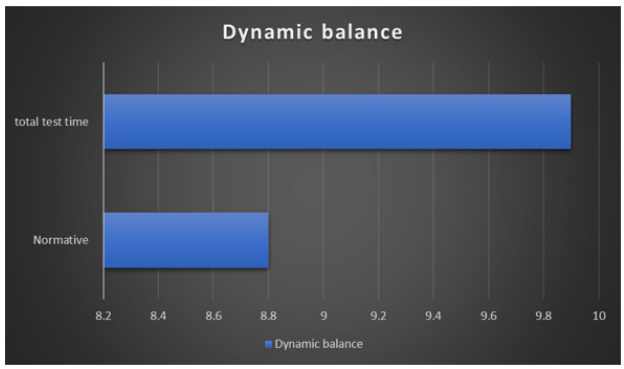


Fig. 4

Gait Analysis

Fig 5 represents graph for gait analysis.

No major difference in gait parameters were seen. The graph below represents only slight difference in cadence when compared to normative.

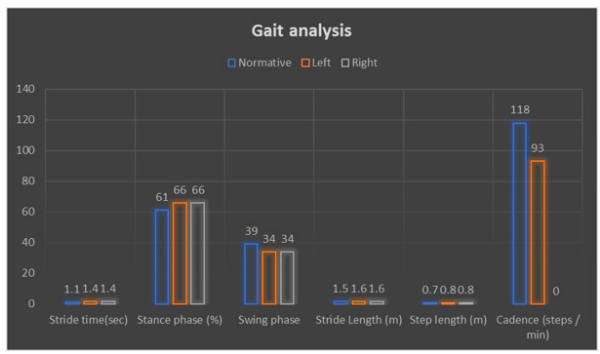


Fig. 5

Discussion

The use of artificial intelligence (AI) is revolutionising the treatment of postural orthostatic tachycardia syndrome (POTS). Beyond its diagnostic potential, AI is essential for remote patient monitoring via wearable technology. It continuously monitors vital indicators and gives people with post-traumatic stress disorder (POTS) real-time insights into their heart rate, blood pressure, and activity levels. AI algorithms improve the personalization of treatment regimens by evaluating patient data and selecting the best interventions based on unique reactions and features. By predicting POTS episodes through pattern identification in past patient data, predictive analytics helps to provide proactive therapy by enabling early intervention and better results.AI in rehabilitation customises workout plans and lifestyle suggestions based on personal health data, assisting in symptom management. AI also helps healthcare professionals make decisions by interpreting tests, recommending courses of action, and guaranteeing that they have access to the most recent findings and recommendations. The full integration of AI into POTS therapy offers the potential to provide individuals with this complex illness with proactive, individualised, and successful management options.

Significant promise exists in the application of AI sensors to the treatment of POTS (Postural Orthostatic Tachycardia Syndrome). AI sensors have the ability to identify and diagnose physiological changes related to POTS early on, enabling quicker management. Through the analysis of patient data and the optimization of therapy options, these sensors make it possible to develop personalized treatment programs. Continuous remote monitoring made possible by AI sensors enables prompt interventions, empowers patients with real-time feedback, and teaches them how to take care of themselves. Additionally, AI helps academics analyze huge amounts of information to better comprehend POTS and its causes. AI sensors lessen the need for frequent in-person visits, which results in cost savings. To achieve responsible adoption, however, ethical considerations and data privacy precautions must be in place.[5]

Informed consent was taken from the patient.

Ethical clearance: Ethical clearance obtained from ST. John's National Academy of Health sciences Ref No 68/2020 on 24th July 2020.

Source of funding: self

Conflict of interest: nil

References

1. Neuhauser HK. The epidemiology of dizziness and vertigo. In: Handbook of Clinical Neurology. Elsevier; 2016. p. 67–82.
2. Wassermann A, Finn S, Axer H. Age-associated characteristics of patients with chronic dizziness and vertigo. J Geriatr Psychiatry Neurol [Internet]. 2022;35(4):580–5. Available from: http://dx.doi.org/10.1177/ 08919887211036185
3. Low PA, Sandroni P. Primer on the Autonomic Nervous System. 2012;517–9.
4. Fedorowski A. Postural orthostatic tachycardia syndrome: clinical presentation, aetiology and management. J Intern Med [Internet]. 2019;285(4):352–66. Available from: http://dx.doi.org/10.1111/joim.12852
5. Shah B, Kunal S, Bansal A, Jain J, Poundrik S, Shetty MK, et al. Heart rate variability as a marker of cardiovascular dysautonomia in post-COVID-19 syndrome using artificial intelligence. Indian Pacing Electrophysiol J [Internet]. 2022;22(2):70–6. Available from: http://dx.doi.org/10.1016/j.ipej.2022.01.004.