



Shaky and unsteady: Dynamic posturography in essential tremor

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ARTICLE INFO

Keywords:

Essential tremor
Dynamic posturography
Balance control
Cerebellar dysfunction

ABSTRACT

Background: The spectrum of symptoms exhibited by patients with essential tremor (ET) extends far beyond the classical tremor. This study aims to explore and establish the presence of subtle balance abnormalities in ET using dynamic posturography (DP).

Methods: DP was performed on 18 patients with ET and 26 controls. Diagnosis of ET was based on the Consensus Statement of the Movement Disorder Society on Tremor. Dynamic stability which included the overall balance index, anterior-posterior index and mediolateral index, and limits of stability were measured.

Results: Patients with ET had significantly impaired balance indices. Impairment of dynamic stability revealed poor static balance control in all directions. Lower limits of stability scores indicated a smaller range of motion prior to which patients have to shift foot balance. No correlations were observed between age at evaluation, age at onset, duration of illness and the balance indices.

Conclusions: Dynamic posturography reveals significant balance impairment in patients with ET which is unrelated to the age at onset, age at evaluation or duration of illness. This finding concurs with pre-existing reports and adds to the growing body evidence of cerebellar involvement in ET.

1. Introduction

Essential tremor (ET) is a highly prevalent movement disorder [1], classically associated with an action tremor of the upper limbs, occasionally involving the head, legs and trunk. ET was always considered to be a monosymptomatic disorder with a relatively benign course. In fact, according to the diagnostic criteria for ET, the presence of other abnormal findings on a neurological examination is indicative of a disorder other than ET [2]. However, this view has been under scrutiny due to several reports suggesting a symptom complex extending beyond the tremor. Patients with ET have been reported to suffer from a variety of symptoms ranging from gait and balance impairments to alterations in cognition [3–5].

Although gait and balance impairment has been known for several decades, the reports were usually anecdotal, with the impairment attributed to old age rather than the disease [6]. Singer et al. [7], provided the first proof of balance and gait impairment in ET. Post this, several studies have concurred with this finding either through the utilization of clinical examinations and scores or complex laboratory

analysis [8–16]. An increase in the number of missteps during tandem gait has been consistently reported in studies which have focused on abnormalities in neurological examination in patients with ET [7–9,11,14,15]. Gait analysis has shown a reduction in the velocity of normal and tandem gait, increased step variability and step width, and a reduction in stride length [8,9,11,12,15]. Posturographic assessment has revealed significant impairments of both static and dynamic balance control in patients with ET [8,10,12,13,16]. However, the actual implication of this impairment is still unclear and the need for therapeutic intervention is doubtful [17].

The presence of subtle cerebellar dysfunction in ET has been previously reported [18,19]. In view of this, gait and balance abnormalities should be expected in this disorder. There are limited studies which have utilized dynamic posturography (DP) to assess the balance impairment in ET [8]. This study aims to explore and establish the presence of subtle balance abnormalities in ET by DP.

Abbreviations: AAO, age at onset; API, anterior-posterior index; BMI, body mass index; DP, dynamic posturography; ET, essential tremor; HT, head tremor; LOS, limits of stability; MLI, mediolateral index; OBI, overall balance index; SP, static posturography

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<https://doi.org/10.1016/j.jns.2017.12.003>

Received 2 August 2017; Received in revised form 24 October 2017; Accepted 1 December 2017

Available online 05 December 2017

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2. Material and methods

2.1. Subject recruitment and clinical evaluation

This study was conducted at the National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore, India. A total of 18 patients with “classic” ET (according to the Consensus Statement of the Movement Disorder Society on Tremor) [20] were included in this study. Tremor of the upper limbs was assessed while (1) both hands were kept on the lap, (2) upper limbs were extended at the elbows and held in front of the chest, (3) upper limbs were flexed at the elbow and held in front of the chest, (4) performing the finger-to-nose test and (5) writing a sentence and drawing Archimedes spirals. Tremor of the lower limbs was assessed while (1) the patient was seated in a chair with feet resting on the floor, (2) the patient was lying on the bed with lower limb lifted off the bed with flexion at the hip and knee, and (3) performing the knee-heel test. A diagnosis of ET was confirmed by a trained movement disorder specialist (author-PKP). Basic demographic data and parameters to calculate body mass index (BMI) – height and weight, was collected. BMI had to be calculated as it plays a crucial role during estimation of DP results. The controls were age and gender matched healthy subjects who gave consent to participate in the study. Patients with ET and healthy controls underwent a neurological examination with emphasis on detection of abnormalities of eye movements, impaired balance and gait, and extrapyramidal signs. None of the subjects included in this study had musculoskeletal problems, joint problems, peripheral neuropathy or other neurological conditions which could have affected gait and balance. Neither the patients with ET nor the controls were on medications which could have caused impairment of balance.

2.2. Dynamic posturography

Balance was tested using the Biodex Balance System. This system consists of a suspended computerized circular platform that can tilt 20° in all directions from the horizontal. The system's microprocessor-based actuator controls the extent of the surface instability of the platform. The surface instability can be adjusted from Level 8 (most stable) to Level 1 (least stable). Level 8 was used for the examination of balance in all the subjects. Prior to the actual test all subjects were explained and oriented to the test in training mode.

The subjects were tested for dynamic stability and limits of stability (LOS). Dynamic stability, included (a) Overall balance index (OBI) which is the ability to control balance in all directions, (b) Anterior-posterior index (API) – front to back balance, and (c) Mediolateral index (MLI) – side-to-side balance. The degree of impairment of balance indices was obtained from the difference between the actual and predictive values.

LOS is defined as the area over which a subject can safely move without changing the base of support towards the target, which appears randomly in eight directions. Each target appears only once during the test. The DP instrument tests the LOS by displaying the blinking target on a screen placed in front of the subject. Subjects are instructed to move their centres of mass toward the target, without changing the foot position. In the present study, LOS was assessed in eight directions – forward (F), backward (B), right (R), left (L), forward-right (FR), forward-left (FL), backward-right (BR) and backward-left (BL). Time taken for completion of the LOS test was also recorded.

Higher scores in the balance indices and time taken for completion of the LOS test are indicative of a poor balance whereas higher scores in the LOS test are representative of better stability.

2.3. Statistical analysis

Descriptive statistical analysis was performed for the demographic features of patients with ET and controls. Continuous variables were

Table 1
Demographic details of patients with essential tremor and controls.

	Essential tremor (n = 18)	Controls (n = 26)	p-Value
Gender (M: F)	14:04	21:05	NS
Age at presentation (years)	44.22 ± 20.89	46.38 ± 16.53	NS
Age at onset (years)	34.83 ± 20.35	–	–
Duration of illness (years)	9.5 ± 4.57	–	–
Body mass index (kg/ m ²)	22.79 ± 3.14	24.15 ± 3.15	NS

analyzed using the *t*-test and the chi-square test was used for categorical variables. Correlations between parameters of ET and results of posturography were evaluated by performing Pearson's correlation. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Demographic data

A total of 44 subjects were studied, which included 18 patients with ET and 26 healthy controls. Men outnumbered women in both groups and there was no significant difference in the age at evaluation. The mean age at onset (AAO) of ET was 34.83 ± 20.35 years and the mean duration of illness was 9.5 ± 4.57 years. Both groups had similar BMI's at 22.79 ± 3.14 kg/m² and 24.15 ± 3.15 kg/m². Details are provided in Table 1.

The treatment profile of patients with ET was as follows: 64.70% were on propranolol (33.33 ± 9.42 mg/day), 35.29% were on primidone (375 ± 0 mg/day) and 23.5% were on clonazepam (0.62 ± 0.37 mg/day). One patient was drug naïve at the time of DP.

3.2. Dynamic posturography

DP revealed impaired balance indices in patients with ET in comparison to controls (Table 2, Fig. 1). The OBI was significantly higher indicating poor balance in all directions. Similarly, the API and MPI were also higher implying poor balance control in the forward-backward and middle-lateral directions. The LOS test revealed significantly lower scores in patients with ET. Although stability was found to be impaired in all directions in ET, significantly poor scores were observed only in the forward-right and forward-left directions, and the impairment in the backward-left direction was found to near significance (Table 3, Fig. 2). Patients with ET took significantly longer to complete the LOS test in comparison to healthy controls.

3.3. Correlations

Pearson's correlation was performed between the age at evaluation, AAO of illness and duration of illness with all the balance indices. No significant correlations were observed between any of the parameters.

Table 2
Results of dynamic posturography in patients with essential tremor and controls.

Dynamic posturography	Essential tremor (n = 18)	Controls (n = 26)	p-Value
Overall balance index	2.59 ± 1.03	1.95 ± 0.54	< 0.01
Anterior posterior index	2.13 ± 0.95	1.58 ± 0.51	< 0.05
Mediolateral index	1.85 ± 0.71	1.22 ± 0.40	< 0.01
Limits of stability	16.36 ± 11.72	27.38 ± 10.32	< 0.01
Time taken to complete	205.33 ± 65.05	154.61 ± 60.31	< 0.05

Limits of stability test (s).

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