The Phenomenology of Primary Orthostatic Tremor

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ABSTRACT: Background: The presence and prevalence of several neurological signs in patients with primary orthostatic tremor have not been systematically studied. Objectives: To assess the prevalence of clinical features of primary orthostatic tremor. Methods: Video-based assessment by four raters of standardized neurological examination of 11 patients with primary orthostatic tremor. Results: On standing, bent knees (7/11), hem sign (6/10), and a broad base of support (6/11) were the three most prevalent signs. Examination of gait revealed abnormal tandem gait (9/11) and bent knees (6/11) as the most prevalent clinical signs. In the arms, none of the patients displayed bradykinesia, ataxia, or dystonia. In the legs, ataxia was absent in all patients and bradykinesia was present in only one patient. Conclusions: Abnormal tandem gait, bent knees, hem sign, and broad base on standing are the most prevalent clinical signs in primary orthostatic tremor. We did not encounter clear extrapyramidal or unequivocal cerebellar signs.

Primary orthostatic tremor (POT) is a rare idiopathic progressive neurological disorder characterized by a high frequency (>13 Hz) tremor in the leg muscles on standing.1,2 Patients complain of instability on standing, with a normal to minimally affected gait.3,4 Patients with POT are often severely disabled, there is no cure and treatment with medication or deep brain stimulation is often unsatisfactory.3

Several clinical signs have been established in POT. These include the helicopter sign, tremor of the knees, and fine-amplitude rippling of leg muscles on standing.3,5 A postural arm tremor with features reminiscent of essential tremor is present in the majority (50%–90%) of patients.6–8 Recently, the hem sign (ie, fast trembling of the hem of the skirt or long shirt covering the thigh on standing) has been reported in POT, but its prevalence is unknown.9 In the original descriptions of POT, abnormal tandem gait as well as a broad base of support and toe clamping on standing have been described.10,11 However, presence and prevalence of these features have not been assessed systematically.

Whereas initial reports describe the absence of ataxia and bradykinesia in POT, several recent reports indicate the potential presence of cerebellar ataxia.10–15 These mainly comprise of features of gait such as reduced step length and increased step width, but also a certain degree of appendicular ataxia has been suggested. These observations are contradicted by case series demonstrating only very rare occurrence of ataxia.16–18 Hence, presence of cerebellar ataxia in POT is still a matter of debate.19

We aimed to assess the prevalence of suggested clinical features of POT including the hem sign, abnormal tandem gait, broad base of support, and toe clamping, as well as the prevalence of extrapyramidal and cerebellar signs.

Methods

At the annual meeting of the Dutch orthostatic tremor patient association on May 24th 2019 patients with POT were asked to...
undergo a video-taped clinical examination. Eleven patients with POT consented and underwent a standardized neurological examination by a movement disorders expert (RMAB). Video recordings were independently assessed by two movement disorders experts (A.F.R. and B.E.K.S.S.) and two residents (A.W.G.B. and H.W.) scoring the presence or absence of an exhaustive list of predefined clinical signs. In case the rating by one assessor was different from the three others, the majority’s rating was used. For features with equal ratings (i.e., the sign being absent by two raters and present by the two others) a majority’s rating was reached through a consensus meeting among the four raters. For each clinical sign the prevalence was determined by standard computations.

To assess interrater reliability, for each clinical sign Light’s Kappa and agreement were computed using RStudio (RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/).

### Results

The patient characteristics are displayed in Table 1. Mean age at assessment was 68 years (range 55–78) with a mean disease duration of 20 years (range 7–34).

### Table 1  Patient characteristics

| Patient characteristics (n = 11) |  |
|----------------------------------|---|
| Sex (M/F)                        | 3/8 |
| Age (mean and range), y          | 68 (55–78) |
| Age at onset (mean and range), y | 48 (25–65) |
| Disease duration (mean and range), y | 20 (7–34) |
| EMG confirmation                 | 11<sup>b</sup> |

<sup>a</sup> At moment of evaluation.  
<sup>b</sup> In one patient only surface EMG with sound recording was performed.  
<sup>c</sup> Perampanel combined with clonazepam (two patients) or propranolol (one patient).

**Abbreviation: EMG, electromyography.**

### Table 2  Standardized neurological examination of 11 primary orthostatic tremor patients by four raters

| Condition                     | Prevalence – n | Interverrater reliability |  |
|-------------------------------|----------------|---------------------------|---|
|                               |                | Light’s κ                 | κ | P value | Agreement (%) |
| **Standing**                  |                |                           |   |         |               |
| Difficulty standing up        | 1              | 0.50                      | 0.99 | 90.9 |
| Tremor legs                   | 5              | 0.59                      | 0.57 | 63.6 |
| Tremor arms                   | 5              | 0.42                      | 0.67 | 45.5 |
| Tremor trunk                  | 4              | 0.54                      | 0.58 | 54.5 |
| Broad base                    | 6              | 0.21                      | 0.79 | 27.3 |
| Hem sign<sup>a,b</sup>        | 6              | 0.59                      | 0.60 | 60.0 |
| Bent knees                    | 7              | 0.75                      | 0.43 | 72.7 |
| Toe clawing                   | 4              | 0.01                      | 0.99 | 9.1  |
| **Walking**                   |                |                           |   |         |               |
| Difficulty starting or stopping| 0              | N/A                       | N/A | 90.9 |
| Hopping on start              | 0              | N/A                       | N/A | 72.9 |
| Unstable                      | 3              | 0.35                      | 0.88 | 54.5 |
| Decreased stride length       | 2              | 0.69                      | 0.88 | 81.8 |
| Broad base                    | 2              | 0.18                      | 0.97 | 54.5 |
| Decreased arm swing           | 4              | 0.57                      | 0.65 | 63.6 |
| Clawed toes                   | 3              | N/A                       | N/A | 54.5 |
| Bent knees                    | 6              | 0.44                      | 0.62 | 45.5 |

(Continues)
The duration of 20 years (range 7–24). Diagnosis of orthostatic tremor was confirmed by surface electromyography (EMG) tremor recording in all patients. At the moment of assessment most patients were taking medication for orthostatic tremor, of which perampanel was the most frequent.

Results are summarized in Table 2. On examination in the standing position, presence of bent knees (7/11), hem sign (6/10, Video 1) and a broad base of support (6/11, Video 1) were the most prevalent signs (Table 2). Of note, in one patient the hem sign could not be assessed as tight clothing was worn. Visible tremor was equally present in the legs (5/11) and arms (5/11), and less frequently in the trunk (4/11). Clawing of the toes during stance was noted in four patients (Video 1). Interrater reliability was moderate to substantial (ie, κ, 0.41–0.80) for all features, but slight to fair (ie, κ, 0.00–0.40) for broad base of support and toe clawing. Interrater reliability was highest for bent knees (0.75) and lowest for toe clawing (0.01).

Examination of gait revealed abnormal tandem gait (9/11, Video 1), bent knees (6/11) and bilateral decreased arm swing (4/11) as the most prevalent clinical signs. Only a minority of patients exhibited an unstable gait (3/11), a broad base (2/11), and decreased stride length (2/11). Interrater reliability was excellent (ie, κ, 1.00) for tandem gait, whereas only slight (ie, κ, 0.00–0.20) for broad base and multi-step turning.

None of the patients displayed bradykinesia, ataxia, or dystonia in the arms. Postural tremor was present in three (arms outstretched) to four (wing-beating posture) patients with perfect (ie, κ, 0.81–1.00) interrater reliability. Kinetic tremor was present in four patients with fair (ie, κ, 0.21–0.40) interrater reliability. Postural and kinetic arm tremor, if present, had a small amplitude and medium to high frequency. Dysmetria during finger tracking was noted in four patients, but with only fair interrater reliability (Video 1).

When examining the legs, ataxia was absent in all patients and bradykinesia was present in only one patient.
On the one hand, ataxia has been reported to be
On the other hand, on certain
Moreover, the absence of clinical cerebellar
Although not assessed in our
Nevertheless based
Moreover, in these reports POT
wearing loose clothes. Toe clawing was seen in around a third of
body part. Of note, the hem sign can best be assessed when
particular body part (eg, visible tremor in the legs), probably
good interrater reliability, making these con
knees to be present in the majority (around 60%) of patients with
was largely unknown. This series indicates the hem sign and bent
tracking (one of each being controversial). For “controversial”
signs a majority’s rating was to be determined during the
consensus meeting.
Video content can be viewed at https://onlinelibrary.wiley.com/
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Discussion
POT is mostly affecting a patient’s ability to stand still. Several
clinical signs on standing have been postulated, but prevalence
was largely unknown. This series indicates the hem sign and bent
knees to be present in the majority (around 60%) of patients with
good interrater reliability, making these confident features of
POT. The hem sign is more prevalent than visible tremor in any
particular body part (eg, visible tremor in the legs), probably
because the hem sign constitutes the congregate of tremor in any
body part. Of note, the hem sign can best be assessed when
wearing loose clothes. Toe clawing was seen in around a third of
patients and exhibits very low interrater agreement. This proba-
bly relates to the difficult discrimination, because of overlap
between physiological variants of toe anatomy in this age group
and pathological toe clawing in POT. Indicative features might
be absence of toe clawing at rest and accompanying whitening
of the toe tips indicating active downward pressure on the toes
(see first case in Video 1, part C). As yet, toe clawing is not to be
regarded as a sensitive or specific sign of POT and requires fur-
ther investigation.

Apart from tremor, no clear extrapyramidal (ie, bradykinesia
or dystonia) or cerebellar features (ie, ataxia) are present in the
arms or legs. Dystymia in the arms was noted in around a third
of patients, however with low interrater agreement and is proba-
bly because of superimposed action tremor, which is also present
in around a third of patients.

During walking certain additional features were present at low
prevalence. Around a third of patients exhibited a decreased arm
swing. Because there were no appendicular extrapyramidal signs
and the reduced arm swing was bilateral, this is probably to be
regarded as a compensatory phenomenon reflecting cautiousness
of gait. Gait was less often broad-based compared to stance, indi-
cating a better stability while walking compared to standing.

The high prevalence of abnormal tandem gait and a broad
base of support when standing raises the possibility of cerebellar
ataxia underlying certain POT features as has been suggested by
others. Additionally, some patients exhibited gait features that are
also present in cerebellar ataxic gait (eg, instability, broad base,
and decreased stride length). However, the observations in this
case series are most compatible with cerebellar ataxia not constitu-
ting a phenomenological role in POT. On specific testing
appendicular ataxia was absent in our patients, whereas the char-
acteristic tremor in POT is most prominently present in the
limbs. Additionally, except for abnormal tandem gait and broad
base of support on standing, prevalence of cerebellar features is
very low. Moreover, several “cerebellar” signs are not specific
cerebellar dysfunction because these may be present because of a
variety of other reasons. In the case of POT, the instability
induced by the rhythmic tremor probably induces a compensa-
tory broadened base of support and shortened stride length
(as one would do when walking on ice or a moving surface).
The high prevalence of abnormal tandem gait in our case series
probably merely reflects the surge of tremor severity when per-
forming this task (ie, at low speed with a lot of support time).
This lack of specificity of several appendicular and axial tests
might explain the high prevalence of ataxic features in previous
reports.12–15
On the one hand, ataxia has been reported to be
present in up to 50% of control patients indicating the low speci-
city for cerebellar dysfunction.14 On the other hand, on certain
used ataxia rating scales contamination by tremor is very likely
(eg, oscillating movement during finger to nose or abnormal tan-
dem gait in the BARS).14 Moreover, in these reports POT
patients scored very low on ataxia rating scales, indicating the
limitedness of this observation.14 Although not assessed in our
patients, gait performance in POT is known to improve with
gait speed, especially with fast walking. This is not in line with
cerebellar ataxia underlying the POT gait disturbance as cerebel-
lar ataxia features become worse with fast walking.20 Neverthe-
less, a certain cerebellar component in the POT gait cannot be
excluded entirely as high spatiotemporal gait variability has been
shown previously.18 Moreover, the absence of clinical cerebellar
ataxia does not preclude the cerebellum from contributing to the
disease mechanism, as several studies have demonstrated func-
tional and structural cerebellar alterations in POT and as several
locations structurally connected to the cerebellum have been
demonstrated to cause secondary OT.21–23 Nevertheless based
on imaging studies, brain regions other than the cerebellum may
be involved as well.22

Altogether, cerebellar ataxia seems not to be a clear nor con-
sistent feature of POT. In fact, presence of clear ataxia is not
compatible with a diagnosis of POT, because it indicates a sec-
ondary OT and should instigate diagnostic tests for secondary
causes of OT.
There are some limitations to our study. No control individuals have been assessed, precluding determination of specificity of clinical features. Whereas interrater agreement was fair to good for most clinical signs, it was insufficient for some (ie, toe clawing, broad base when walking, multi-step turning, and dysmetria on finger tracking). This indicates a limited usefulness in clinical practice when assessing these features. Although the sample size is considerably larger than most previous studies, it is still relatively small. Hence, features could not be related to patient characteristics including disease duration, disease severity, and effects of medication.

When considering all observations together, the hem sign, abnormal tandem gait, and bent knees and broad base on standing are among the most prevalent clinical features in POT. There are no clear extrapyramidal or cerebellar signs. POT seems to be a pure tremor disorder, in line with initial descriptions.10,11

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Disclosures

Ethical Compliance Statement: The authors confirm that the approval of an institutional review board was not required for this work. Signed informed consents have been obtained from the patients. We confirm that we have read the Journal’s position on issues involved in ethical publication and affirm that this work is consistent with those guidelines.

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Author Roles

(1) Research project: A. Conception, B. Organization, C. Execution; (2) Statistical Analysis: A. Design, B. Execution, C. Review and Critique; (3) Manuscript: A. Writing of the First Draft, B. Review and Critique. 

B.E.K.S.S.: 1C, 2A, 2B, 3A
H.W.: 1A, 1B, 1C, 2C, 2B
A.W.G.B.: 1C, 2C, 3B
R.M.A.B.: 1A, 1B, 1C, 2C, 3B
A.F.R.: 1A, 1B, 1C, 2C, 3B

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