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Postural stability in blepharospasm: the effects of dual-tasking and botulinum toxin therapy

Mehmet Balal,[1] Turgay Demir,[1] Miray Erdem,[2] Meltem Demirkiran[1]

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[1]Department of Neurology, Çukurova Üniversitesi Tıp Fakültesi, Sarıçam, Turkey
[2]City Hospital of Neurology, University of Health Sciences, Adana, Turkey

Correspondence to
Dr Mehmet Balal;
memet_balal@hotmail.com

ABSTRACT

Background Blepharospasm is a focal dystonia that presents as involuntary, intermittent, continuous contractions of the eyelids. Abnormal eyelid contractions in blepharospasm are expected to cause balance problems, but there is no clear information.

Objective This study was designed to evaluate the effect of blepharospasm on postural stability (PS) in patients with blepharospasm. As a secondary endpoint, the efficacy of botulinum toxin type-A (BoNT-A) treatment on static balance in patients with blepharospasm was investigated.

Methods Twenty-four patients with blepharospasm receiving regular BoNT-A injections and 20 age-matched and sex-matched healthy controls were included in the study. All subjects were evaluated on a static posturography force platform performing four tasks (eyes open (EO), eyes closed (EC), tandem Romberg (TR) and verbal cognitive task (COGT)). Evaluations of the patients were repeated 4 weeks after the injection.

Results Pretreatment lateral and anterior–posterior sways, sway area and velocities of the sways were significantly higher in patients than controls during the COGT and TR ($p<0.05$). In the patient group, with EO and EC, a few parameters improved after BoNT-A injection. On the other hand, in the TR and COGT, most of the sway parameters and velocities improved significantly after treatment ($p<0.05$).

Conclusions Blepharospasm may cause functional blindness in patients. This study demonstrated that PS worsens in patients with blepharospasm under dual-task conditions. BoNT-A injection treats the disease itself and, thus, markedly improves PS under dual-task conditions in blepharospasm.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Balance problems can be expected in blepherospasm with involuntary eye contractions. Balance problems and the effects of botulinium toxin injection have not been shown before in blephepherospasm.

WHAT THIS STUDY ADDS

⇒ This study demonstrated balance problems in blepherospasm with static posturography during dual task. In addition, botulunium toxin injection has been shown to improve not only eye contractions but also balance problems of patients.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ In patients with blepherospasm, motor and mental tasks lead to a decrease in the quality of life of the patients. Therefore, when evaluating patients, it is necessary to evaluate not only abnormal eye contractions but also increased motor and mental load that impairs quality of life.

BACKGROUND

Blepharospasm is a focal dystonia manifesting as involuntary, intermittent, sustained contractions of the eyelids.[1] Blepharospasm is the second most common type of focal dystonia, with a prevalence between 1.4 and 13.3 in 100 000.[1 2] Functional blindness may occur in a minority of patients due to frequent blinking and eyelid contractions. Balance and postural control are provided by the visual, vestibular and proprioceptive systems. The integration of sensorial inputs is important for the proper functioning of this system.[3] The visual inputs of postural stability (PS) may, thus, be particularly inoperative in patients with blepharospasm.

In most daily activities, cognitive and motor tasks need to be performed together. As the task becomes more complex, all pathways in the brain must work properly.[4] In the literature, there are several reports on the effect of dual-tasking causing postural instability in several different diseases.[5–9] PS is evaluated by both static balance (SB) and dynamic balance (DB).[10 11] SB tests the body's ability to keep it in a stable support. DB tests the body's ability to hold on a moving support.[10 11] Both static and dynamic PS require integration of inputs from visual, vestibular and proprioceptive systems to achieve a motor response.[10 11]

To our knowledge, there are no studies in the literature on the impact of blepharospasm on PS or the effect of dual-tasking on PS in blepharospasm. Botulinum toxin type-A (BoNT-A), which is used effectively in blepharospasm, causes a significant improvement in these patients.[12–14] Considering the currently available data from the literature,

Table 1 Demographic data of the control group and patients

	Control group, n:20 range	Patients, n:24 range
Age	56.45±8.07 (43–72)	58.42±13.09 (34–84)
Gender (F/M)	11/9	13/11
Age at disease onset	–	49.12±14.36 (18–70)
Disease duration (year)	–	7.24±4.76 (2–22)
Treatment duration (year)	–	5.10±3.08 (1–12)
BoNT-A dose (units)	–	45.40±14.60 (20–88)

BoNT-A, botulinium toxin-A; F/M, female and male.

we hypothesised that patients with blepharospasm may have postural instability due to abnormal blinking and a cognitive dual-task may affect PS in these patients. In this sense, the primary aim of our study was to evaluate the effect of cognitive task (COGT) on PS in patients with blepharospasm. We also seek to analyse whether BoNT-A has any effect on the PS of these patients. Therefore, our secondary aim was to evaluate the effect of BoNT-A on PS, within the patient group.

METHODS

Patients

This prospective study was carried out in the Movement Disorders Unit of Cukurova University Neurology Department. Informed consent was obtained from the subjects, and the study was approved by the local ethics committee. Patients with pure blepharospasm who received BoNT-A injection for at least 1 year and with significant improvement after injection were included in the study. Patients with cognitive impairment and diseases that affect posture and stability, such as polyneuropathy, ataxia, cerebrovascular disease, multiple sclerosis, rheumatologic or orthopaedic problems, vestibulopathy or otological disease and severely blurred vision, were excluded. Patients with segmental dystonia affecting cranial, cervical or oromandibular muscles were also excluded. All of the patient group had blepharospasm and were in the focal dystonia group.[15] Twenty age-matched and sex-matched healthy controls were included in the study. The age, sex and weight of the patient and control groups were recorded. In addition, the mean age at disease onset, duration of disease, duration of treatment and mean BoNT-A doses of the patients were recorded. Neurological examination was performed in all subjects. Except for blepharospasm, patients were neurologically normal.

Static posturography measurement

The first assessment was made to patients 3 months after the previous injection. By examining the patients, it was ensured that the effect of Bont-A was fully passed.

Static posturography (SPG) was performed on a force platform (Lucerne II, Otopront, Germany) in a quiet room. The subjects were told to stand on the platform in an upright position as stable as possible, barefoot with their feet 4 cm apart, and with their arms held alongside their body. The first recording was with eyes open (EO), and the second was with eyes closed (EC). The third recording was with tandem Romberg (TR). In the TR, one foot is in front of the other foot, and arms are lifted horizontally in front of the body. The last recording is the COGT with EO producing words starting with the letter 'K'. The cognitive performance of participants was not evaluated during the COGT. Each test lasted 30 s. Lateral sway, anterior posterior sway, sway area and sway velocities were recorded for each task. The definitions of SPG parameters are described in detail in a previous study.[5] Evaluations of the patients were repeated 4 weeks after the injection.

Statistical analysis

All analyses were performed using IBM SPSS Statistics V.20.0 statistical software package. The number of patients was determined using power calculation for sample size. Categorical variables were expressed as numbers and percentages, whereas continuous variables were summarised as the mean and SD and as the median and minimum–maximum where appropriate. The χ^2 test was used to compare categorical variables between the groups. The normality of distribution for continuous variables was confirmed with the Shapiro-Wilk test. For comparison of continuous variables between two groups, Student's t test or the Mann-Whitney U test was used depending on whether the statistical hypotheses were fulfilled. For comparison of two related (paired) continuous variables, a paired samples t test or Wilcoxon signed rank test was used depending on whether the statistical hypotheses were fulfilled. The statistical level of significance for all tests was considered to be 0.05.

RESULTS

Patients

There was no significant difference in age, sex or weight between the patient and control groups. The mean age at disease onset was 49.12±14.36 (18–70) years. The mean duration of disease was 7.24±4.76 (2–22) years. The

Table 2 Pretreatment data of patients and the control group in static posturography

	Control group, n:20 SD	Patients before BoNT−, n:24 SD	P
Eyes open			
A-P sway (cm)	22.30±6.39	25.80±6.13	0.052
Lateral sway (cm)	18.26±6.25	19.92±6.30	0.410
Sway path (cm)	33.11±9.11	38.01±9.01	0.099
Sway area (cm^2)	4.24±2.30	5.04±3.32	0.061
A-P sway velocity (cm/s)	0.75±0.21	0.89±0.22	0.053
Lateral sway velocity (cm/s)	0.61±0.20	0.67±0.21	0.412
Way velocity (cm/s)	1.10±0.31	1.26±0.29	0.107
Sway area velocity (cm^2/s)	0.14±0.75	0.20±0.18	0.217
Eyes closed			
A-P sway (cm)	38.32±24.40	35.84±7.39	0.666
Lateral sway (cm)	22.32±9.19	22.70±7.99	0.890
Sway path (cm)	49.63±16.61	47.38±10.83	0.728
Sway area (cm^2)	9.15±4.28	8.31±4.52	0.720
A-P sway velocity (cm/s)	1.27±0.82	1.20±0.25	0.699
Lateral sway velocity (cm/s)	0.73±0.29	0.74±0.26	0.986
Way velocity (cm/s)	1.64±0.89	1.58±0.35	0.783
Sway area velocity (cm^2/s)	0.32±0.21	0.28±0.14	0.657
Tandem Romberg			
A-P sway (cm)	60.42±23.37	84.40±38.89	0.023
Lateral sway (cm)	56.30±19.49	74.56±19.96	0.006
Sway path (cm)	92.06±29.92	125.54±42.44	0.006
Sway area (cm^2)	23.19±13.68	45.63±29.78	0.004
A-P sway velocity (cm/s)	2.02±0.77	2.81±1.13	0.024
Lateral sway velocity (cm/s)	1.88±0.63	2.48±0.66	0.006
Way velocity (cm/s)	3.08±0.99	4.20±1.41	0.006
Sway area velocity (cm^2/s)	0.76±0.45	1.40±0.98	0.004
Cognitive task			
A-P sway (cm)	27.88±9.17	41.41±18.96	0.007
Lateral sway (cm)	17.21±7.15	23.98±7.05	0.040
Sway path (cm)	39.68±14.70	53.13±19.89	0.020
Sway area (cm^2)	5.85±4.82	10.40±5.69	0.047
A-P sway velocity (cm/s)	0.92±0.30	1.38±0.63	0.006
Lateral sway velocity (cm/s)	0.63±0.24	0.80±0.24	0.049
Way velocity (cm/s)	1.28±0.40	1.76±0.65	0.009
Sway area velocity (cm^2/s)	0.20±0.11	0.34±0.18	0.043

A-P, anterior and posterior; BoNT-A, botulinum toxin type-A.

demographic data of the patient and control groups are shown in table 1.

Posturographic measurement

There was no significant difference between the pretreatment data of the patients and the control group in any parameters with EO and EC. On the other hand, with COGT and TR, all posturographic parameters of pretreatment data were significantly higher in the patient group than in the control group (table 2).

Within the patient group, after BoNT-A injection, only a few parameters in EO and EC were improved. In TR and COGT, most of the sway parameters and velocities improved significantly after treatment, and the improving parameters were similar in both conditions (table 3). Sway area and sway area velocity are the two common

Table 3 Static posturography data of pretreatment and posttreatment patients

	Patients before BoNT-A, n:24 SD	Patients after BoNT-A, n:24 SD	P
Eyes open			
A-P sway (cm)	25.80±6.13	24.90±6.55	0.086
Lateral sway (cm)	19.92±6.30	19.01±6.75	0.094
Sway path (cm)	38.01±9.01	35.79±9.86	0.032
Sway area (cm^2)	5.04±3.32	4.43±2.69	0.066
A-P sway velocity (cm/s)	0.89±0.22	0.84±0.21	0.144
Lateral sway velocity (cm/s)	0.67±0.21	0.63±0.24	0.149
Way velocity (cm/s)	1.26±0.29	1.19±0.32	0.079
Sway area velocity (cm^2/s)	0.20±0.18	0.17±0.12	0.330
Eyes closed			
A-P sway (cm)	35.84±7.39	33.06±10.33	0.157
Lateral sway (cm)	22.70±7.99	20.55±7.28	0.064
Sway path (cm)	47.38±10.83	43.72±12.78	0.078
Sway area (cm^2)	8.31±4.52	6.15±3.32	0.016
A-P sway velocity (cm/s)	1.20±0.25	1.10±0.35	0.135
Lateral sway velocity (cm/s)	0.74±0.26	0.68±0.23	0.036
Way velocity (cm/s)	1.58±0.35	1.46±0.43	0.104
Sway area velocity (cm^2/s)	0.28±0.14	0.21±0.12	0.007
Tandem Romberg			
A-P sway (cm)	84.40±38.89	65.77±16.08	0.041
Lateral sway (cm)	74.56±19.96	68.99±16.88	0.049
Sway path (cm)	125.54±42.44	107.89±22.08	0.075
Sway area (cm^2)	45.63±29.78	26.48±8.71	0.008
A-P sway velocity (cm/s)	2.81±1.13	2.19±0.53	0.044
Lateral sway velocity (cm/s)	2.48±0.66	2.36±0.56	0.354
Way velocity (cm/s)	4.20±1.41	3.59±0.73	0.069
Sway area velocity (cm^2/s)	1.40±0.98	1.08±0.14	0.041
Cognitive task			
A-P sway (cm)	41.41±18.96	33.65±11.25	0.042
Lateral sway (cm)	23.98±7.05	18.63±6.30	0.046
Sway path (cm)	53.13±19.89	44.84±13.09	0.054
Sway area (cm^2)	10.40±5.69	7.66±4.56	0.040
A-P sway velocity (cm/s)	1.38±0.63	1.13±0.37	0.049
Lateral sway velocity (cm/s)	0.80±0.24	0.72±0.21	0.091
Way velocity (cm/s)	1.76±0.65	1.49±0.43	0.062
Sway area velocity (cm^2/s)	0.34±0.28	0.25±0.15	0.043

A-P, anterior and posterior; BoNT-A, botulinum toxin type-A.

parameters improving in three conditions, EC, TR and COGT.

For the correlation analyses, none of the demographic data correlated significantly with any of the posturographic parameters.

DISCUSSION

In the literature, there are several reports of dual-tasking affecting PS in several different diseases.[6–9] To our knowledge, this is the first study evaluating PS and dual tasking in blepharospasm. Furthermore, this is the first study evaluating the effects of BoNT-A on PS in patients with blepharospasm. According to our results, blepharospasm does not affect PS under baseline conditions. Balance is maintained by a complex system spanning the integration of visual, vestibular and proprioceptive systems.[16 17] Interruption of visual inputs may cause balance problems. Because of increased blinking, the

visual input necessary for balance may already be inoperative in these patients. Being already accustomed to this condition, these patients might be providing compensatory mechanisms to improve PS and balance, perhaps overusing the other two systems required for balance.

On the other hand, TR, a harder postural motor task and COGT affected PS in these patients, which can be explained by dual-task paradigms. There are several theories used to explain the difficulties in performing dual tasks. Capacity sharing, bottlenecks (task switching) and crosstalk are the three most recognised theories.[18] In capacity sharing theory, performing two tasks at the same time decreases the performance of each task due to splitting the capacity between the tasks.[18] In the bottleneck (task switching) model, parallel processing can be impossible for some mental operations.[18] If two tasks, concurrently, need the mechanism, a bottleneck occurs, and one or both tasks will be delayed or impaired. The crosstalk model is used to refer to conditions in which informational codes overlap across tasks. Similarity between tasks causes interference; if the tasks are sufficiently different, interference is less likely.[18 19] Among these three, capacity sharing is the most widely accepted and used. Task prioritisation, which enables increased conscious attention while carrying out cognitive or motor tasks, is another concept to explain dual-tasking. Several studies have shown that patients without explicit instructions regarding prioritisation sometimes focus attention on the given task, not PS or walking.[5 20–22] Therefore, we can say that attention is an important variable to maintain PS under dual-task conditions in patients with blepharospasm and that an adequate attention function is required to provide postural control and balance in such patients under dual-task conditions. Hence, patients with blepharospasm may experience a reduction in performance when performing two activities that require attention at the same time, leading to dual-task costs.[6 15 23–26] Without explicit instructions, they may have a tendency to prioritise the given task, costing PS. Frequent blinking and related loss of balance in blepharospasm can cause falls. This may cause loss of workforce as well as increased health costs.

BoNT-A treatment markedly improved PS in patients with blepharospasm under dual-tasking. We believe that its symptomatic effect is the reason for this improvement. BoNT-A injection improves blinking and forceful spasms, leading to better visual input with less or no need for divided attention and task prioritisation and, therefore, probably better balance.

Our study has some limitations. The sample size was small; however, the data obtained were statistically significant. Reversing the order of testing in the blepharospasm group would have been a way of allowing for any practice effect. Getting the control group to perform a repeat study after 4 weeks would have established whether such an effect actually existed. To identify patients with marked improvement with treatment, we included patients who were on treatment for at least 1 year; therefore, treatment-naive patients were not included in this study. For standardisation, we used the same order of tests in the posturographic analysis in every subject. This might have had some practice effect.

CONCLUSIONS

This is the first study showing that postural control is impaired in blepharospasm under dual-task conditions. Dual-task disturbes PS in blepharospasm probably due to divided attention and task prioritisation. BoNT-A injection, in addition to improving the disease itself, has positive effects on PS in these patients. Studies with different designs for dual tasks and dynamic posturographic analysis may add more data on this subject.

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Patient consent for publication Not applicable.

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Data availability statement Data are available upon reasonable request.

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