Reliability and Usability of Telemedicine Evaluations for Facial Dystonia

Punnaka Pongpanich
King Chulalongkorn Memorial Hospital, Thai Red Cross Society

Parima Hirunwiwatkul (hparima@gmail.com)
Chulalongkorn University

Supharat Jarityakosol
Chulalongkorn University

Buravej Assavapongpaiboon
King Chulalongkorn Memorial Hospital, Thai Red Cross Society

Supaporn Krittanupong
King Chulalongkorn Memorial Hospital, Thai Red Cross Society

Wasee Tulvatana
Chulalongkorn University

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Abstract

This study aimed to investigate telemedicine reliability and usability for facial dystonia. Eighty-two telemedicine recordings from 43 adults with blepharospasm (12,27.9%) and hemifacial spasm (31,72.1%) were obtained (mean age 64.5+9.3 years, 32 female (64.4%)). Two recorded in-hospital telemedicine visits were arranged on the same day as in-person visits at baseline and 4-6 weeks. The third non-recorded home-based telemedicine visit was held 2 days prior to the third in-person visit at 12-14 weeks. After 8 weeks, the neuro-ophthalmologists who performed the in-person visits also evaluated the telemedicine video records. Spasm gradings by Jankovic Rating Scale (low, grades 0-2; high, grades 3-4), signs and symptoms indicating botulinum toxin complications were collected. Intra-rater agreements in assessing spasm gradings were moderate (severity: kappa=0.42, 95%CI 0.21 to 0.62, frequency: kappa=0.41, 95%CI 0.21 to 0.61) with substantial agreement in detecting lagophthalmos (kappa=0.61, 95%CI 0.36 to 0.86). Adding symptoms to signs increased sensitivity and negative predictive value in detecting lagophthalmos (66.7% to 100% and 94.3% to 100%) and drooping lips (37.5% to 75% and 93.6% to 96.4%), respectively. High mean usability score of 6.5(SD0.8) out of 7 was determined by “Thai version Telehealth Usability Questionnaire.” Therefore, telemedicine could be an alternative platform to evaluate facial dystonia.

Introduction

Clinical presentations of facial dystonia, including benign essential blepharospasm (BEB) and hemifacial spasm (HFS), are involuntary episodic contractions of the orbicularis oculi muscles. Botulinum toxin injection is the current choice of treatment but reinjections are needed. Standard quarterly in-person visits to limit the ability to detect complications such as lagophthalmos, ptosis, and drooping lips, which often occur with maximum effect at 4 to 6 weeks after injections. Frequent follow-ups to adjust injection dosage and locations are preferred, but cause increased patient traveling burdens. Since the COVID-19 pandemic, the implementation of telemedicine has expanded globally for social distancing and convenience. While the accuracy of telemedicine physical examinations has been validated for many disorders, there has been no evidence on the efficacy of using telemedicine for detecting and monitoring facial dystonia.

This study aimed to investigate the reliability and usability of telemedicine evaluations for facial dystonia compared to in-person evaluation by neuro-ophthalmologists.

Methods

This diagnostic study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (Approval number 433/2021) and registered in the Thai clinical trials registry (TCTR20210508001). Each action in this study was completed in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All participants provided written informed consent.

Samples and participants. This study aimed to collect in-hospital telemedicine visit video recordings of facial dystonia participants from the botulinum toxin outpatient clinic, Department of Ophthalmology, King Chulalongkorn Memorial Hospital (KCMH), Bangkok, Thailand. Potential facial dystonia participants, at any stage of disease, were recruited by invitation at the clinic from 11 November 2021 to 31 March 2022. Eligible participants were at least 18 years old with the ability to use the hospital telemedicine application either by themselves or with help from their caregivers. Participants with fluctuating co-morbidities such as myasthenia gravis and diseases that decrease the ability to communicate through telemedicine such as severe dementia were excluded.

Objectives and methodology. The primary objective was to validate the reliability of telemedicine in evaluating spasm severity and frequency of facial dystonia in participants and any corresponding functional disability. Other secondary objectives were to determine telemedicine's ability to recognize possible complications of botulinum toxin injections, facilitate decisions on further injections, assess impacts on daily life activities, and assess its usability.

Before each telemedicine visit, participants were trained on how to use the telemedicine application including finding the proper environment, position, and lighting for high quality video (Supplementary Appendix 1).

On the first visit, each participant was examined by a neuro-ophthalmologist (PH or SJ) for spasm gradings, signs and symptoms of complications, and impaired daily activities. Less than 2 hours apart, an initial telemedicine visit was held by non-assessor researchers (PP, WT, BA) and recorded without evaluation at KCMH telemedicine clinic. Botulinum toxin was later injected as indicated. At 4 to 6 weeks, the second telemedicine visit was arranged and recorded similar to the first visit. The second in-person evaluation by PH or SJ was held within 2 hours after the second telemedicine recording. Video recordings of the first and second visit were considered to be independent of each other due to different clinical presentations. At 12 to 14 weeks, the last non-recorded telemedicine visit was held from the participant's place within 2 days before the third in-person visit to evaluate the actual telemedicine usability. Further treatment decisions and spasm gradings were
collected in the last visit. After a washout period of more than 8 weeks, the first two telemedicine visits videos were de-identified, re-ordered, and later evaluated by the same neuro-ophthalmologist (PH or SJ), who evaluated the participants during the correlated in-person visits (Fig. 1). All telemedicine and in-person examinations were completed according to an adapted protocol (Supplementary Appendix 2).17

Outcomes and measurements. Spasm severity and frequency gradings were the primary outcomes as measured by the Jankovic rating scale (JRS) graded from 0 to 4.18 Grading were collected separately and later categorized into 2 groups, the high-grade or incapacitated group (grade 3–4) and the low-grade or non-functionally disabled group (grade 0–2). Secondary outcomes were: (1) signs and symptoms of complications after treatment including lagophthalmos, ptosis, drooping lips, and extraocular muscles limitation; (2) impaired daily activities; (3) usability, assessed by the Thai version of Telehealth Usability Questionnaire (TUQ), with permission from the questionnaire developer, University of Pittsburgh.19 Translation, back translation, content validation, and cognitive interview processes were performed to translate TUQ into Thai. Each question was scored based on a 7-point Likert scale and classified into 5 subscales: usefulness, ease of use, effectiveness, reliability, and satisfaction (Table 1).19

Sample size calculations. The five severity gradings were grouped into high-grade and low-grade groups. The calculated sample size was 74 recordings considering an expected kappa coefficient of 0.8, 0.15 precision (kappa = 0.65–0.95) 95% confidence level (95%CI) and outcome proportion of 0.7.20–22 After assuming a drop-out rate of 10%, a sample size of 83 telemedicine visits was targeted.

Statistical analysis. Appropriate descriptive statistics including median with interquartile range (IQR), mean with standard deviation (SD), frequency and percentage were used to describe subject characteristics, affected daily activities, and usability score.

Intra-rater agreement between telemedicine visit videos and in-person visit evaluations was assessed by quadratic weighted kappa coefficient for spasm severity and frequency separately. The kappa coefficient statistic was calculated to evaluate the binary outcomes agreements, which are the categorized severity and frequency gradings, detection of complications by signs alone, detection of complications by signs and symptoms, and decisions for further botulinum toxin injection. The employed definition of kappa was previously described by Landis and Koch.22 Using an in-person evaluation by a neuro-ophthalmologist as the gold standard best practice, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, negative likelihood ratio, and accuracy were further calculated with 95%CI. All analyses were performed using SPSS (version 28.0; IBM Corp) without imputation of missing data. Indeterminate results were discussed between PH and SJ for conclusion.

Results

Demographic data. Forty-three facial dystonia participants gave their consent and completed the first visit for an evaluation by the neuro-ophthalmologist. Due to traveling difficulties and COVID-19-related problems, one participant missed the second visit. Three and one participants dropped out after the first visit and second visit, respectively. A total of 82 video recordings were collected. Five videos had no sound due to recording errors, resulting in 77 videos with symptom evaluation. Grading score data was not collected from one participant during the third home telemedicine visit reducing the final total to only 38 participants for grading score comparison.

Among the 12 BEB participants, one participant was suspected of apraxia in the eyelid opening. Half of the telemedicine videos were recorded after in-person examinations, composed of the 39 first visits and 2 second visits. The other half were recorded before in-person examinations. The mean video assessment washout period was 137.18 days (SD=36.56). The low-grade group was slightly larger than the high-grade group with the highest number of videos in the JRS grade 3 (Table 2).

Reliability. Comparing 82 telemedicine visit videos to in-person visit evaluations, intra-rater agreement for the spasm severity and frequency gradings, displayed by quadratic weighted kappa score, were 0.44 and 0.42. Kappa statistics calculated for the reliability of categorized spasm severity and frequency gradings were 0.42 and 0.41, respectively. Kappa scores in detecting signs of complications were highest for lagophthalmos detection (kappa=0.61) followed by ptosis and drooping lips. No sign of extraocular muscle limitation was present throughout the study (Table 3).

Using the in-person examination as the gold standard, diagnostic accuracy for classified spasm severity and frequency, presence of lagophthalmos, ptosis, and drooping lips showed high specificity, NPV, and accuracy in recognizing complications (Table 4). After including symptoms of complications, the kappa score significantly decreased, with lower specificity and accuracy. The sensitivity and NPV of lagophthalmos and drooping lips detection showed an increase (Table 4).

In the third visit, the spasm severity and frequency weighted kappa scores of 38 telemedicine visits evaluations were 0.51 and 0.49, respectively. Kappa score slightly increased to 0.56 and 0.51 for categorized spasm severity and frequency gradings, respectively. The agreement in determining further injection did show a moderate kappa score of 0.63 (n=39) (Table 3).
Subgroup analyses

The sequence of examinations revealed that most of the prior visit evaluations were found to have higher gradings than the following visits which were held on the same day. Out of 41 telemedicine visits that occurred after in-person examinations, 6 (14.6%) had severe gradings compared to 18 (43.9%) with a lower gradings. Further categorization into high-grade (3 to 4) and low-grade (0 to 2) groups showed similar results with 3 (7.3%) higher-graded telemedicine visits versus 12 (29.2%) lower-graded visits. Additionally, gradings of 18 (43.9%) of the telemedicine visits which came before in-person examinations were more severe than in-person visits, while 8 (19.5%) telemedicine evaluations were less severe. After being categorized, only one (2.4%) telemedicine visit was graded to be milder than the in-person visit in contrast to 7 (17.1%) visits with greater grading scores.

Usability. Forty participants gave high telehealth usability scores with the highest mean score in the satisfaction subscale with 6.69 out of 7. The mean score for reliability subscale was the lowest (6.23). Total mean usability score was 6.5 (SD 0.8) out of 7. Details of all 21 questions are displayed in Table 1.

Effect on daily life activities. Spasmodic eyelids were reported to disturb participant habits in 36 out of 82 (45%) visits. Limited activities were driving (n=8, 36.1%), social meeting (n=11, 30.6%), reading (n=6, 16.7%), walking (n=4, 11.1%), and sewing (n=2, 5.6%). Impacts on eating, watching television, and sleeping were reported in one visit per activity (2.8%). No adverse events were reported during the study.

Discussion

Telemedicine abilities to detect gross presentations have been proven in a wide range of medical specialties including ophthalmology and neurology. Fraint et al. (n = 46) reported excellent reliability (kappa = 0.89; 95% CI 0.71 to 0.95) in determining the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS) motor severity summary score in cervical dystonia, a disease which can be assessed by visual examination similar to facia dystonia. In contrast to this study, our telemedicine evaluation showed moderate agreement for spasm severity (kappa = 0.44; 95% CI 0.25 to 0.64), spasm frequency (kappa = 0.42; 95% CI 0.22 to 0.62), and classified gradings (severity; kappa = 0.42, 95% CI 0.21 to 0.62 and frequency; kappa = 0.41, 95% CI 0.21 to 0.61). This could be explained by the dynamicity of facial dystonia, unlike the study on spasmodic torticollis which was evaluated by a more static component and larger organ movement. The fine periodic facial spasm changes over time and other factors such as stress, light, activity, and attention add to the difficulty of video diagnosis. Video quality and internet signal affected the ability to assess participant grading despite the efforts to enhance recording resolution. Tarolli et al. also mentioned moderate correlations between remote and in-person motor assessments, with an intraclass correlation coefficient (ICC) of 0.43 for the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) and 0.51 for the UPDRS motor assessment. In addition, lower agreement and difficulties in evaluating dystonia (ICC = 0.31) and oculomotor aspect (ICC = 0.41) were demonstrated in a pilot study on remote assessment in Huntington's disease (n = 11). We found that no matter how close the two visits were apart, an hour or a few days, the agreements in facial dystonia grading and injection requirement were similar at moderate agreement.

After taking symptoms into consideration, the increased sensitivity and NPV in detecting lagophthalmos and drooping lips corresponded with previous reports of the screening potential of telemedicine by taking a detailed history together with video or photograph examination. Supporting evidence for greater ability to detect related complications was reported. A kappa coefficient of 0.55 (95% CI 0.39 to 0.88) in detecting facial paresis was correlated with our substantial agreement in lagophthalmos detection (kappa = 0.61; 95% CI 0.36 to 0.86), and moderate agreement for both ptosis (kappa = 0.59, 95% CI 0.31 to 0.86) and drooping lips detection (kappa = 0.47; 95% CI 0.11 to 0.82). Although abnormal eye movement was not present in this study, it was detected in general neurological patients with a kappa coefficient of 0.58 (95% CI 0.39 to 0.88). In addition, an overall kappa coefficient of 0.66 was demonstrated for detecting abnormal extraocular motility, ptosis, and other ocular signs in two ophthalmology clinics. Since lagophthalmos is a complication that could be treated by lubrication or lid tapping to prevent further corneal complications, its high detectability by telemedicine could improve facial dystonia management. Our assessors also noted that the chin-up position could enhance lagophthalmos noticeability. This position was used to detect lagophthalmos in previous reports.

Lower grading severity in the later visit in a post hoc subgroup analysis, whether it was telemedicine or in-person visit, could be due to participant familiarity with the examination processes.
controlled examination steps to minimize influencing factors such as rest status, time, and situation. Lastly, high usability scoring from this study is consistent with prior satisfactory teleconsultation reports.

This study was the first to investigate telemedicine reliability in the evaluation of both the grading and treatment complications of facial dystonia. The examination protocol of this study should be studied further as a possible future standard.

In conclusion, telemedicine produced high usability scores and better reliability in evaluating facial dystonia treatment complications than its spasm gradings. The dynamic periodic spasm of the disease should be taken into consideration when assessing difficulties in reaching higher reliability.

Declarations

Data availability

Full protocol, datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgements

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Author contributions

PP, PH, W.T., S.J., and S.K. contributed to the study design. PP, PH, W.T., S.J., and B.A. collected clinical data. PP analysed the data, performed statistical analysis and wrote the original manuscript. PH, W.T., S.J., B.A. and S.K. critically reviewed and edited the manuscript. PP, PH and S.K. contributed to the resources. Funding acquisition was made by PP and PH.

PH supervised the study. PP and PH equally contributed to the study.

Additional Information

Supplementary information. Supplementary materials are available in online version.

Competing interests. All authors have no known competing financial or non-financial conflicts of interest to declare.

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References


Tables

**Table 1.** Telehealth usability questionnaire and usability score (n = 40 patients)
<table>
<thead>
<tr>
<th>Items and subscales</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telehealth improves my access to healthcare services.</td>
<td>5</td>
<td>7</td>
<td>6.65</td>
<td>0.7</td>
</tr>
<tr>
<td>Telehealth saves me time travelling to a hospital or specialist clinic.</td>
<td>5</td>
<td>7</td>
<td>6.8</td>
<td>0.56</td>
</tr>
<tr>
<td>Telehealth provides for my healthcare need.</td>
<td>5</td>
<td>7</td>
<td>6.4</td>
<td>0.87</td>
</tr>
</tbody>
</table>

**Usefulness**

- It was simple to use this system.                                                                                     | 4   | 7   | 6.45 | 0.96|
- It was easy to learn to use the system.                                                                                | 5   | 7   | 6.33 | 0.83|
- I believe I could become productive quickly using this system.                                                          | 5   | 7   | 6.4  | 0.84|
- The way I interact with this system is pleasant.                                                                          | 5   | 7   | 6.65 | 0.58|
- I like using the system.                                                                                              | 5   | 7   | 6.25 | 0.87|
- The system is simple and easy to understand.                                                                             | 4   | 7   | 6.45 | 0.87|

**Ease of Use**

- This system is able to do everything I would want it to be able to do.                                                   | 5   | 7   | 6.25 | 0.87|
- I can easily talk to the clinician using the telehealth system.                                                          | 4   | 7   | 6.56 | 0.75|
- I can hear the clinician clearly using the telehealth system.                                                            | 5   | 7   | 6.73 | 0.64|
- I felt I was able to express myself effectively.                                                                          | 5   | 7   | 6.48 | 0.72|
- Using the telehealth system, I can see the clinician as well as if we met in person.                                   | 4   | 7   | 6.58 | 0.78|

**Effectiveness**

- I think the visits provided over the telehealth system are the same as in-person visits.                               | 4   | 7   | 6.45 | 0.81|
- Whenever I made a mistake using the system, I could recover easily and quickly.                                         | 5   | 7   | 6.26 | 0.91|
- The system gave error messages that clearly told me how to fix problems.                                                 | 2   | 7   | 5.97 | 1.21|

**Reliability**

- I feel comfortable communicating with the clinician using the telehealth system.                                        | 5   | 7   | 6.78 | 0.48|
- Telehealth is an acceptable way to receive healthcare services.                                                          | 5   | 7   | 6.7  | 0.56|
- I would use telehealth services again.                                                                                 | 5   | 7   | 6.54 | 0.72|
- Overall, I am satisfied with this telehealth system.                                                                     | 5   | 7   | 6.74 | 0.6 |

**Satisfaction**

- 6.69 0.6

Modified from Parmanto, Lewis, Graham, and Bertolet 19
Table 2. Demographic data of recruited participants and video recordings

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. (%)</th>
<th>Jankovic rating scale, No. (%)</th>
<th>Severity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11 (25.6)</td>
<td>Grade 0</td>
<td>16 (19.5)</td>
<td>16 (19.5)</td>
</tr>
<tr>
<td>Female</td>
<td>32 (74.4)</td>
<td>Grade 1</td>
<td>18 (22)</td>
<td>18 (22)</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>64.53 (9.27)</td>
<td>Grade 2</td>
<td>14 (17.1)</td>
<td>16 (19.5)</td>
</tr>
<tr>
<td>Disease</td>
<td>No. participants (%)</td>
<td>No. recordings (%)</td>
<td>Grade 3</td>
<td>24 (29.2)</td>
</tr>
<tr>
<td>BEB</td>
<td>12 (27.9), 21 (25.6)</td>
<td>Grade 4</td>
<td>10 (12.2)</td>
<td>9 (11)</td>
</tr>
<tr>
<td>HFS</td>
<td>31 (72.1), 61 (74.4)</td>
<td>Categorized grading, No. (%)</td>
<td>Severity</td>
<td>Frequency</td>
</tr>
<tr>
<td>Device operating system, No. (%)</td>
<td>High-grade group</td>
<td>48 (58.5)</td>
<td>50 (61)</td>
<td></td>
</tr>
<tr>
<td>IOS</td>
<td>10 (23.3)</td>
<td>Low-grade group</td>
<td>34 (41.5)</td>
<td>32 (39)</td>
</tr>
<tr>
<td>Android</td>
<td>33 (76.7)</td>
<td>Sequence between in-person examination and telemedicine recordation, No. (%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prior telemedicine experience, No. (%)

| Yes             | 29 (67.4) | In-person visit first | 41 (50)  |
| No              | 14 (32.6) | Telemedicine visit first | 41 (50)  |

Table 3. Agreement between telemedicine and in-person evaluations

<table>
<thead>
<tr>
<th>Items</th>
<th>Signs (n = 82 videos)</th>
<th>Signs and symptoms (n = 77 videos)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagophthalmos</td>
<td>0.61 (0.36 to 0.86)</td>
<td>0.35 (0.18 to 0.50)</td>
</tr>
<tr>
<td>Ptosis</td>
<td>0.59 (0.31 to 0.86)</td>
<td>0.08 (-0.04 to 0.20)</td>
</tr>
<tr>
<td>Drooping lips</td>
<td>0.47 (0.11 to 0.82)</td>
<td>0.24 (0.04 to 0.44)</td>
</tr>
<tr>
<td>Eye movement limitation</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

In-hospital telemedicine visit

| Spasm severity score (0-4)     | 0.44 (0.25 to 0.64) | 0.51 (0.23 to 0.78) (n = 38 participants) |
| Classified spasm severity     | 0.42 (0.21 to 0.62) | 0.56 (0.29 to 0.83) |
| Spasm frequency score (0-4)   | 0.42 (0.22 to 0.62) | 0.49 (0.22 to 0.77) |
| Classified spasm frequency    | 0.41 (0.21 to 0.61) | 0.51 (0.23 to 0.79) |
| Further treatment decision    | -                     | 0.63 (0.38 to 0.88) (n = 39 participants) |

Third real-life telemedicine visit

Quadratic weighted Kappa or Kappa (95% confidence interval)

Table 4. Diagnostic accuracy of telemedicine visit evaluation

(95% confidence interval)
<table>
<thead>
<tr>
<th>Diagnostic accuracy</th>
<th>Complications (In-hospital telemedicine)</th>
<th>In-hospital telemedicine</th>
<th>Third home-based telemedicine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lagophthalmos</td>
<td>Ptosis</td>
<td>Drooping lips</td>
</tr>
<tr>
<td></td>
<td>Signs</td>
<td>S&amp;S</td>
<td>Signs</td>
</tr>
<tr>
<td>n=</td>
<td>82 videos</td>
<td>77 videos</td>
<td>82 videos</td>
</tr>
<tr>
<td>Sensitivity, %</td>
<td>66.7</td>
<td>100</td>
<td>(34.9 to 90.1)</td>
</tr>
<tr>
<td>Specificity, %</td>
<td>94.3</td>
<td>64.3</td>
<td>(86 to 98.4)</td>
</tr>
<tr>
<td>PPV, %</td>
<td>66.7</td>
<td>32.4</td>
<td>(41.6 to 84.9)</td>
</tr>
<tr>
<td>NPV, %</td>
<td>94.3</td>
<td>100</td>
<td>(88.1 to 97.4)</td>
</tr>
<tr>
<td>Positive LR</td>
<td>11.7</td>
<td>2.8</td>
<td>(4.2 to 32.8)</td>
</tr>
<tr>
<td>Negative LR</td>
<td>0.4</td>
<td>0</td>
<td>(0.2 to 0.8)</td>
</tr>
<tr>
<td>Accuracy, %</td>
<td>90.2</td>
<td>69.5</td>
<td>(81.7 to 95.7)</td>
</tr>
</tbody>
</table>

Abbreviation: n=number of samples, S&S=sign and symptom, PPV=positive predictive value, NPV=negative predictive value, LR = Likelihood ratio

**Figures**
Figure 1

Study flow diagram

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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