Clinical Case Article • DOI: http://dx.doi.org/10.2478/medu-2020-0018 Medical University • 3(4) • 2020

Medical University

AN OBJECTIVE METHOD FOR ASSESSMENT OF FACIAL EXPRESSION IN PATIENTS WITH PARKINSON'S DISEASE AND HEALTHY POPULATION

S.V. Prokopenko[1], A.A. Khomchenkova[1], V.A. Gurevich[1], N.A. Butenko[2], V.A. Kontorin[2], A.V. Spirin[2]

[1]*FSBEI HE Prof. V.F. Voino-Yasenetsky Krasnoyarsk State Medical University MOH Russia, Krasnoyarsk, Russian Federation*
[2]*Association "Mutual Business Interests (Independent Association of Supplementary Education)", Krasnoyarsk, Russian Federation*

Abstract

Hypomimia is a common symptom of Parkinson's disease. At the present time, issues related to existence of interrelations between hypomimia and manifestations of common hypokinesia remain under-investigated in aspects of both clinical manifestations and rehabilitation efficacy. An objective method for facial muscle movement diagnostics is necessary to achieve this goal. The article presents novel experience in application of a proprietary method using objective facial expression assessment video analysis on the example of a healthy female subject and a female patient with Parkinson's disease. The Parkinson's female patient had objective symptoms of hypomimia: a decrease in velocity and amplitude of eyebrow and mouth movement, slow winking. Therefore, application of this method creates prerequisites for more in-depth study of theoretical and clinical aspects in facial expression of Parkinson's disease patients.

Keywords

Parkinson's disease • hypokinesia • hypomimia • video analysis of facial expression

Introduction

As is commonly known, hypomimia – impairment of facial expression – is among important clinical manifestations of Parkinson's disease (PD). The patient's face assumes mask-like expression, slowness and decrease amplitude of facial muscles is observed. At examination, the patient demonstrates decreased winking frequency, lowered expressiveness of eyebrow movement, weakened movement of the mouth varying from spontaneous smile impairment to half-open resting mouth [1-3]. Hypomimia combined with other motor and non-motor PD symptoms decreases the patients' quality of life [4, 5]. Decrease in facial expressiveness is assumed as manifestation of indifference and detachment by other people, which in turn leads to difficulties in social contacts and promotes appearance of anxiety and depression disorders [6-8]. Generally, facial expression is assessed subjectively [9, 10]. The most frequent method used for hypomimia degree evaluation is a fragment of the UPDRS making it possible to determine the degree of facial muscle movement impairment according to a point system with the degrees varying from 0 to 4 [11]. In clinical practice, increased facial expressiveness in the PD patient is a sign of effective dopaminergic therapy and other rehabilitation activities.

Presently, issues related to the interrelation between hypomimia and general hypokinesia remain insufficiently studied. In particular, it is not clear whether we may exert influence on manifestations of hypokinesia through facial expressiveness activation. Do such facial expressiveness activation methods exist in medical practice? There is little data available [12].

Therefore, assessment of hypomimia manifestations is possibly an important aspect in management of PD patients. A method for objective analysis of velocity and amplitude of facial muscular system movement is required in order to solve a number of clinical and theoretical problems.

The aim of the study was to create a method for objective evaluation of facial expression movements and assess its diagnostic capabilities.

Materials and Methods

An objective method for assessment of facial expression muscles movement has been developed at the department of

Corresponding author: A. Khomchenkova
E-mail: sasha021@mail.ru

sciendo

neurological diseases with a course of postgraduate education at the Prof. V.F. Voino-Yasenetsky Krasnoyarsk State Medical University in collaboration with the Association “Mutual Business Interests (Independent Association of Supplementary Education)”. The method is based on computer video analysis of facial expression and is a hardware and software suite consisting of software created in the Visual Studio 2015 programming package using the PostgreSQL database management system and a video camera with the resolution of 1280x720. Assessment of facial muscle activity is performed without immediate touching and via recording of a video with a web camera. The software registers coordinates of 68 key points on the face using an open-source library of computer vision of the Python programming language. By this means, motion of eyelids, eyebrows and lips is recorded. During examination, the patient is offered to perform six diagnostic tests at the doctor’s signal (see Table 1) that make it possible to evaluate the velocity and amplitude of facial muscles. A total of 10 seconds is given for performance of each of the first five tests. The text-reading test has no time restrictions.

Results and Discussion

According to the data obtained, a digital database is formed containing all aforementioned facial movement parameters.

Below are results of facial expression video analysis results after examination of a healthy female subject aged 73 and a female PD patient aged 74 with an established diagnosis of stage 2 PD according to Hoehn and Yahr Rating Scale, akinetic-rigid-tremulous form. The disease duration was 5 years and the test was performed at the time of Levodopa dose offset (see Table 2).

As it follows from the data presented, the analysis showed significant difference between all spatial and temporal values (decrease in movement amplitude and velocity in the PD female patient). Higher indices of amplitude are observed in the healthy subject: 1.5 times higher along the X axis and 2 times higher along the Y axis. The PD patient performed 1.5 times less smiles that the healthy subject. The area of the

Table 1. Diagnostic tests for facial expression analysis

№	Diagnostic test	Description	Values analysed
1.	Fast smile	The patient is offered to smile as many times as possible and with the maximum amplitude	-quantity of smiles in 10 seconds -mean smile amplitude along the X axis (mm); -mean distance between the upper and the lower lips along the Y axis
2.	Letter “O”	The patient is offered to draw the letter “O” with shut pursed lips	-the area of the “O” letter drawn (mm^2)
3.	Winking	The patient is offered to wink with maximum possible frequency	-quantity of winks in 10 seconds
4.	Eyebrow elevation	The patient is offered to elevate eyebrows at maximum speed and amplitude	-quantity of eyebrow elevations in 10 seconds -mean distance along the X axis (mm) -mean height of eyebrow elevation along the Y axis (mm)
5.	Frowning	The patient is offered to approximate the eyebrows and split them back at maximum speed and amplitude	- quantity of frowns in 10 seconds; - mean distance between the eyebrows
6.	Text reading	The patient is offered to read a text at a comfortable pace	-mean amplitude of the smile along the X axis (mm); -mean distance between the upper and the lower lips along the Y axis; -mean distance between the eyebrows along the X axis (mm) -mean height of eyebrow elevation along the Y axis (mm) -voice pitch (Hz)

Table 2. Results of the objective analysis of facial expression in a clinically healthy female subject and a female PD patient

№	Diagnostic test	Values	Healthy subject, 73 years old	PD patient, 74 years old
1.	Fast smile	X of the mouth (mm)	24.05	16.71
		У of the mouth (mm)	21.66	10.73
		Velocity (times/10 sec)	9	6
2.	Letter “O”	S ($mm^{2)}$	498	248
3.	Winking	Velocity (times/10 sec)	49	27
4.	Eyebrow elevation	X of the eyebrows (mm)	21.29	10.1
		У of the eyebrows (mm)	23.34	12.1
		Velocity (times/10 sec)	10	7
5.	Frowning	X of the eyebrows (mm)	10.4	5.59
		Velocity (times/10 sec)	8	6
6.	Text reading	X of the mouth (mm)	10.03	6.06
		У of the mouth (mm)	27.2	14.8
		X of the eyebrows (mm)	2.4	2.25
		У of the eyebrows (mm)	2.4	1.24
		Pitch (Hz)	187.5	187.5

“O” letter and the winking speed was almost two times higher in the healthy subject. The eyebrow movement and frowning amplitude was reduced twofold in the female PD patient with a 1.5 times lower quantity of eyebrows elevations and insignificant difference in frowning quantity. While reading the text, the healthy subject performed twice more active lip and eyebrows motion in comparison to the PD patient.

Conclusion

Objective facial expression evaluation revealed all main manifestations of hypomimia in the female PD patient: decrease in the amplitude and velocity of mouth and eyebrow movement and winking.

It is possible that the proprietary method of facial expression evaluation has prospects of assessment of its diagnostic value with establishment of its sensitivity and specificity as well as further implementation in clinical practice for analysis of efficacy of conducted therapy and rehabilitation. It is also planned to perform a larger-scale study on PD patients aimed at assessment of the association between hypomimia and general hypokinesia and gait impairment. The data obtained may become the basis for development of rehabilitation methods for correction of hypomimia and general hypokinesia.

Conflict of Interest Statement

The authors declared no conflict of interest.

References

1. Bologna M, Fabbrini G, Marsili L, Defazio G, Thompson PD, Berardelli A. Facial bradykinesia. J Neurol Neurosurg Psychiatry. 2013;84(6):681–5. https://doi.org/10.1136/jnnp-2012-303993
2. Garcia-Ruiz PJ, Feliz-Feliz CE, Maycas-Cepeda T, Del Val-Fernandez J. Amimia in Parkinson's disease. Significance and correlation with the clinical features. Rev Neurol. 2018;66(2):45–8. Spanish. https://doi.org/10.33588/rn.6602.2017387
3. Rinn WE. The neuropsychology of facial expression: a review of the neurological and psychological mechanisms for producing facial expressions. Psychol Bull. 1984;95(1):52–77. https://doi.org/10.1037/0033-2909.95.1.52
4. Kulua TK, Fedorova NV, Bril EV. Quality of life in patients with Parkinson's disease. Pharmateca. 2017;(20):13–8. Russian.
5. Behari M, Srivastava AK, Pandey RM. Quality of life in patients with Parkinson's disease. Parkinsonism & related disorders. 2005;11(4):221–6. https://doi.org/10.1016/j.parkreldis.2004.12.005
6. Kang J, Derva D, Kwon DY, Wallraven C. Voluntary and spontaneous facial mimicry toward other's emotional expression in patients with Parkinson's disease. PLoS One. 2019;14(4):e0214957. https://doi.org/10.1371/journal.pone.0214957
7. Gunnery SD, Habermann B, Saint-Hilaire M, Thomas CA, Tickle-Degnen L. The relationship between the experience of hypomimia and social wellbeing in people with Parkinson's disease and their care partners. J Parkinsons Dis. 2016;6(3):625–30. https://doi.org/10.3233/JPD-160782
8. Ma HI, Gunnery SD, Stevenson MT, Saint-Hilaire M, Thomas CA, Tickle-Degnen L. Experienced facial masking indirectly compromises quality of life through stigmatization of women and men with Parkinson's disease. Stigma Health. 2019;4(4):462–72. https://doi.org/10.1037/sah0000168
9. Ricciardi L, De Angelis A, Marsili L, Faiman I, Pradhan P, Pereira EA, et al. Hypomimia in Parkinson's disease: an axial sign responsive to levodopa. Eur J Neurol. 2020;27(12):2422–29. https://doi.org/10.1111/ene.14452
11. Özekmekçi S, Benbir G, Özdogan FY, Ertan S, Kiziltan ME. Hemihypomimia, a rare persistent sign in Parkinson's disease: follow up of 11 patients. J Neurol. 2007;254(3):347–50. https://doi.org/10.1007/s00415-006-0372-z
12. Buck PO, Wilson RE, Seeberger LC, Conner JB, Castelli-Haley J. Examination of the UPDRS bradykinesia subscale: equivalence, reliability and validity. J Parkinsons Dis. 2011;1(3):253–8. https://doi.org/10.3233/JPD-2011-11035
13. Ricciardi L, Baggio P, Ricciardi D, Morabito B, Pomponi M, Bentivoglio AR, et al. Rehabilitation of hypomimia in Parkinson's disease: a feasibility study of two different approaches. Neurol Sci. 2016;37(3):431–6. https://doi.org/10.1007/s10072-015-2421-9