Movement Disorders
CLINICAL PRACTICE

Graphic Summary of Movement Disorders Society Criteria for Progressive Supranuclear Palsy and Multiple Allocations eXtinction Rules

Takashi Ogawa, MD, Taku Hatano, MD, PhD, Genko Oyama, MD, PhD, Masashi Takanashi, MD, PhD, Daisuke Taniguchi, MD, and Nobutaka Hattori, MD, PhD*

The National Institute of Neurological and Communicative Disorders and Stroke developed criteria for progressive supranuclear palsy (PSP) criteria in 1996,[1] which have played an important role in characterizing diagnosis in clinical and pathological research settings. However, patients with PSP exhibit various clinical phenotypes, particularly at an early stage,[2] and a broader disease concept is required. New PSP criteria, included in "Clinical Diagnosis of Progressive Supranuclear Palsy: The Movement Disorder Society Criteria," were created by the Movement Disorder Society–endorsed PSP Study Group in 2017.[3] The new PSP criteria define the predominance type in detail using 4 core clinical features. Furthermore, sensitivity was improved without lowering specificity when compared with the National Institute of Neurological and Communicative Disorders and Stroke criteria.[4]

Grimm and colleagues[1] developed the Multiple Allocations eXtinction (MAX) rules, making it possible for the new PSP criteria to cope with the earlier diagnosis and changes over time from the overlapping predominance type.[5] Applying the MAX rules increases the usefulness of the new PSP criteria. However, owing to the variety of PSP clinical phenotypes, application of the diagnostic criteria is complex. Thus, we created a figure arranged in a hexagon to provide a visual representation of the diagnosis (Fig. 1A). We included the core clinical features and clues, surrounding the items for each predominance type. Each predominance type is indicated by color. Diagnostic levels of "probable" and "possible" are represented by solid lines, "suggestive of" is represented by broken lines, and "or" connects 2 items with diagnosis of the same color. The "or" between ocular motor dysfunction-highest (O1) and -mid (O2) is always an alternative of O1 and O2. We included the MAX rules at the bottom of figure. The inequality sign indicates that the left box has more diagnostic weight and corresponds to MAX Hierarchy (MAX 4). Phenotypic Hierarchy (MAX3) is described in accordance with the items of the PSP with Richardson's syndrome (PSP-RS), PSP with predominant postural instability (PSP-PI), and PSP with predominant ocular motor dysfunction (PSP-OM) predominance type.

An example of applying the MAX rules to the clinical course is shown in Figure 1B. A 72-year-old male developed gait disturbance and asymmetrical parkinsonism without responsiveness to levodopa (year 1: suggestive of PSP with predominant parkinsonism (PSP-P)). Gait freezing with repetitive unprovoked fall was gradually reported (year 2: possible PSP with progressive gait freezing (PSP-PGF)). Later, vertical supranuclear gaze palsy, apraxia, and frontal releasing sign was emerged, and the patient finally showed dysarthria and easy fall, making it impossible for the patient to stand by himself (year 5: probable PSP-RS). Symptoms progressed further until the patient was bedridden. A gastrostomy was conducted for severe dysphagia, and hospitalization for aspiration pneumonia was repeated (years 9–12: probable PSP-RS). Finally, a pathological anatomy revealed diffuse tau deposition (year 12: definite PSP).

By including items that correspond to clinical symptoms, the graphic summary can aid the clarity of diagnosis. In addition, embedding the disease progression according to the MAX rules in the diagram increases understanding of the patient's disease course. Digital applications are useful for various clinical criteria. However, because the clinical criteria for PSP are too complex for current digital applications, our

Department of Neurology, Juntendo University School of Medicine, Tokyo, Japan

***Correspondence to:** Dr. Taku Hatano, Department of Neurology, Juntendo University School of Medicine, 2-1-1 Hongo, Bunkyo-ku, Tokyo 113-8421, Japan; E-mail: thatano@juntendo.ac.jp
Keywords: progressive supranuclear palsy, MDS-PSP criteria, graphic summary.
Relevant disclosures and conflicts of interest are listed at the end of this article.
Received 18 October 2019; revised 2 December 2019; accepted 7 December 2019.
Published online 20 January 2020 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/mdc3.12894

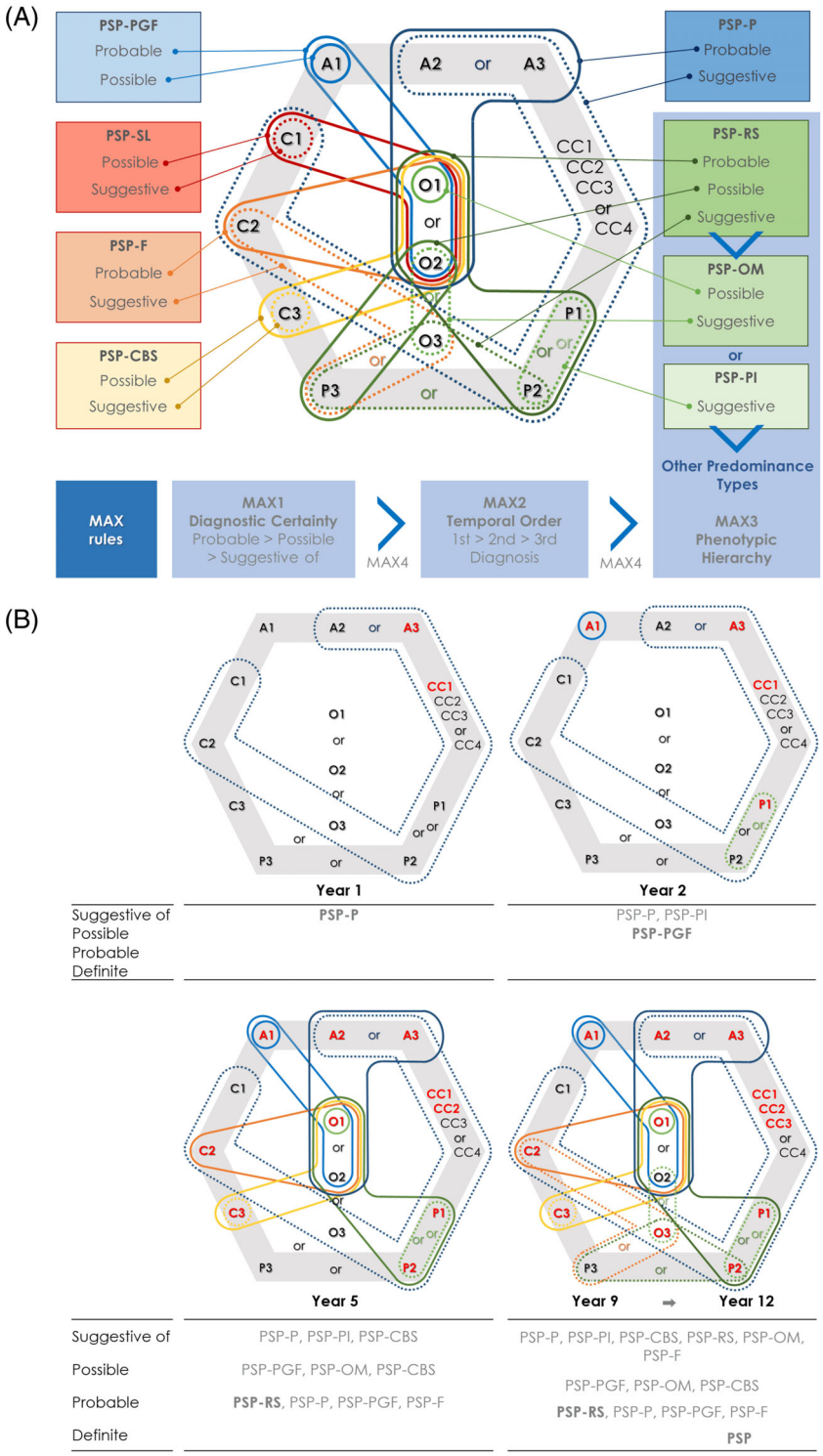

FIG. 1. (**A**) Graphic summary of clinical research criteria for diagnosis of progressive supranuclear palsy. Colors indicate predominance type. (**B**) MAX rules are shown at the bottom and applied to a case pathologically diagnosed with PSP and applied to our figure over time. MAX, multiple allocations extinction; MAX1, Diagnostic Certainty; MAX2, Temporal Order; MAX3, Phenotypic Hierarchy; MAX4, MAX Hierarchy; PSP-PGF, PSP with progressive gait freezing; PSP-P, PSP with predominant parkinsonism; PSP-RS, PSP with Richardson's syndrome; PSP-OM, PSP with predominant ocular motor dysfunction; PSP-PI, PSP with predominant postural instability; PSP-CBS, PSP with predominant corticobasal syndrome; PSP-F, PSP with predominant frontal presentation; PSP-SL, PSP with predominant speech/language disorder.

graphic summary may be useful as an interim solution. This graphic representation may help neurologists with diagnosis of PSP phenotypes.

Acknowledgments

We thank Benjamin Knight, MSc, from Edanz Group (https://en-author-services.edanzgroup.com/) for editing a draft of this article.

Author Roles

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

T.O.: 1A, 1B, 1C, 3A
T.H.: 1A, 1B, 1C, 3A, 3B
G.O.: 1A, 1B, 1C, 3B
D.T.: 1A, 1C, 3B
T.M.: 1A, 1C, 3B
N.H.: 1A, 1C, 3B

Disclosures

Ethical Compliance Statement: This study protocol complied with the Declaration of Helsinki and was approved by the ethics committee of Juntendo University (15-124). Written informed consent for publication was obtained and documented from the patient. 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.

Funding Sources and Conflicts of Interest: This work was funded by Strategic Research Program for Brain Sciences from the Japan Agency for Medical Research and Development under Grant 19dm0107156 and grants-in aid from the Research Committee of CNS Degenerative Diseases; Research on Policy Planning and Evaluation for Rare and Intractable Diseases; Health, Labor and Welfare Sciences Research grants; and the Ministry of Health, Labor and Welfare, Japan.

Financial Disclosures for the Previous 12 Months: Dr. Ogawa has no conflicts to disclose and reports employment with Juntendo University School of Medicine. Dr. Hatano received a grant from the Japan Agency for Medical Research and Development (AMED) under Grant 19dm0107156, a grant from Eisai Co., Ltd., speaker's honoraria (Dainippon Sumitomo, Takeda, FP Pharmaceutical, Corporat Kyowa Hakko-Kirin, Nippon Boehringer Ingelheim, Nihon Medi-Physics, Novartis Pharma K.K., and Otsuka), and employment with Juntendo University School of Medicine. Dr. Oyama has received a KAKEN Grant-in-Aid for Scientific Research (Grant 18K07509) and a grant from Novartis Pharma (Novartis Research Grants 2019) and has received speaker honoraria from Medtronic, Boston Scientific, Otsuka Pharmaceutical, Sumitomo Dainippon Pharma, FP Pharmaceutical Corporation, Kyowa Hakko Kirin, and Abbvie. Dr. Taniguchi and Dr. Takanashi have no conflicts to disclose and reports employment with Juntendo University School of Medicine. Dr. Hattori received grants from JSPS (24390224 and 18H04043) and grants-in aid from the Research Committee of Central Nervous System Degenerative Diseases; Research on Policy Planning and Evaluation for Rare and Intractable Diseases; Health, Labor and Welfare Sciences Research grants; the Ministry of Health, Labor and Welfare, Japan; AMED-CREST; program for Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS 19dm0207070; AMED Grants JP19ek0109393 and 19ek0109358). Dr. Hattori is a member of the advisory boards for Dainippon Sumitomo, Eisai, FP Pharmaceutical, Kyowa Hakko-Kirin, Otsuka, Ono, Tanabe-Mitsubishi, and Takeda; receives grant support (Biogen, Boehringer Japan, Boston Scientific, Eisai, Medtronic, Meiji, Otsuka, and Takeda) and honoraria (DaiNippon, FP Pharmaceutical, Novartis, Otsuka, and Takeda); and reports employment with Juntendo University School of Medicine.

References

1. Grimm MJ, Respondek G, Stamelou M, et al. How to apply the movement disorder society criteria for diagnosis of progressive supranuclear palsy. *Mov Disord* 2019;34:1228–1232.
2. Litvan I, Agid Y, Calne D, et al. Clinical research criteria for the diagnosis of progressive supranuclear palsy (Steele-Richardson-Olszewski syndrome): report of the NINDS-SPSP international workshop. *Neurology* 1996;47:1–9.
3. Williams DR, Lees AJ. Progressive supranuclear palsy: clinicopathological concepts and diagnostic challenges. *Lancet Neurol* 2009;8:270–279.
4. Hoglinger GU, Respondek G, Stamelou M, et al. Clinical diagnosis of progressive supranuclear palsy: The Movement Disorder Society Criteria. *Mov Disord* 2017;32:853–864.
5. Ali F, Martin PR, Botha H, et al. Sensitivity and specificity of diagnostic criteria for progressive supranuclear palsy. *Mov Disord* 2019;34:1144–1153.

Supporting Information

Supporting information may be found in the online version of this article.

Supplemental Material S1. Graphic summary of clinical research criteria for the diagnosis of progressive supranuclear palsy (Steele-Richardson-Olszewski syndrome).