*Year :* 2017

# Testing Head Rotation and Flexion Is Useful in Functional Limb Weakness

Horn Dimitri

UNIL | Université de Lausanne
Ecole doctorale

**UNIVERSITÉ DE LAUSANNE - FACULTÉ DE BIOLOGIE ET DE MÉDECINE**
Département des Neurosciences cliniques
Service de Neurologie

# Testing Head Rotation and Flexion Is Useful in Functional Limb Weakness

THESE

préparée sous la direction du Professeur François Vingerhoets
(avec la co-direction de la Dresse Selma Aybek)

et présentée à la Faculté de biologie et de médecine de
l'Université de Lausanne pour l'obtention du grade de

DOCTEUR EN MEDECINE

par

Dimitri HORN

Médecin diplômé de la Confédération Suisse
Originaire de Trélex (Suisse)

Lausanne
2017

UNIL | Université de Lausanne

Faculté de biologie
et de médecine

Ecole Doctorale
Doctorat en médecine

# Imprimatur

*Vu le rapport présenté par le jury d'examen, composé de*

| | |
|---|---|
| ***Directeur de thèse*** | *Monsieur le Professeur* ***Francois Vingerhoets*** |
| ***Co-Directeur de thèse*** | *Madame la Docteure* ***Selma Aybek*** |
| ***Expert*** | *Monsieur le Professeur* ***Alexandre Berney*** |
| ***Vice-Directeur de l'Ecole doctorale*** | *Monsieur le Professeur* ***John Prior*** |

*la Commission MD de l'Ecole doctorale autorise l'impression de la thèse de*

**Monsieur Dimitri HORN**

*intitulée*

***Testing Head Rotation and Flexion Is Useful in Functional Limb Weakness***

*Lausanne, le 14 novembre 2017*

*pour Le Doyen*
*de la Faculté de Biologie et de Médecine*

*Monsieur le Professeur John Prior*
*Vice-Directeur de l'Ecole doctorale*

Movement Disorders
CLINICAL PRACTICE
RESEARCH ARTICLE

# Testing Head Rotation and Flexion Is Useful in Functional Limb Weakness

*Dimitri Horn, MSc,[1] Silvio Galli, MD,[1] Alexandre Berney, MD,[2] François Vingerhoets, MD,[3] Selma Aybek, MD[1,*]*

**Abstract:** **Background:** Functional (psychogenic) neurological disorders (FNDs) are common and should be diagnosed using positive diagnostic features of internal inconsistency. However, there is a lack of objective data regarding motor signs and a lack of signs relating to motor disorders that affect the upper body and neck. The objective of this study was to provide specificity and sensitivity data on 2 axial motor signs: the sternocleidomastoid (SCM) and platysma signs.
**Methods:** Thirty patients with motor FNDs according to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, and 40 organic controls with unilateral weakness were prospectively included. The SCM functional sign and platysma organic signs were systematically tested and compared between groups.
**Results:** The SCM sign had high specificity of 90% (confidence interval [CI], 77%–96%) to detect FND when the platysma sign had 100% specificity (CI, 88%–100%) for detecting organic weakness. The co-occurrence of a positive SCM and a negative platysma sign in patients with unilateral weakness carried 95% specificity (CI, 83%–99%) and 63% sensitivity (CI, 44%–80%).
**Conclusion:** The SCM test and platysma signs can be used for the diagnosis of motor FND. The extent to which these add value to other validated signs (such as Hoover's sign) should be further evaluated.

Interest in functional symptoms in neurology has reemerged in recent years[1,2] alongside attempts to better validate bedside signs.[3,4] To diagnose functional paresis, it is important, but not sufficient, to exclude organic signs (like Babinski's plantar reflex); it is also necessary to demonstrate the presence of "positive" functional signs,[5] such as Hoover's sign of lower limb weakness,[6] or the hip abductor sign,[7] drift without pronation,[8] or give-way weakness.[9] The clinical utility of these signs has been studied,[4] but little literature is available on axial signs (i.e., signs not lateralized to a limb). Thus, our aim was to select axial signs and conduct a validation study of their clinical utility.

The 3 main axial signs described are the sternocleidomastoid (SCM),[10] platysma,[11] and trunk-thigh[4,11] signs. The SCM sign, tested by Russian researchers,[10,12] suggests that asymmetric weakness of head rotation, with weakness of head turning toward the side of a hemiparesis, represents a positive sign of a functional disorder. If such weakness in hemiparesis is due to a structural cause, such as stroke, then the neck is weak turning *away* from the affected arm and leg. Babinski proposed 2 tests, other than the plantar reflex, as positive indicators of organic rather than functional paresis.[11] He wrote, "*It is in organic hemiplegia that I observed this disorder, which consists, in certain actions involving the platysma, of a more energetic contraction of this muscle on the healthy side than the paralyzed side*." This suggests that asymmetry of platysma contraction represents a positive organic sign. He also described the trunk-thigh test as a positive sign of organic hemiparesis in which the weak leg is elevated when attempting to sit up from a lying position in organic hemiparesis compared with the leg staying on the bed in functional hemiparesis.

We observed, in a previous study, that the SCM test interrater reliability was excellent (Cohen d = 0.83),[9] whereas the trunk-thigh test was poor (Cohen d = 0.18),[4,9] so we decided to focus on the SCM. No data on the platysma sign interrater

[1]Neurology Service, Hôpitaux Universitaires Genevois, Geneva, Switzerland; [2]Liaison Psychiatry, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; [3]Neurology Service, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland

***Correspondence to:** Dr. Selma Aybek, Service de Neurologie, HUG, Rue Gabrielle Perret Gentil 4, 1205 Genève, Switzerland; E-mail: selma.aybek@unige.ch
**Keywords:** clinical examination, functional neurological disorders, positive signs, specificity, sternocleidomastoid.
Relevant disclosures and conflicts of interest are listed at the end of this article.
Received 28 November 2016; revised 9 March 2017; accepted 15 March 2017.
Published online xx Xxxxx 2017 in Wiley InterScience (www.interscience.wiley.com). DOI:10.1002/mdc3.12492





doi:10.1002/mdc3.12492

reliability are available, but we hypothesized that, while looking at head rotation (SCM), the platysma sign is a valuable additional sign, because it examines the same anatomic region.

To assess the clinical value of the SCM and platysma signs in terms of specificity and sensitivity, we set out to systematically test them in a group of patients who had functional and organic hemiparesis.

# Patients and Methods

## Patients

Thirty patients with a diagnosis of conversion disorder (FND) and 40 patients with a known neurological (organic) condition (34 with stroke, 3 with multiple sclerosis, 2 with meningoencephalitis, and 1 with cerebral palsy) were prospectively included at Geneva and Lausanne University hospitals from July 2014 to August 2016. Functional patients were diagnosed according to Diagnostic and Statistical Manual of Mental Disorders, fifth edition criteria (known positive signs, such as the Hoover's sign, give-away weakness, or motor inconsistency, were used, but not the SCM sign or the platysma sign), and organic patients were diagnosed based on clinical features, radiologic imaging, blood tests, and lumbar puncture when needed. Inclusion criteria were the presence of unilateral limb paresis of an arm and/or leg measurable on the Medical Research Council (MRC) scale (scores of <5 vs. 5). Exclusion criteria were age younger than 18 years, an orthopedic disorder interfering with motor testing, and severe cognitive impairment. Institutional review board and ethical approval was obtained for the study protocol (CER Geneva HUG 14-088), and all participants provided a signed, written informed consent form before inclusion.

## Procedure

Patients were examined (by D.H., S.G., or S.A.) using a standardized protocol to assess for SCM and platysma signs. Patients were evaluated in a sitting position in front of the examiner. They turned their head toward each side, against the examiner's resistance, for 5 seconds. The SCM sign was considered as a positive functional sign if a difference in strength was observed between the 2 sides, and the side of weakness was recorded (leftward weakness representing right SCM weakness, and vice versa). Then, participant was asked to open their mouth wide and flex their head toward the chin against the examiner's resistance on their forehead. The platysma sign was considered as a positive organic sign in the presence of observed platysma asymmetric contraction. In addition, limb muscle strength was measured according to the National Institutes of Health Stroke Scale[13] score for the arm (item 5) and leg (item 6; scored from 0 [no drift] to 4 [no movement]).

## Statistical Analyses

The occurrence of each sign was compared between groups (2-tailed Fisher tests), and their sensitivity and specificity were calculated (http://www.openepi.com). We repeated this analysis after removing the participants who presented with only lower limb paresis, because we hypothesized that the signs may be more useful in patients suffering from upper limb weakness.[12]

In the clinic, we hypothesized that it would be useful to identify patients who displayed both a negative platysma sign (no sign of organic disorder) AND a positive SCM sign (sign of functional disorder). Therefore, we also calculated the specificity and sensitivity of this association of signs.

# Results

Clinical and demographic data are presented in Table 1. Among the functional patients (76% women; mean age, 45 years [range, 31–59 years]), 18 had left-sided paresis, and 12 had right-sided paresis. In the group with organic signs (35% women; mean age, 65 years [range, 47–83 years]), 20 had left-sided weakness, and 20 had right-sided weaknesses.

**TABLE 1** Demographic and clinical data

| Variable | Cases, n = 30 | Controls, n = 40 | *P* value |
|---|---|---|---|
| Age: Mean ± SD, y | 44.5 ± 14.1 | 65.4 ± 17.9 | < 0.05* |
| Women: No. (%) | 23 (76.7) | 14 (35) | < 0.05† |
| NIHSS arm: Median [range] | 1 [0–4] | 1 [0–4] | NS* |
| NIHSS leg: Median [range] | 1 [0–4] | 0 [0–4] | < 0.05* |
| Duration of symptoms: Mean [range], days | 833 [2-5844] | 117 [1-2413] | < 0.05* |
| Distribution of motor symptoms: No. (%) | | | |
| Faciobrachiocrural | 4 (13.3) | 22 (55) | |
| Brachiocrural | 15 (50) | 5 (12.5) | |
| Brachial | 5 (16.7) | 8 (20) | |
| Faciobrachial | 1 (3.3) | 1 (2.5) | |
| Crural | 4 (13.3) | 2 (5) | |
| Facial | 1 (3.3) | 1 (2.5) | |
| Faciocrural | 0 (0) | 1 (2.5) | |
| Left | 18 (60) | 20 (50) | |
| Right | 12 (40) | 20 (50) | |

SD, standard deviation; NS, nonsignificant; NIHSS, National Institutes of Health Stroke Scale
*Student *t* test.
†Fisher exact test.



doi:10.1002/mdc3.12492

**TABLE 2** Positive signs data

| SCM functional sign | Cases, n = 30 | Controls, n = 40 | *P* value* |
|---|---|---|---|
| No. with positive sign | 19 | 4 | |
| No. with negative sign | 11 | 36 | |
| Positive sign, % | 63 | 10 | <0.01 |
| Sensitivity (CI), % | 63 (46–78) | | |
| Specificity (CI), % | 90 (77–96) | | |
| **Platysma organic sign** | **Cases, n = 30** | **Controls, n = 40** | ***P* value*** |
| No. with positive sign | 0 | 9 | |
| No. with negative sign | 30 | 31 | |
| Positive sign, % | 0% | 22% | < 0.01 |
| Sensitivity (CI), % | 22 (11–38) | | |
| Specificity (CI), % | 100 (88–100) | | |
| **Positive SCM functional sign AND negative organic platysma sign** | **Cases, n = 30** | **Controls, n = 40** | ***P* value*** |
| No. with positive SCM sign and negative platysma | 19 | 2 | |
| Positive sign, % | 63 | 5 | < 0.01 |
| Sensitivity (CI), % | 63 (44–80) | | |
| Specificity (CI), % | 95 (83–99) | | |
| **Side of SCM weakness** | **Cases, n = 19** | **Controls, n = 4** | ***P* value*** |
| No./total no. with weakness toward limb paretic side (%) | 17/19 (89.5) | 4/4 (100) | — |
| No./total no. with weakness toward healthy side (%) | 2/19 (10.5) | 0/4 (0) | |
| **SCM functional sign without pure leg weakness** | **Cases, n = 26** | **Controls, n = 38** | ***P* value*** |
| No. with positive sign | 18 | 4 | |
| No. with negative sign | 8 | 34 | |
| Positive sign, % | 69 | 11 | < 0.01 |
| Sensitivity (CI), % | 69 (50–84) | | |
| Specificity (CI), % | 89 (76–96) | | |
| **SCM functional sign–only with leg weakness** | **Cases (n = 4)** | **Controls (n = 2)** | ***P* value*** |
| No. with positive sign | 1 | 0 | |
| No. with negative sign | 3 | 2 | |
| Positive sign, % | 25 | 0 | NS |
| Sensitivity (CI), % | 25 (5–70) | | |
| Specificity (CI), % | 100 (34–100) | | |
| **Positive SCM functional sign AND negative organic platysma sign without pure leg weakness** | **Cases, n = 26** | **Controls, n = 38** | ***P* value*** |
| No. with positive SCM sign and negative platysma | 18 | 2 | |
| Positive sign, % | 69 | 5 | < 0.01 |
| Sensitivity (CI), % | 69 (50–84) | | |
| Specificity (CI), % | 95 (83–99) | | |
| **Positive SCM functional sign AND negative organic platysma sign–only with leg weakness** | **Cases, n = 4** | **Controls, n = 2** | ***P* value*** |
| No. with positive SCM sign and negative platysma sign | 1 | 0 | |
| Positive sign, % | 25 | 0 | NS |
| Sensitivity (CI), % | 25 (5–70) | | |
| Specificity (CI), % | 100 (34–100) | | |

SCM, sternocleidomastoid; CI, confidence interval; NS, nonsignificant.
*Fisher exact test.

## SCM Functional Sign

Nineteen of 30 patients with FND (63%) had a positive SCM sign versus 4 of 40 patients with organic signs (10%; $P < 0.05$) (Table 2). The sensitivity was 63% (CI, 46%–78%), and specificity was 90% (CI, 77%–96%).

After removing the 6 participants who had pure leg weakness, x/y (69%) of patients with FND (x%; $P < 0.001$) had a positive sign, reaching a sensitivity of 69% (CI, 50%–84%) with almost the same specificity (89%, CI, 76%–95%).

Among the 19 functional patients with a positive SCM sign, 17 (90%) had a weakness in rotating the head toward the weak side of the body. Among the 4 patients with organic signs who had a positive SCM sign, all (100%) had a weakness in rotating the head toward the weak side of the body.

## Platysma Organic Sign

Nine of 40 patients with organic signs (22.%) had an asymmetry of platysma contraction, whereas none of the patients with FND (0%; $P < 0.05$) showed this asymmetry. Therefore, the specificity of this organic sign was 100% (CI, 88%–100%), but the sensitivity was only 23% (CI, 11%–38%).

## Combining SCM and Platysma Signs

Among the patients with FND, 19 had both a negative platysma sign and a positive SCM sign (63%). Among the patients with organic signs, 2 had both a negative platysma sign and a positive SCM sign (5%). Therefore, the combination of these



doi:10.1002/mdc3.12492

signs represented 95% specificity (CI, 83%–99%) and 63% sensitivity(CI, 44%–80%).

# Discussion

Our study shows that testing head rotation and flexion in patients with unilateral motor paresis can be helpful: finding a weakness of head rotation together with symmetrical platysma contraction strongly suggests an FND with 95% specificity. For clinicians, it is important to use highly specific signs—more than sensitive signs—to correctly identify true-negative results (that is, to identify patients who have true organic signs) and reduce the false-positive rate. This ensures that patients are not mislabeled with FND when they have an organic condition, which has been a concern for many neurologists for a long time.[14–16]

These data compare with previous findings[9,10] of 80% (24 of 30 patients) positive SCM signs in functional patients versus 11% (3 of 24 patients) in organic controls (87.5% specificity, 80% sensitivity), as well as our previous cohort with 35% (7 of 20 patients) positive SCM signs in patients with FND versus 0% (0 of 20 patients) in organic controls (100% specificity, 31% sensitivity).

The SCM muscle is the main head rotator and is innervated by a cranial nerve (the 11th accessory nerve), unlike other neck muscles, which receive cervical root innervation. The peculiarity of the SCM is its ipsilateral cortical control (a right hemispheric lesion can affect the right SCM muscle, thus affecting leftward head rotation, and tends to cause head turning away from the affected side). Evidence from such ipsilateral control comes from observations in epilepsy of head movements directed away from the irritative focus.[17] The excitatory effect causes contralateral, dystonic posturing and head deviation due to contraction of the ipsilateral SCM. The first explanation for this ipsilateral control was an undecussated corticospinal tract,[18] but later evidence indicated a double decussation pathway,[19] first in the pons and then in the spinal cord (Fig. 2). Our finding of reduced SCM strength when rotating the head toward the weak side of the body (SCM muscle contralateral to the weak side), both in patients with FND (90%) and in those with organic signs (100%), is in agreement with this ipsilateral control.

In a series of 124 stroke patients, 17% had ipsilateral SCM weakness,[20,21] which is comparable to the 10% rate (4 of 40 patients) we observed. This rate contrasts with the 63 to 100% rate observed in functional patients and suggests that this pattern of unilateral head rotation weakness is more specific to functional than organic patients. One can hypothesize that in organic patients, the frequency of SCM weakness is low because head rotation is partly compensated by other muscles (like splenius capiti) minimizing the influence of the central lesion. In functional disorders, it has been suggested that the pattern of neurological deficit reflects the mental representation of a deficit,[22] of an "a priori expectation" from the patient of what a paresis should look and feel like, rather than a pattern governed by anatomical rules. Other arguments for the role of a priori expectation that the whole hemibody is affected in FND, the finding in some patients of difficulties directing gaze[23] toward the hemiparetic side and complete midline hemisensory loss on the paretic side.[23,24] There are no other controlled data regarding the platysma sign with which to compare our findings.

Our study has some limitations. First, the examiners were not blinded to the participants' diagnosis, and this may have biased the interpretation of the sign. The SCM sign had good

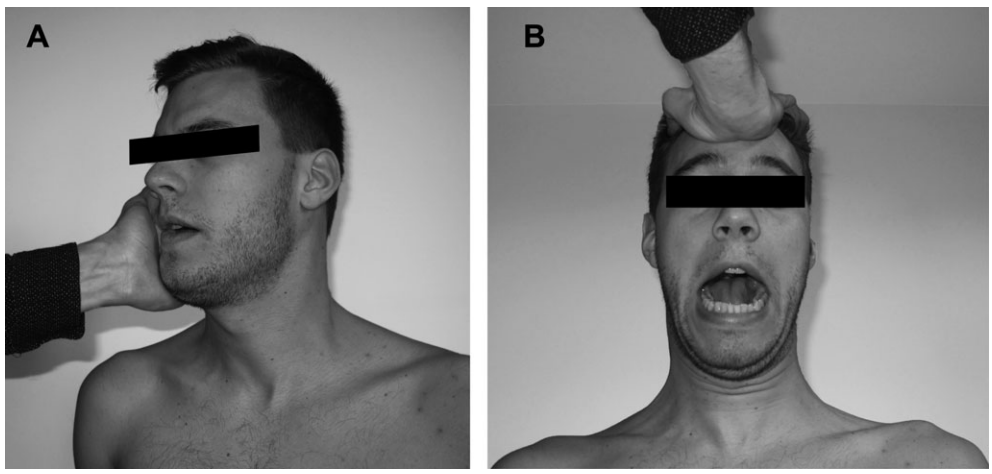


**Figure 1** Illustration of the 2 bedside signs. (A) The sternocleidomastoid test is performed by asking the individual to rotate his or her head toward 1 side of the body against the examiner's resistance. When the examiners detect weakness in the direction of arm or leg weakness, the sign is considered a positive functional sign. (B) The platysma sign is performed by asking the patient to open the mouth wide and flex his or her head against the examiner's resistance. When an asymmetry of contraction of the platysma is observed, the sign is considered a positive organic sign.



doi:10.1002/mdc3.12492

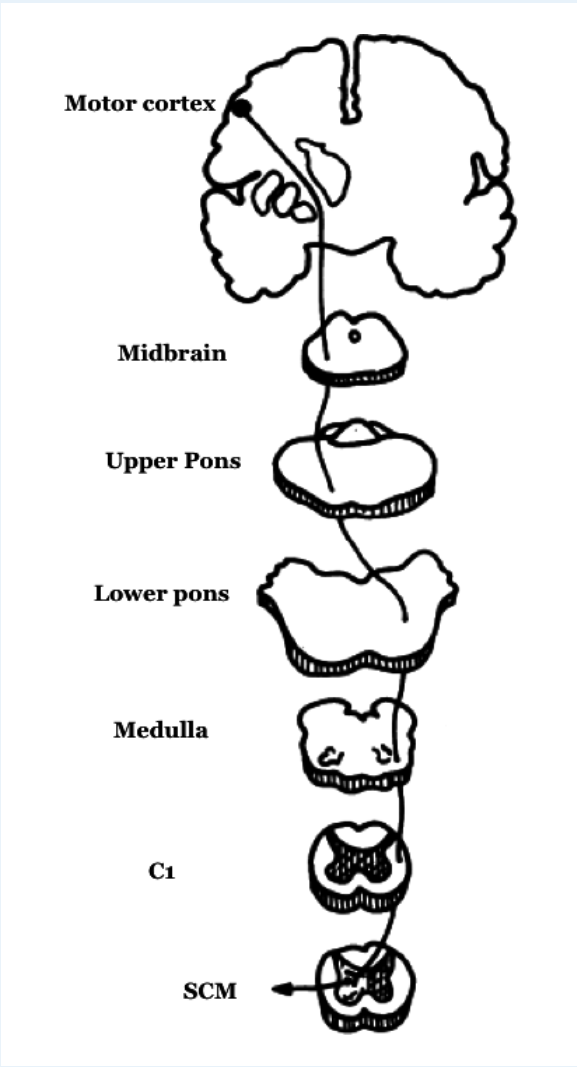


**Figure 2** Double decussion of the sternocleidomastoid (SCM) muscle innervation (from Mastaglia. J Neurol Neurosurg Psychiatry, 1986).

interrater reliability on blinded ratings of video-taped interviews.[24] For the platysma sign, no such data are available, and we cannot suggest the effect of an unblinded evaluation. Because gold standards for both functional and organic diagnoses are clinical, misdiagnoses cannot be ruled out with certainty in any group. However, the misdiagnosis rate in functional disorder is generally low (0.4%).[15,25,26] All of our patients with organic signs underwent paraclinical examinations to confirm the diagnosis (imaging, cerebrospinal fluid analysis), but functional overlay is possible. In addition, the diagnosis of functional paresis was not established with the help of the 2 signs used in this study, which avoids a diagnostic suspicion bias.

Second, our 2 samples demonstrated differences in age, sex, and symptom duration, which are explained by the studied populations (younger age, female preponderance, and longer symptom duration were more frequent in patients with FND than organic controls [mostly patients with stroke]). To our knowledge, however, there is no evidence in the literature suggesting that age, sex, or symptom duration should influence the incidence of positive signs, and we do not expect significant biases. Third, our samples differed in terms of weakness severity (less severe in patients with organic signs), but the difference was not significant for arm weakness, and the SCM sign was still highly specific after excluding patients with only leg weakness.

Overall, our results suggest that testing head rotation and flexion can add to the clinical evaluation of patients with suspected FND. Future studies should add 2 signs: (1) trapezius testing (also innervated by the 11th accessory nerve but with a single decussation and thus with contralateral cortical control), because it can help localize the lesion in organic patients[27]; and (2) head lateral flexion as a weakness is not found in stroke[21] but could be frequent in FND and confirm the hypothesis of an "a priori" dysfunction of all muscles directed at moving the body on 1 side.

In conclusion, asymmetry of head rotation strength in the presence of symmetric platysma contraction should be interpreted as strongly suggesting a functional paresis in patients with unilateral limb weakness. This association of signs is more useful for upper limb weakness but its additional diagnostic value when present with other positive motor signs, such as the Hoover sign requires further evaluation.

**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 the First Draft, B. Review and Critique.

D.H.: 1B, 1C, 3A, 3B
S.G.: 1B, 3B
A.B. 3B
F.V.: 2C, 3B
S.A.: 1A, 1B, 1C, 3B

## Acknowledgments

We thank Patrik Michel, Alexandre Croquelois, and Deepa Pothalil for their help in recruiting patients and Bastien Horn for the pictures.

## Disclosures

**Ethical Compliance Statement:** 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 Conflict of Interest:** This study was supported by an Ambizione grant from the Swiss National Research Foundation (PZ00P3_147997) and a Nested Project grant from the Leenaards Foundation.

**Financial Disclosures for the previous 12 months:** The authors report no sources of funding and no conflicts of interest.



doi:10.1002/mdc3.12492

# References

1. Carson AJ. Introducing a 'neuropsychiatry' special issue: but what does that mean? *J Neurol Neurosurg Psychiatry* 2014;85:121–122.
2. Hallett M. Psychogenic movement disorders: a crisis for neurology. *Curr Neurol Neurosci Res* 2006;6:269–271.
3. Syed TU, laFrance WC, Jr Kahriman ES, et al. Can semiology predict psychogenic nonepileptic seizures? A prospective study *Ann Neurol* 2011;69:997–1004.
4. Daum C, Hubschmid M, Aybek S. The value of 'positive' clinical signs for weakness, sensory and gait disorders in conversion disorder: a systematic and narrative review. *J Neurol Neurosurg Psychiatry* 2014;85:180–190.
5. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. (DSM-5). Washington, DC: American Psychiatric Association; 2013.
6. McWhirter L, Stone J, Sandercock P, Whiteley W. Hoover's sign for the diagnosis of functional weakness: a prospective unblinded cohort study in patients with suspected stroke. *J Psychosom Res* 2011;71:384–386.
7. Sonoo M. Abductor sign: a reliable new sign to detect unilateral non-organic paresis of the lower limb. *J Neurol Neurosurg Psychiatry* 2004;75:121–125.
8. Daum C, Aybek S. Validity of the "drift without pronation" sign in conversion disorder [serial online]. *BMC Neurol* 2013;13:31.
9. Daum C, Gheorghita F, Spatola M, et al. Interobserver agreement and validity of bedside 'positive signs' for functional weakness, sensory and gait disorders in conversion disorder: a pilot study. *J Neurol Neurosurg Psychiatry* 2015;86:425–430.
10. Diukova G, Stolajrova AV, Vein AM. Sternocleidomastoid (SCM) muscle test in patients with hysterical and organic paresis [abstract]. *J Neurol Sci* 2001;187(suppl 1):S108.
11. Babinski J. Diagnostic différentiel de l'hémiplégie organique et de l'hémiplégie hystérique. *Gaz Hôp Paris* 1900;73:533–537.
12. Diukova GM. Weakness of the sternocleidomastoid muscle: a diagnostic test in hysterical paralysis. *Zh Nevrol Psikhiatr Im S S Korsakova* 1999;99:56–59.
13. Brott T, Adams HP Jr, Orlinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke* 1989;20:864–870.
14. Gould R, Miller BL, Goldberg MA, Benson DF. The validity of hysterical signs and symptoms. *J Nerv Ment Dis* 1986;174:593–597.
15. Stone J, Smyth R, Carson A, Lewis S, Prescott R, Warlow C, Sharpe M. Systematic review of misdiagnosis of conversion symptoms and "hysteria" [serial online]. *BMJ* 2005;331:989.
16. Slater E. Diagnosis of "hysteria". *Br Med J* 1965;1:1395–1399.
17. Wyllie E, Luders H, Morris HH, Lesser RP, Dinner DS. The lateralizing significance of versive head and eye movements during epileptic seizures. *Neurology* 1986;36:606–611.
18. Balagura S, Katz RG. Undecussated innervation to the sternocleidomastoid muscle: a reinstatement. *Ann Neurol* 1980;7:84–85.
19. Geschwind N. Nature of the decussated innervation of the sternocleidomastoid muscle [letter]. *Ann Neurol* 1981;10:495.
20. Mastaglia FL, et al. Weakness of head turning in hemiplegia: a quantitative study. *Journal of neurology, neurosurgery, and psychiatry* 1986;49:195–197.
21. Anagnostou E, Paraskevas GP, Spengos K, Vassilopouplou S, Zis V, Vassilopoulos D. Same or opposite? Association of head-movement weakness with limb paresis in stroke. *Neurologist* 2011;17:309–311.
22. Edwards MJ, Fotopoulou A, Parees I. Neurobiology of functional (psychogenic) movement disorders. *Curr Opin Neurol* 2013;26:442–447.
23. Troost BT, Troost EG. Functional paralysis of horizontal gaze. *Neurology* 1979;29:82–85.
24. Stone J, Zeman A, Sharpe M. Functional weakness and sensory disturbance. *J Neurol Neurosurg Psychiatry* 2002;73:241–245.
25. Bexander CS, Mellor R, Hodges PW. Effect of gaze direction on neck muscle activity during cervical rotation. *Exp Brain Res* 2005;167:422–432.
26. Stone J, Carson A, Duncan R, et al. Symptoms 'unexplained by organic disease' in 1144 new neurology out-patients: how often does the diagnosis change at follow-up? *Brain* 2009;132(Pt 10):2878–2888.
27. Manon-Espaillat R, Ruff RL. Dissociated weakness of sternocleidomastoid and trapezius muscles with lesions in the CNS. *Neurology* 1988;38:796–797.



doi:10.1002/mdc3.12492