Motor Overflow and Mirror Movements in Focal Hand Dystonia

Oraporn Sitburana, MD, Laura Jui Chen Wu, MD, PhD, James K Sheffield, MD

Anthony Davidson, BS, Joseph Jankovic, MD

Parkinson's Disease Center and Movement Disorders Clinic, Department of Neurology, Baylor College of Medicine, Houston, Texas

ABSTRACT

Objective: To characterize motor overflow and mirror movements in patients with focal hand dystonia (FHD). Background: Motor overflow is an unintentional muscle contraction which accompanies, but is anatomically distinct from the primary dystonic movement. The overflow into muscles adjacent to the primary dystonic movement is called ipsilateral overflow; when it spreads to the opposite limb, it is called contralateral overflow. A dystonic movement or posture that is induced by a specific task, such as writing, performed by the contralateral homologous normal body part is defined as " mirror dystonia ". This phenomenological nosology has not been systematically studied in FHD. Methods: We enrolled 30 patients with FHD and 40 normal controls. All subjects were videotaped while performing detailed neurological assessments for motor overflow movements and hand dystonia. The subjects were asked to write, draw a spiral, a straight line and a sine wave with each hand. They were also instructed to perform repetitive tasks including wrist flexion - extension, finger tapping, hand grasping, hand pronation – supination, and a finger – to - nose movement. The videotaped segments were randomized and assessed blindly by one rater, trained in using standardized dystonia and overflow scales to rate ipsilateral and contralateral overflow and mirror dystonia. Results: Ipsilateral overflow was identified in 7 (23.3%) FHD subjects and in 2 (5%) normal controls (P = 0.03), mirror dystonia in 20 (66.7 %) FHD subjects and in 12 (30 %) control (P = 0.004), and contralateral overflow in 1 (3.3 %) FHD and in 2 (5 %) control subjects (NS). The greater the severity of dystonia, the more overflow movements appear in multiple tasks. (r = 0.713, P <0.001) Conclusion: Ipsilateral overflow and mirror dystonia occur relatively frequently in patients with FHD. There was a statistic significant correlation between the severity of dystonia and overflow score.

INTRODUCTION

Focal dystonia is characterized by sustained muscle contractions, frequently causing twisting and repetitive movements, or abnormal posture, which affects only a single body part. (Fahn 1998) Task-specific hand dystonia, a form of focal hand dystonia (FHD), has been classified according to specific impairment of particular function, such as writer's cramp (WC), musician's cramp, occupational cramps or sport performance dystonia. (Hallett 2006) FHD is classified as simple or complex FHD depending on whether symptoms only occur in one specific task or multiple tasks (Jedynak, 2001). Mirror movement is defined as an involuntary movement in one side of the body which mirrors (mimicks) voluntary movement performed in the contralateral homologous body part (Armatas 1994). Motor overflow is another unintentional muscle contraction which accompanies, but is anatomically distinct from the primary dystonic movement, and is commonly found in dystonia. (Cohen 1988) In our pilot study (Sitburana and Jankovic, 2006) we identified three different patterns of abnormal muscle activity in patients with FHD: 1. *Ipsilateral overflow*: an involuntary contraction of muscles adjacent to those involved in the focal dystonia; 2. *Contralateral overflow*: motor overflow, which is characterized by an involuntary movement or dystonic posture in the normal, contralateral limb during dystonic movements or posture of the hand primarily affected by FHD; 3. *Mirror dystonia*: a dystonic movement or posture induced by a specific task, such as writing, performed by the opposite, homologous, normal body part. To further study the characteristics of FHD, we prospectively examined and compared patients with FHD to normal controls and provide evidence for widespread abnormality of motor control in patients with FHD.

METHODS

Thirty consecutive patients with task-specific hand dystonia (age 51.0 ± 11.8 years, male 46.7 %) and 40 normal controls (age 58.7 ± 14.2 years, male 47.5 %) were recruited from the Baylor College of Medicine Movement Disorders Clinic. Only patients considered to have primary dystonia were included. All subjects were instructed to perform multiple tasks and were videotaped after signing a consent form approved by the Baylor College of Medicine Institutional Review Board (IRB). They were asked to sit behind a table, adjusted to their height. The video camera was positioned to include head, the upper part of body, both arms and lap. All subjects were asked to perform three times writing, drawing a spiral, a straight line, and a sine wave. While performing writing tasks with one hand, the forearm of the opposite hand rested on a support three inches in height thus allowing the hand to be free and without any constraints. Five repetitive hand tasks were performed with each hand for 10 seconds including wrist flexion – extension with the arm in an outstretched position, finger tapping (tapping of the index finger on the thumb), rapid hand opening – closing, hand pronation – supination and finger – to -nose movements. Subjects were also videotaped in the sitting position with the palms of their hands resting in their lap for 15 seconds and while walking approximately 40 feet. All 70 video segments were randomized and were rated by one movement disorder neurologist, blinded to the history and diagnosis, trained in the Burke – Fahn –Marsden (B-F-M) rating scale (Comella 2003) and motor overflow scale. [Table 1]

Table 1: Scale used to assess the dystonia severity and motor overflow

Burke Fahn Marsden rating, severity scale (arm)
0 = No dystonia present
1 = Slight dystonia. Clinically insignificant
2 = Mild. Obvious dystonia, but not disabling
3 = Moderate. Able to grasp, with some manual function
4 = Severe. No useful grasp
Motor overflow scale
0 = No motor overflow
1 = Motor overflow in less than three tasks
2 = Motor overflow in equal or more than three tasks

RESULTS

The age at onset of the 30 FHD patients was 41.5 ± 11.8 years with dystonia duration of 9.5 ± 7.4 years. Right-handedness was reported by 90% of the 30 FHD patients and 95% of the 40 normal controls. There were 26 subjects with dystonic writer 's cramp (86.7%), 2 pianists, 1 drum player and 1 professional pistol shooter. Ipsilateral overflow was identified in 7 FHD subjects (23.3%) and in 2 (5%) normal controls (P = 0.03), mirror dystonia in 20 FHD subjects (66.7%) and in 12 (30%) control (P =0.004), and contralateral overflow in 1 FHD (3.3%) and in 2 control subjects (5%) (NS). [Figure 1] The average dystonia score in FHD was 1.4 ± 1.2 and the mean overflow score was 1.0 ± 0.8. The more severity of dystonia, the more overflow movements appear in multiple tasks. (r = 0.713, P <0.001) [Figure 2] Writing with non-affected hand had 56.7% sensitivity to detect mirror dystonia, specificity of 70%, and the positive predictive value (PPV) of 58.6%. (P = 0.030) Finger tapping, hand pronation–supination and finger to nose had a 100% PPV and specificity. [Table 2] Of the normal controls, who denied any difficulty handwriting or abnormal hand postures, 25% had some evidence of dystonia with the mean dystonia score of 1.3 ± 0.5.

Figure 1: Types of motor overflow in FHD and normal controls

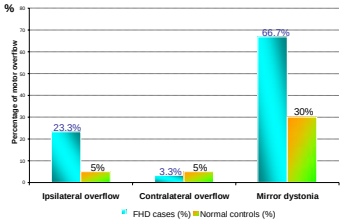
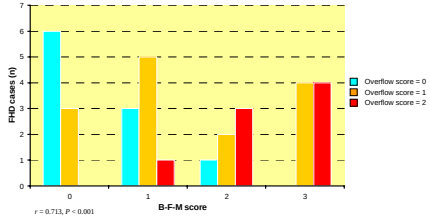


Table 2: Validity of specific tasks for screening mirror dystonia in FHD subjects

Tasks	Sensitivity	Specificity	PPV	P-value
Writing non–affected	56.7	70	58.6	0.030
Wrist flexion – extension non–affected	16.7	90	55.6	NS
Finger tapping non – affected	16.7	100	100	0.0120
Hand opening – closing non –affected	23.3	95	77.8	0.032
Hand pronation – supination non – affected	26.7	100	100	< 0.001
Finger to nose non –affected	6.7	100	100	0.180

PPV positive predictive value
P-value compared between FHD subjects and normal controls

Figure 2: Correlation between the severity of dystonia (BFM) and motor overflow score



CONCLUSIONS

Mirror movements have been previously described as abnormal posture, tremor and jerks of fingers or hands induced by writing or drawing with the opposite hand (Jedynak 2001; Espay et al, 2005; Espay et al., 2006; Li et al, 2007). We found that a quarter of patients with FHD had ipsilateral overflow and two thirds had evidence of mirror dystonia. Writing with non-affected hand had a sensitivity of 56.7%, specificity of 70%, and PPV of 58.6% to detect mirror dystonia. The presence of mirror dystonia may be guide the selection of the most appropriate muscles for botulinum toxin chemodenervation. An abnormality of normal suppression of supraspinal excitability of unwanted movements with surround inhibition at a cortical level has been suggested to play a role in dystonia (Sohn et al, 2004). While a failure of surround inhibition might explain the ipsilateral overflow in our FHD patients, a simultaneous activation of crossed corticospinal pathways, possibly mediated by altered or lost transcollosal fibers inhibition, supported by functional MRI studies, may be contributing to the observed contralateral or mirror dystonia (Merello et al, 2006). We believe that our proposed categorization motor overflow and mirror movements extends the known phenomenology of FHD and may lead to better recognition and treatment (Jankovic, 2006).

REFERENCES

- Armatas CA, Summers JJ, Bradshaw JL. Mirror movements in normal adult subjects. J Clin Exp Neuropsychol 1994; 16: 405-13
- Cohen LG, Hallett M. Hand cramps: clinical features and electromyographic patterns in a focal dystonia. Neurology 1988; 38: 1005-1012.
- Comella CL, Leurgans S, Wiu Joanne, et al. Rating scales for dystonia: a multicenter assessment. Mov Disord 2003; 18: 303 -12.
- Espay AJ, Li JY, Johnston L, Chen R, Lang AE. Mirror movements in parkinsonism: evaluation of a new clinical sign. J Neurol Neurosurg Psychiatry 2005;76(10):1355-8.
- Espay AJ, Morgante F, Gunraj C, Chen R, Lang AE. Mirror movements in Parkinson's disease: effect of dopaminergic drugs. J Neurol Neurosurg Psychiatry 2006;77:1194-5.
- Fahn S, Bressman SB, Marsden CD. Classification of dystonia. Adv Neurol 1998; 78: 1-10.
- Hallett M. Pathophysiology of writer's cramp. Hum Mov Sci 2006; 25: 454-63.
- Jankovic J. Treatment of dystonia. Lancet Neurology 2006; 5: 864-72.
- Jedynak PC, Tranchant C, de Beyl DZ. Prospective clinical study of writer's cramp. Mov Disord 2001; 16: 494-499.
- Li JY, Espay AJ, Gunraj CA, Pal PK, Cunic DI, Lang AE, Chen R. Interhemispheric and ipsilateral connections in Parkinson's disease: Relation to mirror movements. Mov Disord 2007 (in press).
- Merello M, Carpintiero S, Cammarota A, et al. Bilateral mirror writing movements (mirror dystonia) in a patient with writer'cramp: functional correlates. Mov Disord 2006; 21: 683-689.
- Sitburana O, Jankovic J. Overflow, contralateral, and mirror dystonia. Mov Disord 2006;21 (Suppl 15):S383. Presented at 10th International Congress of Parkinson's Disease and Movement Disorders, Kyoto, Japan, 10/28-11/2/06.
- Sohn YH, Hallett M. Disturbed surround inhibition in focal hand dystonia. Ann Neurol 2004; 56: 595 9.