J. Indian Assoc. Child Adolesc. Ment. Health 2008; 4(3):62-66

Original Article

Neurological Soft Signs in Indian Children with Specific Developmental Disorders of Scholastic Skills

Raja Sadhu, MD, Manju Mehta, PhD, Veena Kalra, MD, Rajesh Sagar, MD, Monica Mongia, PhD

Address for Correspondence: Dr Raja Sadhu, Assistant Professor, Institute of Mental Health and Hospital, Mathura Road, Agra-282002. E-mail address: rajasadhoo@gmail.com

ABSTRACT

Aim: To compare the occurrence of neurological soft signs (NSS) in children with specific developmental disorders of scholastic skills (SDDSS) and normal children. **Methods:** 36 cases of SDDSS were compared with 30 control children regarding sociodemographic and clinical variables and neurological soft signs. **Results:** Children with SDDSS had significantly more problems in graphaesthesia, motor task, face-hand and face-noise test, 2-point discrimination, maintenance of posture, and rhythmic movements. **Conclusions:** Children with SDDSS had more NSS in the form of impaired motor task, poorly developed cortical sensory perception and poor body and space concepts. However, the presence of co-morbid hyperkinetic disorder in a large number of SDDSS subjects might have confounded the result.

Key words: Neurologic soft signs, learning disability

INTRODUCTION

Neurological soft signs (NSS) are common in children having academic and behavioral problems, including those diagnosed with dyslexia and hyperkinectic disorder.[1-5] Authors have suggested that evaluation for NSS may be useful for identifying predisposition towards certain disorders (e.g. hyperkinetic disorder, learning disorder); prognosticating; and in monitoring treatment response.[6,7] Though studies on impact of treatment on NSS in children with dyslexia are not available, Lerer et al demonstrated some improvement in NSS after 60 days of treatment with methylphenidate in hyperactive children.[8]

Some authors suggest that dyslexia and NSS are both caused by the same brain abnormalities because of their lateralization patterns, e.g. the greater frequency of left handedness in dyslexic children compared to control children.[9] Gross Tsur et al demonstrated the co-occurrence of arithmetic disability and left sided NSS in children with developmental right hemisphere syndromes.[10] However, it is possible that childhood disorders and NSS may be etiologically independent of each other; as NSS is not disorder-specific and NSS and behavioral problems respond to different doses of medication (methylphenidate in hyperkinetic disorder).[8]

There is no unanimity regarding the cutoff (number of NSS that would be considered clinically significant), tests and norms for the assessment of NSS.[7,8,11-13] Birch et al considered the presence of 2 or more soft signs as evidence of CNS dysfunction.[11] However recent evidence suggests that severity/pervasiveness of learning disabilities may be related to the number of minor neurological dysfunctions.[12]

Few Indian studies have explored the association between SDDSS and NSS.[14] The aim of the present study was to compare NSS in Indian children having SDDSS and in control children.

METHODOLOGY

This cross sectional study was conducted in the Child Guidance Clinic of the Department of Psychiatry, All India Institute of Medical Sciences. Children referred by schools or brought by their parents to the CGC for academic and behavioral problems, were assessed in detail regarding clinical issues and academic (schoolwork and independent assessment in the clinic) difficulties. They were also administered the verbal component of the Malin's Intelligence Scale for Indian Children (MISIC). Specific developmental disorders of scholastic skills (SDDSS) and co morbid disorders were diagnosed according to ICD-10 descriptions. The children diagnosed as having SDDSS were included in the study if they were 6-12 years old, were attending school, and did not have mental retardation (IQ<70) or gross physical and/or neurological deficit. Written informed consent was taken from their guardians. Control children were collected from local government schools, residential areas and the CGC following a detailed clinical and academic assessment and administration of MISIC.

We recorded each child's age, sex, handedness and diagnosis and then a single researcher applied the Neurological Examination for Soft Signs (NESS) part of the Physical and Neurological Examination for Soft Signs (PANESS) scale. For the purpose of expressing the PANESS score, we derived 20 scores from 43 items: *coordination* (items 1-8; e.g. finger-to-nose test; range: 8-32); *graphaesthesia* (items 9-16; e.g. identifying drawn figures on palms; range: 8-32); *stereognosis* (items 17-20; e.g. identifying objects put on palm; range: 4-16); *motor tasks* (items 21-26; e.g. heel walking; range: 4-16); *face-hand and face-noise tests* (items 27-28; range: 0-6); *2-point discrimination* (item 29; range: 0-3); *ability to maintain posture* (items 30-36; e.g. Romberg; range: 7-28); *ability to tap in a smooth rhythm* (items 37-42; e.g. number of taps in a 5-second period and the quality of tapping at the speed of 4/second beat); and *string test* (item 43; opticokinetic test; range 0-4). Item 37 (range: 1-4) that assessed right hand tapping yielded 2 scores: *right hand tapping-number* (number of taps in 5-seconds) and *right hand tapping-quality*. Similarly, each of the items from 38 to 42 (range: 1-4) yielded 2 scores: *left hand tapping-number* and *left hand tapping-quality; right-foot tapping-number* and *right foot tapping-quality; left foot tapping-number* and *left foot tapping-quality; right hand and foot simultaneous tapping-number* and *right hand and foot simultaneous tapping-quality; left hand and foot simultaneous tapping-number* and *left hand and foot simultaneous tapping-quality;* respectively.

Group comparisons were computed using the parametric (student's t-test) and nonparametric (chi-square test, Fisher exact test, Mann Whitney test) as applicable.

RESULTS

The case group consisted of 36 children (29 boys, 7 girls) and the control group of 30 children. About 56% of children in the case group had mixed disorder of scholastic skills with other developmental disorders of scholastic skills. Co morbid hyperkinetic disorder occurred in 89% of cases (boys - 96.6%, girls - 57.1%) whereas only 7 control children (23.3%) were diagnosed to have hyperkinetic disorder (Table 1).

The mean age of children with SDDSS was 10.7 years (SD 1.62) while that of the control children was 10.0 years (SD 1.9). About one fifth of cases and one third of controls were girls. One child with SDDSS and none of the control children were left handed. There was no significant difference between the two groups regarding these background variables. Also there was no significant difference between the case and control groups in total IQ scores and scores on information and arithmetic subscales of MISIC. However the case group had significantly higher scores on the comprehension and digit span subscales, as compared to the control group (Table 2).

Table 1: Frequency of types of Specific Developmental Disorders of Scholastic Skills (N=36) and co-morbidity with Hyperkinetic Disorder (N=32)

Diagnosis	No. (Male, Female)	%	Co-morbid Hyperkinetic Disorder
Specific reading disorder (SRD)	2 (1 M, 1 F)	5.6	1 (1 M)
Specific spelling disorder (SSD)	4 (3 M, 1 F)	11.1	4 (3 M, 1 F)
Specific disorder of arithmetic skills (SDAS)	4 (2 M, 2 F)	11.1	3 (2 M, 1 F)
Mixed disorder of scholastic skills (MDSS)	3 (3 M)	8.3	3 (3 M)
Other developmental disorder of scholastic skills (ODDSS)	1 (1 M)	2.8	0
MDSS with ODDSS	20 (18 M, 2 F)	55.6	19 (18 M, 1 F)
SRD with SSD with ODDSS	1 (1 M)	2.8	1 (1 M)
SSD with ODDSS	1 (1 F)	2.8	1 (1 F)

MDSS includes reading and/or spelling and arithmetic disorder, ODDSS includes difficulty in writing

Table 2: Comparison of I.Q. scores between case (1) and control (2) groups

	SDDSS (N=36) Mean±SD	Controls (N=30) Mean±SD	P values obtained by T test
IQ-Total	99.25±12.874	94.97±9.572	0.063
IQ-Information	93.44±14.111	94.03±8.463	0.417
IQ-Comprehension	114.89±17.434	101.42±9.940	0.000*
IQ-Arithmetic	88.42±18.412	90.60±9.597	0.270
IQ-Digit Span	103.11±16.882	94.23±11.649	0.007*

Children with SDDSS performed significantly worse on tests of graphaesthesia, motor task, face-hand and face-noise test, 2-point discrimination, maintenance of posture, tapping quality (right foot, left foot, right hand and foot simultaneously, left hand and foot simultaneously) and number of taps (right foot, left foot) compared to control children on NESS part of the PANESS (Table 3).

Table 3: Comparison of Scores of NESS Part of PANESS between Case and Control Groups

	SDDSS (N=36) Mean±SD	Controls (N=30) Mean±SD	P value
Coordination	8.28±1.186	8.00±0.000	0.17
Graphaesthesia	11.53±4.109	8.53±1.137	0.000[S]
Stereognosis	4.78±1.245	4.33±0.844	0.09
Motor task	3.67±4.517	0.33±1.155	0.000[S]
Face hand and face-noise test	0.22±0.591	0.00±0.000	0.03S
Two-point discrimination	0.31±0.577	0.00±0.000	0.003[S]
Maintenance of posture	8.58±2.534	7.23±0.817	0.004[S]
Right hand tapping (N)	18.22±2.706	19.13±1.943	0.117
Right hand tapping (Q)	1.19±0.467	1.03±0.183	0.063
Left hand tapping (N)	18.03±2.524	18.73±2.377	0.247
Left hand tapping (Q)	1.33±0.535	1.17±0.379	0.145
Right foot tapping (N)	15.00±3.347	16.60±2.175	0.023[S]
Right foot tapping (Q)	1.33±0.535	1.10±0.305	0.03[S]
Left foot tapping (N)	14.53±3.493	16.27±2.815	0.03[S]
Left foot tapping (Q)	1.39±0.645	1.13±0.346	0.045[S]
Right hand and foot simultaneous tapping (N)	14.11±3.462	14.07±3.300	0.96
Right hand and foot simultaneous tapping (Q)	1.61±0.903	1.07±0.254	0.001[S]
Left hand and foot simultaneous tapping (N)	13.92±3.467	14.20±3.067	0.73
Left hand and foot simultaneous tapping (Q)	1.67±0.956	1.10±0.305	0.002[S]
Opticokinetic test	0.08±0.500	0.00±0.000	0.37

N number, Q Quality, [S] Significant

Group comparison between boys (N=29) and girls (N=7) with SDDSS showed that they did not differ significantly in terms of age (boys; 10.6±1.70, girls: 11.3±1.11), handedness (only 1 boy was left-handed) and IQ score (boys; 100.3±13.62, girls: 94.9±8.59). However, girls with SDDSS performed significantly worse than the boys on the opticokinetic test (boys: 0±0, girls: 0.4±1.13, $p<0.5$).

DISCUSSION

As expected in clinic based samples, most children with SDDSS had severe school problems and comorbid hyperkinetic disorder. The case and control groups consisted predominantly of male children. Children with SDDSS had more neurological soft signs in the form of motor abnormalities (impaired motor task, impaired maintenance of posture, impaired hand and foot tapping - number of quality); poorly developed cortical sensory perception (impaired graphesthesia, face-hand test, face-noise test); and poor body and space concepts (impaired 2-point discrimination). Previous studies have also reported motor abnormalities in children with learning disorders and attention-deficit-hyperactivity disorder.[15,16]

While gender-based comparison of NSS findings is of heuristic interest because of the reported faster resolution of NSS in girls as compared to boys with advancement of age;[17] the value of our finding of greater impairment in optokinetic test in girls with SDDSS is limited by the small number of female cases in the present sample.

The low rate of pure SDDSS (without hyperkinetic disorder) posed a major hurdle to drawing firm conclusions from the present study regarding NSS in SDDSS. Further the results of tests of overflow and dys-rhythmia types of motor abnormalities should be interpreted with caution because of their poor test-retest reliability.[18]

Children with SDDSS (most comorbid for hyperkinetic disorder) had relatively more NSS compared to control children in the form of impaired motor task, poorly developed cortical sensory perception and poor body and space concepts. Future studies on children with SDDSS without co-morbidities can enhance our knowledge on the above mentioned associations.

REFERENCES

1. Fellick JM, Thomson APJ, Hart CA. Neurological soft signs in mainstream pupils. Arch Dis Child 2001; 85:371-374.
2. Allin M, Rooney M, Griffiths T, Cuddy M, Wyatt J, Rifkin L, et al. Neurological abnormalities in young adults born preterm. J Neurol Neurosurg Psychiatry 2006; 77:495-499.
3. Raychev R, Pentscheva S, Rainov W, Valtscheva M, Bojinov S. Neuropsychological aspects of disorders of higher functions or cerebral cortex in children with speech disorders. Psychiatr Neurol Med Psycho (Leipz) 1984; 36:639-648.
4. Jariab Kova K, Hugdahl K, Glos J. Immune disorders and handedness in dyslexic boys and their relatives. Scand J Psychol 1995; 36:355-362.
5. Gustafsson P, Svedin CG, Ericsson I, Lindén C, Karlsson MK, Thernlund G. Reliability and validity of the assessment of neurological soft-signs in children with and without attention-deficit-hyperactivity disorder. Dev Med Child Neurol 2010; 52: 364-370.
6. Breslau N, Chilcoat HD, Johnson EO, Andreski P, Lucia VC. Neurologic soft signs and low birth weight: their association and neuropsychiatric implications. Biol Psychiatry 2000; 47:71-79.
7. Kandt RS. Neurologic examination of children with learning disorders. Ped Clin North Am 1984; 31:297-315.
8. Lerer RJ, Lerer MP. The effects of methylphenidate on the soft neurological signs of hyperactive children. Pediatrics 1976; 57:521-525.
9. Cespedes A, Berneosolo J, Bravo L, Pinto A. Handedness, cerebral dysfunction and dyslexia. Rev Chil Pediatr 1989; 60:18-23.

10. Gross Tsur V, Shalev RS, Manor O, Amir N. Developmental right hemisphere syndrome: clinical spectrum of the nonverbal learning disability. J Learn Disabil 1995; 28:80-86.
11. Birch HG, Gussow JD. From Disadvantaged Children: Health, Nutrition and School Failure. New York: Harcourt, Brace and World; 1970.
12. Bastra L, Neeleman J, Hadders AM. The neurology of learning and behavioral problems in preadolescent children. Acta Psych Scand 2003; 108:92-100.
13. Hortzig ME. Neurological 'soft' signs in low birth weight children. Develop Med Child Neurol 1981; 23:778-791.
14. Karande S, Satam N, Kulkarni M, Sholapurwala R, Chitre A, Shah N. Clinical and psychoeducational profile of children with specific learning disability and co-occurring attention-deficit-hyper-activity disorder. Indian J Med Sci 2007; 61:639-647.
15. Uslu R, Kapçi EG, Oztop D. Neurological soft signs in comorbid learning and attention deficit hyperactivity disorders. Turk J Pediatr 2007; 49:263-269.
16. Pasini A, D'agati E. Pathophysiology of NSS in ADHD. World J Biol Psychiatry 2009; 10:495-502.
17. Martins I, Lauterbach M, Slade P, Luís H, DeRouen T, Martin M, et al. A longitudinal study of neurological soft signs from late childhood into early adulthood. Dev Med Child Neurol 2008; 50:602-607.
18. Vitiello B, Ricciuti AJ, Stoff DM, Behar D, Denckla MB. Reliability of subtle (soft) neurological signs in children. Am Acad Child Adolesc Psychiatry 1989; 28:749-753.

Dr Raja Sadhu, Assistant Professor, Institute of Mental Health and Hospital, Agra
Professor Manju Mehta, Department of Psychiatry, All India Institute of Medical Sciences (AIIMS), New Delhi
Dr. Veena Kalra, Ex-Professor and Head, Department of Pediatrics, AIIMS, New Delhi
Dr. Rajesh Sagar, Associate Professor, Department of Psychiatry, AIIMS, New Delhi
Dr. Monica Mongia, Ex PhD Scholar, Department of Psychiatry, AIIMS, New Delhi

Acknowledgement: Mr Guresh Kumar, working in the department of Biostatistics, All India Institute of Medical Sciences, New Delhi, helped in the statistical analysis of the data.