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Cognitive challenges in persons with spina bifida: Bearing on urological dysfunctions?

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Abstract

Aim: To evaluate if adult persons with spina bifida (SB) who have urinary tract complications have cognitive difficulties that can be identified by neuropsychological tests.

Methods: All individuals with SB ≥ 18 years of age registered at a regional outpatient clinic ($n = 219$) were invited, of which, 154 persons were included. Neuropsychological assessment of their cognitive status was performed with Wechsler Adult Intelligence Scale®—Fourth Edition: Coding, Block design, Arithmetic's, FAS (word generation), Rey Auditory Verbal Test for learning, and delayed recall 30 min. Bladder and bowel function were assessed with questions used by the Nordic Spinal Cord Injury Registry (NSCIR) in structured interviews, by questionnaires, and by chart reviews.

Results: Average neuropsychological test results for this SB population was shown to be approximately 1 *SD* under the median for the general population. The Coding test showed significantly lower test results as compared with the whole SB group in persons with urinary tract complications, especially urinary tract infections, reduced kidney function, dependent emptying of the bladder, and the bowel and accidental bowel leakage. The Arithmetic's test showed a significant difference between subgroups in all parameters except reduced kidney function whereas the other neuropsychological tests were significantly correlated with some but not all urological parameters.

Conclusion: We propose neuropsychological testing with primarily two tests to find those persons with SB who, due to cognitive challenges, might need extra support to minimize urological complications.

KEYWORDS
cognitive impairment, neuropsychological tests, spina bifida, urological dysfunction

1 | INTRODUCTION

The incidence of neurogenic dysfunction of the urinary tract and of the bowel is very high in persons with spina bifida (SB), a congenital birth defect affecting many body systems. Both voiding difficulties, urinary leakage, recurrent urinary tract infections, bowel constipation, and accidental bowel leakage are common problems with high impact on the quality of life and persons with SB also have an increased risk for renal deterioration which can be life threatening.[1,2] Most persons with SB now reach adulthood and a prospect of more independent life including an increased responsibility for managing routines others previously have facilitated. In childhood and as young adults, these persons usually have extensive support from both parents, other relatives and habilitation centers. Many adult persons with SB have needs of assistance to maintain the best possible health status and it is important to identify those who need more support due to the coincidence of SB and cognitive impairments,[3] that might not be obvious initially to all. The cognitive impairments comprise, for example, executive functions, mental speed and attention. In general, individuals with higher lesions (i.e., above L2) are more dependent on others in, for example, bowel and bladder management.[4,5]

At the Spinalis Outpatient Clinic at Rehab Station in Stockholm, responsible for healthcare follow-up for all adults with SB in the Greater Stockholm area, a large survey of life and living conditions in this near-total regional cohort has been performed.[6] The study showed a wide variation in living conditions and the need of assistance from others among the participants. Of the participants in the study, as many as 79% also agreed to be included in a neuropsychological evaluation of their cognitive status. The results for the cohort participating in the study generally showed test scores around 1 *SD* below the average results in the general population.[6]

A more detailed study of the function of the urinary tract and the bowel function in the cohort has also been performed, describing voiding conditions, complications, renal function, urological interventions and bowel function/dysfunction.[7] When analyzing the urological complications, it became apparent that some patients had difficulties to maintain necessary routines for managing voiding and bowel function, which may be related to their cognitive challenges.

The aim of this study was to evaluate if the outcome of one or more of the chosen neuropsychological tests correlated with urological problems. If so, this may indicate an increased need of support to minimize the risk of urological complications and renal failure.

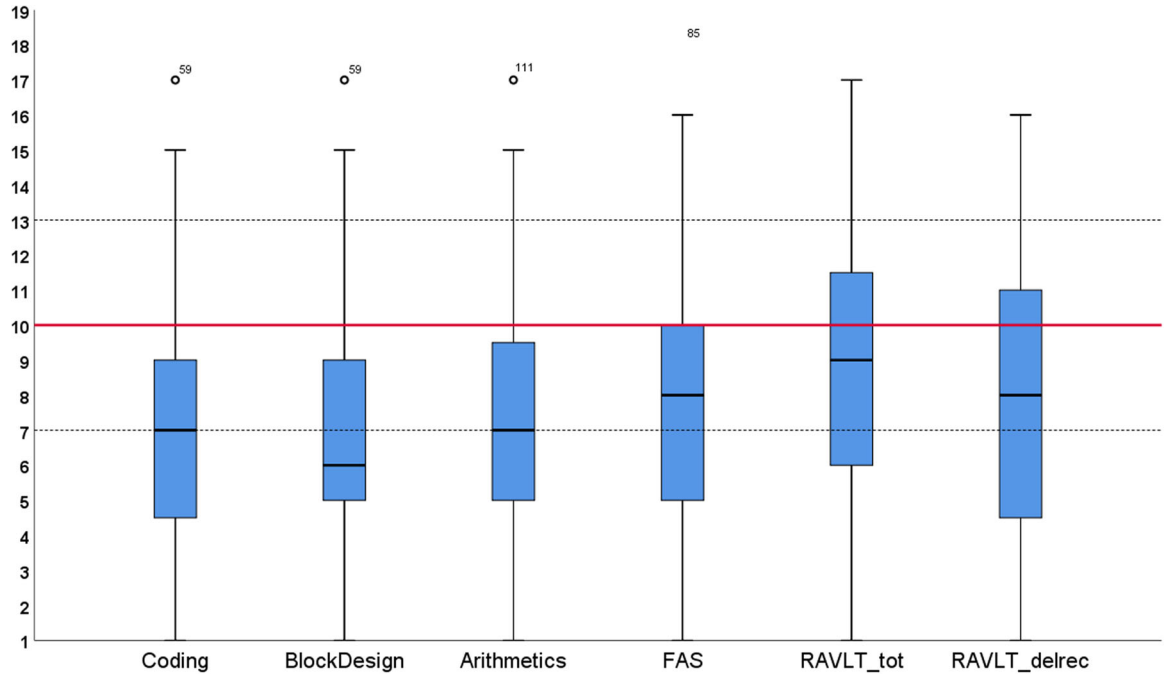

FIGURE 1 Average results for the SB population—average in scaled scores where a value of 10 is the mean with a standard deviation of 3. The red line represents the average for the normal population. Subtests from Wechsler Adult Intelligence Scale®—Fourth Edition (WAIS-IV): Coding, Block design, Arithmetic's, FAS (word generation), R30_tot (Rey Auditory Verbal Test [RAVLT], learning), R30_delrec (RAVLT, delayed recall 30 min). Coding, Block design, and FAS as described by Bendt et al.[6] Arithmetic's, R30_tot, and R30_delrec not previously published

2 | METHODS

Of the 196 persons ≥18 years with SB who accepted to be included in the general survey described above,[6] 154 persons agreed to participate in neuropsychological assessment of their cognitive status. As described earlier by Bendt et al.,[6] average results for this SB population was shown to be approximately 1 *SD* under the median for the general population (Figure 1).

The assessment was performed under the guidance of the neuropsychologist, co-author of this report (GH), and based on descriptions by Riedel et al. (unpublished data). One hundred forty-one persons had a myelomeningocele and 13 persons had a non-myelomeningocele lesion of whom 10 persons were diagnosed with a lipomeningocele and 3 persons with SB occulta. As we in our recently published study[7] found persons in the group with non-myelomeningocele lesions with urologic/bowel problems, we included all persons in the study group in this survey. Neuropsychological tests from Wechsler Adult Intelligence Scale®—Fourth Edition (WAIS-IV), known to be sensitive for common cognitive problems in the population with SB[3] were used in the examination of a relationship to urological problems.[8] Especially three tests, Coding, Block design, and Arithmetic's are suggested to reveal cognitive difficulties common in the SB cognitive phenotype, where specifically complex attention, visuospatial, visual–motor abilities and constructional output seems to be central areas of cognitive difficulty.[9,10] Coding measures processing speed, associative memory and graphomotor speed; Block design is a test for visuospatial processing and problem solving and visual–motor construction; Arithmetic's is a test for working memory, quantitative reasoning, concentration and mental manipulation or working memory. Although, a common discrepancy in intellectual skills favoring verbal over nonverbal abilities in the SB population not uncommonly deficits are also seen in complex language skills (e.g., verbal fluency and learning of word lists, not semantically meaningful).[11] Therefore, three tests for verbal functioning, learning, and memory, respectively and a verbal fluency test was also added—Rey Auditory Verbal Learning Test (RAVLT)[12] and FAS (due to the three initial letters to be generated).[13] The RAVLT test raw scores were transformed to scaled scores according to normative data for 1855 healthy Dutch participants aged 24–81 years and with the influence of age, sex and education.[12] FAS was transformed into scaled scores according to Tallberg et al.,[13] see Table 1.

Bladder and bowel function were assessed according to questions used by the Nordic Spinal Cord Injury Registry (NSCIR)[14] in structured interviews in combination with a review of patient charts. The information on each person were assembled together to cover all aspects. Urological complications, defined as diseases or harmful conditions in the urinary tract including infections, reflux with or without dilatation of the upper urinary tract and urinary stones in the upper or lower urinary tract were registered. For the diagnosis of urinary tract infection, it was mandatory that the patients had symptoms such as urgency, frequency and/or pain differing from their habitual micturition pattern. The occurrence of asymptomatic bacteriuria, which is not uncommon in these persons, was not registered as an infection. Glomerular filtration rate (GFR) was used to analyze the kidney function, using the Caucasian, Asian,

TABLE 1 Types of cognitive test, proposed abilities measured, and estimated time duration for each test

Test	Proposed abilities measured	Approximate time for admin. incl. instructions[d] (min)
Coding[a]	Complex attention, processing and graphomotor speed, associative memory	3
Block design[a]	Visual–spatial processing and problem solving, visual–motor construction	7
Arithmetic[a]	Working memory, quantitative reasoning, concentration, mental manipulation	5
FAS[b]	Verbal fluency (generate words beginning with letters F, A, S; 60 seconds for each letter)	5
RAVLT_immediate recall[c]	Learning ability	6–8
RAVLT_ retention[c]	Memory	3

[a]Subtest from WAIS-IV (Wechsler Adult Intelligence Scale®, fourth edition).

[b]Also called Controlled Oral Word Association Test (COWAT).

[c]Rey Auditory Verbal Learning Test (learning phase with 15 words repeated five times and delayed free recall after 30 min).

[d]Time might slightly vary with age, level of ability, motivation, and attention.

pediatric and adult cohorts (CAPA) equation for eGFR cystatin C.[15] Accidental bowel leakage defined as fecal leakage occurring at least monthly up to every day, was registered. All need of support to empty the bladder or/and the bowel was registered, varying from oral reminders to total assistance.

All participants were informed verbally and in writing about the study and gave their signed informed consent to participate. In a few cases with marked intellectual disability, the written consent was given by the participant's personal assistant.

3 | STATISTICAL ANALYSIS

Descriptive data are presented as numbers and percentages. The Shapiro–Wilk test was used to analyze normal distribution. Mean and *SD* are used for normally distributed variables; median ranges are used for non-normal distributions. Differences were analyzed with the Student *t* test for variables with normal distributions, the χ^2 test for dichotomous variables, and the Mann–Whitney *U* test for variables with non-normal distributions. Statistical significance was determined at $p \leq .05$. The analyses were performed using SPSS version 24 (IBM Corp.).

4 | RESULTS

One hundred fifty-four persons (80 females and 74 males; mean age, 35 years [18–73]) participated. Forty-seven percent of the 154 persons had suffered from a urinary tract complication the year before they were included in the study. Urinary tract infections were by far the most common cause, counting for 96%. The other urinary complications registered consisted of three cases of stones in the upper urinary tract, two cases of stones in an augmented urinary bladder and a continent urinary reservoir, two cases with dilatation of the upper urinary tract and one case of epididymitis. The group of persons who had suffered from urinary tract infections and other urological complications scored significantly lower in the Coding test and in the Arithmetic's test as compared with the rest of the cohort who, as already described, had test results approximately 1 *SD* under the median for the general population (Table 2).

Accidental bowel leakage is a well-known risk factor for urinary tract infections and was reported by 25 (16%) of the participants in the study. Both Coding, Block design, Arithmetic's test and Rey's auditory verbal learning test showed significantly lower results in the group with accidental bowel leakage as compared with the group who reported fecal continence (Table 2).

Seventeen persons (11%) were found to have a reduced kidney function with a lowered glomerular filtration rate for cystatin C, while 134 (87%) persons had a normal function (missing data from three persons, 2%). The group of patients with a reduced kidney function had a significantly lower executive function measured with the Coding test as compared with the group of persons with normal kidney function (Table 2).

A majority, 134 (87%) of the 154 persons, who participated in the neuropsychological evaluation of their cognition were able to empty the bladder without assistance and as many as 130 (84%) persons emptied the bowel without help. The remaining persons needed assistance to a varying degree, from a reminder to empty the bladder up to need of total assistance with both bladder and bowel emptying. The persons requiring help with bladder emptying and/or bowel emptying all had significantly lower results in the neuropsychological assessment in all six tests as compared with the group with no need of help, showing a strong correlation between dependence in this regard and cognitive impairment (Table 2).

5 | DISCUSSION

The ability to maintain necessary routines for managing voiding and bowel function is very important to minimize the risk for urinary tract complications for persons with SB. Urological complications may reduce the quality of life and can also increase the risk for renal failure.[1]

It can be a challenge to detect those persons with SB, who in many respects might be well functioning, but who still have a need for increased urological support related to cognitive impairment, that may not be obvious to all. Persons with SB may proclaim that they follow the recommended routines for emptying the bladder but lack sufficient executive function to manage, which may lead to severe renal impairment in some cases. Repeated urinary tract infections may be a sign of warning, indicating the inability to maintain the necessary routines to avoid urinary tract complications. Cognitive impairment has also been reported as a risk factor for postoperative unwanted side effects in persons with SB undergoing bladder augmentation cystoplasty.[16] We have in our own practice also seen patients with SB who had been operated with a continent reservoir not being able to handle the catheterizations on their own and therefore would have been better off with an ileal conduit.

Thus, we need to identify the persons with SB who have cognitive challenges, so we can provide the best urological care for them and whenever necessary give them more urological support. In our study, we found dependence on others for emptying the bladder and/or

TABLE 2 Odds ratios calculated from dichotomized results by median results in persons with spina bifida

	Coding	Block design	Arithmetic's	FAS	RAVLT_tot	RAVLT_delrec
Urological complications (yes = 72, no = 81, missing = 1)	OR = 2.9** (CI, 1.49–5.56)	OR = 1.8 (CI, 0.97–3.50)	OR = 4.3** (CI, 2.18–8.46)	OR = 1.8 (CI, 0.93–3.36)	OR = 1.7 (CI, 0.87–3.15)	OR = 1.7 (CI, 0.92–3.30)
Urinary tract infections (yes = 69, no = 84, missing = 1)	OR = 2.5** (CI, 1.28–4.74)	OR = 1.8 (CI, 0.92–3.33)	OR = 4.0** (CI, 2.04–7.83)	OR = 1.9 (CI, 0.98–3.55)	OR = 1.4 (CI, 0.73–2.63)	OR = 1.5 (CI, 0.78–2.81)
Independent emptying of the bladder (yes = 134, no = 20, missing = 0)	OR = 10.6** (CI, 2.47–47.62)	OR = 24.6** (CI, 3.20–188.93)	OR = 8.9** (CI, 2.50–32.00)	OR = 5.1** (CI, 1.61–16.02)	OR = 3.5* (CI, 1.25–9.56)	OR = 3.5* (CI, 1.22–10.30)
Normal kidney function (yes = 134, no = 17, missing = 3)	OR = 3.5* (CI, 1.09–11.30)	OR = 1.8 (CI, 0.61–5.14)	OR = 1.9 (CI, 0.67–5.21)	OR = 1.4 (CI, 0.50–3.86)	OR = 1.9 (CI, 0.79–3.46)	OR = 2.7 (CI, 0.89–8.00)
Accidental bowel leakage (yes = 39, no = 84, missing = 1)	OR = 2.3* (CI, 1.08–4.93)	OR = 2.9** (CI, 1.33–6.25)	OR = 2.2* (CI, 1.03–4.52)	OR = 2.0 (CI, 0.96–4.22)	OR = 2.2* (CI, 1.07–4.69)	OR = 1.7 (CI, 0.79–3.46)
Independent emptying of the bowel (yes = 130, no = 24, missing = 0)	OR = 13.9** (CI, 3.14–61.57)	OR = 4.7** (CI, 1.64–13.22)	OR = 8.3** (CI, 2.67–25.60)	OR = 5.0** (CI, 1.78–14.27)	OR = 3.0* (CI, 1.20–7.52)	OR = 2.9* (CI, 1.12–7.42)

Note: Confidence intervals (CIs) for each odds ratio (OR) are provided in parenthesis. Subtests from Wechsler Adult Intelligence Scale®—Fourth Edition (WAIS-IV): Coding, Block design, Arithmetic's, FAS (word generation), R30_tot (Rey Auditory Verbal Test [RAVLT], learning), R30_delrec (RAVLT, delayed recall 30 min).

*$p < .05$ (two-sided significance).

**$p < .01$ (two-sided significance).

the bowel to be a strong indicator for cognitive impairment in persons with SB and in these cases the need for extended urological assistance is obvious. However, this group was only a fraction of the group reporting urinary complications, who scored significantly lower in the Coding test and in the Arithmetic's test as compared with the whole cohort. This implies that further evaluation for the need for extra support might be indicated not only in the persons already known to be in need of assistance.

The extra support should be problem based. If the patient has assistance providers, these persons should have adequate knowledge on how to take care of the patient and they might need more education. For individuals who are independent in some daily life activities but who need support to keep their daily routines for bladder and bowel, it may be very difficult to achieve the requisite assistance. We have in our center started to offer help from an occupational therapist or psychologist to find cognitive strategies to create a structure for daily life. The ability to comply to these strategies is individual and we have identified persons who would gain from daily coaching while others may manage with a weekly supportive phone call. We believe this type of coaching could be very helpful but have not yet had the possibility to implement it. Of course, this is a complement to the regular follow-up visits on a yearly basis.

Evaluation of the cognitive abilities should be performed when there is a problem with complications and questions are raised concerning problems with the daily routines. The ability to manage the daily routines is of utmost importance when deciding on strategies for emptying the bladder and the bowel. Also, cognitive assessment is of great value when surgical procedures are considered and the current capacity of self-care for the individual needs an evaluation.

When analyzing the outcome of the neuropsychological testing, the results of the Coding test were found to show significant difference in executive function between the subgroups in our study in all selected urological parameters. The Arithmetic's test measuring ability for reasoning, concentration, and or working memory, which also has an impact on the ability to maintain necessary routines, turned out to show a significant difference between the subgroups in all urological areas investigated except for reduced kidney function. According to these results, the combination of the Coding test and the Arithmetic's test provides important information of different abilities necessary to be able to manage urological routines. The tests are easy to perform, and it takes about 10 min to do both for trained staff. Therefore, we propose an assessment with the Coding test and the Arithmetic's test for screening to find persons with cognitive challenges in this regard. If a person in the screening tests shows neuropsychological results over the median for this whole group, he/she would probably not be at risk of needing extra support with urological management. If on the other hand, the results are below the median for the whole group, a more detailed assessment of the cognitive functions may indicate what kind of extra support is needed.

These neuropsychological tests might also be of help to suggest the best type of urological surgery for the individual patient if there are alternative surgical techniques requiring different levels of cognitive ability to maintain postoperative routines. Kalogirou et al.[17] have also addressed this issue and proposed an evaluation of cognitive ability in patients before deciding which type of urinary diversion should be offered.

Standardized neuropsychological assessment of cognitive capacity is already in use for the selection of patients undergoing deep brain stimulation for Parkinson's disease[18] and cognitive performance is one of the domains identified as relevant for the selection of candidates for lung transplantation.[19]

6 | CONCLUSION

Neurogenic dysfunction of the urinary tract and of the bowel is very common in persons with SB and it is important to identify those who need more support due to cognitive challenges to reduce urological complications and renal deterioration. We propose the use of neuropsychological testing with primarily two tests, Coding test and Arithmetic's test, as a possible way of screening the cognitive ability to find those in need of extra urological support.

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