The predictive value of colon transit time and anorectal manometry in the approach of faecal continence in children with spina bifida

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Abstract

***Purpose* : The aim of this study is to analyse colon transit time (CTT) and anorectal manometry (ARM) in children with spina bifida (SB) as a predictor for achieving spontaneous faecal continence.**

***Methods* : SB patients (2.5-7 years old) followed at the SB Reference Centre Ghent University Hospital underwent CTT and/or ARM before starting bowel management. A standardized questionnaire about the presence of constipation and faecal incontinence was completed. CTT was measured using a 6-day pellet abdominal X-ray method. ARM was performed in non-sedated children using a latex-free catheter.**

***Results* : Twenty-two patients were studied, with a median age of 4.57 years. They all underwent a CTT study, 17 (77%) also agreed to ARM. 10/22 patients (45.5%) were constipated. 5/22 patients (22.7%) became spontaneously continent, 10/22 (45.5%) became pseudo-continent with bowel management, the others remained incontinent. SB patients had a significant prolonged CTT compared to healthy controls. In the group with an abnormal CTT study (12 patients), none of the patients developed faecal continence spontaneously, irrespective of the ARM result. In case of a normal CTT study (10 patients), 7 agreed to ARM. All children with normal resting pressure (4 patients) gained continence spontaneously. The 3 children with abnormal low resting pressure remained incontinent.**

***Conclusions* : This prospective study confirms the predictive value of normal CTT and normal resting pressure, in the evolution towards spontaneous faecal continence. If CTT is abnormal, irrespective of the ARM, bowel management will be necessary to obtain pseudo-continence. In these cases, ARM is not a designated examination.** (Acta gastroenterol. belg., **2018**, 81, **277-282**).

Keywords : Spina bifida, Child, Faecal incontinence, Manometry, Transit Time

Ethics Committee of Ghent University approval : reference number UZG 2016/0841. All authors have contributed to this work, have approved the manuscript and none have reported a conflict of interest.

Introduction

Spina bifida (SB) is a congenital impairment of neural tube closure taking place between 3 to 4 weeks of gestation, resulting in a partial or total paralysis below the level of the defect. (1) Depending on the level of the spinal cord lesion, patients are suffering from a varying degree of motor and sensory problems, cognitive dysfunction, musculoskeletal impairment, but also urinary and/or bowel dysfunction. Faecal incontinence is caused by a combination of blunted rectal sensitivity, intestinal dysmotility, and anorectal dysfunction. (2) Despite adequate bladder and/or bowel management, a Dutch study in young adults with SB described a persistent urinary and/or faecal incontinence in a substantial part of them (61% and 34%, respectively), and that most of these patients perceived this as problematic (70% and 77%, respectively). (3) Faecal incontinence leads to skin irritation and increased risk of urinary tract infections, but has also a significant impact on social interaction, lowers self-esteem and independence, and causes psychosocial problems. (4) Therefore, incontinence has a major impact on the quality of life in children and their relatives. (3,5,6,7) These parents indicate that they would like clarity as early as possible on future perspectives and treatment possibilities. (7)

A previous study in older children described a normal colon transit time (CTT) in combination with normal anorectal manometry (ARM) in children who gained continence spontaneously, and disturbed tests in those who needed bowel management. (8) However, the predictive value of these examinations was not tested before the start of bowel management treatment. During the follow up, from birth on, at the SB Reference Centre (SBRC) Ghent University Hospital constipation is often treated aggressively and a stepwise approach to obtain faecal continence is used, starting from the developmental age of 4 years old. (4,9) It remains however difficult to predict whether achieving spontaneous faecal continence is a possibility. Nevertheless, it is necessary to avoid time consuming and frustrating attempts at toilet training in those children not able to achieve faecal continence and who will need bowel management interventions. Hence, predicting is important, not only for parents and patients, but also for the urologist who needs to plan the eventual surgical interventions with regard to urinary continence.

The aim of the present study is to prospectively analyse CTT and ARM in young children with SB,

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before starting bowel management, as predictors for achieving spontaneous faecal continence in relation to different patient characteristics, hereby trying to bring clarity to parents on outcome on faecal continence as soon as possible.

Materials and Methods

Patients and controls

The present study is a prospective, descriptive study with data from the SBRC at the Ghent University Hospital. One hundred and twelve patients are followed by a multidisciplinary team, consisting of a paediatric neurologist, neurosurgeon, urologist, gastroenterologist, orthopaedic surgeon and several paramedics. All SB patients (n=37), aged between 2.5 and 7 years old at the moment of inclusion and not using a bowel management technique to gain pseudo-continence, were contacted to participate in the study. Twenty-two (60%) children (9 boys and 13 girls), selected between September 2011 and October 2016, accepted to participate in the study, after informed consent.

CTT normal values were retrieved from an earlier study by Vande Velde *et al*., using the results of the children in the subcategory "toddlers 3-6 years old" as control patients (16 patients, 11 boys and 5 girls). (10) In this study, all children underwent a CTT study by the method of Abrahamsson *et al*. (See also section Colon Transit Time). CTT was considered normal if the total CTT was below 79.2h (95th percentile of normal values). Normal values for ARM were obtained from a study by Kumar *et al* in 90 healthy children between 3 days and 12 years old. (11)

Methods

Patient characteristics were extracted from the medical file. Cognitive function was divided into normal (normal education), mildly impaired (adapted education, expected to be able to perform simple reading and math), and severely impaired (education limited to the goal of achieving independence on daily activities). According to the lesion level, patients were categorized in 4 subgroups : level T9 or more cranial, level T10-L2, level L3-S1, and level S2 or more caudal. These levels were used as cut-off because of innervation aspect. (1,3) Mobility of patients was defined as normal ability to walk, walking with splints or a walker, and wheelchair dependence. The bowel habits of SB patients were studied using different questionnaires. Stool consistency was scored using the Bristol Stool Scale. (12) The Rome III criteria were used for evaluation of the presence of constipation or incontinence. (13) Patients were considered constipated in the presence of at least two of the Rome III criteria for paediatric functional constipation. (13) Faecal incontinence was defined as having one or more bowel accidents a month, requiring the need to change clothes or diaper, in patients with or without the use of bowel management methods. (3) Spontaneous faecal continence was defined as involuntary stool loss less than once a month, without any form of therapy. Pseudo-continence was determined by involuntary stool loss less than once a month with bowel management therapy.

Colon Transit Time

Total and segmental CTT was measured by using radiopaque solid markers. This was performed according to the method by Abrahamsson *et al*. (14) According to this method, children were asked to take a small capsule containing 10 polythene radiopaque markers (Marquat ®, France) during six consecutive days, i.e. 60 pellets in total. A plain radiograph of the abdomen was taken on day seven. Markers located to the right of the midline of vertebrae and above an imaginary line between the body of the fifth lumbar vertebra and the pelvic outlet were assigned to the right colon, markers located to the left of the midline and above the line to the left iliac crest were designated to the left colon, and pellets below these lines were assigned to the rectosigmoidal colon, as also described by Keshtgar *et al*. (15) Total and segmental CTT were calculated by multiplying the number of markers by 2.4, according to Abrahamsson *et al*. (14)

Anorectal Manometry

Manometric studies were performed with the child in right lateral position, without previous bowel preparation nor sedative. All measurements were performed by the same investigator (SVdV), using a water-perfused, latex-free catheter (MMS G-90080). The anorectal probe, consisting of a rectal balloon and three cylindrical ports at 1-cm intervals, was positioned in the anal canal to measure rectal and anal sphincter pressures. The fourth port was used to inflate the rectal balloon with a 60ml air-filled syringe with a stop lock, which allowed the administration of large balloon volumes. Data were generated using MMS Solar GI anorectal manometry analyser software. A well-lubricated anorectal catheter was introduced gently. After 3 minutes of stabilization, the resting pressure was measured. The absence or presence of recto-anal inhibitory reflex was elicited with rapid inflation of the rectal balloon with air (up to 60ml). When possible, squeeze pressure and threshold of minimal sensation were evaluated. For measuring the maximal tolerable volume, the rectal balloon was inflated until the child indicated urge or pain. The subject could decide to stop at any time during the examination.

Statistics and Ethics

Data were analysed using SPSS Statistics 23 for Windows. Results were described as median and minimum-maximum or upper limit with 95th centile. Normality of distribution was tested and non-parametric

tests (Mann-Whitney U) or parametric tests (unpaired t-test) were used accordingly to compare differences. Categorical variables were analysed using the Pearson Chi-square or Fisher's Exact test. In all cases, two-sided tests were used with a threshold of $p<0,05$. The study protocol was approved by the Ethics Committee of Ghent University, with reference number UZG 2016/0841. Informed consent from all parents was obtained.

Results

Patient characteristics

Thirty-seven out of one hundred twelve patients met the inclusion criteria. Parents of 22 patients (60%), with a median age of 4.57 (2.5-6.5) years old (9 boys and 13 girls), consented in the study. Seventeen of them (77.3%) also agreed to ARM. Reasons for refusal of ARM were the invasive character and extra time investment needed. The median age at evaluation of continence was 7.50 (3.2-9.8) years old.

The majority (73%) of patients achieved faecal continence (spontaneously 5/22 (23%), or pseudo-continence 11/22 (50%)). The others (6/22) remained incontinent. The therapies used in order to gain pseudo-continence were systematic toilet seating 2/11 (18%), use of laxatives 1/11 (9%), manual evacuation 3/11 (27%), retrograde enema 4/11 (36%) and anterograde enema 1/11 (9%). Four of the incontinent patients didn't use any therapy. Ten out of twenty-two patients (45.5%) suffered from constipation, according to the Rome III criteria. Bristol stool scale was insufficiently reported. At the moment of the CTT study, none of the children received any form of treatment to achieve faecal continence. Patient characteristics are listed in Table 1.

Factors associated with spontaneous faecal continence were normal ability to walk, normal cognitive function, absence of constipation, and urinary continence (with or without catheterization). All patients (n=3) gaining urinary continence without catheterization developed also spontaneous faecal continence.

Colon transit time

CTT results in different subgroups are summarized in Table 2. Median age for CTT study was 4.4 years in the patient group, in comparison to 5.0 years in the control group. SB patients had a significant longer CTT compared to healthy controls ($p = 0.001$). This difference was mainly due to a significant prolonged transit time in the left CTT ($p = 0.037$) and the rectosigmoidal CTT ($p = 0.007$), but not in the right CTT ($p = 0.068$). SB patients with constipation had a significant increase in their CTT compared to patients without constipation ($p = 0.0001$). This difference was due to a significant increase in every segment: right CTT ($p = 0.034$), left CTT ($p = 0.001$) and rectosigmoidal CTT ($p = 0.028$). SB patients without constipation did not differ from the healthy control group ($p = 0.157$). All five patients who gained continence spontaneously had a normal CTT. The

Table 1. — **Patient characteristics**

Total number of patients (n=22)			Spontaneous // pseudo faecal continence
Sex	Male Female	9 (40.9%) 13 (59.1%)	2 // 4 3 // 7
Age		4.57 y (2.5 – 6.5)	
Lesion level	T9 or higher T10-L2 L3-S1 S2 or lower	1 (4.5%) 0 17 (77.3%) 4 (18.2%)	0 // 1 0 // 0 4 // 8 1 // 2
Cognitive function	Normal Mildly impaired Severely impaired	18 (81.8%) 4 (18.2%) 0	5 // 7 0 // 4 0 // 0
Mobility	Normal walking Walking with splints Wheelchair dependent	11 (50.0%) 9 (40.9%) 2 (9.1%)	5 // 3 0 // 6 0 // 2
Constipation	No Yes	12 (54.5%) 10 (45.5%)	5 // 5 0 // 6
Faecal continence	Spontaneous Pseudo-continent Incontinent	5 (22.7%) 11 (50.0%) 6 (27.3%)	
Faecal continence treatments	Systematic toilet seating Laxatives (only) Manual evacuation Retrograde enema Anterograde enema No treatment	2 (9.1%) 2 (9.1%) 3 (13.6%) 5 (22.7%) 1 (4.5%) 9 (40.9%)	0 // 2 0 // 1 0 // 3 0 // 4 0 // 1 5 // 0
Urinary continence (with or without catheterization)	No Yes	12 (54.5%) 10 (45.5%)	1 // 8 4 // 3
Urinary treatment	Catheterization None	16 (72.7%) 6 (27.3%)	1 // 9 4 // 2

Table 2. — **Results of the colon transit time (CTT)**

CTT (hours)	Controls	SB patients				
		Total	Constipation		Continence	
			Yes	No	Spont.	Not Spont.
Total	31,2h (0,0-74,4)	87,6h (9,6-139,2)	117,6h (55,2-139,2)	36,0h (9,6-110,4)	31,2h (9,6-36,0)	98,4h (33,6-139,2)
Right	2,4h (0,0-21,6)	12,0h (0,0-60,0)	24,0h (0,0-60,0)	2,4h (0,0-36,0)	0,0h (0,0-19,2)	18,0h (0,0-60,0)
Left	2,4h (0,0-26,4)	12,0h (0,0-50,4)	26,4h (9,6-50,4)	2,4h (0,0-31,2)	2,4h (0,0-12,0)	21,6h (0,0-50,4)
Rectosigmoidal	18,0h (0,0-52,8)	36,0h (2,4-88,8)	45,6h (31,2-88,8)	32,4h (2,4-67,2)	12,0h (2,4-33,6)	43,2h (28,8-88,8)

Median and minimum/maximum of total and segmental colon transit time (CTT) of controls and spina bifida (SB) patients, as well as subgroups of SB patients according to the presence of constipation or continence.

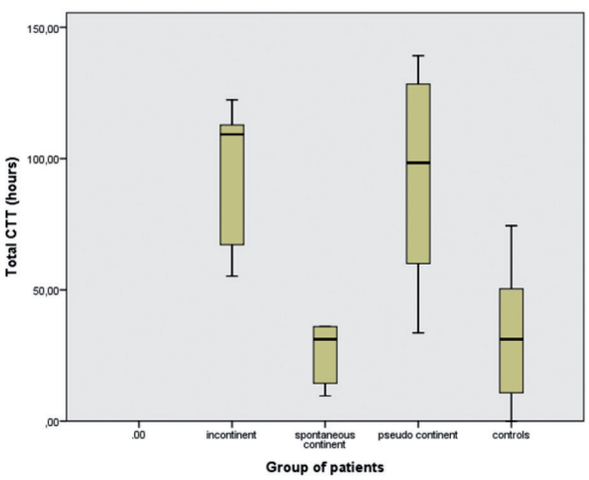

Fig. 1.

CTT was significantly different between the patients with spontaneous faecal continence and the others (p = 0.001). The children with SB who became continent spontaneously did not have a longer CTT in comparison to the healthy controls (p = 0.719). No difference in CTT was observed between the pseudo-continent and incontinent patients (p = 0.961). (Fig. 1)

Anorectal manometry

Seventeen out of twenty-two (77.3%) patients underwent ARM. A resting pressure of more than 44 mmHg was considered normal, according to Kumar *et al*. (11) All patients had a recto-anal inhibition reflex (RAI-reflex). The median resting pressure in SB patients was 39 mmHg (12-83 mmHg). Median first sensation was 20 mL (10-90 mL). Median maximum tolerable volume was 90 mL (20-240 mL). Nine out of seventeen patients (52.9%) had an abnormally low resting pressure, 8/17 (47.1%) patients had normal resting pressure. In the group SB patients with an abnormal CTT study (12 patients), 10 had undergone ARM, of which 6 (60%) had an abnormal and 4 (40%) a normal test result. None of these patients developed continence spontaneously. From the 10 patients with a normal CTT study, 7 had undergone ARM. Four (57.1%) of them had a normal ARM, while 3/7 (42.9%) had abnormal ARM test results. All patients with a normal CTT study in combination with normal ARM developed continence spontaneously. The three patients with a normal CTT study and abnormal ARM did not develop continence spontaneously. For the 3 patients in this group, who refused ARM, 2 remained incontinent, while one patient developed continence spontaneously. (Fig. 2)

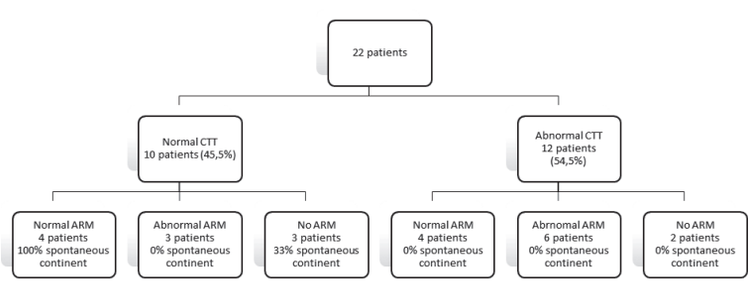

Fig. 2.

There was no significant difference in resting pressure according to faecal continence status (p = 0.156), although the patients with spontaneous faecal continence tended to have a higher resting pressure (p = 0.06). Neither was there a significant difference the resting pressure according to normal or abnormal CTT study (p = 1.00).

Discussion

In literature, the reported combined faecal continence rate (i.e. spontaneous continent and pseudo-continent) in SB patients varies between 67-81%, depending on the technique for bowel management described (conservative, pharmacological or surgical). (16) The success rate in the present study (73%), including all patients even those without any faecal continence therapy (18%), is comparable to these studies. Since this study looked in particular at younger children, of whom some did not start a bowel program yet, final (pseudo-) continence rates could still improve.

Patient characteristics associated with the development of spontaneous faecal continence were normal ability to walk, normal cognitive function, absence of constipation and spontaneous urinary continence. Since these patient characteristics are known to be associated with less severe SB, it seems logical they are associated with spontaneous faecal continence. On the other hand, with the exception of spontaneous urinary continence, these characteristics give only a 50% or less chance of spontaneous faecal continence. Therefore, they are not sensible enough to predict the need for bowel management. In this small study group, with very few patients having a high lesion level, this did not seem an influencing factor on faecal continence.

Di Lorenzo *et al* described two mechanisms for faecal incontinence in SB patients, who are known to have a neurogenic bowel dysfunction: 1) paralyzed external anal sphincter with faecal loss at the moment of internal anal sphincter relaxation, and 2) the presence of slow transit constipation because of absence of reflex contraction when the rectum distends. (17) In the past, the usefulness of CTT in the evaluation of faecal incontinence has been proven in different populations, including SB. (8,18,19) A slow transit in the different colon segments in the SB patient has already been demonstrated in the past. (2,10) The present study confirmed this observation and is in contrast to an only slow rectosigmoidal CTT, what would be observed in children with functional faecal retention. (17) Especially the constipated SB patient had an important increase in CTT (117.6h vs 36.0h). Although the diagnosis of constipation was based on the Rome III criteria, due to the timing of the study, applying the revised Rome IV criteria did not change the outcomes of this cohort. (13,20)

Up to date, only four studies reported on ARM results in SB patients, with contradictory conclusions. (21-24) Two of these studies reported on rectal sensation and faecal continence, where no correlation was found. (23-24) This study could not confirm resting pressure differences according to continence classification, although the spontaneous continent group tended to have a non-significant higher resting pressure (p = 0.06). All these spontaneous continent children had a normal resting pressure. Not reaching significance might be the consequence of small number of patients. Neither was there a difference in ARM according to CTT.

According to an earlier study, combined CTT and ARM seemed to predict spontaneous faecal continence when performing the tests at an older age. (8) This study reported the results of the same study protocol, but now before bowel management was started with the intention to predict spontaneous faecal continence. This could lead to a more personalized treatment protocol avoiding unnecessary medical interventions and examinations. Sixty percent of the young SB children followed at the SBRC in the Ghent University Hospital had a CTT before any type of bowel management was started, and 50% also underwent an ARM. The difficulty in obtaining more ARM results lied in the invasiveness and time investment to perform these tests.

All patients who gained spontaneously faecal continence had a normal CTT. ARM contributed further to this prediction, since the positive predictive value of achieving faecal continence spontaneously was 100% in the presence of a normal CTT in combination with a normal ARM. The study confirms the earlier post hoc results of Vande Velde *et al.* (8)

On the other hand, if CTT was abnormal, a treatment was always needed (negative predictive value was 100%), irrespective of the results of ARM. Therefore it does not seem useful to perform ARM, which is a stressful examination, systematically in this patient group. These study results were used to draw a decision diagram to predict the evolution towards spontaneous faecal continence. (Fig 3)

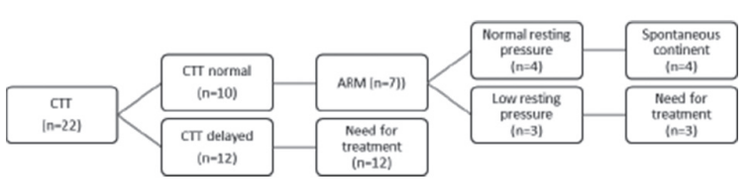

Fig. 3.

These results can give extra insight into the future of the SB patient and might therefore be important to take into account whenever surgery for urinary continence is necessary. Before sacrificing the appendix for a vesicostomy, a CTT prior to the procedure could indicate whether antegrade continence enema procedure might be necessary in the future of the patient. Up to now, we were not able to tailor the treatment options of the largest group not achieving spontaneous faecal continence. Further research is needed to tailor the treatment options in this group.

The major limitation of this study is the small cohort. With a continuously decreasing incidence of children born with SB, multicentre studies will be necessary to answer the remaining questions.

Conclusion

The current study confirms the hypothesis that a normal CTT in combination with a normal anal sphincter resting pressure predicts spontaneous faecal continence in children with SB. An abnormal CTT implicates the need for bowel management to acquire faecal pseudo-continence, independent of the result of ARM. Therefore ARM is not useful in patients with an abnormal CTT. In case of normal CTT it is necessary to perform ARM to differentiate between the development of spontaneous faecal continence and the need for a technique. In order to identify the patients who will become faecal continent spontaneously, we propose to perform a CTT at the age of 3 years, potentially associated to an ARM. Larger studies are necessary to make recommendations for a tailored approach of bowel management of a child with spina bifida.

Key : ARM = anorectal manometry. CTT = colon transit time. SB = spina bifida. SBRC = spina bifida reference centre.

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