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Comprehensive analysis of the clinical and urodynamic outcomes of secondary tethered spinal cord before and after spinal cord untethering

Ahmad Alzahrani [a], Ossamah Alsowayan [a,b], Jean-Pierre Farmer [a], John-Paul Capolicchio [a], Roman Jednak [a], Mohamed El-Sherbiny [a]

[a]Department of Pediatric Surgery, Division of Pediatric Urology and Neurosurgery, The Montreal Children's Hospital and McGill University Health Center, Shriners Hospital of Montréal, QC, Canada

[b]Department of Urology, College of Medicine and King Fahd Hospital of the University, University of Dammam, Kingdom of Saudi Arabia, Saudi Arabia

Correspondence to:
O. Alsowayan, Department of Urology, College of Medicine and King Fahd Hospital of the University, University of Dammam, PO Box 40086, Alkhobar 31952, Saudi Arabia

sowayan81@gmail.com
(O. Alsowayan)

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Summary

Objective
Secondary tethering of the spinal cord (TSC) occurs in 3–30% of patients with history of spinal cord dysraphism repair. As many patients with spinal cord dysraphism already have symptoms, it might be difficult to diagnose secondary TSC. Regular clinical/urodynamic (UDS) evaluation is therefore advised to pick-up changes early before they progress. This study aimed at presenting clinical/UDS outcomes for patients with secondary TSC who underwent spinal cord untethering (SCU).

Study design
Charts of patients with secondary TSC between 1998 and 2010 were reviewed retrospectively. Patients who underwent pre/post SCU clinical/UDS evaluation were included. All patients were followed-up for a minimum of 5 years for proper clinical outcomes assessment. Urologic, neuro-orthopedic, and UDS outcomes were collected and studied. Continence status was assessed in children aged ≥5 years. Patients were considered continent if they were dry for ≥4 h or socially continent if they stayed dry most of the day using maximum 1–2 pads/day. Categorical data were compared using the Fisher–Exact test and continuous variables were compared using the Wilcoxon Signed Rank test. A p-value < 0.05 was considered significant.

Results
Twenty-three patients met our inclusion criteria. The median age at time of SCU was 8.8 (range 2.3–16.2) years. The median age at time of UDS follow-up after SCU was 8.8 (range 2.9–17) years. The median follow-up time was 5 (range 5–13.4) years. Urological symptoms were reported in 56.5% of patients before SCU and improved in 61.5% post SCU. Neuro-orthopedic symptoms were reported in 87% of patients before SCU and improved in 65% post SCU. Continence was achieved in 73.9% of the entire cohort on long-term follow-up, while 26.1% had socially acceptable continence. UDS outcomes are summarized in the Table.

Conclusions
Patients with secondary TSC are expected to have progression of their symptoms over time if not untethered. From here comes the importance of closely performing clinical/UDS evaluation to pick-up changes early before they progress. Surprisingly, clinical outcomes after SCU with detailed description of the auxiliary management are sparse in the literature. Most studies focus on UDS outcomes. We provided in the current study a detailed discussion of the clinical outcomes, auxiliary-managements used to achieve continence, and the UDS outcomes. Careful periodic clinical/UDS evaluation is recommended for early pick-up of changes suggestive of TSC. SCU could improve existing symptoms, and prevent worsening or development of new symptoms. UDS parameters that showed most improvement were intravesical pressure at TCBC and bladder compliance.

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Table Urodynamic outcomes.

Parameter	Median	Range	*p*-value
Percentage of change of EBC after SCU	10.5	5–36.8	0.376
Percentage of change of actual bladder capacity after SCU	12.4	−37.7 to 279.4	
Pressure at TCBC before SCU (cmH_2O)	35	9–92	0.009
Pressure at TCBC after SCU (cmH_2O)	25	7–77	
DLPP before SCU (cmH_2O)	51	14.5–86	0.05
DLPP after SCU (cmH_2O)	28	11.3–79	
Compliance at TCBC before SCU (ml/cmH_2O)	5.5	1.7–45.1	0.01
Compliance at TCBC after SCU (ml/cmH_2O)	6.9	1.4–28	
Compliance at 75% capacity before SCU (ml/cmH_2O)	6.7	2–50.6	0.044
Compliance at 75% capacity after SCU (ml/cmH_2O)	10.5	3–59.5	

Introduction

Secondary tethering of the spinal cord (TSC) occurs in 3–30% of patients with a history of spinal cord dysraphism repair [1–4]. Abnormal fixation of the spinal cord by the postoperative adhesions limits its motion and results in stretching as the boney spine grows. This will eventually impair the blood circulation and metabolic function of the spine, resulting in symptom appearance or progression [5,6]. As a large number of patients with spinal cord dysraphism already have symptoms, it might be difficult to diagnose secondary spinal cord tethering. Regular clinical and urodynamic (UDS) evaluation is therefore advised. Here, we present clinical and UDS outcomes for patients with secondary TSC who underwent spinal cord untethering (SCU).

Materials and methods

We reviewed retrospectively charts of patients with secondary TSC who underwent SCU between 1998 and 2010. We included patients who underwent pre and post SCU clinical and UDS evaluation. All patients were followed up for a minimum of 5 years for proper clinical outcomes assessment.

Secondary TSC was suspected because of the presence of symptoms. This was confirmed with magnetic resonance imaging (MRI) in all patients. SCU was carried out as described by Vernet et al. [7]. A comprehensive clinical, UDS and upper tract evaluation with ultrasound was done pre as well as post SCU. UDS was repeated 6–12 months after SCU and annually thereafter if clinically warranted. Voiding cystourethrogram (VCUG) was done when grade 3–4 hydronephrosis, according to Society for Fetal Urology grading system [8], was detected or when there was history of febrile UTI.

Continence status was assessed in children aged $\geq$5 years. Patients were considered continent if they were dry for $\geq$4 h or socially continent if they stayed dry most of the day using maximum 1–2 pads/day.

Urologic and neuro-orthopedic outcomes were collected and studied.

Clinical improvement was defined as resolution of symptoms that derived SCU. Stability was considered when the patient showed neither improvement nor deterioration post SCU, or worsening when the patient had progression of the main symptom and/or developed a new symptom.

Preoperative and 6–12-month postoperative UDS data were collected. The following parameters were examined. Total cystometric bladder capacity (TCBC), intravesical pressure at TCBC, detrusor leak point pressure (DLPP), compliance at TCBC as well as 75% bladder capacity, uninhibited bladder contractions (UC), detrusor sphincter dyssynergia (DSD), and percentage change in bladder capacity before and after SCU. We compared the percentage change in expected bladder capacity with the percentage change in actual bladder capacity before and after SCU to eliminate the false impression of improvement related to the natural growth of the bladder. The expected bladder capacity (EBC) was calculated using (24.5 (age) + 62) formula [9].

Categorical data were compared using the Fisher exact test and continuous variables were compared using the Wilcoxon Signed Rank Test. A p-value < 0.05 was considered significant.

Results

Of the 50 patients with tethered spinal cord syndrome (TSCS) identified in our database, 23 patients, 13 males and 10 females, met our inclusion criteria. The median age at time of SCU was 8.8 (range 2.3–16.2) years. The median age at time of first follow-up UDS after SCU was 8.8 (range 2.9–17) years. The median age at time of last follow-up was 14.3 (range 7.4–21.3) years. The median follow-up time was 5 (range 5–13.4) years. Of the 27 excluded patients, 22 had primary TSCS but five were lost to follow-up.

The indication for SCU was urological in 4/23 patients (17.4%) and neuro-orthopedic in 19/23 patients (82.6%) (Table 1).

Brain and spine MRI showed 18/23 (78.3%) patients with lumbo-sacral and 5/23 (21.7%) with thoraco-lumbar spinal dysraphism. Cord tethering was secondary to myelomeningocele (MMC) closure in 16/23 patients (69.6%) and spinal cord retethering in 7/23 (30.4%) patients with spina bifida occulta. Six of those seven patients had lipomyelomeningocele and one diastematomyelia. Sixteen of the 23 patients (69.6%) had chiari malformation type 2 and required placement of a ventriculoperitoneal shunt. Eleven of the 23 (47.8%) had spinal cord syrinx, with three of the 11 (27.3%) requiring syrinx drainage.