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# Predictors of urinary continence following tethered cord release in children with occult spinal dysraphism

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## KEYWORDS

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Filum terminale;  
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**Abstract** *Objective:* Children with occult spinal dysraphism represent a wide spectrum of patients. Previous studies assessing urologic outcomes have in part been deficient due to the inability to appropriately categorize these patients and gather long-term follow-up data. In this study, a uniform set of patients that had occult spinal dysraphism with magnetic resonance imaging findings of a fatty filum terminale (FF) and/or low-lying cord (LLC) was identified. Utilizing long-term follow-up data, predictors for achieving urinary continence following tethered cord release (TCR) were determined.

*Methods:* A retrospective chart review of pediatric patients with a diagnosis of tethered cord who underwent TCR from 1995 to 2005 was performed. Analysis was limited to patients who had primary TCR by one of two neurosurgeons within our multidisciplinary spina bifida clinic, who had greater than 1-year follow-up, and who were old enough to have continence status assessed (age > 6 years unless definitively toilet trained earlier). Patients with other associated forms of spinal dysraphism (lipomyelomeningocele, spinal lipomas, sacral agenesis), anorectal malformations, and genitourinary anomalies were excluded. Pre- and post-TCR urodynamics, radiographic studies, functional orthopedic status, and urologic outcomes were assessed. Urodynamic results were categorized by three blinded urologists into one of three urodynamic patterns: (1) normal, (2) indeterminate, and (3) high risk.

*Results:* A total of 147 patients with FF and/or LLC that underwent TCR were reviewed. 51 patients were excluded because of another associated spinal dysraphism (15/51 patients) or an anorectal/genitourinary anomaly (36/51 patients). Fifty-nine of the remaining 96 patients had adequate long-term follow-up data to be included in the study. 20 patients were asymptomatic at the time of TCR while 39 presented with orthopedic and/or urologic symptoms. The average

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age at surgery was 59.3 months (range 2–277 months) with an average follow-up of 7.0 years (range 1–16 years). At latest follow-up, 47 (80%) patients were continent while 12 (20%) were either incontinent or utilizing clean intermittent catheterization (CIC). Statistical analysis revealed that age of untethering, type of cutaneous lesion, level of conus, presence of hydronephrosis, and high-grade vesicoureteral reflux (VUR) were not independent predictors of continence. In patients with a cutaneous lesion who were asymptomatic, 19/20 obtained continence post-TCR ( $*p = 0.036$ ). In patients who were old enough to assess continence pre-TCR, 14/25 patients were continent pre-TCR and 11/25 were incontinent. Of the 14 who were continent pre-TCR, all remained continent post-TCR ( $*p = 0.002$ ). Of the 11 who were incontinent pre-TCR, five (45%) eventually became continent post-TCR. Assessment of urodynamic data revealed that neither pre- nor post-TCR urodynamics predicted continence status. *Conclusion:* Isolated cutaneous lesions and preoperative continence status are positive predictors for post-TCR continence. While pre- and post-TCR urodynamics do not predict continence status, their utility in preoperative work-up, monitoring for retethering, and long-term urologic follow-up requires further examination.

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## Introduction

Controversy exists regarding the indications to operate on patients with a tethered spinal cord as well as the appropriate timing for surgical tethered cord release (TCR) [1–3]. In patients who do become symptomatic, the constellation of clinical symptoms that develop are referred to as tethered cord syndrome (TCS). The development of symptoms can occur at any age causing a wide array of symptoms that can be neurological, orthopedic, and/or urologic in nature. In children, new-onset urinary incontinence or an inability to toilet train may be one of the first indicators of TCS. In such patients with TCS, prompt surgical TCR is widely accepted to prevent worsening of symptoms and to potentially reverse those that are already present [1,3].

Occult spinal dysraphism (OSD) encompasses several abnormalities that occur due to incorrect or incomplete development of the neural tube and are associated with a tethered cord. Children born with OSD are not only believed to be anatomically tethered based on radiographic findings, but also have an inherent risk of developing symptomatic TCS. Included within the spectrum of OSD are abnormalities such as fatty filum terminale, spinal lipoma, lipomyelomeningocele, diastematomyelia (split cord malformation), neurenteric cyst, and terminal syringohydromyelia [4].

To date, there are no studies that adequately examine factors that influence the attainment of urinary continence in children with TCS following TCR. Furthermore, studies on TCS and OSD often lump the various forms of OSD into a single grouping [5–9]. Failure to distinguish between the different forms of OSD may lead to inaccurate assumptions regarding prognosis and treatment for specific groups of patients. Thus, there exists a need to better determine urologic outcomes within the specific subtypes of OSD. In this study, a uniform subset of OSD patients with magnetic resonance imaging (MRI) findings of a fatty filum terminale (FF) and/or low-lying cord (LLC) was identified. These two subtypes of OSD are commonly seen in association with one

another and typically represent a more uniform population within OSD. This study did not seek to determine the need for TCR or the appropriate timing for surgical TCR in this subset of patients. Rather, utilizing long-term follow-up data, this study simply sought to identify predictors for achieving urinary continence in patients with FF and/or LLC following TCR.

## Methods

Data of pediatric patients with a diagnosis of FF and/or LLC who underwent primary TCR from 1995 to 2005 at our institution were retrospectively reviewed. Analysis was limited to patients who were old enough for continence status to be assessed at latest follow-up (age  $\geq 6$  years unless definitively toilet trained earlier). At least 1 year of follow-up post-TCR was also required for inclusion in the study. Patients with other associated forms of OSD (lipomyelomeningocele, spinal lipoma, anterior meningocele, diastematomyelia, and dermal sinus tract) or anorectal malformations/genitourinary anomalies (VACTERL association, imperforate anus, cloacal anomalies, sacral agenesis) were excluded.

Baseline characteristics including sex, age at TCR, MRI findings, presenting symptoms, presence of a global, confounding diagnosis, and level of the conus were recorded. Pre- and post-TCR evaluation of urodynamics, radiographic studies, and urologic, orthopedic, and gastrointestinal function were also assessed. The primary outcome examined was the ability or inability to achieve urinary continence following TCR.

All preoperative MRIs were interpreted by both a radiologist and neurosurgeon. The exact level of the conus was identified and considered normal when it was located superior to the midpoint of the L2 vertebrae and was considered low-lying when below this point. All patients then underwent subsequent tethered cord release. After a laminotomy, the filum was exposed intradurally under microscopic guidance, cauterized, and transected, thereby

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