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Original Research Article

# RECURRENT TETHERED CORD SYNDROME- A VITAL CALL WISELY VALUED AND VENDED

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## ABSTRACT

**Background:** Recurrent adult tethered cord syndrome (TCS) is a challenging neurosurgical condition due to scarring from prior surgeries. Redo surgery aims to detether the spinal cord, resect cysts if present, and prevent retethering. Microsurgical techniques, intraoperative neurophysiological monitoring (IONM), and wide dural repair are critical for safe outcomes. **Materials and Methods:** A prospective observational study was conducted on 50 adult patients undergoing redo TCS surgery. Preoperative MRI assessed the conus, cysts, and adhesions. Surgery involved careful scar dissection, partial cyst resection, filum terminale division, and wide watertight duroplasty using fascia lata, synthetic dural substitute, and fibrin glue. IONM was used to monitor EMG signals, somatosensory evoked potentials (SSEPs), and identify functional nerve roots. Postoperative neurological and urinary outcomes were recorded. **Result:** All patients had preserved EMG signals and functional nerve roots intraoperatively. Temporary reduction in IONM signals occurred in 36% of patients but resolved by the end of surgery. Postoperatively, 84% of patients voided normally after catheter removal, while 16% experienced temporary urinary hesitancy, which resolved within five days with medical management. No permanent neurological deficits were observed, and wide duroplasty prevented CSF leaks. **Conclusion:** Redo surgery for recurrent TCS is safe and effective when performed with meticulous microsurgical technique, IONM, and wide dural repair. Temporary neuropraxia may occur but resolves with supportive management. IONM provides reliable intraoperative guidance, and alternative approaches like spinal column shortening may reduce cord tension in complex cases.

## INTRODUCTION

Recurrent tethered cord syndrome (TCS) represents a complex and challenging neurosurgical condition, predominantly affecting patients who have undergone prior spinal surgeries. The syndrome is defined by pathological fixation or tethering of the distal spinal cord, often due to adhesions, scar tissue, or residual anatomical anomalies, resulting in abnormal tension on the cord.[1] Clinically, recurrent TCS can manifest as progressive neurological deficits, chronic pain, sensory disturbances, bladder and bowel dysfunction, and gait abnormalities. The recurrence of TCS is frequently attributed to postsurgical fibrosis, incomplete detethering during the initial surgery, or underlying congenital anomalies that predispose the spinal cord to retethering, making surgical management particularly demanding and high-risk.[2]

Recurrent TCS arises in both pediatric and adult populations and is commonly associated with prior correction of congenital spinal anomalies such as dorsal lipomas, dermoid cysts, sinus tracts, myelomeningoceles, or lipomyelomeningoceles.[3] In children, as they grow, the spinal cord is subjected to progressive stretching, which can exacerbate neurological deficits, orthopaedic deformities, and compromise spinal cord perfusion. Previous studies, including those by Yamada et al., have demonstrated that tethering with a tight filum leads to a stretch-induced functional disorder at the lumbosacral spinal cord. The pathophysiology is believed to involve mitochondrial dysfunction, particularly a reduction in cytochromes a and a3, resulting in an abnormally inelastic filum.[4] This inelasticity restricts normal cord ascension, leading to a low-lying conus medullaris below the L1–L2 vertebral level.[5] Symptoms are often activity-dependent, increasing


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with spinal flexion and extension, a mechanism that is likely amplified in cases of recurrent tethering due to more extensive adhesions or scarring.[5] Clinical presentation of recurrent TCS varies with age. Pediatric patients typically report diffuse, poorly localized pain in the lower back or perineum, sometimes radiating to the legs. Neurological manifestations may include bowel and bladder dysfunction, lower limb weakness, fatigue with activity, gait instability, paresthesia, and frequent bruising. Examination may reveal spinal deformities such as scoliosis or kyphosis, muscle spasms, tenderness, truncal imbalance, and lower limb atrophy or asymmetrical weakness.[6] Urodynamic evaluation often serves as a sensitive early indicator of neurogenic bladder, even before overt physical signs are apparent.[6] In adult patients, progressive neurological deficits, chronic pain, and sensory disturbances are the most prominent features. Magnetic resonance imaging (MRI) of the spine remains the gold standard for diagnosis, revealing recurrent tethering at previous surgical sites, and may also show secondary changes such as proximal syringomyelia or arachnoiditis.[2] Certain genetic conditions, particularly neurofibromatosis type 1 (NF1), may predispose patients to spinal cord tethering.

Surgical management of recurrent TCS poses unique challenges due to the increased risk of complications, particularly new neurological deficits.[7-9] Pediatric patients with severe kyphosis or meningomyelocele may benefit from vertebral kyphectomy, which improves sitting balance, reduces pressure sore risk, and preserves the integrity of the skin envelope.[10] For patients with severe kyphoscoliosis, combined anterior-posterior spinal reconstruction provides enhanced exposure, facilitates mobilization of spinal elements, and allows controlled correction through posterior compression and anterior distraction.[10] Spine shortening techniques have also been employed to achieve significant deformity correction while minimizing the risk of neurologic injury, even without performing an initial detethering procedure.[10] Given the progressive nature of recurrent TCS, the multifactorial pathophysiology, and the technical complexity of surgical management, early recognition and meticulous multidisciplinary planning are crucial. Therefore, this study was designed to analyze the clinical presentation, diagnostic challenges, and surgical strategies in patients undergoing repeat detethering procedures.

## MATERIALS AND METHODS

This study was conducted involving adult patients undergoing redo surgery for recurrent tethered cord syndrome. The study included a total of 50 patients who met the inclusion criteria. Adult patients with recurrent tethered cord syndrome who required redo detethering surgery were included. Patients with contraindications for surgery or inability to provide consent were excluded.

**Preoperative Assessment**

All patients underwent a detailed preoperative evaluation, including:

- Neurosurgical and urological assessment USG (KUB + PVR) + Urofloemetry.
- Magnetic Resonance Imaging (MRI) of the entire spine to locate the conus, identify cysts, and assess adhesions.
- Counseling regarding the surgical procedure, risks, and postoperative care.

**Surgical Procedure**

- Exposure was started at a level above the previous laminectomy to identify virgin dura. Dissection proceeded inward toward scar tissue to prevent early neural injury.
- Cyst walls were partially removed after suctioning their contents, and samples were sent for histopathological examination.
- The filum terminale was identified within the scar tissue under intraoperative neurophysiological monitoring (IONM). Scar tissue showing minimal or no signals was carefully dissected, cauterized, and divided.
- Additional fibrous bands and adhesions that tethered the conus were identified and divided.
- IONM checks were performed at the beginning and end of the procedure to ensure functional neural integrity.
- Due to fragile dura, watertight dural closure was performed using fascia lata for wide duroplasty. Synthetic dural substitutes and fibrin glue were applied to reduce the risk of postoperative cerebrospinal fluid (CSF) leak.
- Bethanechol given for 5-10 days and silodosin for 10-30 days depending upon response.

**Postoperative Care**

- Patients were maintained in lateral and prone positions for the first 72 hours postoperatively.
- Early mobilization was initiated once clinically feasible, and Foley catheters were removed as tolerated.
- Temporary urinary retention, when present, was managed with Bethanechol and Silodosin, and resolved within 2 weeks.

## RESULTS

The study included 50 adult patients undergoing redo surgery for recurrent tethered cord syndrome. The demographic profile showed that the majority of patients were aged between 31–40 years (30%), followed by 41–50 years (28%), 51–60 years (26%), and 18–30 years (16%) [Table 1, Figure 1]. Male patients constituted 56% , while females comprised 44% [Table 1, Figure 1]. This indicates a slight male predominance in the study population.


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**Table 1: Patient Demographics and Baseline Characteristics (n = 50)**

| Parameter | Number of Patients | Percentage (%) |
|---|---|---|
| Age (years) | | |
| 18–30 | 8 | 16 |
| 31–40 | 15 | 30 |
| 41–50 | 14 | 28 |
| 51–60 | 13 | 26 |
| Sex | | |
| Male | 28 | 56 |
| Female | 22 | 44 |

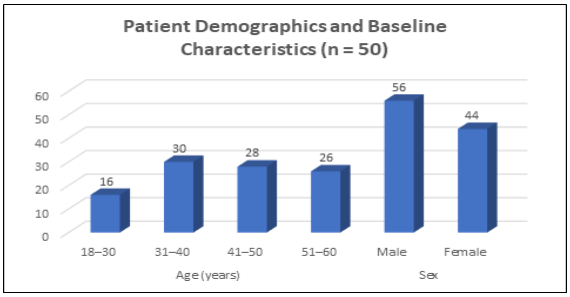


**Figure 1: Patient Demographics and Baseline Characteristics (n = 50)**

Intraoperative findings and surgical interventions revealed that all patients (100%) had scar tissue requiring dissection. Cysts were present in 12 patients (24%), while the filum terminale was divided in 15 patients (30%). Additional fibrous bands causing tethering of the conus were divided in 35 patients (70%). Wide watertight duroplasty was performed in all patients (100%), with synthetic dural substitutes used in 48 patients (96%) and fibrin glue applied in all patients (100%) to reduce the risk of cerebrospinal fluid leakage [Table 2, Figure 2].

**Table 2: Intraoperative Findings and Surgical Interventions (n = 50)**

| Intraoperative Parameter | Number of Patients | Percentage (%) |
|---|---|---|
| Cyst present | 12 | 24 |
| Scar tissue requiring dissection | 50 | 100 |
| Filum terminale divided | 15 | 30 |
| Additional fibrous bands divided | 35 | 70 |
| Watertight duroplasty performed | 50 | 100 |
| Use of synthetic dural substitute | 48 | 96 |
| Fibrin glue applied | 50 | 100 |

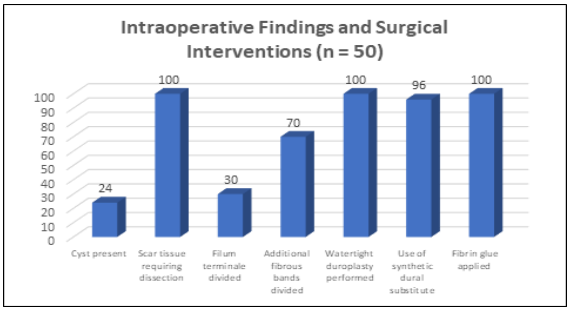


**Figure 2: Intraoperative Findings and Surgical Interventions (n = 50)**

Intraoperative neurophysiological monitoring (IONM) demonstrated that EMG signals from the anal sphincter and leg muscles were present in all patients (100%), confirming preserved motor function. Somatosensory evoked potentials (SSEPs) were maintained in 49 patients (98%). Functional nerve roots within scar tissue were identified in all patients (100%). Temporary reduction in IONM signals during scar dissection occurred in 18 patients (36%), which was transient and resolved by the end of the procedure [Table 3].

**Table 3. Intraoperative Neurophysiological Monitoring (IONM) Outcomes (n = 50)**

| IONM Parameter | Number of Patients | Percentage (%) |
|---|---|---|
| EMG signals present in anal sphincter & leg muscles | 50 | 100 |
| SSEPs maintained | 49 | 98 |
| Functional nerve roots identified within scar | 50 | 100 |
| Temporary signal reduction during dissection | 18 | 36 |

Postoperative urinary outcomes showed that the majority of patients (42/50; 84%) were able to void normally immediately after Foley catheter removal. Temporary urinary hesitancy or retention occurred in 8 patients (16%), all of whom were managed with Bethanechol and Silodosin. The condition resolved within 2 weeks, and catheter re-insertion was required in all 8 patients during this period [Table 4].

**Table 4: Postoperative Urinary Outcomes and Recovery (n = 50)**

| Postoperative Parameter | Number of Patients | Percentage (%) |
|---|---|---|
| Normal voiding immediately after catheter removal | 42 | 84 |
| Temporary urinary hesitancy/retention | 8 | 16 |
| Managed with Bethanechol and Silodosin | 8 | 16 |
| Resolved within 2 weeks | 8 | 16 |
| Catheter re-insertion required | 8 | 16 |


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## DISCUSSION

Recurrent tethered cord syndrome (TCS) in adults remains one of the more complex challenges in spinal neurosurgery, largely due to adhesions and scarring from previous detethering procedures. In our study of 50 adult patients undergoing redo surgery for recurrent TCS, meticulous microsurgical technique, intraoperative neurophysiological monitoring (IONM), and wide watertight duroplasty were central to achieving favourable outcomes.In our study, all 50 patients demonstrated preserved EMG signals and functional nerve root identification intraoperatively , reflecting the importance of IONM in guiding neural dissection and reducing the risk of inadvertent nerve injury. This aligns with Paradiso et al. (2005),[11] who reported that multimodality neurophysiological monitoring during TCS surgery helped reliably identify critical neural structures and minimize postoperative deficits in adults. Their study documented no new neurologic symptoms post-operatively and improvements in bowel and bladder function in a proportion of patients, highlighting the utility of EMG and somatosensory evoked potentials (SSEPs) during surgery. Our postoperative urinary outcomes showed that 84% of patients voided normally following catheter removal, with only 16% experiencing temporary urinary hesitancy requiring Bethanechol and Silodosin that resolved within5-10 days and 10-13 days respectively. This reflects the transient nature of neuropraxia from nerve manipulation, where bladder dysfunction often improves with time and supportive care. In contrast, Garcés-Ambrossi et al. (2009),[12] reported improvement in urinary symptoms in 47% of adult TCS patients after first-time detethering, with a median time of 4.3 months for urinary recovery, suggesting that urinary improvements may continue to evolve well beyond the immediate postoperative period. Our intraoperative findings of cysts present in 24% of cases and additional fibrous bands dividing in 70% similar to the complex pathological heterogeneity seen in adult TCS. Lee et al. (2006),[13] in a long-term outcome study involving 60 adults described mixed tethering etiologies (tight filum, post-myelomeningocele repair, lipomas, etc.) and emphasized the variability in anatomical substrates encountered at surgery. They also noted that bladder dysfunction was present in a majority (71%) preoperatively and that microsurgical detethering with IONM was crucial to minimize neurologic complications. Considering neurological outcomes, our study reported no permanent neurological deficits and only temporary signal reductions in 36% of patients during intraoperative dissection. Van Leeuwen et al. (2001),[14] similarly showed that the majority of adult TCS patients experienced stable or improved muscle strength after surgery, and only 3.5% had significant postoperative deterioration. These findings support the idea that careful microsurgical technique, particularly under IONM, limits new neurological morbidity. The rate of persistent or evolving symptoms in recurrent TCS has been reported variably in the literature. Abdallah et al (2018),[15] observed that long-standing symptoms (>6 months) and bladder dysfunction correlated with poorer surgical outcomes, suggesting that early intervention may favour better recovery. They reported that 64% of adult cases had good clinical outcomes at long-term follow-up. In contrast, our results reflect immediate perioperative outcomes, and longer-term follow-up will be necessary to directly compare rates of sustained improvement or retethering. Regarding alternative surgical approaches, Lampros et al (2026),[16] highlighted spinal column shortening techniques (posterior vertebral column subtraction osteotomy) as emerging options for complex or recurrent TCS cases to reduce neural tension without direct intradural scar dissection. Although cadaveric and small clinical series suggest tension reduction benefits with vertebral shortening, traditional detethering with microsurgical release remains the mainstay for recurrent TCS, given established safety and efficacy when combined with IONM.

## CONCLUSION

Redo surgery for recurrent tethered cord syndrome in adults is feasible and safe when meticulous microsurgical techniques are employed along with intraoperative neurophysiological monitoring (IONM). Our study demonstrated that functional nerve roots can be preserved, temporary neuropraxia may occur, and early postoperative urinary disturbances are generally transient and manageable. Wide watertight duroplasty with synthetic dural substitutes and fibrin glue reduces the risk of CSF leaks and retethering. IONM provides a reliable intraoperative guide and helps predict prognosis. Alternative approaches, such as spinal column shortening, may offer additional options for reducing cord tension in complex cases. Overall, careful planning and surgical execution result in favourable short-term neurological and urological outcomes.

**Limitations**

This study was limited by its small sample size (n = 50) and short-term follow-up. Being a single-center study, the findings may have limited generalizability.

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