Preventing cerebrospinal fluid leak following transection of a tight filum terminale

Clinical article

**Object.** Tethered cord release for a tight filum terminale is a common pediatric operation associated with low morbidity and mortality rates. While almost all would agree that keeping patients lying flat after the operation will prevent a CSF leak, the optimal period of doing so has not been determined. In this study, the authors examined whether a longer length of stay in the hospital for the sole purpose of maintaining patients flat correlates with a decreased rate of CSF leakage.

**Methods.** Intraoperative and postoperative data were retrospectively collected in 222 cases of simple tethered cord release at 3 large children’s hospitals. Risk factors for postoperative CSF leakage were identified.

**Results.** Thirty-eight patients were maintained lying flat for 24 hours, 86 for 48 hours, and 98 for 72 hours at the individual surgeon’s discretion. A CSF leak occurred in 13 patients (5.9%) and pseudomeningocele developed in 9 patients (4.1%). In the univariate analysis, operating time, use of the microscope, use of dural sealant, and duration of remaining flat after surgery failed to correlate with the occurrence of complications.

**Conclusions.** A longer hospital stay for maintaining patients flat after a simple tethered cord release appears not to prevent CSF leakage. However, a larger patient cohort will be needed to detect small differences in complication rates. (DOI: 10.3171/2011.4.PEDS10502)

**Key Words** • tight filum terminale • surgical complication • cerebrospinal fluid leak

Tethered cord release for a tight filum terminale is a common pediatric operation associated with low morbidity and mortality rates. Complication rates reported in past surgical series have ranged from 0% to 5%.\(^1\)\(^-\)\(^6\) Arguably, the most feared postoperative complication of this procedure is CSF leakage, and various intra- and postoperative strategies have been developed to combat this problem. While almost all would agree that maintaining the patient in a flat position after the operation will help prevent a CSF leak, the optimal period and the setting (home vs inpatient stay) for this maneuver have not been determined. In this study, we first documented complications associated with tethered cord release for a tight filum terminale in 222 children, and we then examined whether a longer-length hospital stay for the sole purpose of maintaining patients flat after surgery correlated with a decreased rate of CSF leakage.

**Abbreviation used in this paper:** POD = postoperative day.
ham (March 1, 2002–March 31, 2010), and 38 patients from St. Louis Children’s Hospital (March 1, 2002–June 31, 2010). Fourteen of 15 neurosurgeons were certified by the American Board of Pediatric Neurological Surgery. All neurosurgeons were board certified by the American Board of Neurological Surgery.

The following operative parameters were prospectively documented by the operating room administrations at both institutions: use of microscope, use of dural sealant or dural substitute, and operating time. The date of discharge for each patient was recorded in the discharge summary in the electronic medical record and independently in the hospital admission and discharge databases. All patients had one or more clinical visits after surgery. Records from these postoperative visits were reviewed. Centricity Electronic Medical Record (version 9.0, GE, 2008) was used at Birmingham Children’s Hospital and Texas Children’s Hospital. All Scripts Enterprise Electronic Medical Record (version 11.1.7.535) was used at St. Louis Children’s Hospital.

Statistical Analysis

Statistical analysis was performed using SPSS (SPSS, Inc.). In the univariate analysis, contingency tables were used to analyze categorical variables, and continuous variables were compared with a Student t-test. A variable was chosen to construct a multivariate logistic regression model only if its probability of a Type I error was less than 0.05 in the univariate analysis.

Results

Patient Demographics

The mean age at untethering was 4.5 years (median 2.8 years). There were 115 girls and 107 boys. Bowel and bladder dysfunction and/or abnormal urodynamics was documented in 47 patients (21%). In 48 patients (21%), a low-lying conus medullaris was incidentally found during workup for caudal regression syndrome, imperforate anus, and VATER syndrome. Orthopedic-related findings, including abnormal spinal curvature, gait, and various degrees of hip and sacral dysplasia were found in 63 patients (28%). In the cases in which imaging was available for review, preoperative MR imaging demonstrated a low-lying conus (at or below the L2–3 level), a thickened filum (> 2 mm diameter), or lipomatous elements within the filum without the presence of other structural lesions. Indications for surgery varied with individual surgeons. All of the surgeons agreed that surgery was indicated when changes in bowel or bladder function, neurological deterioration, weakness or lower-extremity deformity, back pain, or progressive scoliosis were identified.

Intraoperative Factors

All patients underwent surgery on the same day they were admitted. The mean operating time was 121 ± 50 minutes (median 109 minutes). An operating microscope was used in 165 cases, and dural sealant was used in 130 cases. Adipose tissue within the filum was described by the surgeon or documented in the pathology reports in approximately 50% of cases (101 of 222). In two cases, nerve root tissues were found in the pathological specimens.

Postoperative Management

Three postoperative management strategies were used among the 14 surgeons with the explicit goal of preventing CSF leakage. Two surgeons maintained their patients lying flat for 24 hours and discharged them on POD 1, with instructions to the parents to keep their child lying flat at home for an additional 48 hours (Strategy 1). Eight surgeons maintained their patients flat for 48 hours and discharged them on POD 2 (Strategy 2). Five surgeons maintained their patients flat for 72 hours and discharged them on POD 3 (Strategy 3). For Strategies 2 and 3, the surgeons did not require the patients to stay flat at home (Table 1).

Wound care instructions varied. Parents were asked to keep the dressings in place for 1–7 days. While some surgeons asked that the wound be cleaned daily, either with soap and water or hydrogen peroxide, some surgeons asked that the wound remain dry until the follow-up appointment. All surgeons restricted bath tub use until the follow-up appointment.

Overall, there was good concordance among individual surgeons’ management strategies and the actual day of discharge. Thirty-eight patients were managed per Strategy 1, 86 patients per Strategy 2, and 98 patients per Strategy 3. The actual day of discharge showed that 38 patients were discharged on POD 1, 69 patients on POD 2, and 87 patients on POD 3; 19 patients were discharged between POD 4 and 7, and 9 patients stayed in the hospital for more than 7 days. In 3 cases, CSF leak was noted within the first 3 postoperative days, which resulted in a lengthier stay. The other 25 patients stayed longer than the surgeons intended due to medical or social issues. These patients were allowed to be upright while in the hospital consistent with the individual surgeon’s postoperative management strategy.

Complications and Statistical Analysis

A CSF leak occurred in 13 patients, 11 of whom were taken to the operating room for wound revision. Two leaks were oversewn at the bedside. Pseudomeningocele was noted in 9 patients. Local wound infection was documented in 7 patients, but none had meningitis. The complication rates for CSF leakage, pseudomeningocele formation, and local wound infection were 5.9%, 4.1%, and 3.2%, respectively. There were no permanent neurological consequences due to these complications.

Univariate analysis was used to correlate differ-

| TABLE 1: Management strategies after tethered cord release |
|------------------|----------|------------------------|
| Op Management    | No. of Patients | Descriptions          |
| Strategy 1       | 38        | lying flat in hospital for 24 hrs, then flat at home for 48 hrs |
| Strategy 2       | 86        | lying flat in hospital for 48 hrs |
| Strategy 3       | 98        | lying flat in hospital for 72 hrs |
CSF leak after tight filum terminale release

ent variables with the occurrence of CSF leakage and/or pseudomeningocele formation. The complications of CSF leakage and pseudomeningocele formation were considered together because they were both results of CSF egress from the durotomy. None of the independent variables reached statistical significance (Table 2).

Discussion

Surgical Technique and Complications

If, and when, to detether a tight filum terminale remains a topic of debate, but how the task should be done is less controversial. The incision for a simple tethered cord release is usually less than 1 in long, and minimal muscle dissection is required. A single-level laminotomy or partial laminectomy is made, and the dura is opened sharply. Special attention is paid to minimize blood spillage into the subarachnoid space. Intraoperative neurophysiological monitoring is less often used in this setting than it is with surgery for other tethering etiologies. After the filum is cut, the surgeon then performs a primary watertight closure. The suture line may be augmented by fat, muscle, fascia, or other adjuvant agents, such as DuraGen, fibrin glue, Tisseel, or DuraSeal. To the best our knowledge, there has not been a dedicated study on the operative technique for this relatively straightforward surgery.

Authors who advocate early surgery for a tight filum often imply that the morbidity rate associated with the procedure is so low that it significantly increases the benefit-risk ratio. A critical review of past surgical series, however, revealed that even though the number of complications was often mentioned, the details were lacking. While it is true that severe, long-term consequences due to surgical complications rarely occur, and we had none in our series of 222 children, the complication rate is nevertheless not trivial. A CSF leak was noted in 13 cases (5.9%), pseudomeningocele formation in 9 cases (4.1%), and wound infection in 7 cases (3.2%). The overall complication rate was 13.2%. This percentage is likely an underestimate because small pseudomeningoceles may remain asymptomatic and may not be detected or considered clinically significant enough to be documented.

Preventing CSF Leakage

The topic of iatrogenic durotomy, whether it is intentional or unintentional, is familiar to all neurosurgeons. The merits of various dural sealants, CSF diversion procedures, closure techniques, and subcutaneous drains will not be discussed here. From the collective experience of neurosurgeons, it is generally believed that postoperative bed rest should be maintained for at least a few days. The optimal period of bed rest and its setting, however, has not been critically evaluated.

Based on the practice pattern of surgeons involved in this study, we believe a 48-hour period of bed rest is a minimal requirement. Three postoperative management strategies were observed among the 15 surgeons. Eight surgeons kept the patients in the hospital for the sole purpose of maintaining patients flat for 48 hours after the operation. Five surgeons kept the patients flat for 72 hours

TABLE 2: Univariate analysis of risk factors and their relation to complications

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leak Through the Skin</th>
<th>Leak &amp; Pseudomeningocele Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of episodes</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>age*</td>
<td>0.8961</td>
<td>0.7734</td>
</tr>
<tr>
<td>operating time*</td>
<td>0.6617</td>
<td>0.3841</td>
</tr>
<tr>
<td>use of microscope†</td>
<td>0.6706</td>
<td>0.4961</td>
</tr>
<tr>
<td>use of dural sealant†</td>
<td>0.3535</td>
<td>0.6884</td>
</tr>
<tr>
<td>Strategy 1 vs 2 vs 3†</td>
<td>0.4000</td>
<td>0.1370</td>
</tr>
</tbody>
</table>

* Student t-test.
† 2 × 2 and 2 × 3 contingency table.

in the hospital. Two surgeons kept the patients flat for 24 hours and discharged them with instructions to lie flat for an additional 48 hours at home. The degree of patient compliance with this last strategy is not known. Because of the differences in the management strategy, patients were kept in the hospital for various lengths of time. A longer hospital stay for the sole purpose of maintaining the patient flat, however, did not correlate with a lower complication rate. Of note, the use of a dural sealant also failed to demonstrate efficacy in preventing CSF leakage. The putative advantages rendered by these intervention measures have to be balanced against the additional financial cost to the patient and health care system.

Weakness of the Study

Because the complication rate of a simple tethered cord release is low, questions should be raised regarding the power of the study to detect small differences in treatment. A power analysis was prepared prior to the initiation of the study. At a complication rate of 10%, 150 patients would be needed to detect a significant difference if the complication rate is to be halved. Our cohort size of 222 patients is sufficient; however, it is underpowered to detect a difference in complication rates between 10% and 7.5% (sample size needed, 690 patients). The complication rate documented in this study is essential if one were to design a future prospective study on this topic.

We are also aware that there were other intra- and postoperative factors that were not analyzed. For instance, the presence of various cutaneous lesions or the type of suture used for dural closure may influence the CSF leak rate. Some surgeons performed laminoplasty, and some applied pressure dressings or dermal adhesives onto the wound. In the design of a retrospective study, the assumption was that minor differences in surgical techniques and surgeon preferences might evenly distribute across the comparison groups with a large enough patient cohort, multiple participating surgeons, and a fairly well-defined single pathology (tight filum only). As an imperfect way of supporting this assumption, we documented that the distribution of operative lengths followed the bell curve (the mean operative time was 121 ± 50 minutes [median 109 minutes]).

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Last, we are aware that some surgeons have claimed success in terminal filum transections without requiring the patients to lie flat after surgery. It is certainly a management strategy that is worthy of further testing against all other strategies.

Conclusions
Cerebrospinal fluid leakage through the skin and pseudomeningocele formation were noted in 5.9% and 4.1% of simple tethered release surgeries, respectively. A longer hospital stay for maintaining patients flat after a simple tethered cord release appears not to prevent CSF leakage. However, a larger patient cohort will be needed to detect small differences in complication rates.

Disclosure
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Chern, Oakes. Acquisition of data: Chern, Patel. Analysis and interpretation of data: Tubbs, Chern, Gordon. Drafting the article: Chern. Critically revising the article: Tubbs, Chern, Oakes. Reviewed submitted version of manuscript: all authors. Statistical analysis: Chern. Study supervision: Chern.

References

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