









Does the Incidency Duraplasty with Synthetic Dural Graft or Standard Primary Dural Closure reduce the risk of retethering? A comparative analysis of 36 pediatric patients

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Background: Spinal lipomas in pediatric patients pose a significant risk of neurological deterioration due to the potential for retethering after surgical excision. This study aims to assess the efficacy of duraplasty in mitigating the risk of retethering following spinal lipoma excision in pediatric patients. We compared outcomes between two groups: one treated with duraplasty using synthetic dura and another with primary dural closure.

Methods: A retrospective analysis was performed on 36 pediatric patients who underwent spinal lipoma excision between 2019 and 2024. Group 1 (n=15) received duraplasty with synthetic dura, while Group 2 (n=21) underwent primary dural closure. The primary outcome was the incidence of retethering, defined by clinical and radiological criteria, over a follow-up period averaging 2.6 years (range: 2–5 years).

Results: A total of 36 pediatric patients with spinal lipomas were included in this retrospective analysis. The mean age of the study cohort was 9 years and 3 months, ranging from 25 days to 18 years. Group 1 demonstrated a significantly lower incidence of retethering (13.3%) compared to Group 2 (38.1%), with a p-value of 0.02. The mean time for retethering was also significantly longer in Group 1 (3.5 years) versus Group 2 (2.1 years), with a p-value of 0.045.

Conclusion: Duraplasty with synthetic dura may reduce the risk of retethering in pediatric patients undergoing spinal lipoma excision. However, further prospective studies with larger sample sizes are required to validate these findings.

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INTRODUCTION

Lumbosacral lipomas create major medical issues because they are linked to spinal dysraphism and tethered cord syndrome. These conditions can lead to severe neurological deficits, including motor and sensory impairments, as well as bladder dysfunction, necessitating timely surgical intervention. The primary goal of surgery is to excise the lipoma and release the tethered cord to prevent further neurological deterioration [1,2]. However, one of the most concerning postoperative complications is retethering, where the spinal cord reattaches to surrounding tissues, leading to a recurrence of symptoms. Retethering often requires repeat surgeries, which carry additional risks and can further compromise patient outcomes [3].

To mitigate the risk of retethering, duraplasty—a technique that involves expanding and reinforcing the dura

mater with synthetic or autologous grafts—has been introduced as an adjunct to spinal lipoma excision. The rationale behind duraplasty is to create a more spacious dural sac that reduces the likelihood of the spinal cord re-adhering to surrounding structures [4]. Despite its growing use, the effectiveness of duraplasty in preventing retethering remains a topic of debate, with varying results reported in the literature [5].

MATERIAL AND METHODS

Study Design and Patient Population

This was a retrospective observational study including 36 pediatric patients who underwent surgical excision of spinal lipomas at Morozovskaya Children's City Clinical Hospital between 2019 and 2024. Patients were grouped according to a change in surgical practice at the institution. The



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RESULTS

A total of 36 pediatric patients with spinal lipomas were included in this retrospective analysis. The mean age of the study cohort was 9 years and 3 months, ranging from 25 days to 18 years. Group 1 demonstrated a significantly lower incidence of retethering (13.3%) compared to Group 2 (38.1%), with a p-value of 0.02. The mean time to retethering was also significantly longer in Group 1 (3.5 years) versus Group 2 (2.1 years), with a p-value of 0.045.

Demographic and Clinical Characteristics

A total of 36 pediatric patients with spinal lipomas (figure 1) were included in this retrospective analysis. The mean age of the study cohort was 9 years and 3 months, ranging from 25 days to 18 years (Table 1-3, Figure 1- 4).

- Group 1 (n=15): spinal lipoma excision with expansile duraplasty using synthetic dura
- Group 2 (n=21): spinal lipoma excision with primary dural closure

Patients with incomplete records or inadequate radiological follow-up were excluded.

Age Distribution and Group Comparability

Because age is a recognized risk factor for retethering—particularly during periods of rapid growth (5–9 years)—special attention was given to ensure transparency of age distribution (Table 1).

Table 1: Mean age and range of the study population

Group	Mean age (years)	Age range
Overall (n = 36)	9.3	25 days – 18 years
Group 1 (Duraplasty, n = 15)	8.7	2 months – 17 year
Group 2 (Primary closure, n = 21)	9.8	25 days – 18 years

Age categories were also compared (Table 2):

Table 2: Age distribution across groups

Age category	Group 1 (Duraplasty) n=15	Group 2 (Primary closure) n=21	Total n=36
< 5 years	5 (33%)	6 (29%)	11 (31%)
5–9 years	4 (27%)	7 (33%)	11 (31%)
≥ 10 years	6 (40%)	8 (38%)	14 (39%)
Mean age (years)	8.7	9.8	9.3

There were no statistically significant differences in age distribution between the two groups (p = 0.71).

There were no statistically significant age differences between groups (p = 0.71), minimizing the likelihood that age-related growth bias accounted for differences in retethering.

Classification of Lipoma Types

Spinal lipomas were classified radiologically into five types (Table 3):

1. Terminal
2. Caudal
3. Dorsal
4. Lipomyelomeningocele
5. Mixed lesions

The distribution of lipoma subtypes was recorded because anatomical complexity influences the feasibility of primary dural closure and the risk of retethering.

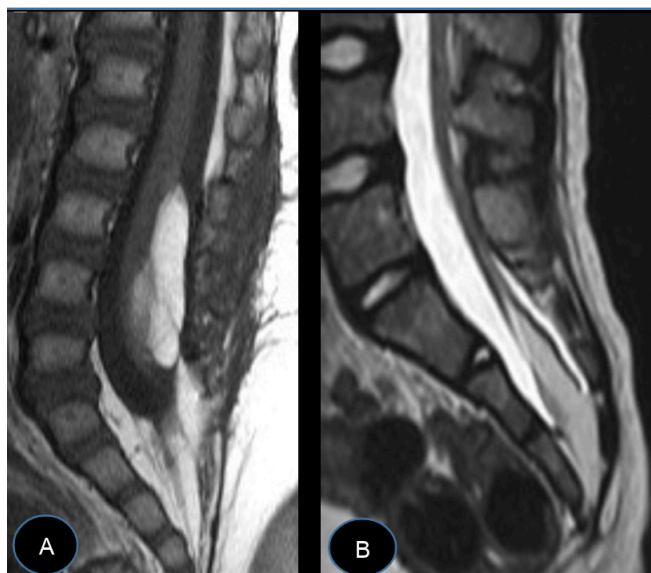


Figure 1. a) MRI, Spinal lipoma, Patients selective for duraplasty stage 2-3, b) late stage 3-4 type, conus medularis.

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Table 3: Summary of the general characteristics of 36 patients. Variables of patients undergoing surgery with tethering of the spinal cord by two comparative groups.

Parameter	Patients	Group 1	Patients	Group 2
Sex	No. 15	n (%)	No. 21	n (%)
Male	7	46	12	57
Female	8	53	9	43
Clinical features				
Weakness	6	40	13	62
Sensory	4	26	3	14
Urinary	5	33	5	24
Radiological type				
Terminal	6	40	11	52
Caudal	2	13	5	24
Dorsal	5	33	4	19
Lipomyelomeningocele	2	13	3	14
Mixed	0	0	2	9
Complications				
CSF leak	1	6	2	9
Wound infection	2	13	2	9
Incidence of Retethering	2	13	8	38
Time to Retethering	0	3.5 years	0	2.1 years
Neurological Outcomes	-	93%	-	86%

Surgical Approach

The surgical procedure is standard with a midline skin incision over the affected vertebral levels and subperiosteal dissection to expose the laminae, followed by a laminectomy. Careful attention is given to preserving spinal stability and avoiding injury to adjacent neural structures. Under high magnification, the dura is incised to expose the spinal cord and the associated lipoma (figure 2).

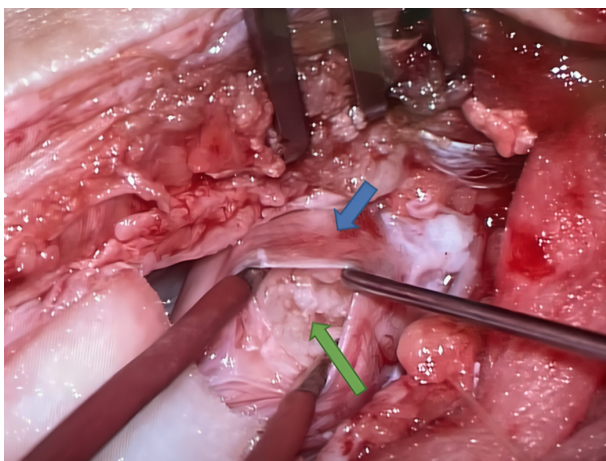


Figure 2: Intraoperative image. The dura (blue arrow) is opened in a standard fashion exposing the intradural lipoma (green arrow).

Group 1: Duraplasty with Synthetic Dural Graft

In this group, following the complete or near-complete resection of the spinal lipoma and meticulous untethering of the spinal cord, a synthetic dural graft (neo-dura) was utilized for an expansile duraplasty. The graft was carefully tailored to fit the dural defect and was sutured to the native dura using interrupted 6-0 or 7-0 Prolene sutures in a watertight fashion.



Figure 3: Intraoperative image showing Duraplasty with synthetic dura.

Group 2: Primary Dural Closure Standard

In the second group, the dura was repaired using conventional primary closure techniques without the use of a synthetic dural graft following lipoma removal and spinal cord untethering. In order to create a watertight seal and provide sufficient protection for the spinal cord while preserving the natural dural architecture, the dura was directly sutured using fine interrupted sutures. Postoperatively, all patients were monitored in the pediatric intensive care unit (PICU) for 24-48 hours with a focus on neurological assessment, pain management, and early detection of complications like CSF leaks. Patients were placed on strict bed rest for 24-72 hours to reduce CSF leakage risk, and potential CSF leaks were managed with bed rest, fluid control, and lumbar drainage if needed. Postoperative pain was managed using multimodal analgesia, and wound care involved regular checks for infection. Neurological assessments were conducted at multiple intervals (3, 6, and 12 months and any other hospital visit) to detect signs of retethering or deficits. Standardized care protocols were applied to both groups to ensure comparable outcomes.

Incidence of Retethering

Retethering occurred in 2 patients (13.3%) in Group 1 and 8 patients (38.1%) in Group 2, demonstrating a statistically significant reduction in the incidence of retethering with duraplasty ($p = 0.02$) (figure 4). The odds ratio (OR) for retethering in Group 2 compared to Group 1 was 0.25, indicating that expansive duraplasty reduced the odds of retethering by approximately 75%.

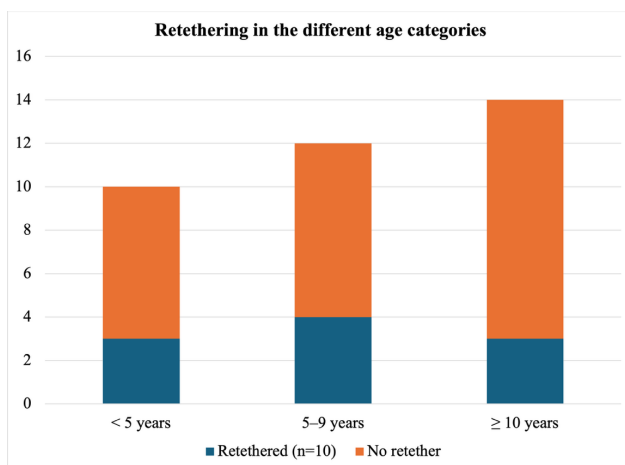


Figure 4: risk of retethering in the different age groups. Risk was highest (50%) in the age group 5 – 9yrs.

Time of Retethering

The mean time to retethering was significantly longer in Group 1 (3.5 years) compared to Group 2 (2.1 years),

suggesting that duraplasty may delay the onset of retethering ($p = 0.045$).

Postoperative Complications

Group 1 had fewer complications, with 1 case of cerebrospinal fluid leak (6.7%) and 2 cases of wound infection (13.3%), compared to 2 cases each in Group 2 (9.5%). While these differences were not statistically significant ($p = 0.32$), the trends suggest a potential reduction in complications with duraplasty.

Neurological Outcomes

Neurological outcomes were favorable in both groups, with 89% of patients in Group 1 and 84% in Group 2 showing improvement or stabilization of preoperative deficits. Although not statistically significant ($p = 0.65$), the slightly better outcomes in Group 1 align with the lower incidence of retethering observed in this group.

Statistical analysis

The statistical analysis was performed using, categorical variables, such as sex distribution, clinical features, radiological types, and postoperative complications, were compared between the two groups using the Chi-square test or Fisher's exact test where applicable, given the small sample sizes in some categories. All statistical analyses were conducted using STATA version 17.0 (StataCorp, College Station, TX). A p-value of less than 0.05 was considered statistically significant. The incidence of retethering between the two groups was analyzed using the Chi-square test. For continuous variables, such as time to retethering, the student's t-test was employed to compare mean values.

Outcome Measures

The primary outcome measure was the incidence of retethering, defined as the recurrence or worsening of neurological symptoms, such as motor weakness, sensory deficits, or bladder dysfunction, which were absent or had improved postoperatively, and radiological evidence of tethered cord syndrome on MRI (low-lying conus medullaris, new or increased adhesions, and reduced spinal cord mobility). These criteria were selected based on established diagnostic standards for tethered cord syndrome, ensuring consistency with existing literature and clinical practice. The combination of clinical deterioration and radiological confirmation provided a robust framework for diagnosing retethering. Secondary outcome measures included the time to retethering, postoperative complications, and neurological outcomes.

DISCUSSION

Lumbosacral lipomas are intricate congenital anomalies that require precise surgical intervention to prevent or

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alleviate neurological impairments associated with tethered cord syndrome [6–8]. Our study aimed to evaluate the effectiveness of duraplasty in reducing the incidence of retethering in pediatric patients following spinal lipoma excision. Our findings reveal a significantly lower incidence of retethering in patients who underwent duraplasty compared to those who did not [9–11].

Recent literature underscores the importance of meticulous surgical techniques in managing spinal dysraphism and minimizing postoperative complications such as retethering [12–17]. Pang et al. highlighted that duraplasty may offer a protective layer preventing the adhesion of the spinal cord to surrounding tissues, thereby reducing the likelihood of retethering. Our study corroborates these findings, demonstrating that only 13.3% of patients in the duraplasty group experienced retethering compared to 38.1% in the non-duraplasty group. This significant difference ($p < 0.05$) emphasizes the potential efficacy of expansive duraplasty as a preventive measure against retethering. It should be noted that the rate of retethering is significantly higher compared to contemporary literature and was attributed to the relatively small sample size in the study [17–19].

Additionally, the mean time to retethering in our study was notably longer in the duraplasty group (3.5 years) than in the non-duraplasty group (2.1 years). This finding aligns with research by Roger Samuels et al. (2009), who reported that duraplasty prolongs the period before any recurrence of symptoms, specifically with complex lesions like lipomyelomeningocele or multiple previous surgeries [20,21]. This extended time to retethering could provide a crucial window for pediatric patients to grow and develop without recurrent surgical interventions, potentially enhancing their overall quality of life.

Postoperative complications, including cerebrospinal fluid (CSF) leaks and wound infections, were lower in the duraplasty group. Although our study did not find a statistically significant difference in postoperative complications between the two groups ($p = 0.32$), the trend towards fewer complications in the duraplasty group is noteworthy [19]. Other studies have similarly reported lower rates of postoperative complications with the use of synthetic and bovine pericardial dura grafts, suggesting that duraplasty may contribute to a safer postoperative course [20,22,36].

One widely used method of expansive duraplasty in lumbosacral lipoma surgery is the application of synthetic dural grafts, such as Gore-Tex or collagen-based materials like bovine pericardium [19], which are sutured to the native dura to expand the dural sac and prevent postoperative adhesions [24]. Autologous grafts (fascia or pericranium) offer a biocompatible option with potentially less inflammatory response [25]. Additionally, the dural splitting

technique, which involves splitting the dura mater longitudinally and then re-suturing it in an expanded configuration, avoids harvesting autologous tissue and complications of synthetic material. These methods collectively aim to reduce the risk of retethering. Several studies have compared the advantages and disadvantages of the various materials [15,26].

Neurological outcomes, measured by the stabilization or improvement of preoperative deficits, were similar between the two groups, with 89% and 84% improvement rates in the duraplasty and non-duraplasty groups, respectively. This finding is consistent with prior studies indicating that while duraplasty may significantly reduce retethering rates, its impact on immediate neurological outcomes is comparable to standard surgical techniques [8,10,15].

The primary advantage of duraplasty appears to lie in its long-term benefits, particularly in reducing the need for subsequent surgeries due to retethering [7].

Despite these promising findings, our study has several limitations. The retrospective nature of the study and the relatively small sample size may limit the generalizability of the results. Additionally, the follow-up period, although a minimum of 2 years, may not capture all instances of late retethering. Future prospective studies with larger cohorts and longer follow-up periods are necessary to validate our findings and further elucidate the long-term benefits and potential risks associated with duraplasty in the surgical management of lumbosacral lipomas [27,28].

Limitations and future direction

Future research directions should include the need to standardize duraplasty techniques and develop consensus guidelines based on comprehensive reviews and multi-center studies [29]. Comparative studies of different duraplasty materials, such as autologous grafts and synthetic biomaterials, are also suggested to determine the most suitable options for various clinical scenarios [7,30]. The integration of adjunctive therapies like anti-fibrotic agents and the exploration of minimally invasive techniques are recommended to enhance outcomes [31,38]. Long-term follow-up studies are essential to assess the durability of duraplasty and its impact on neurological outcomes over time, while expansion of research to diverse patient populations and pediatric-specific considerations is necessary for a more comprehensive understanding [31–33]. Additionally, the development of predictive models using clinical, radiological, and molecular markers could guide personalized treatment planning and improve patient outcomes [34,35,37].

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CONCLUSION

In this retrospective series of 36 children with spinal lipomas, expansile duraplasty after lipoma excision was associated with a lower incidence and delayed onset of retethering compared with primary dural closure, while neurological outcomes and complication rates were similar. These findings support duraplasty as a potentially protective strategy by increasing dural capacity and limiting adhesions. Nevertheless, the study's retrospective design, small sample, and heterogeneity of lesions warrant cautious interpretation. Larger prospective studies are required to confirm these results and to better define which patients derive the greatest benefit.

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DISCLOSURES

Ethical approval

This work is a retrospective analysis of a single clinical case and was conducted in accordance with the principles of the Declaration of Helsinki.

Consent to participate

The patients gave consent to use their information and images for research purposes.

Conflict of interest

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

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Artificial intelligence

The authors affirm that no artificial intelligence tools were used in the writing, editing, or content generation of this manuscript. All work was conducted manually, based on thorough research and academic expertise.

CONTRIBUTIONS

Renato Colenci: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing.

Miguel Ossuna: Writing – original draft, Writing – review & editing.

Cristiano Franco do Val Serafim: Conceptualization, Data curation, Writing – review & editing.

Manuella Pacífico de Freitas Segredo: Supervision, Validation.

Marco Antônio Zanini: Project administration, Supervision, Validation, Visualization.

Pedro Tadao Hamamoto Filho: Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation.

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