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Minimally Invasive Surgical Approach to Filum Lipoma

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Abstract

Filum terminale lipoma (FTL) causes various spinal symptoms known as tethered cord syndrome. The treatment for FTL is surgical untethering by sectioning the FTL, which can prevent symptom progression and often results in improvement of symptoms. This report describes a minimally invasive surgical strategy that we have introduced for FTL sectioning. The pediatric patients with FTL since 2007 were treated using this minimally invasive surgical strategy, which we refer to as an interlaminar approach (ILA). In summary, the surgical technique involves: minimal skin incision to expose the unilateral ligamentum flavum in the lower lumbar region; ligamentum flavum incision to expose the dural sac, and dural incision followed by identification and sectioning of the filum. Postoperatively, no bed rest was required. Prior to introducing ILA, we had used standard one level laminectomy/laminotomy (LL) with more than 1 week of postsurgical bed rest until 2007, providing an adequate control group for the benefit of the ILA. A total of 49 consecutive patients were treated using ILA. While 37 patients were treated using LL. Surgical complications that need surgery were seen only in one patient, who developed cerebrospinal fluid (CSF) leak in LL patients. No retethering or additional neurological symptoms were seen during follow-up. All patients complained of minimal postsurgical back pain, but no patients required postoperative bed rest in ILA patients, while LL patients need postsurgical bed rest because of back pain. The ILA strategy provides the advantage of a minimal tissue injury, associated with minimal postoperative pain, blood loss, and bed rest.

Key words: bedrest, filum lipoma, interlaminar approach, minimal invasive

Introduction

Filum terminale lipoma (FTL), or tight filum terminale, is known to cause spinal cord tethering, which results in various spinal symptoms collectively called tethered cord syndrome (TCS). With the increasing use of magnetic resonance imaging (MRI) in screening for abnormal lumbar skin findings in children, the identification of FTLs in patients without any significant neurological findings has increased. The MRI studies have demonstrated a prevalence of 0.24–4% for FTL.[1)]

The treatment for FTL is surgical untethering by sectioning the filum terminale, which can prevent symptom progression and often results in symptom improvement. The standard surgical technique includes one level of laminotomy or laminectomy followed by dural incision and sectioning the filum.[2)] Surgical untethering is indicated for patients with symptoms of TCS and for prophylactic purposes in asymptomatic patients with radiological findings. A surgical approach that minimizes complications and stressors on the patient is very important. This report describes a minimally invasive surgical strategy that we have recently introduced for FTL sectioning.

Methods

A total of 49 consecutive pediatric patients (26 girls, 23 boys) with a mean ± standard deviation age of 2.9 ± 3.2 years (range, 11 months to 13 years; mode, 6 years; median, 1.2 years) were treated at Miyagi Children's Hospital between 2007 and 2012 using a minimally invasive technique for filum sectioning that we call the interlaminar approach (ILA) (Fig. 1). All the patients were followed for

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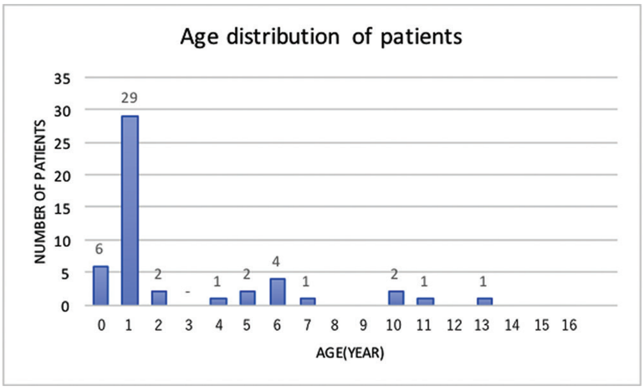

Fig. 1 Age distribution of patients.

>5 years postoperatively, and all had been diagnosed with FTL based on MRI studies. The pre- and postoperative clinical and radiological findings, surgery-related complications were reviewed. Prior to introducing ILA, we had used standard one level laminectomy/laminotomy (LL) at L-5 or S-1, providing an adequate control group for the benefit of the ILA [15 girls, 24 boys with mean ± standard deviation age of 3.0 ± 2.8 years (range, 6 months to 10 years; mode, 1.1 years; median, 1.8 years)].

At Miyagi Children's Hospital, spinal cord untethering is advocated in cases of progressive and significant neurological deterioration attributed to a tethered cord as diagnosed by a multidisciplinary spina bifida team, consisting of doctors from the department of neurosurgery, orthopedics, and urology. If the family of the asymptomatic patients required the prophylactic surgery, we perform untethering surgery to prevent future neurological deterioration after informed consent was obtained.

Surgical technique for ILA

Radiological findings of a representative case are shown in Fig. 2. All patients underwent surgery in the prone position. Neurophysiological intraoperative monitoring was used for all patients. We monitored free-running and stimulated electromyographic activity of the muscles of the lower extremities and the external anal sphincter. The surgeon stood on the left side of the patient.

A midline 1.5 cm skin incision was performed at the level of the L5 vertebra. After making the skin incision, a periosteal elevator was inserted directly against the left side of the spinous process to strip the periosteum from the vertical side of the spinous process and then laterally along the lamina to elevate the muscles subperiosteally from the arch of the vertebrae (Fig. 3A). The dissection was then extended to the adjacent interspinous ligament to expose the ligamentum flavum (Fig. 3B). We preferred

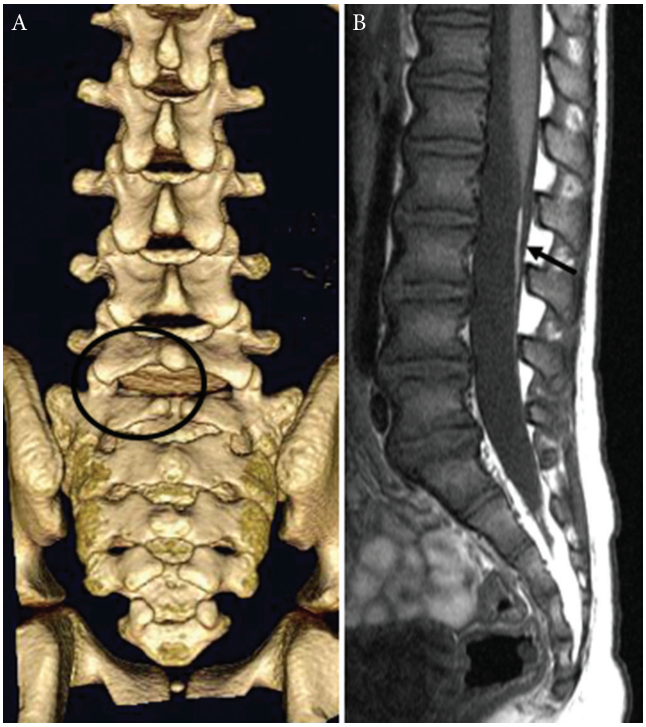

Fig. 2 Representative case of filum terminale lipoma (FTL). One-year-old boy with urological symptom who showed dimple in the sacral region. (A) Three-dimensional computed tomography showing the bony structures of the lumbosacral region; note the wide space between the L5 and S1 laminae (*black circle*). (B) T1-weighted magnetic resonance image; sagittal image showing FTL (*arrow*).

to approach the wider interlaminar space, so either the left L4–L5 or L5–S1 interlaminar space could be exposed using a skin hook. The ligamentum flavum was incised at its midpoint. After grasping the edge of the medial side of the incised ligamentum flavum, the incision was continued to the upper and lower margins of the interspinous space, and we then retracted the flavum medially using 4-0 nylon suture to expose the epidural fat tissue. After minimal electrocoagulation of the epidural fat tissue, we incised and dissected fat tissue from the surface of the dural sac using a cotton pad (Fig. 3C).

The exposed dura was incised longitudinally and the arachnoid membrane was tacked to the dural edge with 8-0 nylon sutures for later arachnoid plasty (Fig. 3D). After incising the arachnoid membrane, the fatty filum was identified by its thickness and pale color, and the yellow color of the fatty tissue. We typically inserted a small dissector into the dural sac toward the posteromedial direction and scooped the filum (Fig. 3E), which was then pulled out from the dural sac (Fig. 3F). We stimulated the fatty filum and confirmed that no evoked electromyographic activity was observed. The filum was

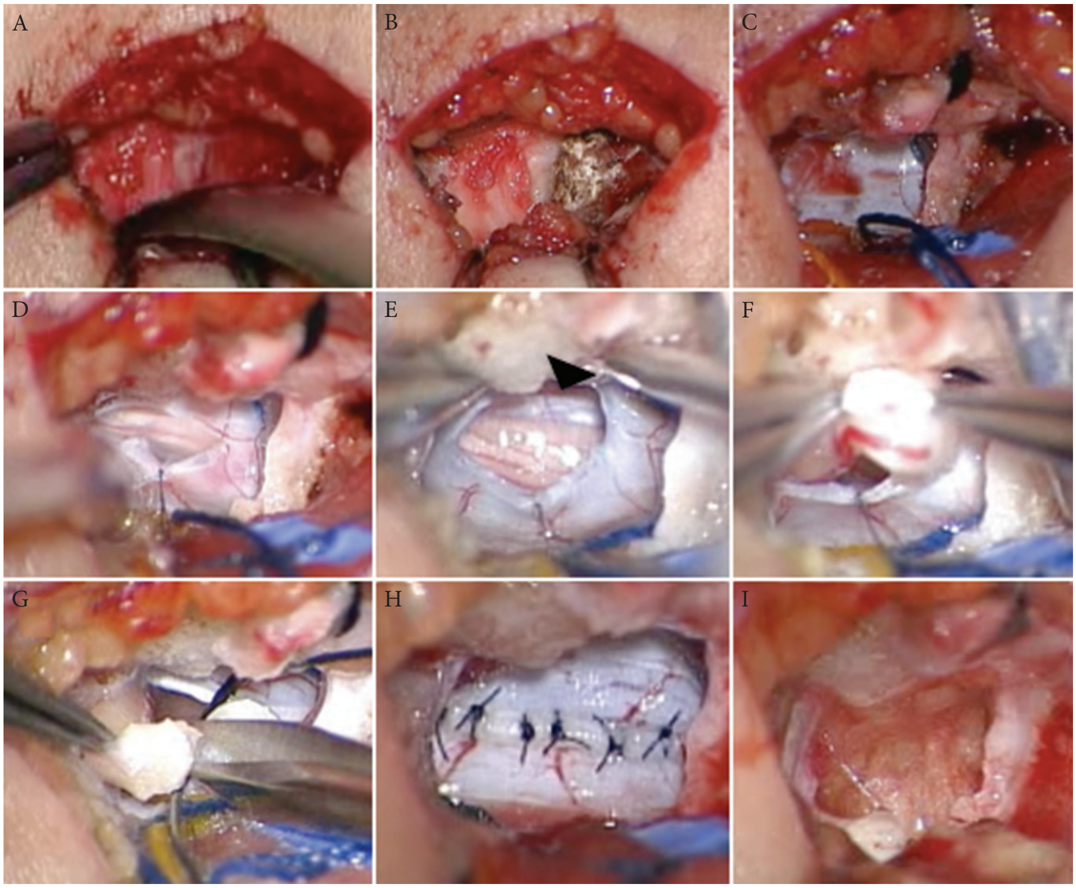

Fig. 3 Intraoperative findings of interlaminar approach. (A, B) After the skin incision, a periosteal elevator is inserted directly against the left side of the spinous process and interlaminar space is exposed. (C) Ligamentum flavum is incised and then the epidural fat tissue is wiped off from the dural surface. (D) After dural incision, the arachnoid membrane is tacked to the dural edge with 8-0 nylon sutures. (E) Small dissector is inserted into the dural sac toward the posteromedial direction and scoop filum terminale lipoma (FTL) (*arrow head*). (F) The FTL is pulled out from the dural sac. (G) The FTL is then coagulated and is sectioned. (H) Watertight closure of the dural incision. (I) Dural surface is covered by epidural fat tissue.

then coagulated using a bipolar coagulator and was sectioned (Fig. 3G). The sectioned filum was usually retracted upward, out of the microscopic field. The dural incision, along with the underlying arachnoid membrane, was closed using 8-0 nylon sutures (Fig. 3H) with use of fibrin glue. The epidural fat tissue was then restored over the dural sac, followed by wound closure (Fig. 3I).

A representative surgical video has been provided in *Operative Neurosurgery*.[3]

Postoperative treatment

After the operation, all patients were returned to the general ward. No bed rest was required unless necessitated by postoperative general condition for ILA. Prior to introducing ILA, bed rest was required for 1 week. Patients who performed ILA were typically discharged 7 days after surgery (now 2 days after surgery) while patients who performed LL were typically discharged 10 days after surgery, and after discharge, each patient was evaluated at 4 weeks, 3 months, and 6 months postoperatively and annually thereafter. Postoperative MRI was performed 3 months after surgery to check for postoperative complications, such as cerebrospinal fluid (CSF) leakage and subcutaneous fluid collection. The postoperative neurological evaluation was performed 6 months after surgery. Worsened or additional sensorimotor symptoms or urological symptoms were recorded as complications.

Statistical analysis was performed using Fisher's exact test to compare categorical variables. A value of $P < 0.05$ was considered significant.

Results

The indications for an initial MRI study in 88 patients were as follows (Table 1): abnormal skin findings in

Table 1 Patient demographics

	ILA	LL
Number of patients	49	39
Mean age (years)	2.9 ± 3.2	(3.0 ± 2.8)
Initial symptom (indication for MRI study)		
Abnormal skin findings	35	(31)
Urological symptoms	7*	(1)
Lower extremity symptoms	3	(6)
Screening for anorectal anomalies	4	(1)
Neurological symptoms at the time of surgery		
None	35	(30)
Urological symptoms	6	(1)
Lower extremity symptoms	4	(8)
Back pain	1	(0)
MRI findings		
Filum lipoma	49	(39)
Low-set conus	14	(13)
Surgical complication		
CSF leak require surgery	0	(1)
Retethering	0	(0)
Additional neurological symptoms	0	(0)
Total hospital stays (days)	8.1 ± 2.1	(10.9 ± 2.2)

ILA: an interlaminar approach, LL: laminectomy/laminotomy, MRI: magnetic resonance imaging, *One patient had developed a urinary tract infection, but recovered at the time of diagnosis and urodynamic study showed no significant findings just before surgery.

66 patients, urorectal symptoms in eight patients, lower extremity symptoms in nine patients, and screening for anorectal anomalies in five patients. There was no statistical difference in age distribution between patients who underwent ILA and LL ($P = 0.81$). A low-set conus was detected on MRI in 27 patients (31%). Sixty-five patients (74%) did not have any neurological symptoms at presentation. Twenty-three patients (26%) were considered to be symptomatic. Among the patients, seven showed urological symptoms and 12 showed lower extremity symptoms. One patient with urological symptoms also complained of back pain and 12 patients were symptomatic with low-set conus (57% of symptomatic patients), while 15 patients were asymptomatic with low-set conus (22% of asymptomatic patients). Symptomatic patients showed a significantly high rate of low-set conus on MRI compared to asymptomatic patients ($P = 0.0055$).

All patients who underwent ILA complained of minimal postsurgical back pain, but none of them were confined to bed rest postoperatively, while patients who underwent LL need bed rest for several days because of postsurgical back pain. Surgical complications that need additional surgical procedure were seen only in one patient who developed CSF leak in the early postoperative period that need repair of dural sac in LL patients. No retethering or additional neurological symptoms were seen during follow-up in both groups (ILA group: range, 60–121 months; mean, 88.8 ± 20.5 months, LL group: range 116–160 months; mean 137.5 ± 13.4 months). All patients remained stable or showed improvement of preoperative symptoms in the follow-up period. Total hospital stays of the patients who underwent ILA and LL was 8.1 ± 2.1 days (range, 3–10 days) and 10.9 days ± 2.2 days (range, 8–20 days). There was a statistically significant difference in the hospital stays between both groups ($P < 0.001$).

Discussion

To the best of our knowledge, this minimally invasive surgical strategy for filum terminale sectioning has not been described previously. Traditionally, sectioning the filum involves open laminectomy and exposure of the dorsal dural sac. Even the minimally invasive method has been reported to sometimes require laminotomy before dural exposure.[2,4–7] Potts et al. reported minimal invasive surgical procedure using tubular dilators for adult patients, while others reported endoscopic approach through tubular retractor that needs minimal laminectomy.[5–7] Surgical approach through sacral hiatus without using laminectomy was also reported for adult patients.[8,9] For pediatric patients, Di et al. reported endoscopic surgical technique via hemilaminectomy.[4] These procedures have an advantage of reduced soft tissue injury, minimal blood loss, and smaller skin incision. Our ILA can be indicated for both adult and pediatric patients and results in smaller skin incision and minimal muscle injury, and more, no bony structural damage, such that all patients complained of only minimal back pain. Although LL group need several days of bed rest for postsurgical pain, the ILA group did not complain any severe postsurgical pain. Furthermore, our strategy did not need postoperative bed rest to reduce postoperative CSF leakage,[10] which result in shorter hospital stays of ILA group than that of LL group. We have no patients with postoperative CSF leak require surgical repair in ILA group until now, while LL group have one patient with postoperative CSF leak. Keeping a child flat in bed after an operation represents one of the most stressful orders for both the patient and medical staff. Considering that the dead space derived from the surgical corridor offers the chance of CSF collection, the ILA technique can provide a minimal surgical corridor and prevent CSF collection. A previous report suggested the importance of the method of closing the fascia and muscle and the handling of the lamina at closure in preventing CSF leakage.[10] The lack of bony structure damage together with minimal muscle dissection in ILA also contributes to the prevention of CSF leakage. The fascia and muscle are easily closed tightly with minimal closure line.

We also anticipate a low incidence of retethering with this strategy. Recently, some postoperative recurrent spinal cord tethering has been reported in FTL patients who have undergone transection of the fatty filum.[11–13] The known surgical principles for preventing retethering include minimizing inflammation and injury to the subarachnoid space and the maintenance of neural elements within the patent subarachnoid space circumferentially. The ILA needs only a small dural incision and minimal arachnoid incision through the interlaminar space from which to expose and section the filum, thus, requiring minimal intradural procedures. We were also able to easily perform watertight dural closure together with arachnoid plasty under the microscopic field. As a result, the complication rate was quite low in our series. Conversely, because surgical corridor through interlaminar space is limited, the ILA may not be indicated as surgery for large FTL. The surgical technique of ILA is more meticulous compare to that of LL through narrow surgical window. For the cases with large FTL, we sometimes drill the lamina using a high-speed drill to widen the inter laminar space and obtain sufficient space. Considering that our series was relatively small and the follow-up period was not long (some patients with retethering have shown neurological symptoms >10 years after their initial surgery[12,13]), further study with a larger number of patients is needed to clarify this important issue.

With the increasing use of MRI, FTL has been identified more frequently in asymptomatic individuals. Our data showed that 26% of cases were symptomatic at presentation. Considering that symptomatic patients showed a significantly high rate of low-set conus on MRI compared to asymptomatic patients, asymptomatic patients with low-set conus on MRI are good indication for ILA because of its minimal invasiveness.

Although our data suggest that retethering or additional neurological symptoms were not seen during the follow-up period, the surgical indication for asymptomatic patients showing a normal conus level on MRI is controversial. In this case series, informed consent was obtained from all patients and/or families that chose prophylactic surgical untethering rather than course observation. Further study with a larger number of patients is needed to clarify the important issue of surgical indications for asymptomatic patients. Considering that surgical indication must be decided as a balance between estimated surgical risks and benefits, our ILA could represent a useful option for filum sectioning, because it can decrease the risk of postoperative complications and postoperative pain and may reduce both the risk of retethering and the need for postoperative bed rest. Neurosurgeons should consider this minimally invasive surgery as an option for filum sectioning providing an advantageous approach for patients.

Conclusion

Tethered spinal cords can be safely and effectively untethered using this minimally invasive ILA. This technique provides the advantage of a small skin incision, reduced soft-tissue injury, less postoperative pain, minimal blood loss, and minimal intradural procedures. The minimal amount of tissue injury generated by this technique may also provide the added advantage of reducing the risk of retethering.

Conflicts of Interest Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper. All authors are the member of the Japanese Neurosurgical Society (JNS), and have registered online self-reported COI disclosure statements forms through website for JNS members.

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