# The Essence of Clinical Practice Guidelines for Ossification of Spinal Ligaments, 2019: 5. Treatment of Thoracic OPLL

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**Keywords:**
ossification of posterior longitudinal ligament, thoracic spine, surgical treatment

Spine Surg Relat Res 2021; 5(5): 330-333
dx.doi.org/10.22603/ssrr.2021-0095

This article is the fifth part of the seven-article series, *The Essence of Clinical Practice Guidelines for Ossification of Spinal Ligaments*, published in the Spine Surgery and Related Research, Special Issue: Volume 5, Issue 5.

## Treatment of Thoracic OPLL

### *Summary*

・Usefulness of surgical treatment methods, indications of surgery, and appropriate timing for thoracic OPLL
- In surgery for thoracic OPLL, posterior decompression with fusion, anterior decompression by anterior approach, and anterior decompression with fusion resulted in a mean improvement rate of approximately ≥50% in the JOA score improvement rate.
- No previous report has suggested suitable timing for surgery for thoracic OPLL.

・Is additional fusion useful in patients who select the posterior approach for thoracic OPLL?
- In cases of thoracic OPLL in which anterior pressure is applied to the spinal cord, when physiological kyphosis is present in the thoracic spine, it is useful to perform concurrent decompression and fusion, excluding areas of the thoracic vertebra above where the kyphosis angle is small to prevent exacerbation of neurological injury caused by increased kyphosis and persistent dynamic factors postoperatively.

・What are the frequency, details, and risk factors of surgical complications in thoracic OPLL ?
- The frequency of surgical complications in thoracic OPLL is high (51.3%) according to a multicenter prospective conducted study in Japan.
- Dural injury is a common intraoperative complication, and motor paralysis of the lower limbs (including temporary) is a common postoperative complication.
- Factors associated with the development of postoperative complications include the degree of spinal cord compression on imaging, preoperative myelopathy, invasive surgery, and intraoperative spinal cord decompression.

・Is monitoring of the spinal cord function in thoracic OPLL surgery useful in the prevention of neurological complications?
- While monitoring of spinal cord function in cervical and thoracic OPLL surgery is thought to contribute to the prevention of neurological complications, various issues need to be resolved, including the fact that not all neurological complications can be detected and the low derivation rate in patients with severe spinal cord damage.

・What factors affect the prognosis of thoracic OPLL?
- Preoperative neurological symptoms, long disease duration, multilevel lesions, another spinal level lesions, positive preoperative prone position and supine position test (PST), additional fusion at the time of posterior decompression, kyphosis correction, and the presence or absence of spinal cord floating on intraoperative ultrasound affect prognosis.

### *Commentary*

*1. Usefulness of surgical treatment methods, indications of surgery, and appropriate timing for thoracic OPLL*

The usefulness of surgery for thoracic OPLL has been re-

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Received: April 29, 2021, Accepted: July 8, 2021

ported in large-scale multicenter studies by the Japan Ministry of Health, Labour, and Welfare Research Program for Intractable Diseases, with the JOA score improvement rate of 37% at postoperative 3 years in the 2008 report[1] and of 55% at postoperative 1 year in the 2018 report[2]. This means a more stable improvement rate has become achievable in recent years. The recent increased improvement rate was influenced by concurrent fusion via the posterior approach[1], and various procedures, which include posterior decompression and fusion[3,4], anterior decompression and fusion[5], and anterior decompression via the posterior approach[6], are reported as useful surgical procedures. However, a high rate of complications has been reported in surgery for thoracic OPLL, and the usefulness needs to be examined in future studies assessing symptom improvement and the risk of complications.

There are no detailed reports on the natural course of thoracic OPLL and no data to serve as grounds to discuss the timing of surgery. However, a relationship between the length of disease duration and poor postoperative improvement rate has been reported[7], and in patients in whom myelopathy progresses slowly, the decision to perform surgery should be proactively considered.

*2. Is additional fusion useful in patients who select the posterior approach for thoracic OPLL?*

Theoretically, directly eliminating compression caused by OPLL seems to be useful. However, performing surgical procedures around a spinal cord with severe damage carries a high risk of aggravation of neurological damage[8,9]. Thus, procedures of posterior surgery for thoracic OPLL that do not involve resection of the ossification are often selected. They are divided into posterior decompression (laminectomy and laminoplasty) and posterior decompression and fusion (including the method combining fusion with laminectomy and laminoplasty and kyphosis-reducing procedure [dekyphosis]). With posterior decompression, neurological damage is aggravated by increased instability caused by posterior invasion into the tissue supporting the spinal column and when kyphosis progresses due to age-related intervertebral degeneration and concurrent compression fracture of the spine, which frequently occurs in women[10]. With regard to the mid-thoracic spine, decompression alone is rarely performed, except in patients with continuous ossification.

However, when performing posterior surgery for thoracic OPLL, fusion is not necessary. It has been reported that surgical outcomes are good with posterior decompression alone for OPLL if the severity is at a level at which alignment shows mild lordosis and kyphosis, such as that of the upper thoracic vertebrae[1].

*3. What are the frequency, details, and risk factors of surgical complications in thoracic OPLL?*

To prevent complications including postoperative motor paralysis, usefulness of posterior decompression and fusion with instrumentation have been reported in some literatures[3,10,11]. While the decompressive effect of anterior decompression and fusion is high in thoracic OPLL, complications such as cerebrospinal fluid leakage are common[12,13].

In a systematic review of postoperative complications in thoracic OPLL, among 595 patients in 15 retrospective studies, complications were observed in 39.4% of patients, and postoperative exacerbation of neurological symptoms, such as postoperative motor and sensory disturbance, was observed in 13.9% of patients[14]. The Japan Ministry of Health, Labour, and Welfare Research Program for Intractable Diseases has conducted five nationwide retrospective multicenter studies on surgery for thoracic OPLL[1,15-18]. In a nationwide multicenter prospective study for thoracic OPLL in 2018, postoperative complications in 115 patients who had undergone surgery for thoracic OPLL were reported[2]. The most common surgical procedure was posterior decompression (correction) and fusion in 85 patients (74%). At 1 year after surgery, the mean improvement rate in the JOA score was 55%, which was the best rate among those in previous nationwide multicenter trials; however, postoperative complications developed in 59 patients (51.3%). Temporary cases included the improvement of postoperative paralysis in 37 patients, which was the most common postoperative complication, following rehabilitation and repeat surgery (nine patients), with a mean recovery period of 2.7 months postoperatively. When several segments were affected by OPLL, the preoperative JOA score was low, there was abundant blood loss, and the time taken to recover from postoperative motor paralysis was significantly longer. Five factors were significantly associated with the onset of postoperative complications: number of segments with OPLL, low preoperative JOA score, positive results on preoperative PST, surgical duration, and absence of spinal cord floating on intraoperative ultrasonography. Furthermore, factors that were significantly associated with the onset of postoperative motor paralysis included the number of segments with OPLL, concurrent OLF, low preoperative JOA score, positive preoperative prone and supine position test (PST) results, surgical duration, amount of blood loss, absence of spinal cord floating on intraoperative ultrasonography, and reduced potential on intraoperative spinal cord monitoring[2].

Thus, although a prospective multicenter study also revealed a high incidence of surgical complications for thoracic OPLL, the surgical outcomes were improved compared with those reported previously. To achieve better surgical outcomes in the future, attention should be paid to preventing such complications, and, if they do develop, appropriate measures should be adopted.

*4. Is monitoring of the spinal cord function in thoracic OPLL surgery useful in the prevention of neurological complications?*

The same as cervical OPLL[19-22], several studies show that in surgery for thoracic OPLL, intraoperative spinal cord monitoring is important as it is associated with postoperative complications and outcomes[2,19,23]. In a prospective study of

70 patients who underwent surgery at a single institution with beak-shaped thoracic OPLL, following posterior decompression and corrective fusion, significant factors for the absence of improvement in motor paralysis and the requirement of second surgery for thoracic OPLL included reduced waveform amplitude on intraoperative spinal cord monitoring at the time of surgery completion[24]. Moreover, recovery operations need to be performed in accordance with reduced intraoperative spinal cord monitoring[25]. Furthermore, in a nationwide multicenter study on surgery for thoracic OPLL in which intraoperative spinal cord monitoring was performed, multivariate analysis of the risk factors for postoperative motor paralysis identified disease duration (odds ratio, 3.3), corrected kyphosis angle (odds ratio, 2.4), and decrease in brain-evoked muscle action potential (odds ratio, 2.2), and the importance of intraoperative spinal cord monitoring was reported[26].

However, some patients who undergo surgery for thoracic OPLL present severe motor paralysis preoperatively, making it difficult to detect the onset of paralysis by intraoperative spinal cord monitoring[10,27]. In contrast, a recent nationwide multicenter prospective study for thoracic OPLL revealed that waveforms could be obtained in most cases and were useful in preventing postoperative motor paralysis[2]. In surgery for thoracic OPLL with a high incidence of complications, intraoperative spinal cord monitoring is believed to contribute to the prevention of postoperative neurological complications with improving skills and performing multichannel and multimodality spinal cord monitoring[28,29]. It should be noted that it is currently difficult to prevent all cases of postoperative paralysis despite using intraoperative spinal cord monitoring.

*5. What factors affect the prognosis of thoracic OPLL?*

In a multicenter study conducted by the Japan Ministry of Health, Labour, and Welfare Research Program for Intractable Diseases, multilevel lesions, concurrent ossification of the ligamentum flavum, low preoperative JOA score, positive PST results, amount of intraoperative bleeding, absence of spinal cord floating on intraoperative ultrasound, and waveform abnormality on intraoperative spinal cord monitoring were found to be risk factors for the appearance of postoperative paralysis and perioperative complications[2]. In addition, factors related to poor long-term improvement following surgery included disease duration, multilevel decompression, cervical OPLL concurrent with OLF[5], maximum ossification located at the T1-T4 level[1], length of the long axis of the OPLL, ossification occupancy rate within the spinal canal[24], decompression of five or more vertebral bodies[27], insufficient kyphosis correction at the time of posterior decompression and fixation[30], decrease in intraoperative spinal cord monitoring waveform, simultaneous concurrent surgery of the cervical and lumbar spine, use of instrumentation, and position at a mid-thoracic spine[31].

**Conflicts of Interest:** The author declares that there are no relevant conflicts of interest.

This is a part of *The Essence of Clinical Practice Guidelines for Ossification of Spinal Ligaments* (2019), which is listed below.

1. Epidemiology of OPLL, written by Tomohiko Hasegawa, MD, PhD, Hamamatsu University, School of Medicine, Japan. https://doi.org/10.22603/ssrr.2021-0096
2. Pathology of OPLL, written by Takashi Kaito, MD, PhD, Osaka University Graduate School of Medicine, Japan. https://doi.org/10.22603/ssrr.2021-0074
3. Diagnosis of OPLL, written by Hirotaka Chikuda, MD, PhD, Gumma University, School of Medicine, Japan. https://doi.org/10.22603/ssrr.2021-0118
4. Treatment of Cervical OPLL, written by Toshitaka Yoshii, MD, PhD, Tokyo Medical and Dental University Hospital, Japan. https://doi.org/10.22603/ssrr.2021-0100
5. Treatment of Thoracic OPLL, written by Shiro Imagama, MD, PhD, Nagoya University Graduate School of Medicine, Japan. https://doi.org/10.22603/ssrr.2021-0095
6. Diagnosis of OLF, written by Masao Koda, MD, PhD, University of Tsukuba, Japan. https://doi.org/10.22603/ssrr.2021-0116
7. Treatment of Thoracic OLF, written by Kanji Mori, MD, PhD, Shiga University of Medical Science, Japan. https://doi.org/10.22603/ssrr.2021-0094

The original version of this clinical practice guidelines appeared in Japanese as Sekichu Jintai Kokkashou Shinryo Guidelines 2019, published by the Japanese Orthopaedic Association and the Japanese Society for Spine Surgery and Related Research, and its translated version in English appeared in the Journal of Orthopaedic Science 26 (2021) 1-45.

## References

**1.** Matsumoto M, Chiba K, Toyama Y, et al. Surgical results and related factors for ossification of posterior longitudinal ligament of the thoracic spine: a multi-institutional retrospective study. Spine. 2008;33(9):1034-41.
**2.** Imagama S, Ando K, Takeuchi K, et al. Perioperative complications after surgery for thoracic ossification of posterior longitudinal ligament: a nationwide multicenter prospective study. Spine. 2018;43(23):E1389-97.
**3.** Matsuyama Y, Sakai Y, Katayama Y, et al. Indirect posterior decompression with corrective fusion for ossification of the posterior longitudinal ligament of the thoracic spine: is it possible to predict the surgical results? Eur Spine J. 2009;18(7):943-8.
**4.** Yamazaki M, Okawa A, Fujiyoshi T, et al. Posterior decompression with instrumented fusion for thoracic myelopathy caused by ossification of the posterior longitudinal ligament. Eur Spine J. 2010;19(5):691-8.
**5.** Fujimura Y, Nishi Y, Nakamura M, et al. Myelopathy secondary to ossification of the posterior longitudinal ligament of the thoracic spine treated by anterior decompression and bony fusion. Spinal

Cord. 1997;35(11):777-84.
6. Kato S, Murakami H, Demura S, et al. Gradual spinal cord decompression through migration of floated plaques after anterior decompression via a posterolateral approach for OPLL in the thoracic spine. J Neurosurg Spine. 2015;23(4):479-83.
7. Fujimura Y. Anterior decompression and fusion by anterior approach for thoracic ossification of the posterior longitudinal ligament. Spine Spinal Cord. 2002;15(2):105-11.
8. Kawahara N, Tomita K, Murakami H, et al. Circumspinal decompression with dekyphosis stabilization for thoracic myelopathy due to ossification of the posterior longitudinal ligament. OPLL Ossification of the Posterior Logitudinal Ligament. 2nd ed. Germany: Springer, 2006. p. 235-40.
9. Abumi K, Ito M, Minami A. Anterior decompression through posterior approach for thoracic myelopathy caused by OPLL: Ohtsuka Procedure. OPLL the Posterior Logitudinal Ligament. 2nd ed. Germany: Springer; 2006, p. 249-58.
10. Yamazaki M, Mochizuki M, Ikeda Y, et al. Clinical results of surgery for thoracic myelopathy caused by ossification of the posterior longitudinal ligament: operative indication of posterior decompression with instrumented fusion. Spine. 2006;31(13):1452-60.
11. Yamazaki M, et al. Evaluation of QOL and function. An analysis of factors of poor postoperative outcomes in thoracic ossification of the posterior longitudinal ligament. 2000 Annual Report on Research on Specific Disease Control of the Ministry of Health and Welfare, Survey of ossification of the spinal ligaments. 2001:145-9.
12. Fujimura Y, et al. The indications and limitations of anterior decompression for thoracic ossification of the posterior longitudinal ligament (OPLL). Spine Spinal Cord. 1989;2(9):671-7.
13. Cho JY, Chan CK, Lee SH, et al. Management of cerebrospinal fluid leakage after anterior decompression for ossification of posterior longitudinal ligament in the thoracic spine: the utilization of a volume-controlled pseudomeningocele. J Spinal Disord Tech. 2012;25(4):E93-102.
14. Xu N, Yu M, Liu X, et al. A systematic review of complications in thoracic spine surgery for ossification of the posterior longitudinal ligament. Eur Spine J. 2017;26(7):1803-9.
15. Imagama S, et al. Surgical methods and outcomes for thoracic ossification of the posterior longitudinal ligament in a nationwide multicenter study: a review. Clin Orthop Surg. 2017;52(1):33-7.
16. Fujimura Y, et al. Ministry of Health, Labour and Welfare Specific Diseases: A Survey of Surgical Cases of Thoracic Ossification of the Posterior Longitudinal Ligament; vol 1995;1994 [research report]:217-21.
17. Kaneda K, et al. Postoperative outcomes and QOL in myelopathy caused by ossification. A study of surgical cases of thoracic ossification of the posterior longitudinal ligament. 1998 Annual Report on Research on Specific Disease of the Ministry of Health and Welfare, Research group examining bone and joint diseases; 1998: 138-42.
18. Matsumoto M, Toyama Y, Chikuda H, et al. Outcomes of fusion surgery for ossification of the posterior longitudinal ligament of the thoracic spine: a multicenter retrospective survey: clinical article. J Neurosurg Spine. 2011;15(4):380-5.
19. Kobayashi S, Matsuyama Y, Shinomiya K, et al. A new alarm point of transcranial electrical stimulation motor evoked potentials for intraoperative spinal cord monitoring: a prospective multicenter study from the Spinal Cord Monitoring Working Group of the Japanese Society for Spine Surgery and Related Research. J Neurosurg Spine. 2014;20(1):102-7.
20. Li H, Jiang LS, Dai LY. A review of prognostic factors for surgical outcome of ossification of the posterior longitudinal ligament of cervical spine. Eur Spine J. 2008;17(10):1277-88.
21. Nakashima H, Imagama S, Yukawa Y, et al. Multivariate analysis of C-5 palsy incidence after cervical posterior fusion with instrumentation. J Neurosurg Spine. 2012;17(2):103-10.
22. Shou F, Li Z, Wang H, et al. Prevalence of C5 nerve root palsy after cervical decompressive surgery: a meta-analysis. Eur Spine J. 2015;24(12):2724-34.
23. Imagama S, Ando K, Kobayashi K, et al. Factors for a good surgical outcome in posterior decompression and dekyphotic corrective fusion with instrumentation for thoracic ossification of the posterior longitudinal ligament: prospective single-center study. Oper Neurosurg. 2017;13(6):661-9.
24. Imagama S, Ando K, Ito Z, et al. Risk factors for ineffectiveness of posterior decompression and dekyphotic corrective fusion with instrumentation for beak-type thoracic ossification of the posterior longitudinal ligament: a single institute study. Neurosurgery. 2017; 80(5):800-8.
25. Imagama S, et al. Advanced surgical skills: Tips and pitfalls of surgery. Surgical treatment of the spine and thoracic OPLL. Aiming to ensure greater safety. Orthop Surg. Surg Technol. 2017;7(2): 184-92.
26. Ito Z, Matsuyama Y, Ando M, et al. Postoperative paralysis from thoracic ossification of posterior longitudinal ligament surgery risk factor of neurologic injury: nationwide multiinstitution survey. Spine. 2016;41(19):E1159-63.
27. Takahata M, Ito M, Abumi K, et al. Clinical results and complications of circumferential spinal cord decompression through a single posterior approach for thoracic myelopathy caused by ossification of posterior longitudinal ligament. Spine. 2008;33(11):1199-208.
28. Ito Z, Matsuyama Y, Ando M, et al. What is the best multimodality combination for intraoperative spinal cord monitoring of motor function? A multicenter study by the monitoring Committee of the Japanese Society for Spine Surgery and Related Research. Glob Spine J. 2016;6(3):234-41.
29. Yoshida G, Ando M, Imagama S, et al. Alert timing and corresponding intervention with intraoperative spinal cord monitoring for high risk spinal surgery. Spine. 2019;44(8):E470-9.
30. Ito Z, Matsuyama Y, Ando M, et al. Postoperative paralysis from thoracic ossification of posterior longitudinal ligament surgery risk factor of neurologic injury: nationwide multiinstitution survey. Spine. 2016;41(19):E1159-63.
31. Onishi E, Sano H, Matsushita M. Surgical treatment for thoracic myelopathy due to simultaneous ossification of the posterior longitudinal ligament and ligamentum flavum at the same level. Clin Spine Surg. 2016;29(8):E389-95.