



## Clinical Study

# Mid- to long-term outcomes of posterior decompression with instrumented fusion for thoracic ossification of the posterior longitudinal ligament



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## ARTICLE INFO

## Article history:

Received 7 March 2015

Accepted 19 July 2015

## Keywords:

Ossification of the posterior longitudinal ligament

Posterior fusion

Thoracic spine

## ABSTRACT

Posterior decompression with instrumented fusion (PDF) surgery has been previously reported as a relatively safe surgical procedure for any type of thoracic ossification of the longitudinal ligament (OPLL). However, mid- to long-term outcomes are still unclear. The aim of the present study was to elucidate the mid- to long-term clinical outcome of PDF surgery for thoracic OPLL patients. The present study included 20 patients who had undergone PDF for thoracic OPLL and were followed for at least 5 years. Increment change and recovery rate of the Japanese Orthopaedic Association (JOA) score were assessed. Revision surgery during the follow-up period was also recorded. Average JOA scores were 3.5 preoperatively and 7.1 at final follow-up. The average improvement in JOA score was 3.8 points and the average recovery rate was 47.0%. The JOA score showed gradual increase after surgery, and took 9 months to reach peak recovery. As for neurological complications, two patients suffered postoperative paralysis, but both recovered without intervention. Six revision surgeries in four patients were related to OPLL. Additional anterior thoracic decompression for remaining ossification at the same level of PDF surgery was performed in one patient. Decompression surgery for deterioration of symptoms of pre-existing cervical OPLL was performed in three patients. One patient had undergone lumbar and cervical PDF surgery for *de novo* ossification foci of the lumbar and cervical spine. PDF surgery for thoracic OPLL is thus considered a relatively safe and stable surgical procedure considering the mid- to long-term outcomes.

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## 1. Introduction

Ossification of the posterior longitudinal ligament (OPLL) in the thoracic spine is a relatively rare condition that may cause severe myelopathy and is often difficult to treat. Various surgical procedures for thoracic OPLL have been reported, including posterior decompression (laminectomy and laminoplasty) [1], posterior decompression with instrumented fusion (PDF) [2–4], circumferential spinal cord decompression using either a single posterior approach [5] or a combined posterior and anterior approach [6], and anterior decompression with fusion [7,8]. These surgical procedures have specific advantages and disadvantages. PDF surgery has been previously reported as technically undemanding to

perform and a relatively safe surgical procedure for any type of thoracic OPLL. However, the mid- to long-term clinical course is still unclear because the follow-up periods in previous reports have been relatively short.

The aim of the present study was to elucidate the mid- to long-term clinical outcome of PDF surgery for thoracic OPLL patients.

## 2. Patients and methods

The present study was a retrospective case series and included 20 patients (11 men and nine women). Each patient had undergone PDF for thoracic OPLL at the authors' institute between September 1998 and October 2009 and had been followed for at least 5 years. Before the present series, we encountered patients with neurological deterioration following posterior decompression surgery for thoracic OPLL, whose paresis was improved by additional posterior

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**Table 1**  
Demographic and clinical characteristics of patients with thoracic OPLL undergoing posterior decompression and fusion

Characteristic	All patients (n = 20)
Age at surgery, years	53.7 (32–74)
Male:Female	11:9
Follow-up, months	123.2 (61–314)
Levels fused, n	9.1 (6–12)
Type of OPLL	
Beaked	5
Continuous waveform	11
Continuous cylindrical	2
Circumscribed	2
Level of maximum cord compression	
Upper thoracic (T1–T4)	5
Middle/lower thoracic (T5–T12)	15

Data are presented as mean (range) or number of patients unless otherwise specified. OPLL = ossification of the posterior longitudinal ligament.

instrumented fusion [9]. Therefore, we performed PDF surgery for all thoracic OPLL patients during the current study period, except for those with cervico-thoracic OPLL with lordotic alignment, who were treated by extended cervico-thoracic laminoplasty (five patients).

The average age of patients at the time of surgery was 53.7 years (range 37–74 years), and the mean follow-up period was 123.2 months (range 61–314 months). The morphology of the ossification foci was assessed using a CT scan, midsagittal, multiplanar, reconstructed image and was categorized into the linear, beaked, continuous waveform, continuous cylindrical, or mixed types according to the classification established by The Research Group for Ossification of the Spinal Ligament sponsored by the Japanese Ministry of Health, and Welfare in 1993 [10]. In addition, we added the circumscribed type, which was defined as ossification localized at the level of the disc without continuation between vertebrae [11]. The maximum compression level was determined using CT scan and MRI, and patients were divided into either the upper thoracic (T1–T4) group or the middle/lower thoracic (T5–T12) group based on a previous report which described that upper thoracic OPLL resulted in a better recovery than a middle/lower thoracic OPLL [12]. Patient demographics are shown in Table 1.

Clinical measures included the Japanese Orthopaedic Association (JOA) score (which excluded upper extremity scores) with a possible total of 11 points, and an assessment of recovery rate (expressed as a percentage) using Hirabayashi's method (recovery rate = [JOA score at follow-up – preoperative JOA score]/[11 – preoperative JOA score] × 100). The increment change of the JOA score was calculated by the subtraction of postoperative and preoperative JOA scores. The average JOA score increment and recovery rate were compared among the different morphological classifications described above. Kyphotic angles in fused thoracic spinal segments were measured preoperatively on a lateral radiograph using the Cobb method, as well as immediately after surgery, and at the time of the final follow-up visit.

The incidence of perioperative complications was assessed using the clinical records. Revision surgery during the follow-up period was also assessed.

Statistical analyses were performed using the Tukey–Kramer test and the differences were considered significant at  $p < 0.05$ .

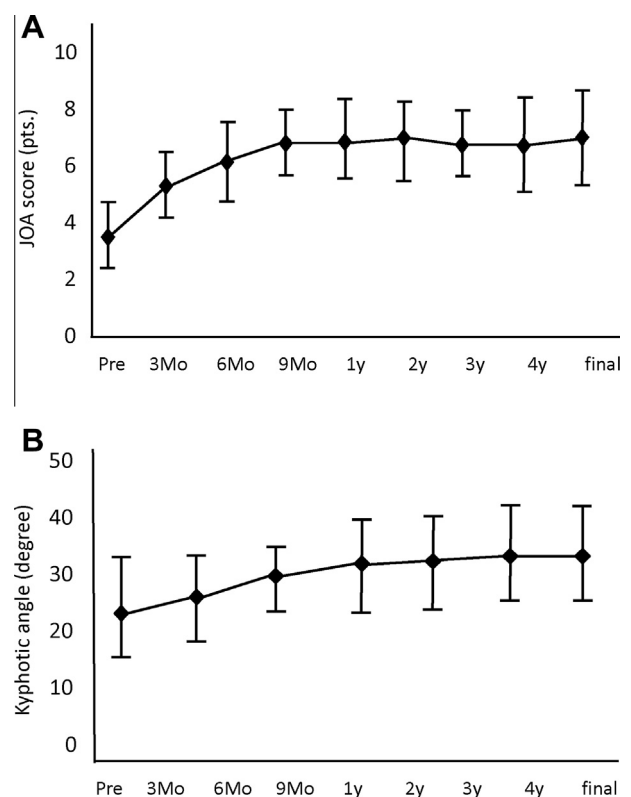
### 3. Results

Average JOA scores were 3.5 (range 1–6) preoperatively and 7.1 (range 5–10) at the final follow-up visit. The average change in the

JOA score was 3.8 points (range 0.5–8 points) and the average recovery rate was 47.0% (range 9.1–88.9%). The JOA score gradually increased after surgery and took 9 months to reach peak recovery. Thereafter, the JOA score plateaued during the remainder of the follow-up period (Fig. 1A).

The average JOA score recovery rates for the various morphological classifications were 63.9% (36.8–88.9%) in the beaked type (n = 5), 39.2% (range 9.1–70%) in the continuous waveform type (n = 11), 45% (range 20.0–70.0%) in the continuous cylindrical type (n = 2), and 49.8% (range 46.2–53.3%) in the circumscribed type (n = 2). There were no significant differences in the JOA score recovery rates among the various OPLL morphologies. The average JOA score recovery rates by OPLL levels were 64.0% (range 45.5–80.0%) in the upper thoracic group (maximum compression at T1–T4, n = 5) and 42.2% (range 9.1–88.9%) in the middle/lower thoracic group (maximum compression at T5–T12, n = 15). The upper thoracic group tended to recover better when compared with the middle/lower thoracic group ( $p = 0.06$ ). The average kyphotic angle in fused segments was 25° (range 10.1–43°) before surgery, 27° (18–40°) immediately after surgery, and 32° (28–57°) at the final follow-up visit (Fig. 1B). The kyphotic angles of the fused segments at the final follow-up were smaller than they were in the preoperative sitting or standing radiographs. Follow-up sagittal CT reconstructed images revealed there had been no apparent progression of OPLL after surgery.

In terms of neurological complications, we encountered two patients with postoperative paralysis. Complete paralysis occurred postoperatively in one patient who recovered without intervention and became ambulatory 6 months later. Incomplete paralysis, graded as Frankel classification C (no useful motor function), occurred in another patient who became ambulatory 2 months



**Fig. 1.** Postoperative course of the (A) Japanese Orthopaedic Association score and (B) kyphotic angles of fused spinal segments after posterior decompression and fusion for thoracic ossification of the posterior longitudinal ligament. JOA = Japanese Orthopaedic Association, Mo = months, Pre = preoperatively, y = years.

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