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A comparative study on clinical outcomes and safety of accurate anterior cervical ossified posterior longitudinal ligament en bloc resection versus piecemeal resection in patients with ossification of the cervical posterior longitudinal ligament: a propensity score-matching analysis

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Abstract

Objective The anterior approach for cervical ossification of posterior longitudinal ligament (OPLL) excision can improve long-term neurofunctional recovery by providing direct spinal cord decompression. The objective of the present study was to compare the clinical outcomes and complications between accurate anterior cervical ossified posterior longitudinal ligament en bloc resection (ACOE) versus piecemeal resection (ACOP) using propensity score-matching analysis.

Methods Included in this study were 189 OPLL patients (65 female) who underwent anterior cervical surgery, with a mean age of 54.85 years. Of them, 105 patients (39 female) with a mean age of 55.69 years underwent ACOE, and the remaining 84 patients (26 female) with a mean age of 53.80 underwent ACOP. Of the 189 patients, 70 patients (37%) had a canal occupying ratio (COR) ≥ 50%, and therefore the patient data were stratified by COR with 50%. The clinical outcomes were compared between the two groups during a at least 27-month follow-up period.

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Results The mean final follow-up JOA score in ACOE group was higher than that in ACOP group. The JOA recovery rate of patients with COR ≥ 50% was higher in ACOE group. The mean operative time and intraoperative blood loss were both lower in ACOE group. However, postoperative complications were not significantly different between the two groups.

Conclusion This study demonstrated that the ACOE technique gained higher JOA recovery rates and better neurological recovery than ACOP for OPLL patients with COR ≥ 50%. In addition, ACOE offered a shorter operative time and less intraoperative blood loss as compared with ACOP. Therefore, the postoperative complications were not more common between two groups.

Keywords Ossification of posterior longitudinal ligament, Spinal Canal, Treatment outcome, Neurologic recovery, Canal occupying ratio

Background

Ossification of the posterior longitudinal ligament (OPLL) is a progressive spinal disease characterized by ectopic bone formation within the posterior longitudinal ligament. The overall incidence of OPLL in Asia is about 2.4%, with the main concomitant of significant compression on the spinal cord and/or nerve roots, leading to quadriparesis or other myelopathies in severe cases [1–3]. Various options are currently available for OPLL management, including follow-up observation and surgical intervention. Surgery is one of the ideal treatments for patients with severe neurological impairment [4]. Studies have demonstrated that early surgical intervention can improve neurological function of OPLL patients [5].

However, there have long been debates on the optimal approach for OPLL [6, 7]. Anterior surgery can directly remove ossification and provide direct spinal decompression to improve long-term neurological function [8], especially for OPLL patients with a high canal occupying ratio (COR) [9–11]. But dural sac adherence is reported to occur in 13–15% OPLL lesions, which may cause cerebrospinal fluid (CSF) leak when direct excision is performed [12, 13]. Other typical complications such as dysphagia and hoarseness due to postoperative retropharyngeal edema or recurrent laryngeal nerve injury are also major concerns in anterior approach surgery. For this reason, many surgeons choose to float the lesion anteriorly or discard the anterior approach [14].

In this retrospective study, we introduced a safe surgical procedure for OPLL excision, known as accurate anterior cervical OPLL en bloc resection (ACOE) [15], and compared it with anterior cervical OPLL piecemeal resection (ACOP) in terms of safety and prognosis. The surgical outcomes were also compared in propensity score matched patients to minimize bias between groups. To the best of our knowledge, this is the largest cohort study to compare ACOE and ACOP for OPLL patients.

Methods

Study participants

This retrospective cohort study included 206 patients with cervical OPLL who were treated with anterior cervical surgery in Changzheng Hospital (Shanghai, China) between November 2007 and July 2021. Patient data, including complications, were obtained from the electronic medical record database of the hospital and patients or their guardians. The study was approved by the Ethics Committee of the said hospital. Written informed consent was obtained from all patients or their guardians. This study followed the reporting guideline of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) for cohort studies.

Population

The inclusion criteria were patients age between 35 and 80 years with cervical OPLL detected by imaging scan, and their clinical manifestations failed to improve after more than three-month conservative treatment. The exclusion criteria were patients with incomplete clinical data and those who failed to complete postoperative follow-ups.

Of the initially enrolled 206 patients, 17 patients were excluded from the study due to missed follow-up data, and finally 189 patients were included for analysis using a sealed envelope (Fig. 1). The demographic data, including age, gender, body mass index (BMI), days of hospital stay, duration of symptoms, history of alcohol and smoking use, diabetes, hypertension, and history of surgery, are summarized in Table 1. The radiological data including OPLL classification and COR of patients are also summarized in Table 1. The mean follow-up duration was 67.67 ± 35.89 months (51.79 months in ACOE group vs. 87.51 months in ACOP, $p < 0.001$) (Table 1).

Surgical procedures

ACOP was chosen for cases in which the OPLL could be easily and completely resected intraoperatively without the use of a grinding drill at an additional charge. In cases in which the OPLL was adherent to a large area of the

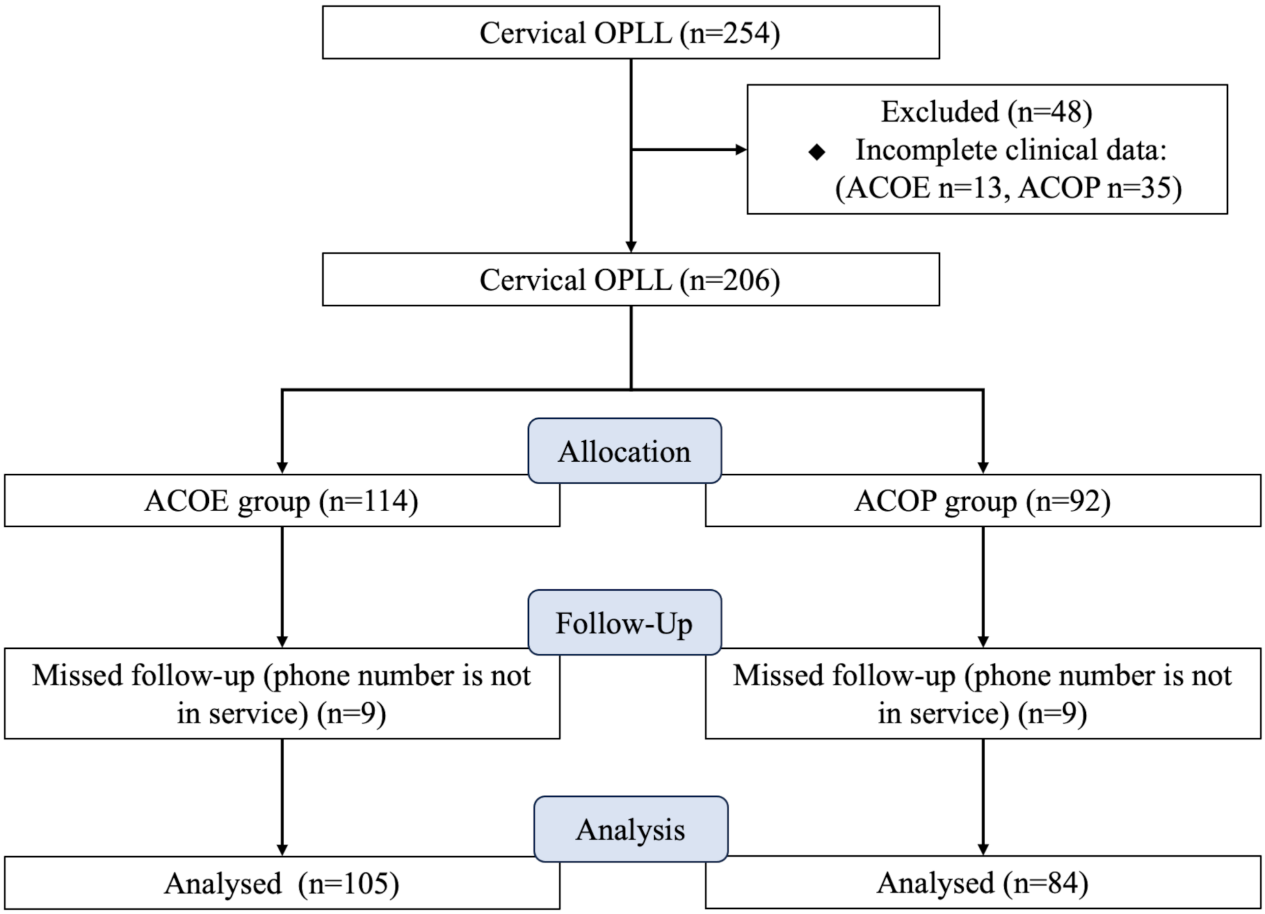

Fig. 1 Enrolment, cohort, treatment and follow-up. OPLL, ossification of the posterior longitudinal ligament; ACOE, accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP, anterior cervical ossified posterior longitudinal ligament piecemeal resection

dura mater and a whole resection would result in a large defect of the dural sac causing severe CSF leak, the same choice was made to resect the ossification as much as possible in chunks, which would not result in spinal cord compression, although some of the ossification might be left to be adhered to the dural sac. Cases in this group were also assigned to ACOP group, in which the OPLL was not entirely resected, although the same grinding drill was applied.

The exposure was the different type of operation received by OPLL patients, which comprised ACOE and ACOP. ACOE was performed as described previously [15]. During surgery, most of the vertebral body was bitten off, with the posterior wall of the vertebral body and the ossified mass (OM) preserved, or the intervertebral disc to the OM removed. The OM was floated by using a high-speed burr to drill along the edges of the OM to the depth of the dura. The posterior wall of the vertebral body and the OM were removed with a Kocher or Allis clamp. The ossification was separated from the dural sac with a sharp nerve dissector. The remaining vertebral posterior wall-ossification complex (VPWOC) was removed en bloc (Fig. 2). The width of the dissection was the area of least compression of the OM edge, which could ensure protection of the spinal cord and preserve the dura during elevation of the ossified ligament. The extent of resection was a little lager than the segment responsible for the patient's chief complaint or the segment with obvious cord or nerve root compression. For dura defects with an intact arachnoid membrane without CSF leak, no repair was performed. In case CSF leak occurred, the dura would be repaired with a dura guard patch to protect the spinal cord. The dural ossification (DO) would be preserved as much as possible if no spinal cord compression by the DO was observed; otherwise, the DO would be resected en bloc.

In ACOP surgery, the OPLL was removed in piecemeals using a Kerrison rongeur or a neural stripper with a hook and a sharp scalpel after exposing the ossification.

The operation was performed by the same team of surgeons. All ossifications were resected by senior spine surgeons. All procedures were performed in accordance with the standard procedures and pre-operative planning.

Table 1 Baseline demographic characteristics of the patients

Characteristic	ACOE (*n* = 105)	ACOP (*n* = 84)	*p*-value
Mean age, y (SD)	55.69 (8.81)	53.80 (9.81)	0.166 [a]
35–39, *n* (%)	3 (2.86)	6 (7.14)	
40–49, *n* (%)	22 (20.95)	22 (26.19)	
50–59, *n* (%)	40 (38.01)	36 (42.86)	
60–69, *n* (%)	34 (32.38)	15 (17.86)	
70–79, *n* (%)	6 (5.71)	5 (5.95)	
Female, *n* **(%)**	39 (37.14)	26 (30.95)	0.373 [b]
BMI range (kg/m^2)	25.13 (2.91)	24.72(3.30)	0.369 [a]
≤18.4, *n* (%)	0	4 (4.76)	
18.5–24.0, *n* (%)	35 (33.33)	31 (36.90)	
24.1–27.9, *n* (%)	57 (54.29)	39 (46.43)	
≥28.0, *n* (%)	13 (12.38)	10 (11.90)	
Days of hospital stay, d (SD)	7.12 (1.26)	7.90 (3.85)	0.052 [a]
Course of disease, m (SD)	26.71 (48.29)	28.14 (39.94)	0.828 [a]
Classification, *n* **(%)**			
Segmental	36 (34.29)	34 (40.48)	
Continuous	19 (18.10)	9 (10.71)	
Localized	36 (34.29)	34 (40.48)	
Mixed	14 (13.33)	7 (8.33)	
Mean COR, (SD)	46.05 (15.40)	40.34 (14.87)	0.011 [a]
COR, *n* **(%)**			
≥50%	46 (43.81)	24 (28.57)	
<50%	59 (56.19)	60 (71.43)	0.031 [b]
Medical history, *n* **(%)**			
Alcohol use	10 (9.52)	14 (16.67)	0.143 [b]
Smoking	34 (32.38)	30 (35.71)	0.63 [b]
Diabetes	14 (13.33)	11 (13.10)	0.962 [b]
Hypertension	32 (30.48)	24 (28.57)	0.776 [b]
Surgical history	45 (42.86)	25 (29.76)	0.064 [b]
Time of follow-up, **m (SD)**	51.79 (14.87)	87.51 (43.85)	< 0.001 [a]

[a] Independent-samples t-test. [b] Chi-square test. [c] Fisher's exact test

ACOE = accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP = anterior cervical ossified posterior longitudinal ligament piecemeal resection; BMI = body mass index; COR = canal occupying ratio

Outcome measures

The perioperative data including operative time, volume of intraoperative blood loss (IBL), and complications, such as CSF leak, pain, C5 palsy [defined as muscle power of the deltoid by at least one grade using manual muscle testing with potential biceps involvement and without deterioration of lower extremity function [16].], hoarseness, internal fixation displacement (IF failure), hematoma, and Horner syndrome.

All participating patients were followed up on the outpatient basis or by telephone interviews in July 2023. The primary outcome was the improvement of postoperative neurological function assessed by the Japanese Orthopedic Association (JOA) score [15]. The recovery rate was calculated according to the following formula: JOA recovery rate = (final JOA score - preoperative JOA score) / (17 - preoperative JOA score) × 100% [17].The JOA recovery rate ≥ 75% was defined as excellent, 50–74% as good, 25–49% as fair, and < 25% as poor [10]. The pain intensity was measured by the visual analogue scale (VAS) score using a numerical rating scale.

All patients received preoperative cervical CT scan. OPLL was classified basing on sagittal CT scans as segmental, continuous, localized, and mixed type. COR was defined as the maximum ratio of OM thickness to the sagittal diameter of the spinal canal on CT scans. IF failure was defined as the internal fixation sinking > 2 mm or departure from the original radiographic fixation position between immediate and follow-up postoperative radiograms [18].

Statistics

Data were analyzed by R software (version 4.2.1). Descriptive statistics were calculated to determine the mean post-operative JOA, VAS score and JOA recovery rate. Because the comparison between ACOE and ACOP groups was stratified by severity of cord compression, the balance of baseline characteristics was also assessed in patients with severe compression (COR ≥ 50%). Differences in continuous data as JOA, VAS scores, mean operative time, volume of blood loss, and baseline including age, BMI, days of hospital stay, and timing of surgery between ACOE and ACOP groups were calculated using two sample t test. And categorical data as gender, medical history, and complications were computed by Chi-square or Fisher's exact test. All tests were 2-tailed, with a significance level of $P < 0.05$.

The propensity scores for the surgical procedures were calculated based on the age, gender, BMI, days of hospital stay, duration of symptoms, history of alcohol and smoking use, diabetes, hypertension, history of surgery, preoperative JOA score, COR, and follow-up duration. Patients who underwent ACOE or ACOP were matched on the basis of propensity scores and provided that the caliper value ≤ 0.02.

Results

There was no significant difference in mean preoperative JOA, VAS, final follow-up VAS score and JOA recovery rate between the two groups. The mean final follow-up JOA score and good or excellent prognosis (JOA recovery rate ≥ 50%) in ACOE group were both significantly higher than those in ACOP group. The mean final follow-up VAS score was significantly lower than the preoperative value in both groups (both $P < 0.001$). The mean operative time and IBL in ACOE group were significantly lower than those in ACOP group (Table 2).

The JOA recovery rate of the patients with COR ≥ 50% in ACOE group was significantly higher than that in ACOP group, but there was no significant difference between the two groups when COR was < 50% (Table 3).

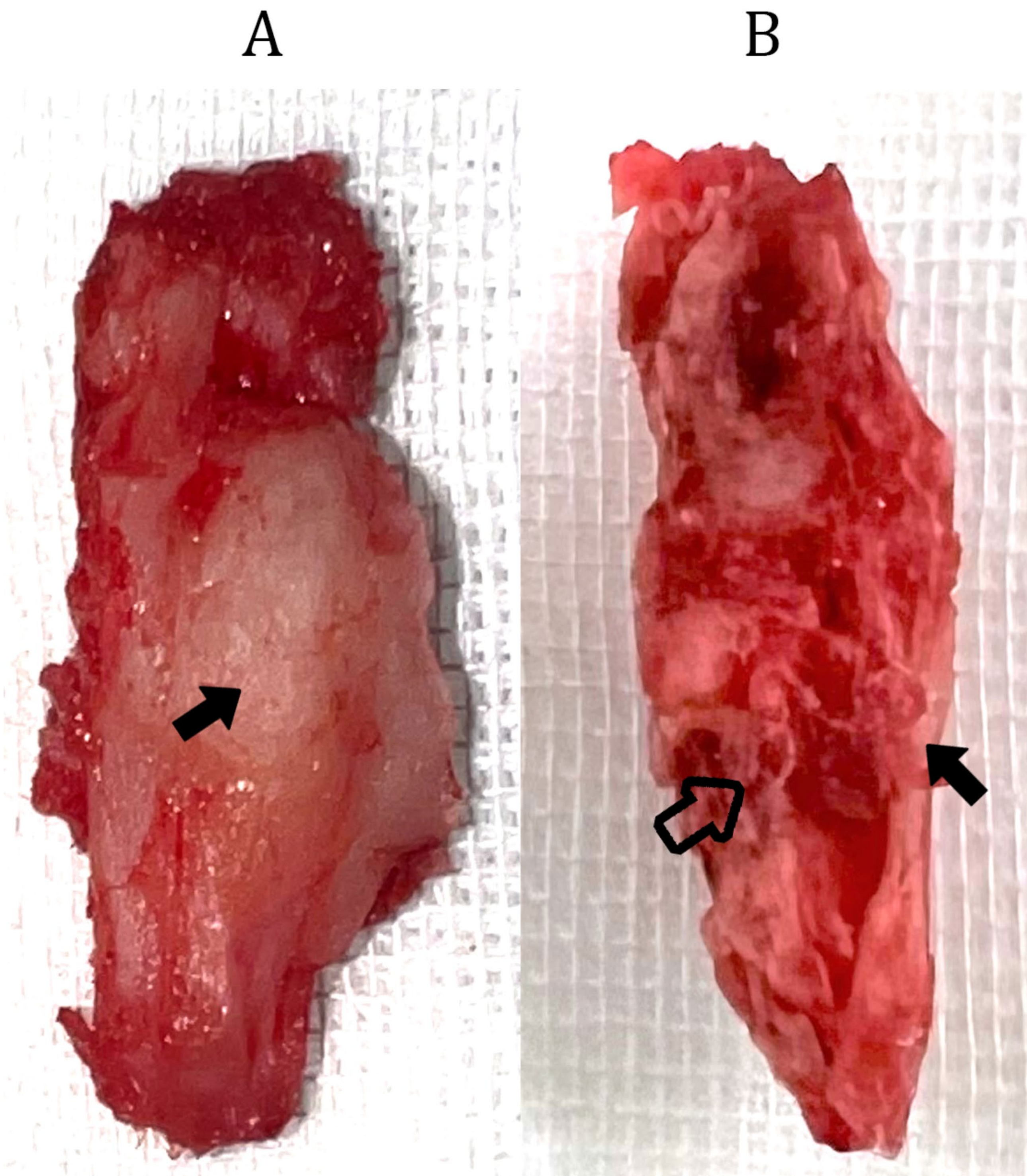

Fig. 2 En bloc resected ossification: ossification view **(A)**, solid arrow indicates ossification; lateral view **(B)**, posterior vertebral wall on the left (hollow arrow) and ossification on the right (solid arrow)

Table 2 Perioperative characteristics and clinical outcomes (crude analysis)

Characteristics	ACOE (*n* = 105)	ACOP (*n* = 84)	*p*-value
Mean JOA score (SD)			
Preoperative	9.81 (2.81)	9.39 (3.07)	0.332 [a]
Final	15.15 (1.57)	14.64 (1.83)	0.041 [a]
RR, %	74.31 (21.42)	68.72 (21.87)	0.079 [a]
≥75, *n* (%)	54 (51.43)	38 (45.24)	
<75, ≥ 50, *n* (%)	44 (41.90)	30 (35.71)	
<50, ≥ 25, *n* (%)	4 (3.81)	14 (16.67)	
<25, *n* (%)	3 (2.86)	2 (2.38)	
Mean VAS score (SD)			
Preoperative	3.85 (1.42)	3.79 (1.12)	0.744 [a]
Final	1.49 (0.82)	1.40 (0.75)	0.484 [a]
Reduction	2.36 (1.26)	2.38 (1.10)	0.913 [a]
Mean operative time, min (SD)	131.78 (36.80)	146.49 (45.67)	0.015 [a]
≤120, *n* (%)	44 (41.90)	27 (32.14)	
121–180, *n* (%)	50 (47.62)	43 (51.19)	
>180, *n* (%)	11 (10.48)	14 (16.67)	
Mean blood loss, mL (SD)	158.05 (114.64)	214.05 (194.75)	0.015 [a]
0-100, *n* (%)	52 (49.52)	35 (41.67)	
101–200, *n* (%)	39 (37.14)	23 (27.38)	
201–300, *n* (%)	10 (9.52)	14 (16.67)	
>300, *n* (%)	4 (3.81)	12 (14.29)	

[a] Independent-samples t-test

ACOE = accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP = anterior cervical ossified posterior longitudinal ligament piecemeal resection; JOA = Japanese Orthopaedic Association; RR = recovery rate; VAS = visual analogue scale

Table 3 Comparison of JOA score between the two groups by the Canal occupying ratio

Characteristics	Mean JOA score		Mean RR, % (SD)
	Preoperative, (SD)	Final, (SD)	
COR < 50%			
ACOE (*n* = 59)	9.92 (2.81)	15.12 (1.74)	75.38 (21.13)
ACOP (*n* = 60)	9.60 (3.15)	14.95 (1.63)	71.41 (22.03)
p-value	0.566 [a]	0.587 [a]	0.318 [a]
COR ≥ 50%			
ACOE (*n* = 46)	9.67 (2.84)	15.20 (1.34)	72.93 (21.93)
ACOP (*n* = 24)	8.88 (2.85)	13.88 (2.09)	61.98 (20.35)
p-value	0.268 [a]	0.002 [a]	0.046 [a]

[a] Independent-samples t-test

JOA = Japanese Orthopaedic Association; ACOE = accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP = anterior cervical ossified posterior longitudinal ligament piecemeal resection; RR = recovery rate; COR = canal occupying ratio

There was no significant difference in the number of cases of CSF leak, C5 palsy, hoarseness, internal fixation failure, hematoma, Horner syndrome, neurological deterioration, and vertebral artery injury between the two groups (Table 4).

Table 4 Postoperative complications during the final follow-up

Characteristics	ACOE (*n* = 105)	ACOP (*n* = 84)	*p*-value
Total, *n* **(%)**	18 (17.14)	12 (14.29)	0.593 [a]
CSF leak	9 (8.57)	6 (7.14)	0.718 [a]
C5 palsy	3 (2.86)	2 (2.38)	> 0.99 [b]
Hoarseness	2 (1.90)	1 (1.19)	> 0.99 [b]
IF failure	2 (1.90)	2 (2.38)	> 0.99 [b]
Hematoma	1 (0.95)	1 (1.19)	> 0.99 [b]
Horner Syndrome	1 (0.95)	0	-
Neurological deterioration	0	0	-
Vertebral artery injury	0	0	-

[a] Chi-square test. [b] Fisher's exact test

ACOE = accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP = anterior cervical ossified posterior longitudinal ligament piecemeal resection; CSF = cerebrospinal fluid

A 1:1 matched comparison (*n* = 37 patients in each group) showed no significant difference in the demographics, VAS score and operative time between the two groups. Meanwhile, the final JOA score and recovery rate in ACOE group were significantly higher than those in ACOP group. The mean IBL in ACOE group was significantly lower than that in ACOP group (Table 5).

Discussion

It was found in our study that ACOE was more effective than ACOP in improving neurologic function in cervical OPLL patients who required surgical treatment. In addition, IBL was smaller in patients of ACOE group. These tendencies were similar in the matched patients.

There are still controversies over whether the anterior or posterior approach is more suitable or preferred for OPLL patients [19–22]. As the main pathologic mechanism of OPLL is the compression of OM on the spinal cord, anterior resection of OPLL seems to be a radical procedure for these patients [7], and could prevent further progression of ossification and the possibility of recompression of the spinal cord [15]. To patients with high COR [11, 15, 20, 21] who have myelopathies caused by compression of cervical OPLL, anterior approach resection is reported to bring about better neurological recovery than posterior approach surgery [15, 20]. Meanwhile, the ossification will continue to progress in more than 56.5–70% patients who have undergone posterior cervical surgery [23–26]. Therefore, some patients may require revision surgery through the anterior approach due to decreased neurological function during long-term follow-up after surgery [17, 27, 28]. Although anterior surgery offers greater advantages in terms of neurological recovery of patients, it also represents a significant challenge for the surgeons [22]. In this article, we introduced a safe approach for anterior cervical excision of OM known as the ACOE technique and compared it with conventional piecemeal ACOP surgery.

Table 5 Comparison of matched patients of ACOE and ACOP groups

Characteristics	ACOE (*n* = 37)	ACOP (*n* = 37)	*p*-value
Mean age, y (SD)	53.95 (9.97)	54.14 (10.31)	0.936 [a]
Female, *n* **(%)**	11 (39.73)	12 (32.43)	0.802 [b]
BMI range (kg/m²)	25.33 (3.05)	25.01 (3.98)	0.694 [a]
Days of hospital stay, d (SD)	7.11 (1.52)	7.16 (1.32)	0.871 [a]
Course of disease, m (SD)	19.57 (19.79)	25.80 (41.89)	0.871 [a]
Mean COR, (SD)	45.40 (17.03)	43.58 (14.94)	0.626 [a]
Medical history, *n* **(%)**			
Alcohol use	5 (13.51)	4 (10.81)	> 0.99 [c]
Smoking	11 (29.73)	6 (16.22)	0.167 [b]
Diabetes	4 (10.81)	2 (5.41)	0.674 [c]
Hypertension	13 (35.14)	13 (35.14)	> 0.99 [b]
Surgical history	10 (27.03)	11 (29.73)	0.797 [b]
Time of follow-up, m (SD)	53.15 (13.21)	51.78 (19.53)	0.724 [a]
Preoperative JOA score (SD)	10.81 (2.82)	10.11 (2.45)	0.256 [a]
Mean JOA score (SD)			
Final	15.76 (1.44)	14.84 (1.57)	0.002 [d]
RR, %	78.65 (22.76)	68.14 (21.99)	0.017 [d]
Mean VAS score (SD)			
Preoperative	4.08 (1.21)	3.95 (1.08)	0.632 [d]
Final	1.54 (0.84)	1.30 (0.81)	0.130 [d]
Reduction	2.54 (1.02)	2.65 (1.09)	0.672 [d]
Mean operative time, min (SD)	120.30 (28.35)	127.05 (49.27)	0.418 [d]
Mean blood loss, mL (SD)	113.38 (55.00)	152.16 (91.63)	0.035 [d]

[a] Independent-samples t-test. [b] Chi-square test. [c] Fisher's exact test. [d] Paired-samples t-test

ACOE = accurate anterior cervical ossified posterior longitudinal ligament en bloc resection; ACOP = anterior cervical ossified posterior longitudinal ligament piecemeal resection; BMI = body mass index; COR = canal occupying ratio; JOA = Japanese Orthopaedic Association; RR = recovery rate; VAS = visual analogue scale

Our crude analysis showed that the final JOA score in ACOP group was higher than that in ACOE group, especially in patients with COR ≥ 50%, in whom the final JOA score and JOA recovery rates were both superior. In addition, the overall good and excellent JOA recovery rate in ACOE group was significantly higher than that in ACOP group (93.33% vs. 80.95%, $p = 0.01$), which is also higher than 88% reported in the literature [7, 29]. Knowing that some confounders may influence the results, we then matched the patients who underwent ACOE and ACOP using the propensity score (PS) 1:1 matching method with the caliper set as 0.02 to restrain the match. As a result, all confounding factors (i.e., age, gender, BMI and duration of symptoms) were matched well between the two groups. The results indicate that the neurological improvement was more positive in ACOE group vs. ACOP group, demonstrating the advantage of ACOE for beneficial neurological outcomes.

The above results demonstrate that ACOE offers better neurological function recovery and clinical outcomes as compared with ACOP. It begins with suspension of ossification by grinding and lifting, followed by separation of the en bloc VPWOC with a neural stripper which is much thinner than the Kerrison rongeur so that it avoids repeated disturbance of the spinal cord during the bite of the OPLL piecemeal. The whole process of ACOE involves removal of the ossification followed by decompression of the nerve root foramen, thus providing a clearer view and more space for manipulation of the nerve in the operated segment with little nuisance to the nerve root.

Our study also showed that the mean IBL in ACOE group was significantly less than that in ACOP group (158.05mL vs. 214.05mL, $p = 0.015$), and much lower than that (292.8-763mL) reported in the literature for anterior cervical surgery [30–32]. The mean operative time in ACOE group was also significantly less than that in ACOP group, though matched analysis failed to obtain the same result. This may be because ACOE technique can accurately resect OPLL, thus greatly reducing the time required for removing the OM and then hemostasis because we used the high-speed burr to grind the edges of the OPLL to the depth of the dura of the operated segment during surgery. And removal of the VPWOC in ACOE only requires hemostasis around the cavity, thus shortening the operative time and reducing IBL.

ACOE is a safe and effective anterior cervical approach surgery for OPLL resection, especially for patients with COR ≥ 50%. We did not observe neurological impairment, or vertebral artery injury during the long-term follow-up period. No significant difference in overall complication rates was observed between the two groups (17.14% vs. 14.29%, $P = 0.593$), but both were lower than 21.8% reported in the literature [33]. The most common complication of anterior OPLL surgery is CSF leak [7], mainly due to adhesion of ossification to the dura mater and/or DO. The incidence of CSF leak in anterior cervical surgery reported in the literature is 6.5–30.8% [20, 21, 34], while it is similar in both groups of our study (8.57% in ACOE and 7.14% in ACOP). CSF leak was successfully managed in all patients by pressure dressing and/or repeated aspiration without intravertebral infection. Spinal cord injury (SCI) is also a serious complication of anterior cervical surgery [35]. Repetitive Kerrison rongeur impacts on the compressed SC during OPLL was piecemeal resected could improve the possibility of SCI. No patients suffered SCI at the final follow-up of the ACOE technique in our study, mostly because the surgeons used a high-speed burr to make a slotting to the depth of the dura from where the spinal cord sustained relatively slight compression. The VPWOC was lifted with the Allis or Kocher clamp to provide an enlarged space under the ligament, thus facilitating en bloc resection with the nerve stripper. The ACOE technique can therefore reduce secondary compression of the spinal cord severely compressed by the Kerrison rongeur during piecemeal resection and avoid Iatrogenic injuries.

Conclusions

This retrospective cohort study has demonstrated that ACOE is comparable to ACOP in terms of postoperative VAS score reduction, and complication rates. More importantly, for OPLL patients with COR ≥ 50% and matched analysis, ACOE can provide a higher JOA recovery rate and better neurological recovery than ACOP. In addition, ACOE offers less IBL, demonstrating that it is a safe and reliable surgical procedure for the treatment of severe cervical OPLL compared with ACOP.

Limitation

The present study provides a safe and efficient technique to remove cervical OPLL, but some potential limitations need to be pointed out. First, selection and confounding bias may be unavoidable due to the retrospective design of the study. In addition, we were unable to adjust the analysis for the effect on patient prognosis after discharge, although most patients underwent a standard rehabilitation program during the follow-up period. Multi-center randomized control studies are required to determine the efficacy of ACOE so that postoperative outcomes can be controlled by the medical environment at the time of discharge. Second, although the training of surgeons is standardized wherever possible, over such a long period of time the surgeon's surgical technique will have become more sophisticated and may have some impact on the outcome. Notwithstanding the limitations mentioned above, the present study is the first to compare the long-term outcomes of ACOE vs. ACOP for patients with cervical OPLL by using PS matching analysis of collected data. These findings will be helpful to surgeons in the selection of a surgical technique and in making an appropriate, informed decision for patients with OPLL.

Abbreviations

ACOE	Accurate anterior cervical ossified posterior longitudinal ligament en bloc resection
ACOP	Anterior cervical ossified posterior longitudinal ligament piecemeal resection
BMI	Body mass index
COR	Canal occupying ratio
CSF	Cerebrospinal fluid
DO	Dural ossification
IBL	Intraoperative blood loss
IF	Internal fixation
JOA	Japanese Orthopedic Association
OM	Ossified mass
OPLL	Ossification of posterior longitudinal ligament
PS	Propensity score
SCI	Spinal cord injury
VAS	Visual analogue scale
VPWOC	Vertebral posterior wall-ossification complex

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-025-08624-w.

Supplementary Material 1

Supplementary Material 2

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Author contributions

K.C., H.Z. and Y.L. wrote the main manuscript text and prepared data interpretation; J.Z. and X.L. contributed the acquisition and analysis; L.J. designed the work; X.D. and X.C. gave the conception and designed the work; K.C., H.Z. and Y.L. contributed equally to this work as co-first authors; X.D. and X.C. are co-corresponding authors. All authors have reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study protocol was established according to the ethical guidelines of the Helsinki Declaration and approved by Shanghai Changzheng Hospital Biomedical Research Ethics Committee (Approval Number 2017SL015). Written informed consent was obtained from all included patients and their guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Saetia K, et al. Ossification of the posterior longitudinal ligament: a review. Neurosurg Focus. 2011;30(3):E1.
2. Koyanagi I, et al. Acute cervical cord injury associated with ossification of the posterior longitudinal ligament. Neurosurgery. 2003;53(4):887–91. discussion 91– 2.
3. Matsunaga S, Sakou T. Ossification of the posterior longitudinal ligament of the cervical spine: etiology and natural history. Spine (Phila Pa 1976). 2012;37(5):E309–14.
4. Le HV, et al. Ossification of the posterior longitudinal ligament: pathophysiology, diagnosis, and management. J Am Acad Orthop Surg. 2022;30(17):820–30.

5. Ogawa Y, et al. Long-term results of expansive open-door laminoplasty for ossification of the posterior longitudinal ligament of the cervical spine. J Neurosurg Spine. 2004;1(2):168–74.
6. Mizuno J, Nakagawa H. Outcome analysis of anterior decompressive surgery and fusion for cervical ossification of the posterior longitudinal ligament: report of 107 cases and review of the literature. Neurosurg Focus. 2001;10(4):E6.
7. Mizuno J, Nakagawa H. Ossified posterior longitudinal ligament: management strategies and outcomes. Spine J. 2006;6(6 Suppl):S282–8.
8. Meyer SA, Wu JC, Mummaneni PV. Laminoplasty outcomes: is there a difference between patients with degenerative stenosis and those with ossification of the posterior longitudinal ligament? Neurosurg Focus. 2011;30(3):E9.
9. Liu H, et al. Cervical curvature, spinal cord MRIT2 signal, and occupying ratio impact surgical approach selection in patients with ossification of the posterior longitudinal ligament. Eur Spine J. 2013;22(7):1480–8.
10. Fujimori T, et al. Long-term results of cervical myelopathy due to ossification of the posterior longitudinal ligament with an occupying ratio of 60% or more. Spine (Phila Pa 1976). 2014;39(1):58–67.
11. Kim B, et al. Surgical outcome and prognostic factors of anterior decompression and fusion for cervical compressive myelopathy due to ossification of the posterior longitudinal ligament. Spine J. 2015;15(5):875–84.
12. Mizuno J, et al. Dural ossification associated with cervical ossification of the posterior longitudinal ligament: frequency of dural ossification and comparison of neuroimaging modalities in ability to identify the disease. J Neurosurg Spine. 2005;2(4):425–30.
13. Belanger TA, et al. Ossification of the posterior longitudinal ligament. Results of anterior cervical decompression and arthrodesis in sixty-one North American patients. J Bone Joint Surg Am. 2005;87(3):610–5.
14. Boody BS, Lendner M, Vaccaro AR. Ossification of the posterior longitudinal ligament in the cervical spine: a review. Int Orthop. 2019;43(4):797–805.
15. Cao B, et al. Comparison of the outcome after anterior cervical ossified posterior longitudinal ligament En bloc resection versus posterior total laminectomy and fusion in patients with ossification of the cervical posterior longitudinal ligament: a prospective randomized controlled trial. Bone Joint J. 2023;105–B(4):412–21.
16. Deshpande N, et al. Defining postoperative C5 palsy and recovery: a systematic review. J Neurosurg Spine. 2023;38(4):457–64.
17. Kawaguchi Y, et al. Anterior decompressive surgery after cervical laminoplasty in patients with ossification of the posterior longitudinal ligament. Spine J. 2014;14(6):955–63.
18. Kast E, et al. Subsidence after anterior cervical inter-body fusion. A randomized prospective clinical trial. Neurosurg Rev. 2009;32(2):207–14. discussion 14.
19. Smith ZA, et al. Ossification of the posterior longitudinal ligament: pathogenesis, management, and current surgical approaches. A review. Neurosurg Focus. 2011;30(3):E10.
20. Feng F et al. Anterior versus posterior approach for the treatment of cervical compressive myelopathy due to ossification of the posterior longitudinal ligament: A systematic review and meta-analysis. Int J Surg. 2016;2726–33.
21. Zhang J, et al. The anterior versus posterior approach for the treatment of ossification of the posterior longitudinal ligament in the cervical spine: A systematic review and meta-analysis. J Spinal Cord Med. 2021;44(3):340–9.
22. Tani T, et al. Relative safety of anterior microsurgical decompression versus laminoplasty for cervical myelopathy with a massive ossified posterior longitudinal ligament. Spine (Phila Pa 1976). 2002;27(22):2491–8.
23. Hori T, Kawaguchi Y, Kimura T. How does the ossification area of the posterior longitudinal ligament thicken following cervical laminoplasty? Spine (Phila Pa 1976). 2007;32(19):E551–6.
24. Chiba K, et al. Multicenter study investigating the postoperative progression of ossification of the posterior longitudinal ligament in the cervical spine: a new computer-assisted measurement. J Neurosurg Spine. 2005;3(1):17–23.
25. Kato Y, et al. Long-term follow-up results of laminectomy for cervical myelopathy caused by ossification of the posterior longitudinal ligament. J Neurosurg. 1998;89(2):217–23.
26. Kawaguchi Y, et al. Progression of ossification of the posterior longitudinal ligament following En bloc cervical laminoplasty. J Bone Joint Surg Am. 2001;83(12):1798–802.
27. Tokuhashi Y, Ajiro Y, Umezawa N. A patient with two re-surgeries for delayed myelopathy due to progression of ossification of the posterior longitudinal ligaments after cervical laminoplasty. Spine (Phila Pa 1976). 2009;34(2):E101–5.
28. Ogawa Y, et al. Long-term results after expansive open-door laminoplasty for the segmental-type of ossification of the posterior longitudinal ligament of the cervical spine: a comparison with nonsegmental-type lesions. J Neurosurg Spine. 2005;3(3):198–204.
29. Eleraky MA, Llanos C, Sonntag VK. Cervical corpectomy: report of 185 cases and review of the literature. J Neurosurg. 1999;90(1 Suppl):35–41.
30. Sakai K, et al. Five-year follow-up evaluation of surgical treatment for cervical myelopathy caused by ossification of the posterior longitudinal ligament: a prospective comparative study of anterior decompression and fusion with floating method versus laminoplasty. Spine (Phila Pa 1976). 2012;37(5):367–76.
31. Iwasaki M, et al. Surgical strategy for cervical myelopathy due to ossification of the posterior longitudinal ligament: part 2: advantages of anterior decompression and fusion over laminoplasty. Spine (Phila Pa 1976). 2007;32(6):654–60.
32. Lin D, et al. Cervical ossification of the posterior longitudinal ligament: anterior versus posterior approach. Indian J Orthop. 2012;46(1):92–8.
33. Li H, Dai LY. A systematic review of complications in cervical spine surgery for ossification of the posterior longitudinal ligament. Spine J. 2011;11(11):1049–57.
34. Kimura A, et al. Perioperative complications of anterior cervical decompression with fusion in patients with ossification of the posterior longitudinal ligament: a retrospective, multi-institutional study. J Orthop Sci. 2012;17(6):667–72.
35. Bayley E, et al. Major neurological deficit following anterior cervical decompression and fusion: what is the next step? Eur Spine J. 2015;24(1):162–7.

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