International Journal of Surgery 40 (2017) 91–96

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Review

Anterior corpectomy comparing to posterior decompression surgery for the treatment of multi-level ossification of posterior longitudinal ligament: A meta-analysis

Songgang Wang [a], Yanxiao Xiang [b], Xia Wang [a], Hao Li [a], Yong Hou [a], Hua Zhao [a, *], Xin Pan [a, **]

[a] Department of Orthopaedics, Qilu Hospital of Shandong University, Jinan, China
[b] Department of Clinical Pharmacy, Qilu Hospital of Shandong University, Jinan, China

HIGHLIGHTS

- Anterior surgery achieve better JOA scores and recovery rates for OPLL.
- The complications caused by anterior surgery are more than posterior surgery.
- Anterior directly decompression is advised when complications could be controlled.

ARTICLE INFO

Article history:
Received 4 January 2017
Received in revised form
8 February 2017
Accepted 17 February 2017
Available online 22 February 2017

Keywords:
OPLL
ACCF
Laminoplasty
Multilevel
Meta-analysis

ABSTRACT

Background: Ossification of posterior longitudinal ligament (OPLL) can be treated by two surgical strategies, anterior decompression with fusion and posterior decompression with laminoplasty or laminectomy. It has been debated which surgical approach is more appropriate for the treatment of multilevel OPLL. The purpose of this study is to compare the outcomes of anterior corpectomy surgery to posterior decompression surgery for the treatment of multilevel ossification of OPLL.
Materials and methods: The databases of Medline, Embase, Pubmed, Cochrane library, and Cochrane Central Register of Controlled Trials was searched and we included trials which comparing anterior to posterior surgery for multilevel OPLL. There was no language restrictions. Two authors independently assessed the methodological quality of included trials. The data of outcomes was extracted and analyzed by STATA 12.0.
Results: Six studies were included in this meta-analysis, and totally 123 patients were undergone anterior cervical corpectomy and fusion (ACCF) and 216 patients were decompressed by posterior approach. In this meta-analysis, the postoperative JOA score of anterior surgery was higher than posterior surgery at one year follow-up. Consistently, the recovery rate of anterior surgery was higher than posterior surgery. However, the anterior surgery (ACCF) showed significantly more complications comparing to posterior surgery for the treatment of multilevel OPLL.
Conclusion: This meta-analysis indicates that the parameters of outcomes and functional recovery of patients performed with anterior surgery achieve better JOA scores and recovery rates to those with posterior surgery. Though the incidence of complications of anterior surgery are higher than posterior surgery, the anterior directly decompression is advised when the complications could be controlled by advanced surgical technique.

1. Introduction

Ossification of posterior longitudinal ligament (OPLL) usually occurs in cervical vertebra in Asian population. It can be treated by two surgical strategies, anterior decompression with fusion and posterior decompression with laminoplasty or laminectomy. The

* Corresponding author. Department of Orthopaedics, Qilu Hospital of Shandong University, Jinan 250012, China.
** Corresponding author. Department of Orthopaedics, Qilu Hospital of Shandong University, Jinan 250012, China.
E-mail addresses: zhaohuadr@163.com (H. Zhao), panxinqilu@163.com (X. Pan).

http://dx.doi.org/10.1016/j.ijsu.2017.02.058
1743-9191/© 2017 Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd.

anterior approach can achieve complete decompression by removing the ossified ligament, and accomplish a solid fusion of cervical vertebra. The posterior approach makes the decompression from the dorsal part of the cervical spinal cord. It was previously reported that when the ossification of posterior longitudinal ligament involves less than 3 segments, especially when the canal narrowing ratio >60%, the anterior approach would be advised [1,2]. The anterior approach could make a direct decompression and reconstruct the stability by a solid spinal fusion, however, the anterior approach required more techniques, more bone grafts for fusion and longer postoperative immobilization of the neck [3].

The posterior surgery has been thought to decompress the spinal cord indirectly by laminoplasty or laminectomy for the treatment of multilevel myelopathy and OPLL [4]. The surgical technique is less difficult than anterior cervical corpectomy and fusion (ACCF). But the effect of the posterior surgery depends on the backward shift of the cervical spinal cord. If the ossified mass of ligament invades the canal severely and the spinal cord still cannot escape from the compression after posterior surgery, the outcomes may not be satisfying [5]. Therefore, it has been debated which surgical approach is more appropriate for the treatment of multilevel ossification of posterior longitudinal ligament. The purpose of this study was to compare the outcomes of anterior surgery to posterior surgery for the treatment of multilevel OPLL.

2. Materials and methods

2.1. Search strategy

A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)-compliant search was performed in the databases of Medline, Embase, Pubmed, Cochrane library, and Cochrane Central Register of Controlled Trials (CENTRAL) by using combinations of the following keywords: ossification of posterior longitudinal ligament (OPLL), multilevel/multi-level myelopathy, cervical decompression, anterior cervical corpectomy and fusion (ACCF), laminoplasty, laminectomy. We searched for randomized controlled trails (RCTs), prospective cohort and retrospective cohort published between January 1990 and June 2016 that compared anterior surgery with posterior surgery for the treatment of multilevel OPLL. We placed no restrictions on the language of the publication. References cited in the relevant articles were also reviewed. All researches were carefully estimated to identify repeated data. Criteria used to define duplicate data included study centers, treatment information, and any additional inclusion criteria.

2.2. Inclusion and exclusion criteria

Researches that conformed to the following criteria were eligible for inclusion in this study: (1) original researches; (2) studies that include anterior surgery with posterior surgery for the treatment of multilevel OPLL; (3) studies with follow-up more than one year. We excluded studies in the thoracic or lumbar spine, articles that were duplicate reports of an earlier trial, reviews, and case-reports.

2.3. Data extraction

Two of the authors extracted the data from eligible studies independently, discussed discrepancies, and reached conformity for all items. The indispensable information extracted from all primary researches included the titles, author names, year of publication, original country, study design, sample size, surgical technology, duration of follow-up, and outcome parameters. The corresponding author of each study was contacted to obtain any missing information if it was required. The extracted data were rechecked for accuracy or against the inclusion criteria by the corresponding author.

2.4. Outcomes

The following outcomes were extracted from the included publications: 1) Japanese Orthopedic Association (JOA) score system was used to evaluate the severity of cervical myelopathy; 2) Recovery rate. The recovery rate was calculated by the JOA scores evaluated before surgery and 1 year after surgery; 3) Complications included the following severe events related to surgical procedures or implants: numbness or paresthesia, dural tear, cerebrospinal spinal fluid leakage, hematoma formation, dysphagia, dysphonia, and deep infections.

2.5. Quality assessment

The quality of the studies was independently assessed by the authors according to the Newcastle-Ottawa Scale (NOS). The manual was downloaded from Ottawa Hospital Research Institute online. The NOS uses a pentagram symbol "✫" rating system (a pentagram symbol stands for one score), to judge quality of cohorts based on three aspects of the cohort studies: selection, comparability and outcomes. Scores were ranged from 0 to 9. Studies with a score $\geq$7 were regarded to be of high quality.

2.6. Statistical analysis

We performed all meta-analyses with the STATA 12.0 (StataCorp LP, College Station, TX, USA). For continuous outcomes, means and standard deviations were pooled to generate a mean difference (MD), and 95% confidence intervals (CI) were generated. For dichotomous outcomes, the risk ratio (RR) or the odds ratio (OR) and 95% CI were assessed. A probability of $p < 0.05$ was considered to be statistically significant. Assessment for statistical heterogeneity was calculated using the I-square tests, which described the proportion of the total variation in meta-analysis assessments from 0 to 100% [6]. The random effects model was used for the analysis when an obvious heterogeneity was observed among the included studies ($I^2 > 50\%$). The fixed-effects model was used when there was no significant heterogeneity between the included studies ($I^2 \leq 50\%$) [7]. The possibility of publishing bias was not evaluated because there were less than ten studies assessed.

3. Results

3.1. Study characteristics

By searching in PubMed, Embase, Medline, and Cochrane library, 104 studies were initially identified. 98 studies were excluded because they did not meet the inclusion criteria. A flow diagram of the selection process for relative articles was shown in Fig. 1. Finally, six studies [8–13] were included into our meta-analysis and the characteristics were presented in Table 1. One of these six studies is designed as prospective cohort and the other five are retrospective cohort. Totally, 123 patients were undergone ACCF and 216 patients were decompressed by posterior approach.

3.2. Quality assessment

Assessment of the study specific quality scores from NOS system were shown in Table 2. The median score of included studies was 7.33, with a range from 6 to 8. Five of the six studies were identified as relatively high-quality.

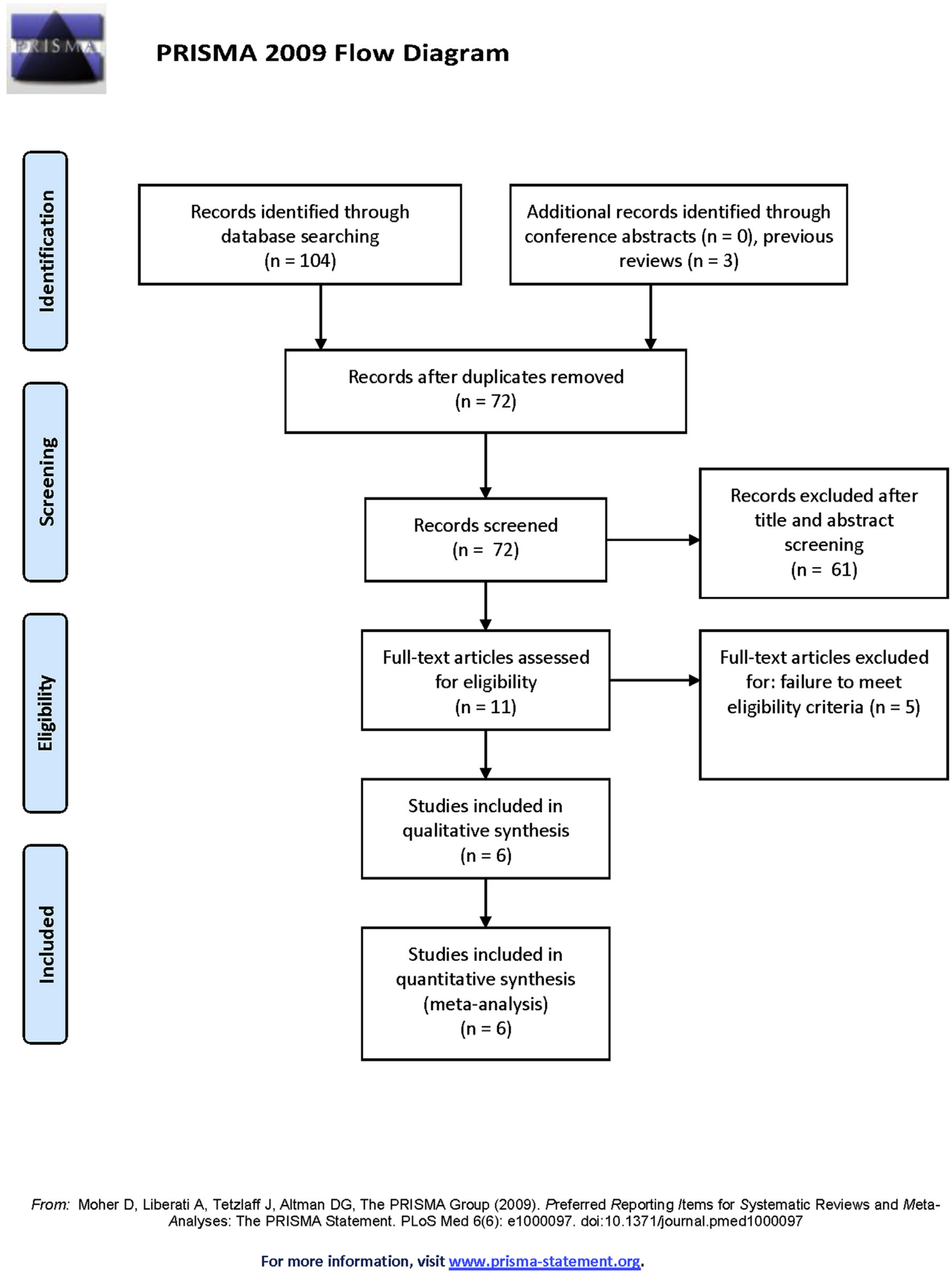

Fig. 1. The flow diagram of the selection process for relative articles. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)-compliant search of Medline, Embase, Pubmed, Cochrane library, and Cochrane Central Register of Controlled Trials (CENTRAL) was performed.

3.3. Outcomes analysis

3.3.1. JOA

Four studies reported a postoperative JOA score of anterior and posterior surgery. The data was extracted and analyzed by “metan” system in STATA 12.0. The results showed that the between-study heterogeneity existed (I-squared = 70.2%), so the random effects model was used to calculate the summary risk ratio with corresponding 95% CI. In forest plots, the overall effect estimate was shown by a diamond of total 95% confidence intervals (CI). When

Table 1
Patient and study characteristics of the four included studies in the meta-analysis.

Source	Study Location	Trials Design	Sample size		Mean age (years, range)		Gender (M/F)		Intervention		Follow-up (month, range)	
			A	P	A	P	A	P	A	P	A	P
Sakai 2012	Japan	Prospective	20	22	59.5 ± 9.3 42–80	58.4 ± 9.6 39–79	33/9		Corpectomy and fusion	Laminoplasty	60	60
Lee 2008	Korea	Retrospective	21	27	56.8 42–72	54.7 30–70	15/5	26/1	Corpectomy and fusion	Laminoplasty	21.8 6–61	21.9 11–64
Masaki 2007	Japan	Retrospective	19	40	51.8 ± 6.6 39–64	62.6 ± 10.3 38–82	14/5	30/10	Corpectomy and fusion	Laminoplasty	12 18–34	12 18–34
Iwasaki 2007	Japan	Retrospective	27	66	58 41–74	57 41–75	15/12	51/15	Corpectomy and fusion	Laminoplasty	72 24–120	122 60–240
Chen 2005	China	Retrospective	22	53	57.2 43–71	54.7 32–66	14/8	35/18	Corpectomy and fusion	Laminoplasty Laminectomy	48	48
Jain 2005	India	Retrospective	14	13	51.5 ± 8.4 35–68	53.74 ± 9.8 30–74	24/3		Corpectomy and fusion	Laminoplasty	13–36	13–36

Table 2
Methodological quality of studies included in the meta-analysis assessed by the Newcastle-Ottawa Scale.

Studies	Selection	Comparability	Outcome	Total score
Sakai 2012	☆☆☆	☆☆	☆☆☆	8
Lee 2008	☆☆☆	☆☆	☆☆☆	8
Masaki 2007	☆☆☆	☆☆	☆☆	7
Iwasaki 2007	☆☆☆	☆	☆☆☆	7
Chen 2005	☆☆☆	☆☆	☆☆☆	8
Jain 2005	☆☆☆	☆	☆☆	6

The Newcastle-Ottawa scale contains eight items that are divided into three categories: selection (four items, one star each), comparability (one item, up to two stars), and exposure/outcome (four items, one star each). A "☆" presents a "high-quality" choice of individual study.

the diamond overlapped the vertical line of no effect, it indicated no statistically significant difference. When the diamond was located in the right area, it indicated anterior surgery showed higher JOA score comparing to posterior surgery. The SMD was 0.81 for the JOA score (95% CI = 0.53 to 1.10) (Fig. 2).

3.3.2. *Recovery rate*

Four studies reported the recovery rate of patients with anterior or posterior surgeries postoperatively, which was analyzed by "metan" system in STATA software. The fixed effects model was used in the analysis of one year follow-up because of the heterogeneity was not significant (I-squared = 0.0%). The results showed the anterior surgery achieved significantly higher recovery rate comparing to posterior surgery. The SMD was 0.55 (95% CI = 0.25 to 0.84) in 1 year follow-up (Fig. 3).

3.3.3. *Complications*

Five studies reported the occurrence of complications included numbness or paresthesia, dural tear, cerebrospinal spinal fluid leakage, hematoma formation, dysphagia, dysphonia postoperatively. The data was extracted and analyzed by meta-analysis in STATA. The random effects model was used in the analysis because of the heterogeneity (I-squared = 70.2%). The anterior surgery (ACCF) showed significantly more complications comparing to posterior surgery for the treatment of multilevel

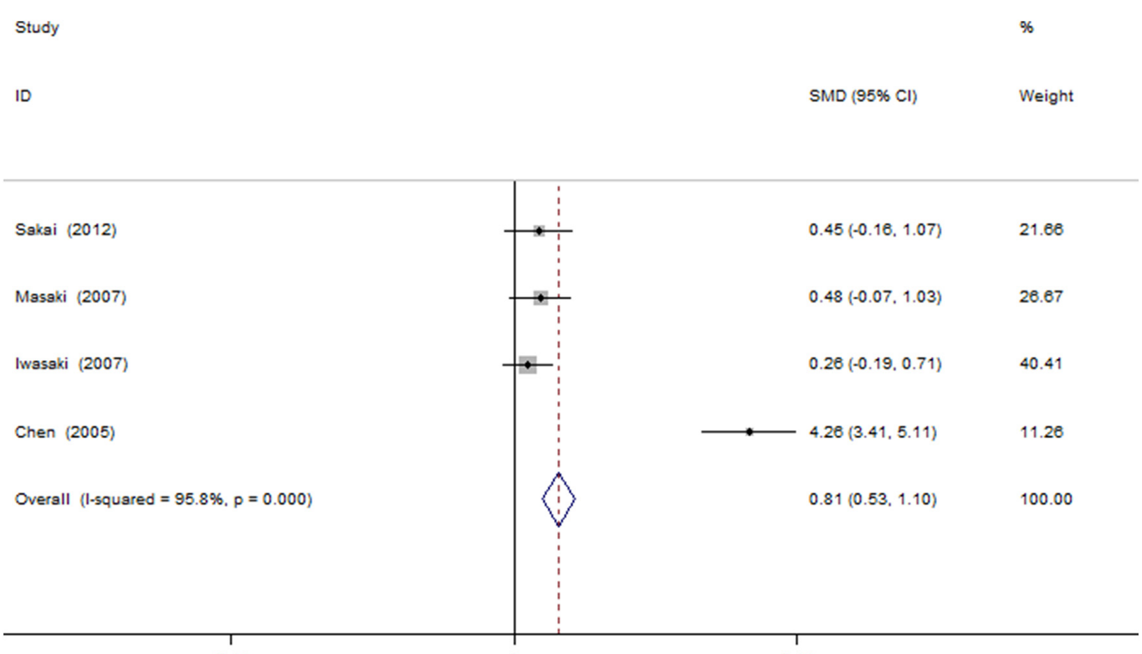

Fig. 2. Forest plot of the meta-analysis of the JOA score comparing anterior with posterior surgery for multilevel OPLL. Diamonds stand for the overall effect estimate. The diamond was located in the right area, which indicated anterior surgery showed higher JOA score comparing to posterior surgery.

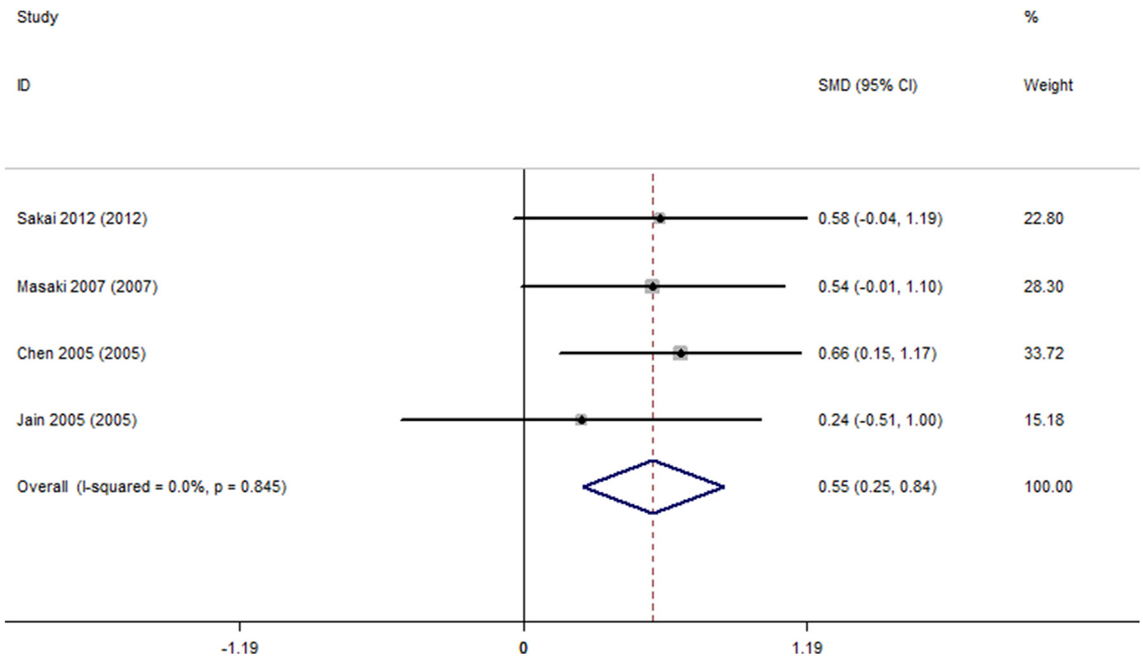

Fig. 3. Forest plot of the recovery rate of the two surgeries. The diamond was located in the right area, showing the anterior surgery achieved significantly higher recovery rate comparing to posterior surgery.

OPLL. The SMD was 2.77 (95% CI = 1.63 to 4.71) (Fig. 4).

4. Discussion

The surgical choice for the treatment of multilevel OPLL is still debatable up to now. In the present study, we searched databases and included six cohort studies that comparing the effect of anterior approach with posterior approach in the treatment of multilevel OPLL. However, no RCT comparing anterior surgery with posterior surgery was obtained. The methodological quality assessed by NOS system showed that five of the cohorts were identified as relatively high-quality and one was moderate. As a result, these methodological quality deficits should be considered when interpreting the findings of this meta-analysis. Besides, the possibility of publication bias was not assessed because there was no more than ten studies included.

In this meta-analysis, the postoperative JOA score of anterior surgery was higher than posterior surgery. We pooled the studies

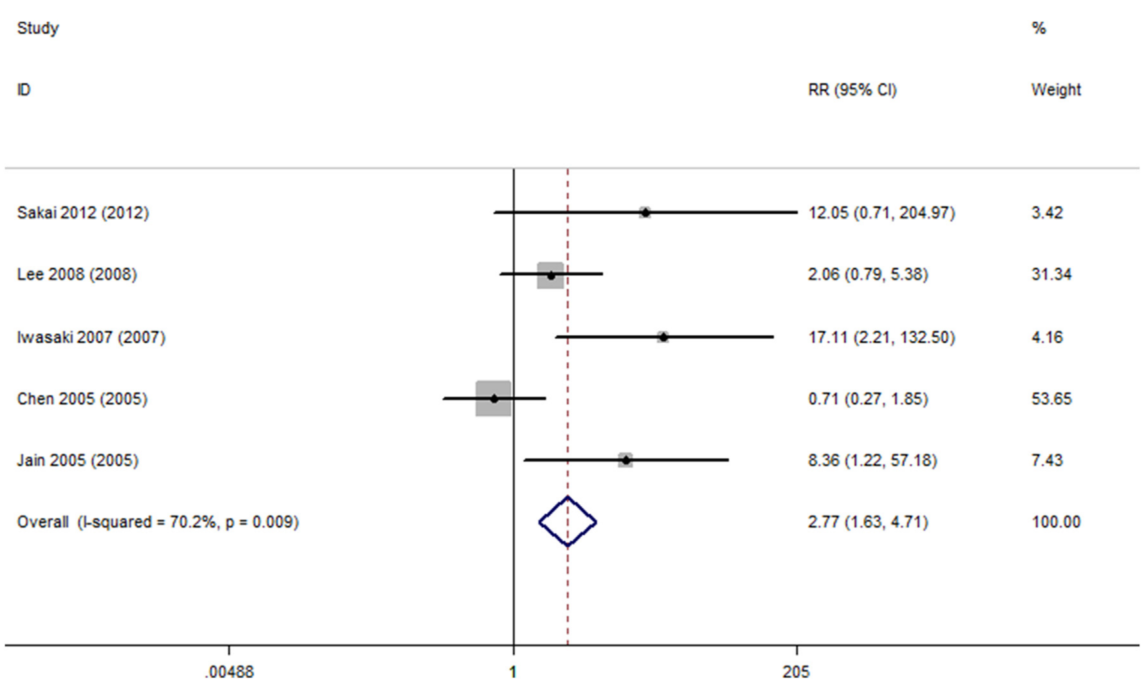

Fig. 4. Forest plot of the incidence of complications post-surgery. The diamond was on the right of the null line, which demonstrated the anterior surgery showed significantly more complications comparing to posterior surgery for the treatment of multilevel OPLL.

reporting the JOA score of the two approaches by using random effect model in the meta-analysis. The heterogeneity and diversity between different studies may be contributed to different locations. Consistent to the JOA score, the meta-analysis also showed the recovery rate of anterior surgery was higher than posterior surgery. There was no heterogeneity in the recovery rate between the studies. Theoretically, the removal of ossified posterior longitudinal ligament by ACCF may achieve the direct decompression of cervical spinal cord. And the meta-analysis also shows that the anterior procedure can result in a higher score of functional assessments and more satisfying functional recovery. Paradoxically, The result of meta-analysis shows that anterior surgery (ACCF) leads to significantly more complications, including dural tear, cerebrospinal spinal fluid leakage, hematoma formation, dysphagia, dysphonia postoperatively, comparing to posterior surgery for the treatment of multilevel OPLL. If the complications can be well-controlled by the team of surgery, the anterior surgery could be a satisfying treatment to multilevel OPLL.

There are several strengths and limitations of this study. The strengths include a rigorous search strategy, no language limitations, article screening and methodological assessments performed in duplicate, abstracted data verified by a second reviewer and utilization of the NOS system to judge the quality of the evidence. In addition, this is the first meta-analysis on this topic to compare the difference between anterior and posterior surgery for the treatment of multilevel OPLL. However, some limitations of this study should be acknowledged. First, there was no RCT comparing anterior and posterior surgery in multilevel OPLL. The studies included five retrospective and one prospective cohorts, the statistic quality of which was inferior to RCTs. Second, the statistical power could be improved in the future by including more studies. Due to the small number of included studies, some parameters could not be analyzed by subgroups to avoid a high heterogeneity which may exert instability on the consistency of the outcomes. Moreover, clinical heterogeneity might be caused by the different indications for surgery and the surgical technologies used at different treatment centers.

In summary, this meta-analysis indicates that the parameters of outcomes and functional recovery of patients performed with anterior surgery achieve better JOA scores and recovery rates to those with posterior surgery. However, the meta-analysis also shows that the complications caused by anterior surgery are significantly more than posterior surgery, which need to be noted when the surgical strategy is made. Though the incidence of complications of anterior surgery are higher than posterior surgery, the anterior directly decompression is advised when the complications could be controlled by advanced surgical technique. Besides, more well-designed studies with large groups of patients are needed to provide further evidence of the advantages or disadvantages of anterior and posterior surgery in the treatment of multilevel OPLL.

Ethical approval

There is no need to gain Ethical Approval for this meta-analysis.

Author contribution

Songgang Wang: data collections and writing.
Yanxiao Xiang: data analysis.
Xia Wang: data collections.
Hao Li: data collections.
Yong Hou: data collections.
Hua Zhao: study design and data analysis.
Xin Pan: data analysis and review.

Conflicts of interest

There is no conflict of interest in this study.

Guarantor

Hua Zhao and Xin Pan.

Acknowledgements

The work was supported by the National Natural Science Foundation of China (grant number 81601067), the Medical Science Development Program of Shandong Province, China (grant number 2016W0361).

References

[1] I. Yamaura, Y. Kurosa, T. Matuoka, S. Shindo, Anterior floating method for cervical myelopathy caused by ossification of the posterior longitudinal ligament, Clin. Orthop. Relat. Res. (1999) 27–34.
[2] T. Isu, S. Mabuchi, S. Minoshima, N. Nakayama, Surgical treatment for ossification of the posterior longitudinal ligament of the cervical spine, No Shinkei Geka 22 (1994) 839–844.
[3] J. Xu, K. Zhang, X. Ma, Q. Yin, Z. Wu, H. Xia, Z. Wang, Systematic review of cohort studies comparing surgical treatment for multilevel ossification of posterior longitudinal ligament: anterior vs posterior approach, Orthopedics 34 (2011) e397–402.
[4] N. Nishida, T. Kanchiku, Y. Kato, Y. Imajo, H. Suzuki, Y. Yoshida, J. Ohgi, X. Chen, T. Taguchi, Cervical ossification of the posterior longitudinal ligament: factors affecting the effect of posterior decompression, J. Spinal Cord. Med. 40 (2016) 93–99.
[5] P.D. Kiely, J.C. Quinn, J.Y. Du, D.R. Lebl, Posterior surgical treatment of cervical spondylotic myelopathy: review article, HSS J. 11 (2015) 36–42.
[6] J.P. Higgins, S.G. Thompson, J.J. Deeks, D.G. Altman, Measuring inconsistency in meta-analyses, BMJ 327 (2003) 557–560.
[7] N. Mantel, W. Haenszel, Statistical aspects of the analysis of data from retrospective studies of disease, J. Natl. Cancer Inst. 22 (1959) 719–748.
[8] K. Sakai, A. Okawa, M. Takahashi, Y. Arai, S. Kawabata, M. Enomoto, T. Kato, T. Hirai, K. Shinomiya, 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) 37 (2012) 367–376.
[9] S.H. Lee, Y. Ahn, J.H. Lee, Laser-assisted anterior cervical corpectomy versus posterior laminoplasty for cervical myelopathic patients with multilevel ossification of the posterior longitudinal ligament, Photomed. Laser Surg. 26 (2008) 119–127.
[10] Y. Masaki, M. Yamazaki, A. Okawa, M. Aramomi, M. Hashimoto, M. Koda, M. Mochizuki, H. Moriya, An analysis of factors causing poor surgical outcome in patients with cervical myelopathy due to ossification of the posterior longitudinal ligament: anterior decompression with spinal fusion versus laminoplasty, J. Spinal Disord. Tech. 20 (2007) 7–13.
[11] M. Iwasaki, S. Okuda, A. Miyauchi, H. Sakaura, Y. Mukai, K. Yonenobu, H. Yoshikawa, 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) 32 (2007) 654–660.
[12] Y. Chen, Y. Guo, X. Lu, D. Chen, D. Song, J. Shi, W. Yuan, Surgical strategy for multilevel severe ossification of posterior longitudinal ligament in the cervical spine, J. Spinal Disord. Tech. 24 (2011) 24–30.
[13] S.K. Jain, P.S. Salunke, K.H. Vyas, S.S. Behari, D. Banerji, V.K. Jain, Multisegmental cervical ossification of the posterior longitudinal ligament: anterior vs posterior approach, Neurol. India 53 (2005) 283–285 discussion 286.