Predictors for cervical kyphotic deformity following laminoplasty: a systematic review and meta-analysis

Samuel D. Pettersson,1 Paulina Skrzypkowska,1 Shan Ali, MD,2 Tomasz Szmuda, MD, PhD,1 Michał Krakowiak, MD,1 Tadej Počivavšek,1 Fanny Sunesson,1 Justyna Fercho, MD,1 and Grzegorz Miękisiak, MD, PhD3

1Neurosurgery Department, Medical University of Gdansk, Poland; 2Neurology Department, Mayo Clinic, Jacksonville, Florida; and 3Institute of Medicine, Opole University, Opole, Poland

OBJECTIVE  Laminoplasty is a common treatment for cervical spondylotic myelopathy (CSM) and for ossification of the posterior longitudinal ligament (OPLL). However, approximately 21% of patients undergoing laminoplasty develop cervical kyphotic deformity (KD). Because of the high prevalence rate of KD, several studies have sought to identify predictors for this complication, but the findings remain highly inconsistent. Therefore, the authors performed a systematic review and meta-analysis to establish reliable preoperative predictors of KD.

METHODS  PubMed, Scopus, and Web of Science databases were used to systematically extract potential references. The first phase of screening required the studies to be written in the English language, involve patients treated for CSM and/or OPLL via laminoplasty, and report postoperative cervical KD. The second phase required the studies to provide more than 10 patients and include a control group. The mean difference (MD) and odds ratio (OR) were calculated for continuous and dichotomous parameters. Study quality was evaluated using the Newcastle-Ottawa Scale. CSM and OPLL patients were further assessed by performing subgroup analyses.

RESULTS  Thirteen studies comprising patients who developed cervical KD (n = 296) and no KD (n = 1254) after receiving cervical laminoplasty for CSM or OPLL were included in the meta-analysis. All studies were retrospective cohorts and were rated as high quality. In the combined univariate analysis of CSM and OPLL patients undergoing laminoplasty, statistically significant predictors for postoperative KD included age (MD 2.22, 95% CI 0.16–4.27, p = 0.03), preoperative BMI (MD 0.85, 95% CI 0.06–1.63, p = 0.04), preoperative C2–7 range of flexion (MD 10.42, 95% CI 4.24–16.59, p = 0.0009), preoperative C2–7 range of extension (MD −4.59, 95% CI −6.34 to −2.83, p < 0.00001), and preoperative center of gravity of the head to the C7 sagittal vertical axis (MD 26.83, 95% CI 9.13–44.52, p = 0.003). Additionally, among CSM patients, males were identified as having a greater risk for postoperative KD (OR 1.73, 95% CI 1.02–2.93, p = 0.04).

CONCLUSIONS  The findings from this study currently provide the largest and most reliable review on preoperative predictors for cervical KD after laminoplasty. Given that several of the included studies identified optimal cutoff points for the variables that are significantly associated with KD, further investigation into the development of a preoperative risk scoring system that can accurately predict KD in the clinical setting is encouraged.

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KEYWORDS  laminoplasty; cervical spondylotic myelopathy; ossification of the posterior longitudinal ligament; deformity

Keywords

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ion, preventing sufficient decompression. The result is a sagittal imbalance, chronic neck pain, and the potential for myelopathy to reoccur, which may require the patient to undergo an additional operation. In the early 1980s, laminoplasty was developed as an alternative to laminectomy to offer extensive spinal cord decompression and preserve motion and mechanical stability of the cervical spine. Because the procedure spares the posterior structures such as the covering of the ligamentum flavum and laminar bone, laminoplasty offers greater postoperative stability but with the cost of higher technical requirements and its own unique complications. However, KD still occurs in roughly 21% of patients who undergo the procedure, and therefore, identifying the preoperative variables that can predict this complication is of great interest.

Multiple single-center studies and a multicenter study have identified preoperative predictors for postoperative KD following laminoplasty, but the identified variables vary among studies in terms of which factors are significantly associated with KD. Typically, in the literature, patients with degenerative CSM and OPLL are not part of the same cohort, despite the large overlap in symptomatology. Multiple factors play a role in the etiology of CSM, but the process usually begins with degeneration of the cervical disc due to old age, with further collapse of the discal space. With weight becoming more unevenly distributed due to the degenerating disc, osteophytes naturally form, which can begin narrowing the spinal canal, leading to entrapment of the spinal cord. In contrast, OPLL results from abnormal endochondral ossification, but the exact etiology is not yet understood. It is important to note that not all patients with OPLL have symptoms of myelopathy when first diagnosed. Regardless of whether the patient is asymptomatic, surgical treatment is still commonly performed as the ossifying ligament has a history of resulting in myelopathy in the years after the initial diagnosis. Because of the overlap in symptomology between CSM and OPLL, some studies that have sought out predictors for the disorder have mixed the two groups in the same cohort or performed separate analyses for the two groups. Therefore, to eliminate the number of confounders in the search for reliable predictors of postoperative KD following cervical laminoplasty, we performed a meta-analysis and incorporated subgroup analyses for CSM and OPLL patients when possible. The findings from this study may be of great value for those seeking to develop a predictive model for the occurrence of KD in the clinical setting.

Methods

Search Strategy

The screening process was performed according to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). PubMed, Web of Science, and Scopus databases were used to retrieve studies from inception to December 22, 2021, without language limits. The following keywords were used in all three databases: (posterior_decompression_surgery OR laminoplasty OR open-door OR double-door OR french-door) AND (cervical_myelopathy OR cervical_spondylotic_myelopathy OR posterior_longitudinal_ligament) AND ((cervical_deformity) OR (kyphotic_deformity)). The search was performed independently by two authors (S.D.P and T.P.), and another author (G.M.) arbitrated any disagreements on inclusion or exclusion of the studies. This study protocol was registered through PROSPERO (registration no. CRD42022299795; https://www.crd.york.ac.uk/PROSPERO/).

Selection Criteria

The first phase of screening included assessing the article titles and abstracts for three requirements: written in the English language, involving patients treated for CSM and/or OPLL via laminoplasty, and reporting postoperative cervical KD. The studies that passed the first screening were reassessed in a second screening phase. The studies were required to provide extractable data. Any studies that involved fewer than 10 patients and/or lacked a control group of patients who did not experience postoperative KD were excluded.

Quality and Publication Bias Evaluation

The quality of each extractable study fulfilling the selection criteria was assessed using the modified Newcastle-Ottawa Scale. A maximum number of 2 points could be given within the comparability category, while in the remaining ones, a maximum of 1 point was allowed. A total score ≥ 7 indicated high quality, 6–4 moderate quality, and ≤ 3 low quality. The quality assessment was performed independently by two authors (S.D.P and T.P.), and in the case of any disagreements, the concerned study was discussed and a final decision on the quality rating was made by another author (G.M.). Publication bias among the included studies was assessed by visual inspection of funnel plot asymmetry.

Statistical Analysis

Dichotomized variables such as sex, alcohol use, etc., were pooled into an overriding odds ratio (OR) and 95% confidence interval (CI) to identify risk factors for postoperative KD. Continuous variables such as preoperative radiological parameters were analyzed by the mean difference (MD) with a 95% CI. If a study failed to provide standard deviations, the value was calculated using standard errors, CIs, t values, or p values that relate to the differences between means in two groups. When possible, patients with CSM and OPLL were subdivided into respective subgroups for each variable. Random-effects models were used and the heterogeneity of the overall OR and MD was calculated using the I² statistic. Publication bias was assessed by visual inspection of funnel plot asymmetry. A p value < 0.05 was considered statistically significant. All analyses were performed using Review Manager version 5.4 (Cochrane IMS).

Results

Search Results

A total of 842 unduplicated records were identified. Titles and abstracts were assessed for relevance and 776 records were removed. Of the remaining 66 records, 24 in-

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cluded patients undergoing treatment for conditions other than CSM or OPLL, 14 provided no comparison group of nondeformity patients, 9 included anterior approaches, 2 involved patients with myelopathy induced by tumors, 3 involved fewer than 10 patients, and 2 studies4,19 involved the same patients in their analysis, resulting in the exclusion of the older study19 (Fig. 1). A total of 13 studies were included in this meta-analysis (Table 1). All studies were retrospective cohorts and were of high quality (Supplementary Table 1).

### Publication Bias

The funnel plot revealed a slight asymmetrical distribution of the included studies in the graph between the MD and standard error (MD), indicating the presence of publication bias (Supplementary Fig. 1).

### Predictors for Cervical KD

A total of 21 extractable pre- and intraoperative variables reported in the literature were assessed (Figs. 2–7, Supplementary Figs. 2–16). Of these 21 variables, 3 demographic and 3 preoperative radiographic variables were identified as statistically significant predictors for postoperative KD. Among CSM patients only, males were identified as having a greater risk for postoperative KD (OR 1.73, 95% CI 1.02–2.93, p = 0.04; Fig. 2). In the analysis combining patients with CSM and those with OPLL, a greater BMI (MD 0.85, 95% CI 0.06–1.63, p = 0.04; Fig. 3) and a greater age (MD 2.22, 95% CI 0.16–4.27, p = 0.03; Fig. 4) were both associated with postoperative KD.

### TABLE 1. Characteristics of included studies

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Country</th>
<th>Mean Age ± SD (yrs)</th>
<th>KD Definition</th>
<th>Date of KD Diagnosis (mos)†</th>
<th>Controlled for pKA Pathology</th>
<th>No. of Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abe et al., 2022¹</td>
<td>Japan</td>
<td>72.3 ± 9.1</td>
<td>ΔSVA ≥ 0 mm</td>
<td>12</td>
<td>No CSM</td>
<td>63</td>
</tr>
<tr>
<td>Cao et al., 2017²</td>
<td>China</td>
<td>62.9 ± 10.2</td>
<td>pCA &lt; 0°</td>
<td>12</td>
<td>Yes CSM</td>
<td>21</td>
</tr>
<tr>
<td>Choi et al., 2018³</td>
<td>Korea</td>
<td>57.41 ± 10.25</td>
<td>pCA &lt; 0°</td>
<td>6</td>
<td>No CSM &amp; OPLL</td>
<td>19</td>
</tr>
<tr>
<td>Fujishiro et al., 2021⁴</td>
<td>Japan</td>
<td>68.3 ± 11.7</td>
<td>ΔCA ≤ −10°</td>
<td>18.2</td>
<td>Yes CSM</td>
<td>10</td>
</tr>
<tr>
<td>Jeon et al., 2021⁵*</td>
<td>Korea</td>
<td>58.65 ± 10.44</td>
<td>ΔCA ≤ 10°</td>
<td>12</td>
<td>No CSM</td>
<td>12</td>
</tr>
<tr>
<td>Matsuoka et al., 2018⁶</td>
<td>Japan</td>
<td>65.1 ± 10.0</td>
<td>pCA &lt; 0°</td>
<td>12</td>
<td>No OPLL</td>
<td>10</td>
</tr>
<tr>
<td>Lee et al., 2017⁷</td>
<td>Korea</td>
<td>NR</td>
<td>ΔCA &lt; −5°</td>
<td>12</td>
<td>No CSM &amp; OPLL</td>
<td>27</td>
</tr>
<tr>
<td>Lee et al., 2019⁸</td>
<td>Korea</td>
<td>60.70 ± 11.14</td>
<td>ΔCA &lt; −10°</td>
<td>12</td>
<td>Yes CSM &amp; OPLL</td>
<td>10</td>
</tr>
<tr>
<td>Matsuoka et al., 2018⁹</td>
<td>Japan</td>
<td>66.3 ± 10.3</td>
<td>pCA &lt; 0°</td>
<td>12</td>
<td>Yes CSM</td>
<td>13</td>
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<tr>
<td>Oe et al., 2021¹⁰</td>
<td>Japan</td>
<td>NR</td>
<td>pCA &lt; −10°</td>
<td>12</td>
<td>Yes CSM &amp; OPLL</td>
<td>27</td>
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<tr>
<td>Ono et al., 2021¹¹</td>
<td>Japan</td>
<td>70.9 ± 9.4</td>
<td>ΔCA ≤ −10°</td>
<td>12</td>
<td>No CSM &amp; OPLL</td>
<td>24</td>
</tr>
<tr>
<td>Sakai et al., 2016¹²</td>
<td>Japan</td>
<td>68.9 ± 9.2</td>
<td>pCA &lt; 0°</td>
<td>12</td>
<td>Yes CSM</td>
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<tr>
<td>Sakai et al., 2021¹³</td>
<td>Japan</td>
<td>65.9 ± 11.0</td>
<td>pCA &lt; 0°</td>
<td>12</td>
<td>Yes OPLL</td>
<td>6</td>
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<tr>
<td>Xu et al., 2020¹⁴</td>
<td>China</td>
<td>63.2 ± 13.6</td>
<td>ΔCA ≤ −5°</td>
<td>24</td>
<td>Yes OPLL</td>
<td>38</td>
</tr>
</tbody>
</table>

CA = Cobb angle from C2 to C7; ΔCA = change in CA from the final follow-up compared with the preoperative measurement; NR = not reported; pCA = preoperative Cobb angle; pKA = preoperative kyphotic alignment; pt = patient; ΔSVA = change in cervical SVA from C2 to C7 at the final follow-up compared with the preoperative measurement.

The level of quality was high in all studies, and all were retrospective cohorts.

* Study presented data on CSM and OPLL patients separately.

† This refers to how many months after laminoplasty that KD was diagnosed.
Preoperative C2–7 flexion range of motion (fROM; the difference between C2–7 angles in the flexion and neutral positions) in the KD group was significantly greater (MD 10.42, 95% CI 4.24–16.59, p = 0.0009; Fig. 5) when compared with the no-KD group. Using subgroup analyses to individually assess the CSM and OPLL patients was not possible due to the lack of studies.

Preoperative C2–7 extension ROM (eROM) was identified as a predictor for postoperative KD. In the analysis combining CSM and OPLL patients, the KD group had a significantly lower eROM (the difference between C2–7 angles in the neutral and extension positions; MD −4.59, 95% CI −6.34 to −2.83, p < 0.00001) when compared with the latter group (Fig. 6). When assessing patients with CSM only, eROM was also significantly lower (MD −5.16, 95% CI −8.09 to −2.23, p = 0.0006; Fig. 6). A subgroup analysis for preoperative C2–7 eROM could not be performed for the OPLL group.

In the analysis combining CSM and OPLL patients, the preoperative center of gravity of the head to the C7 sagittal vertical axis (CGH–C7 SVA; the interval between the plumb line of the anterior margin of the external auditory canal and the posterior-cranial corner of the C7 vertebral body) was significantly greater in the KD group (MD 26.83, 95% CI 10.34–43.32, p = 0.0006; Fig. 7). Among the patients with OPLL, the CGH–C7 SVA was also signifi-
siently greater (MD 22.66, 95% CI 0.65–44.67, p = 0.04; Fig. 7) in the KD group compared with the no-KD group. A subgroup analysis for CSM patients could not be performed.

Variables Lacking Association With Cervical KD

All pre- and intraoperative variables reported among the included studies were assessed for an association with postoperative KD. Among the 21 variables, the following 15 were not statistically significant: a patient diagnosed with CSM versus OPLL, a history of smoking, the duration of myelopathy before the operation, C2–7 Cobb angle, C2–7 SVA, C7 slope, T1 slope, T1–cervical lordosis (CL) slope, McGregor’s line, C2–7 range of motion (ROM), the preoperative Japanese Orthopaedic Association score, intraoperative blood loss, operation time, and the number of decompressed cervical vertebral levels (Supplementary Figs. 2–16).

FIG. 4. Forest plot with subgroup analysis showing the MD of age in years between patients with and without KD. Figure is available in color online only.

FIG. 5. Forest plot showing the MD of preoperative C2–7 ROM (in degrees) between patients with and without KD. Figure is available in color online only.

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Discussion

Decompression surgery is an effective treatment for both CSM and OPLL. The anterior approach, which involves a discectomy and anterior fusion, has its own various strengths and weaknesses when compared with the posterior approach. The association that one approach has over the other in terms of the risk of postoperative KD is currently unknown; therefore, patients who are identified as high risk for KD may be candidates for either anterior or posterior decompression. Several studies do exist that identify predictors for KD following posterior cervical decompression; thus, it is of great interest to pool the results from the available studies to provide the most reliable information on the topic.

The laminectomy was the first posterior decompressive technique for treating CSM and OPLL, and dates back to the 16th century. Despite its success in alleviating the compressed spinal cord, increasing reports of postoperative KD began to raise concerns about the procedure. In the 1980s, laminoplasty was introduced to improve upon the prior offering of extensive spinal cord decompression while preserving motion and mechanical stability of the cervical spine. However, KD continues to be reported in the literature among patients undergoing laminoplasty, with a prevalence rate of 21%. Therefore, it is of interest to identify the preoperative variables associated with this complication. Of the 13 included cohort studies, a total of 1550 patients were included in this analysis. To the best of our knowledge, this is the first systematic review and meta-analysis to identify predictors for KD following laminoplasty.

Patient Demographics

Demographic variables have been well assessed by the included studies and are shown to lack consistency in terms of having an association with postoperative KD following laminoplasty. Notably, no studies reported patient sex or BMI as having a significant association with KD, yet our pooled analysis reports the contrary. For patients with CSM, males were identified as having a significantly greater risk for KD development compared with females. This finding is interesting as the opposite would be ex-

FIG. 6. Forest plot with subgroup analysis showing the MD of preoperative C2–7 eROM (in degrees) between patients with and without KD. Figure is available in color online only.

FIG. 7. Forest plot with subgroup analysis showing the MD of preoperative CGH–C7 SVA (in millimeters) between patients with and without KD. Figure is available in color online only.
pected given that among the elderly, women are at greater risk for loss of CL due to their lower bone density and increased risk for cervical disc degeneration. We suspect that various factors are contributing to males having an increased risk for postoperative KD, and our finding warrants an investigation. An analysis of patient sex for only patients with OPLL was not possible given the small number of studies.

A significantly greater BMI was identified in the KD group when compared with the no-KD group. In general, it is known that patients with a higher BMI undergoing surgery are at a greater risk for complications, but similarly to patient sex, the exact association of BMI with the development of KD after laminoplasty is most likely multifactorial. Given that the subgroup analysis on CSM patients only was close to significant ($p = 0.07$), further research is required to confirm whether BMI has a significant association with postoperative KD among patients with CSM. An analysis of BMI in patients with only OPLL was not possible given the small number of studies. For now, preoperative BMI is a variable of interest regarding predictors for KD. Until additional studies assessing this variable among CSM and OPLL patients separately are available, our findings regarding BMI should be interpreted with caution.

Regarding patient age, only 1 study has identified this variable as a predictor for postoperative KD.$^{11}$ Our combined analysis of CSM and OPLL patients confirmed this association, which is unsurprising as it is known that the sagittal global balance of the adult spine worsens with increased age. Because of a decreasing lumbar lordosis with an increasing thoracic kyphosis with advancing age, greater work is required to maintain CL.$^{11}$ However, neither the individual CSM nor OPLL subgroup analysis yielded supporting results, likely due to the low numbers of studies available for the analysis. Therefore, it is not yet possible to confirm whether the statistical significance of age as a predictor for KD was contributed solely from the CSM group, or a combination of the two groups. We encourage future studies to continue to report this variable to improve on our results. With patient sex, age, and BMI identified as predictors for KD, we recommend that future studies also perform a multivariate analysis to confirm if the three variables are independently associated with KD. Furthermore, with the use of predictive modeling, identifying the optimal cutoff value of the exact age and BMI that can accurately predict postoperative KD has yet to be performed and is of great interest.

**C2–7 fROM**

Preoperative C2–7 fROM is a variable that has been assessed by only 2 studies,$^{4,10}$ both of which found it to have a significant association with postoperative KD. Our pooled analysis for CSM and OPLL patients combined confirmed that a significantly greater preoperative fROM among the KD group was identified when compared with the no-KD group. It is speculated that patients with limited preoperative fROM are more unlikely to develop KD due to the cervical flexion being hindered by degenerative structures such as vertebral osteophytes, intervertebral disc degeneration, and muscular-ligament contracture.$^{19}$ Conversely, these structural forces that hinder cervical flexion are weaker among patients who have a greater fROM. The result is believed to cause a greater dependence and burden on the posterior muscular-ligament complex (PMLC), which maintains CL. Surgical invasion of the PMLC during laminoplasty is thus thought to put these patients at a higher risk of developing postoperative KD.$^{4}$

Because it was not possible to perform subgroup analyses due to the lack of studies, it is critical that future studies assessing the fROM association with KD perform separate analyses on CSM and OPLL despite the common practice of combining the two groups. Furthermore, to apply the variable to clinical use, the optimal cutoff angle must be identified that can accurately predict whether a patient develops postoperative KD before surgery. One study has investigated this value. Fujishiro et al. in their study of CSM patients identified the optimal cutoff angle as 37° (85.7% sensitivity, 85.9% specificity).$^{19}$ Given the high accuracy of the optimal angle, we encourage future studies to continue to assess the optimal cutoff angle for fROM to confirm the replicability of the results from Fujishiro et al.

**C2–7 eROM**

Preoperative C2–7 eROM is a variable shown to have a strong association with postoperative KD among recent studies.$^{4,5,7,8,10}$ Our analysis on CSM and OPLL patients combined, as well as CSM-only patients, confirmed that the KD group had a significantly lower preoperative eROM when compared with the no-KD group. It is believed that a greater eROM is interrelated to a greater PMLC construction reservoir, and therefore patients with a lower eROM have less capacity to maintain cervical lordotic posture.$^{7}$ Although a lower eROM among patients with CSM was found to be significantly associated with KD following laminoplasty, the optimal cutoff angle must be identified. Only 1 study$^{7}$ has reported an angle using predictive modeling. Lee et al.$^{7}$ identified a cutoff point of 14° or less as the optimal threshold to predict the occurrence of KD in their sample of CSM and OPLL patients combined. That is, if a patient had an eROM greater than 14°, then no significant KD would occur. This cutoff angle had a sensitivity of 100% but a specificity of 52.4%. We encourage future studies to attempt to improve on these results by reducing the false-positive rate.

Because it was not possible to perform an analysis for OPLL patients in our meta-analysis, we encourage future studies involving OPLL patients to continue to report the eROM to confirm whether the variable may be used among OPLL patients to predict KD following laminoplasty. If this variable is found to be significant, further analysis should be conducted using predictive modeling as previously mentioned.

**CGH–C7 SVA**

The combined analysis of CSM and OPLL patients, as well as CSM patients only, reported CGH–C7 SVA as a predictor for postoperative KD (significantly greater among the KD group). All 3 studies that assessed the CGH–C7 SVA identified the variable as significantly associated with KD.$^{14,11}$ Of the 3 studies, two investigated the variable further by identifying the optimal cutoff point for predicting KD: 38.50 mm (81.6% sensitivity, 93.7%
specífico) en el estudio por Xu et al.13 y 42 mm (88.9% sensibilidad, 92.1% especificidad) en el estudio por Sakai et al.11 Xu et al. mencionaron que sus puntos de corte inferior, cuando se comparó con los resultados de Sakai et al., es más probable debido a que los pacientes seleccionados por Xu et al. estudiaron de forma estricta con un solo acceso laminoplastia, mientras que Sakai et al. utilizaron laminoplastia doble puerta. Ambos estudios involucraron OPLL pacientes y, al igual que Xu et al. creen que la laminoplastia con puerta doble introduce por Kurokawa, se abre asimétricamente al canal espinal en un lado y se apoya en el otro, creando un aislamiento de la parte más larga y la parte más corta. Puertas dobles y Puertas francesas (puertas dobles), ambas técnicas de laminoplastia pueden ser realizadas requiere discusión.

Tratamiento de pacientes con riesgo alto para KD

Aunque los predictores para KD después de la laminoplastia ha sido identificado, es importante discutir cómo el cirujano debe tratar a los pacientes identificados como de alto riesgo mientras proporciona cuidado óptimo. Como se mencionó anteriormente, la cirugía actualmente es el único método efectivo para tratar CSM y OPLL. Por lo tanto, se requiere discusión sobre cómo el cirujano debe tratar a los pacientes identificados como de alto riesgo mientras se proporciona el cuidado óptimo. Como se mencionó anteriormente, la cirugía actualmente es el único método efectivo para tratar CSM y OPLL. Por lo tanto, se requiere discusión sobre cómo el cirujano debe tratar a los pacientes identificados como de alto riesgo mientras se proporciona el cuidado óptimo. Como se mencionó anteriormente, la cirugía actualmente es el único método efectivo para tratar CSM y OPLL. Por lo tanto, se requiere discusión sobre cómo el cirujano debe tratar a los pacientes identificados como de alto riesgo mientras se proporciona el cuidado óptimo.

Limitaciones

Este meta-análisis contiene varias limitaciones. Primero, solo 8 de los 13 estudios controlaron para la presencia de KD preoperatorio (la presencia preoperatoria de KD). Por lo tanto, los hallazgos en los 5 estudios restantes tienen una menor calidad, que puede ser debido a la falta de inclusión de datos en los estudios anteriores. Además, el estudio de Cao et al. se basó en términos de cómo el KD se definía. A pesar de que la mayoría de los estudios consideraron a un paciente para KD basado en un corte de datos en el ángulo Cobb C2–7, el umbral de selección del ángulo Cobb fue un valor >5º o >–10º, que podría haber tenido un impacto en nuestros resultados. Trece de los 21 variables identificadas en este estudio para asociación con KD no fueron significativas. Sin embargo, es importante recordar que el uso de asociación no significa asociación causativa, aunque el cálculo debe ser interrumpido con cautela. Las variables identificadas que pueden ser las causas de la KD pueden requerir una mayor discusión en el futuro.

Conclusões

Este resumen sistemático y meta-análisis evaluó todos los factores pre y intraoperatorios reportados en la literatura por estudios que analizan los factores asociados con KD después de laminoplastia. Los pacientes con OPLL y CSM, y las variables preoperatorias que estuvieron significativamente asociadas con la postoperatoria KD, se identificaron. Cabe destacar que este resumen sistemático tiene varias limitaciones y que, aunque la correlación no indica causa efecto, debe ser considerado con cautela en el futuro. Los hallazgos de este estudio pueden requerir una mayor discusión en el futuro.

Referências

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Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Pettersson. Acquisition of data: Pettersson, Skrzypkowska. Analysis and interpretation of data: Miękisiak, Pettersson, Skrzypkowska, Ali, Szmuda, Počivavšek, Sunesson. Drafting the article: Pettersson, Ali. Critically revising the article: Miękisiak, Pettersson, Ali, Szmuda, Krakowiak. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Miękisiak. Statistical analysis: Miękisiak, Pettersson, Szmuda. Study supervision: Miękisiak, Ali, Szmuda, Krakowiak, Fercho.

Supplemental Information
Online-Only Content
Supplemental material is available with the online version of the article.

Correspondence
Grzegorz Miękisiak: Institute of Medicine, Opole University, Opole, Poland. gmiekisiak@gmail.com.