

# Anterior Cervical Corpectomy and the Operating Team: A Controversy?

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## Abstract

Cervical myelopathy is multifactorial disease that can lead to many dysfunctions. Surgical treatment is believed to be the best healing choice. The authors searched the published data on Medline on this subject and found a difference between the neurosurgeons and orthopaedics on the topic of anterior corpectomy for cervical myelopathy. The difference between the orthopaedics and neurosurgeons is not big, but it could be relevant to the final outcome, which appears to be better in the neurosurgeons. The complication rate is also variable between the groups, with lower rates of complication reported by the neurosurgeons. Therefore, despite the fact that the postoperative outcome depends on many factors, such as preoperative condition, additional comorbidities, age, and lifestyle, this article also finds that the surgical team, after comparing basic techniques that the team used for anterior cervical corpectomy (ACC), is also responsible to some extent. This, however, is not a competition, and future cooperation between the teams might be beneficial for all.

## Keywords

- ▶ cervical myelopathy
- ▶ improvement
- ▶ outcome
- ▶ surgery
- ▶ quality of life

## Introduction

Cervical myelopathy (CM) was first introduced to the scene of pathology of the cervical spine by Lees and Turner and by Clarke and Robinson.<sup>1</sup>

CM is indeed a progressive pathologic state based on reduction in the spinal canal followed by cord dysfunction and, in some cases, paralysis. It is linked to spinal cord compression or ischemia and degenerative changes. As a result, there is an injury to the spinal cord, of the vascular and nerve function. Because of that, those patients' quality of life is observed to decrease constantly without management.

Proper therapy and enhancement of the quality of life are believed to be achieved with surgery, and for this reason, the reviewers aspire to show that the operating team plays a role for the postoperative outcome of those patients.

## Methods

The researchers chose this subject because of the controversial interest that stems from it, as well as the lack of information. The topic, whether orthopaedics or neurosurgeons or both, have better results, and the percentage of complication

of each team after corpectomy for CM triggered the initiative to search the published data on Medline. For the analysis, the authors collected published studies between 1991 and 2017 with Mesh terms “cervical myelopathy,” “neurosurgeons,” “orthopaedics,” “corpectomy,” and “anterior spine surgery.” The studies encompass all kinds of age categories, including elderly patients and patients with comorbidities (diabetes, cardiac problems, etc.) and single or/and multilevel CM.

Inclusion criteria for the study were articles on humans; articles written in English; articles providing information on the technique of the corpectomy and, if there are complications, the publishing team to be only from one kind of department—neurosurgery or orthopaedics—and finally articles with improvement rate based on Japanese Orthopedic Association (JOA) score. After the search, the authors included 47 articles with the aforementioned criteria (23 neurosurgeons and 24 orthopaedics) (▶ **Tables 1, 2**, ▶ **Fig. 1**).

On the other hand, the reviewers excluded letters to editor; comments; case reports; animal trials; articles without abstracts; multicenter studies; most of the reviews and meta-analyses; articles in other than English language; articles that do not show the complications, and/or the

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**Table 1** List of studies reported by neurosurgeons

Team	No. of patients	Technique	Improvement rate (%)
Za'iri et al <sup>12</sup>	26	Titanium cage, plate, bone graft from the corpectomy; ACCF	100
Acosta et al <sup>13</sup>	20	ACCF; cage, plate, corpectomy graft, or allograft	83
Shaker et al <sup>14</sup>	26	Oblique corpectomy	76.9
Koc et al <sup>15</sup>	44	ACCF; iliac graft and plate	88.6
Thakar et al <sup>19</sup>	67	Central corpectomy; plate and iliac graft	88.05
Lee et al <sup>20</sup>	22	Oblique	70.81
Chibbaro et al <sup>21</sup>	70	ACCF; iliac graft, plate, and cage	94.2
Costa et al <sup>23</sup>	34	ACCF; iliac graft and plate	73.3
Rochhi et al <sup>24</sup>	48	Oblique corpectomy	85.42
Turel et al <sup>25</sup>	28	Oblique corpectomy	97.37
Chang et al <sup>26</sup>	15	ACCF; cage and plate	100
Lau et al <sup>31</sup>	60	ACCF; cage, plate, and graft from the corpectomy	95
Ozer et al <sup>32</sup>	11	Open-window corpectomy; iliac or allograft	100
Duzkalir et al <sup>36</sup>	60	Central corpectomy; fibular and iliac graft	100
Epstein <sup>37</sup>	48	ACCF; iliac graft or allograft and plate	89
Epstein and Silvergleide <sup>38</sup>	46	ACCF; plate and iliac graft	83
Ernestus et al <sup>39</sup>	46	Central corpectomy; iliac or corpectomy graft, cage, implants, and plate	93
Perrini et al <sup>41</sup>	42	ACCF; cage, plate, iliac and corpectomy graft	100
Gupta and Rajshekhar <sup>43</sup>	33	Central corpectomy; fibula graft	90
Kristof et al <sup>50</sup>	42	ACCF; iliac graft and plate	79
Kotil and Tari <sup>53</sup>	25	ACCF; iliac graft and plate	69
Kumar et al <sup>54</sup>	410	Central corpectomy; iliac or fibula graft	98
Rajshekhar et al <sup>56</sup>	60	Central corpectomy; cage, plate, and iliac of fibula graft	100

Abbreviation: ACCF, anterior cervical corpectomy with fusion.

improvement and/or the operative technique; articles from more than one kind of departments or not sufficient operating team, publishing the article; and articles that report improvement based on other than JOA score system. Finally, the authors blindly excluded articles that were last in the row on Medline, to compare approximately the same numbers of studies, because of the insufficient number of papers from the neurosurgeons (not enough articles that meet the inclusion criteria).

Thereafter, the authors analyzed the data with F-test and t-test on Excel.

### Surgical Management and Outcome

Treatment of CM is generally divided into operative and nonoperative.<sup>1,2</sup> Operative treatment is being considered in presence of symptomatic cord dysfunction or pain and earlier operation in case of rapid neurologic deterioration.<sup>1</sup> Studies show that most patients following surgical treatment have an improvement of their functionality.<sup>3</sup> There are plenty of surgical options, including anterior and posterior approaches with or without fusion.<sup>4</sup>

The most common posterior technique is laminectomy (LAMT), performed with or without fusion.<sup>4</sup> Laminoplasty (LAMP), on the other hand, is a posterior approach used to

prevent complications with the disadvantage of axial symptoms after surgery.<sup>4,5</sup>

On the other hand, anterior approach (corpectomy or discectomy) is thought to have less complications, compared with the posterior approach, and the advantage of straight excision of the pathology, better fusion and reconstruction of deformities, relief of the spinal artery, and neck-pain restoration.<sup>6,7</sup> Rates of improvement and fusion are the same between corpectomy and discectomy, except the level of complications,<sup>8,9</sup> whereas other studies report that corpectomy has better general recovery rate than others.<sup>10</sup> Because of this controversy, the authors chose to analyze the cervical corpectomy.

### Corpectomy Technique and Rate of Improvement

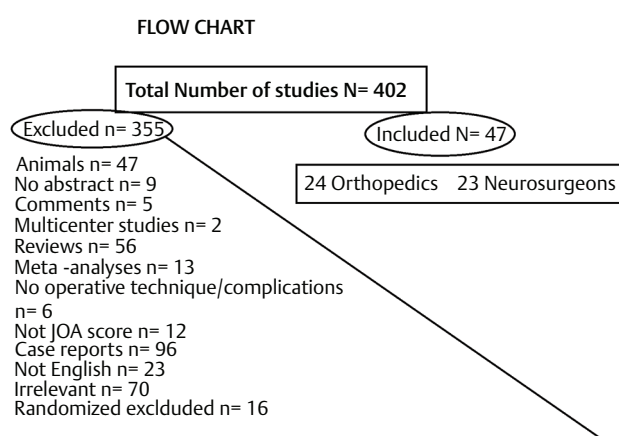
Regarding the improving rate, the worldwide guidelines<sup>11</sup> report that these techniques have similar outcomes. The authors of this study, however, investigating the surgical group for corpectomy suggest that the outcome is highly dependable on the operating team, while the number of patients do not play a major role to the outcome.

Concluding from the reviewed studies, the outcome for CM after surgery is quite promising. The general improving

**Table 2** List of studies reported by orthopaedic surgeons

Study	No. of patients	Technique	Improvement rate (%)
Shaker et al <sup>14</sup>	8	ACCF; fibula graft and plate	100
Aramomi et al <sup>17</sup>	9	Anterior pedicle; fibula graft, plate	82.79
Shibuya et al <sup>18</sup>		Subtotal corpectomy; iliac graft	55.5
Ying et al <sup>62</sup>	178	Corpectomy with preserved vertebral wall; cage, plate, and iliac graft	76.49
Lin et al <sup>22</sup>	63	ACCF or skip-level corpectomy; cage and plate	93.23
Gao et al <sup>27</sup>	145	ACCF; cage, plate, iliac or corpectomy graft	62.5
Huang et al <sup>28</sup>	19	ACCF; allograft or corpectomy graft, plate	71.4
Yang et al <sup>29</sup>	67	ACCF; cage, plate, corpectomy graft	85.64
Liu et al <sup>30</sup>	24	Subtotal corpectomy; iliac graft and plate	67.09
Yan et al <sup>33</sup>	75	ACCF; cage, plate, and corpectomy graft	82.05
Williams et al <sup>10</sup>	24	ACCF; plate, iliac graft	62.35
Fengbin et al <sup>34</sup>	58	ACCF; cage, plate, and corpectomy graft	58
Mao et al <sup>35</sup>	42	ACCF; cage, plate, and corpectomy graft	86.96
Niu et al <sup>40</sup>	23	Key hole; allograft or corpectomy graft	83
Li et al <sup>42</sup>	39	Segmental ACCF; cage, corpectomy graft, and plate	88.16
Gupta and Rajshekhar <sup>43</sup>	15	ACCF; cage, implants, plate, corpectomy graft	81.82
Li et al <sup>45</sup>	39	Segmental ACCF; iliac graft, cage, and plate	87.1
Liu et al <sup>46</sup>	28	Hybrid; implant, cage, plate, and corpectomy graft	55.83
Tateiwa et al <sup>47</sup>	27	Subtotal corpectomy; fibula graft	62
Zhang et al <sup>48</sup>	117	ACCF; cage, corpectomy graft	90
Wada et al <sup>49</sup>	23	Subtotal corpectomy; iliac or fibula graft	82.41
Kimura et al <sup>51</sup>	16	ACCF; iliac or fibula graft and plate	78.95
Odate et al <sup>52</sup>	42	Hybrid; plate and fibula graft	53.8
Lu et al <sup>55</sup>	51	ACCF; cage, plate, and corpectomy graft	69.7

Abbreviation: ACCF, anterior cervical corpectomy with fusion.



**Fig. 1** Flowchart. JOA, Japanese Orthopedic Association.

rate is mainly more than 50% with good fusion rate and improvement of the quality, results comparable to those by the Congress of Neurological Surgeons.<sup>11</sup> However, it should be taken into consideration the fact that neurosurgeons have better rate of improvement than the orthopaedics (all of the rates are calculated on the principle: Sum of improving rates/

Number of studies). As it could be seen in ►Table 3–5,<sup>12–56</sup> the average rate of improvement after corpectomy of the neurosurgeons is 89.56% whereas the same rate for the orthopaedics is 75.95%.

Further analyzation of the techniques shows that orthopaedics use only fusion for the corpectomy with or without instrumentation, whereas some of the neurosurgeons do not. The improving rate after fusion is 89.70% for the neurosurgeons and 75.95% for the orthopaedics. Furthermore, the F-test and *t*-test, as it could be seen in ►Tables 4 and 5, support that the fusion rate of the orthopaedics and neurosurgeons is not equal. The authors performed these tests for the four categories—corpectomy with fusion, fusion with graft only, with cage and plate, and with plate only—and all these showed that these categories are not equal. The fusion is further analyzed, based on the used graft, as is shown in ►Table 6 that shows that fibula autograft fusion has better results in orthopaedics whereas every other autograft or allograft has better results in neurosurgeons.

Finally, as the authors analyzed the technique used for the anterior approach, it seems that the most common technique—anterior cervical corpectomy with fusion

**Table 3** Improving rate in orthopaedics and neurosurgery<sup>12-56</sup>

Criteria	Neurosurgeon Mean value of improvement	Orthopaedics Mean value of improvement
Average improving rate based on JOA score	89.56%	75.95%
Corpectomy with fusion	N <sup>a</sup> = 20 (89.7%)	N = 24 (75.95%)
Corpectomy without fusion	N = 3 (86.56%)	N = 0
Fusion with cage (and plate)	N = 8 (95.65%)	N = 13 (78.74%)
Fusion with plate only	N = 7 (81.42%)	N = 7 (75.08%)
Fusion with screw only	N = 2 (85.41%)	N = 0
Fusion without graft	N = 1 (100%)	N = 0
Fusion with graft only	N = 3 (96%)	N = 4 (70.73%)

Abbreviation: JOA, Japanese Orthopedic Association.

<sup>a</sup>N, number of studies.

Note: Mean value of improvement = Sum of the improving rates reported by every study based on JOA score/Number of studies.

**Table 4** F-test of corpectomy with fusion

F-test: Two-sample for variances		
	Corpectomy with fusion	Corpectomy with fusion
Mean	89,698	75,94875
Variance	106,7223	187,8816
Observations	20	24
df	19	23
F	0,56803	
P (F≤f) one-tail	0,10721	
F critical one-tail	0,470973	

**Table 5** t-test of corpectomy with fusion

t-test: Two-sample assuming unequal variances		
	Corpectomy with fusion	Corpectomy with fusion
Mean	89,698	75,94875
Variance	106,7223	187,8815592
Observations	20	24
Hypothesized mean difference	0	
df	42	
t stat	3,789453	
P (T≤t) one-tail	0,000238	
t critical one-tail	1,681952	
P (T≤t) two-tail	0,000476	
t critical two-tail	2,018082	

(ACCF)—has better improving rate in the neurosurgical group rather than in orthopaedics. ACCF actually means a total incision of the pathology that requires fusion (graft or cage) for spinal stabilization.<sup>57</sup> Oblique corpectomy, on the other hand, is a technique that does not require grafting

**Table 6** Graft techniques and improving rate<sup>12-56,62</sup>

Fusion with graft technique	Improving rate in neurosurgery (Mean value of improvement, %)	Improving rate in orthopaedics (Mean value of improvement, %)
Iliac autograft only	N = 7 (82.16%)	N = 5 (69.71%)
Fibula autograft only	N = 1 (90%)	N = 2 (91.4%)
Local bone graft or iliac autograft	N = 1 (93%)	N = 0
Local bone graft only	N = 2 (97.5%)	N = 9 (78.2%)
Fibula or iliac autograft	N = 3 (99.33%)	N = 2 (80.68%)
Allograft or other graft	N = 3 (90.67%)	N = 2 (77.2%)
Implants	N = 1 (93%)	N = 2 (68.83%)

Abbreviation: N, number of studies.

Note: Mean value of improvement = Sum of the reported improvements/Number of studies.

but also could not treat bilateral symptomatology.<sup>58</sup> Central corpectomy is used mainly for ossification of the posterior longitudinal ligament (PLL) and could be accompanied by graft.<sup>54</sup> As it can be observed in ►Table 7, oblique corpectomy and central corpectomy are techniques adopted by neurosurgeons.

Subtotal corpectomy, as it could be seen, is adopted by the orthopaedic team and represents a partial removal of the vertebral body with fusion.

In the unusual techniques are encompassed hybrid techniques of discectomy and corpectomy, open-window corpectomy, “key hole” technique, and anterior pedicle screw.

All these techniques could be performed with or without a microscope. From the orthopaedic articles, no one reported the use of microscope for the anterior corpectomy, whereas plenty of the neurosurgical articles reported the use of microscope for the operation.

**Table 7** Operative technique and improving rate<sup>12–56,62</sup>

Operative technique	Improving rate in neurosurgeons (Mean value, %)	Improving rate in orthopaedics (Mean value, %)
Oblique corpectomy	82.63%	–
Subtotal corpectomy	–	66.75%
Central corpectomy	94.84%	–
Anterior cervical corpectomy with fusion (ACCF)	87.84%	77.95%
Segmental ACCF	–	87.63%
Unusual techniques	100%	74.19%

### Complications

Despite the fact that surgical treatment is prescribed to patients who fulfill the inclusion criteria, many of the patients experience complications. The rate of complication is variable, depending on the patients' characteristics, such as age and other conditions; the surgical technique; and the preexisting condition, and as it stems from this study, it also depends on the surgical team.

Many clinical studies show their complication rates. Saunders et al<sup>59</sup> report complication rate of 47.5% after corpectomy. For the same approach, Lian et al<sup>60</sup> show rate of complication rate equal to 16.19% and Perrini et al<sup>41</sup> equal to 15%. Liu et al<sup>30</sup> show complication rate of 18.2%. The report of the complications, however, does not necessarily mean that every surgical technique is accompanied with problems. Thakar et al<sup>19</sup> and Chibbaro et al,<sup>21</sup> for instance, do not report complications after surgery. In this study, four articles from the orthopaedics and five from the neurosurgical team reported “no complications.”

Other authors,<sup>61</sup> after detailed research, report the prevalence of every complication, based on the technique.

Until now, however, no article on Medline reports the complication rate, based on the surgical team. The authors of this study searched every kind of complication separately from the general complication rate and found that the incidence of complications is higher in orthopaedics (Sum of complication rates/Number of studies) (► **Table 8**). A few kinds of complications, however, are more frequent in neurosurgeons.

Complications with higher prevalence of neurosurgeons, reported in a single study from one patient, include bleeding (4.35%), mortality (4.17%), adjacent segment disease (6.3%), hoarseness (7.1%), muscle weakness (3.85%), and kyphosis (3.8%). Most of those kinds of complications are reported in multiple studies by orthopaedic teams, but the mean number is lower than the number in neurosurgeons. Complications with higher prevalence of the neurosurgeons, reported in more than one studies and compared with the orthopaedics, include graft fracture (6.85% neurosurgery, 5.73% orthopaedics), radiculopathy (6.19% neurosurgery, 3.64% orthopaedics), screw back-out (17.79% neurosurgery, 7.32% orthopaedics), and Horner's syndrome (29.93% neurosurgery, 0% orthopaedics, reported by two studies).

Postoperative problems with equivalent mean score include reoperation (7.16% orthopaedics and 7.68% neurosurgeons) and pain (7.7% orthopaedics and 7.7% neurosurgeons).

**Table 8** Complications after corpectomy<sup>12–56,62</sup>

Kind of complication	Neurosurgery (%)	Orthopaedics (%)
Dysphagia	9.19	17.28
Screw loosening		35.5
Enterotropic ossification <sup>a</sup>		10.53
Infection	6.23	7.91
Bone graft displacement/migration	4.75	7.05
Delirium <sup>a</sup>		1.96
Pulmonary embolism	4.35	7.1
CSF leak	2.99	6.02
Pseudoarthrosis	7.92	18.89
Screw extrusion <sup>a</sup>		3.33
Esophagus fistula <sup>a</sup>		4.35
Laryngeal nerve palsy	1.49	4.17
Dural tear <sup>a</sup>		7.14
Hematoma		2.38
Hardware failure		12.5
Respiratory failure		13.57
C5 palsy	7.9	8.42

Abbreviation: CSF, cerebrospinal fluid.

<sup>a</sup>Reported in single study.

Every other kind of postoperative complication is more frequent among orthopaedics (► **Table 8**). Some of the complications are reported by single studies, but the majority represents an average number.

Concluding to this, orthopaedics have less improvement rate and higher values of the postoperative complications, whereas neurosurgeons report lower rates of complications and better improvement rate, a fact that should end the controversy. The general frequency of every kind of complication, however, is comparable to the one, reported by Wang et al.<sup>61</sup>

### Discussion

The progress of CM differs among patients. In some cases it follows step-wise way; in other there is an improvement or stabilization and worsening after years. Many studies have

been made to evaluate the outcome and the postoperative improvement in the patients with CM. More of them suggest a quite better outcome, but the data collected from different studies and trials would be never sufficient to establish a constant result for the postoperative quality of the patients with CM.<sup>62</sup> In general, it is believed that the degree of improvement after surgery and the level of functionality depend on the severity of the disease and the time of the surgery and much from the neurological recovery.<sup>1,63</sup> Decompression procedure results in stabilization or improvement in long-tract spinal cord function.<sup>63</sup> As expected, the function is better in patients who have good reinstatement of spinal canal dimensions, those without substantial comorbidity, and those who have earlier decompression surgery. For this reason, the authors have come to the conclusion that for the outcome, an important role is played by the surgeon, who performed the procedure.

Recent study by Witiw et al<sup>64</sup> states that patients' health is generally improved by surgical therapy for CM. The advantages of the anterior approach, however, are thought to be the better improving rate, the more direct approach to the pathology, better stabilization, and better clinical results.<sup>65</sup> Corpectomy is believed furthermore to be prevalent in those findings. Patient's recovery rate after anterior corpectomy with or without fusion is reported in every study and seems to be very promising. However, when comparing the both surgical teams, there is an estimated difference of the recovery rate's outcomes. Both are more than 50%, but neurosurgeons seem to be dominant, which could be explained by comparing the training program of both specialties and the used techniques.

In many of the studies are added factors that accompany the improvement of the patients. Arnold et al<sup>66</sup> reported that the studied patients improved after surgery, but the outcome is linked to the tobacco use and smokers have lower result compared with nonsmokers. According to studies by Cheng et al<sup>63</sup> and Rao et al,<sup>67</sup> the postoperative recovery is highly dependable on the age, health status, pathology, and the mode of the surgery. Rao et al pointed the age-related fallout with the myelinated fibers and motor neurons of the spinal cord, and it has been proposed that earlier surgery can improve the neurologic recovery much better. Machino et al<sup>68</sup> showed through the recovery rate the values of the postoperative JOA compared with the pre-JOA score, indicating that the recovery depends strongly on the age group, but the score in general do not differ much among groups.

On the other hand, researches by Fehling<sup>69</sup> and Liu<sup>70</sup> suggest general improvement in the functional quality of life and status result after surgery no matter the severity of the disease at first as well as the underlying factors. The only "must" that was mentioned, was the appropriate surgical approach. For this reason, it is important the operation be performed by qualified surgeons. This study shows that neurosurgeons have prevalence regarding the improvement rate after corpectomy, except of the cases of fibula graft. This could be explained better by the fact that the routine of the general orthopaedic team is wider (whole skeletomuscular system), whereas the routine of the general neurosurgeons is more limited. Last but not least, the general complication

rate of the orthopaedics in this study is higher than the same rate of the neurosurgeons. However, once again because of the everyday practice routine, the complications regarding grafting are lower in the orthopaedic team, whereas the complications from fine structures are lower in neurosurgeons. For this reason, the reviewers believe that the outcome of the CM is, to some extent, dependable on the operating team. The authors believe that future improvement of this subject could be achieved with the cooperation of the both sites, as it is organized in many medical centers worldwide.

## Conclusion

CM is multifactor disease resulting in nerve, cord, and vascular dysfunction. Operative treatment of this condition can seriously improve the patient's condition. Not only does it enhance the neurologic function, but it also relieves the pain that the patient experiences. Concluding from different studies and researches, surgical treatment of CM cannot only restrict further worsening of the condition for a certain period, but it also can improve patients' quality of life. For this reason, the surgical team, who would perform the surgery, is very important

### Conflict of Interest

None.

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