



# The role of cervical collar in functional restoration and fusion after anterior cervical discectomy and fusion without plating on single or double levels: a systematic review and meta-analysis

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## Abstract

**Purpose** Even though the anterior cervical discectomy and fusion (ACDF) is one of the most common spinal procedures, a consensus on the real need for prescribing a cervical collar (CC) after surgery is still missing. In fact, the role of external immobilization in decreasing non-fusion rate and implants displacement has not been clarified yet.

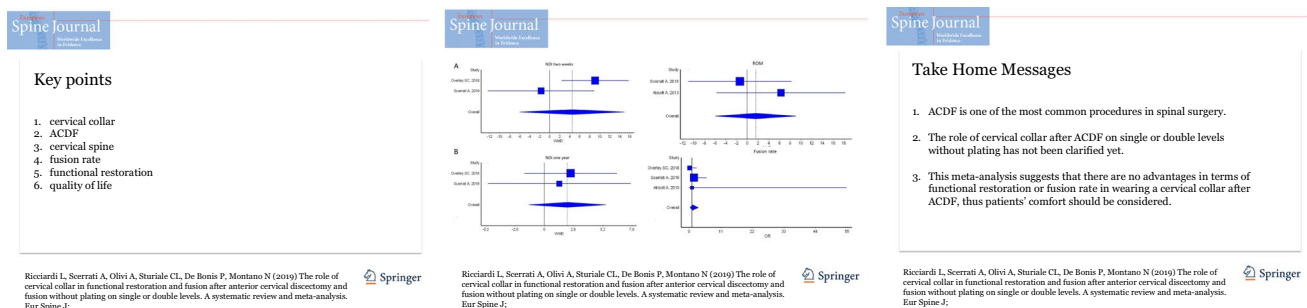
**Methods** This study was conducted according to the PRISMA statement. Six different online medical databases were screened. Papers reporting the neck disability index (NDI), cervical range of motion (RoM) and fusion rate after ACDF without plating, on single or multiple levels, for cervical spondylosis were considered for eligibility.

**Results** There were no significant differences in terms of NDI scores at 2 weeks (WMD=4.502; 95% CI −5.953, 14.957;  $p=0.399$ ;  $I^2=65.14\%$ ;  $p=0.090$ ) and 1-year (WMD=2.052; 95% CI −1.386, 5.490  $p=0.242$ ;  $I^2=0\%$ ;  $p=0.793$ ), RoM reduction at 1-year (WMD=1.597; 95% CI −5.886, 9.079;  $p=0.676$ ;  $I^2=0\%$ ;  $p=0.326$ ) or fusion rate (OR=1.127; 95% CI 0.387, 3.282;  $p=0.827$ ;  $I^2=2.166\%$ ;  $p=0.360$ ).

**Conclusions** The use of a CC after ACDF without plating on single or double levels for cervical spondylosis seems not supported by scientific evidence.

## Graphic abstract

These slides can be retrieved under Electronic Supplementary Material.



**Keywords** Cervical spine · Collar · Cervical spondylosis · ACDF · Functional outcome

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## Introduction

Cervical spondylosis and its related conditions, such as myelopathy, radiculopathies, neck pain and limited cervical range of motion, represent a severe burden in high-income countries [1–5].

Surgery is still considered the gold standard in those patients who are non-responders to conservative treatments or reporting severe myelopathy [6]. Although different surgical options have been reported, the anterior cervical discectomy and fusion (ACDF) on single or multiple levels has demonstrated many advantages compared to posterior approaches [5].

Even though the ACDF is one of the most common spinal procedures, a consensus on the real need for prescribing a cervical collar (CC) after surgery is still missing [7–9]. In fact, the role of external immobilization in decreasing non-fusion rate and implant displacement has not been clarified yet [7, 10]. Since these patients are postoperatively managed by different specialists, such as spinal surgeons, physiotherapists and family doctors, evidence-based indications would be tremendously helpful to a wide audience.

The present systematic review and meta-analysis aimed to investigate any existing difference, in terms of clinical and radiological outcomes, when wearing or not a CC after single- or double-level ACDF without plating.

## Materials and methods

### Study design

This study was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement [11].

### Review questions

The review question was formulated according to the PICO (P: patients; I: intervention; C: comparison; O: outcomes) scheme:

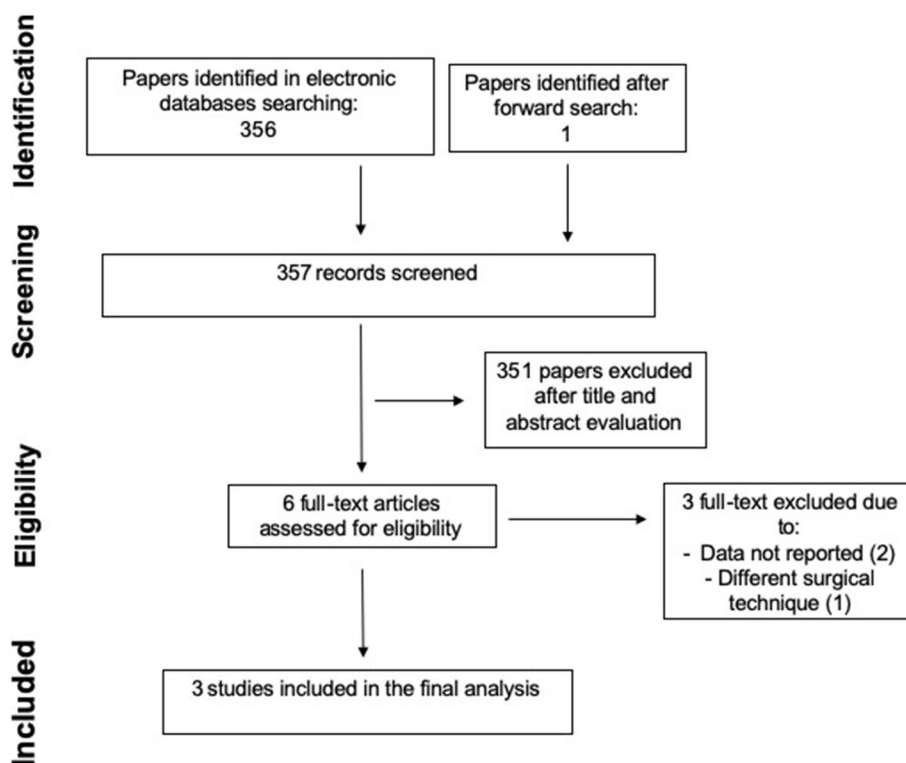
Do patients suffering from cervical spondylosis-mediated myelopathy or radiculopathies and who underwent to ACDF on single or double levels without plating (P) report better clinical or radiological outcomes (C), in terms of neck disability, cervical range of motion and fusion rate (O), when wearing or not a cervical collar (I) after surgery?

### Inclusion criteria and outcome measurement

Five medical online databases (Cochrane Library, Mendeley, PubMed, Science Direct and Scopus) were screened for studies in English language, using as search terms “anterior cervical discectomy and fusion,” “orthoses,” “orthosis,” “collar,” “immobilization,” “brace” [MeSH], combined with Boolean operators.

Comparative studies with a minimum follow-up of 1 year, focused on wearing or not a CC after ACDF for cervical spondylosis, on single or double levels without plating, reporting the neck disability index (NDI), the cervical range of motion (RoM) and the fusion rate were considered eligible for inclusion. Quantitative data unavailability or incompletely reported, different diagnosis or surgical techniques and implants with self-locking systems were considered as exclusion criteria. Titles and abstracts were screened at the

Fig. 1 Search strategy



**Table 1** Included studies and data for meta-analysis

References	Groups	Pt	Sex M/F	Age (DS)	BMI (DS)	Oper- ated levels	NDI-pre (DS)	2 weeks	1 year	RoM reduction at 1 year <sup>a</sup>	Fused levels	Follow-up
Overley et al. [9]	Collar	22	12/10	55.21 (11.72)	26.98 (4.80)	38	25.85 (10.50)	26.23 (11.05)	9.30 (6.86)		34/38	1-year
	No-collar	22	12/10	50.15 (9.79)	27.56 (6.33)	32	22.14 (9.25)	17.14 (11.52)	6.95 (7.00)		31/32	
Scerrati et al. [7]	Collar	36	17/19	50.89 (10.36)	29.92 (6.05)	56		18.6 (25.8)	8.7 (15.8)	79.1 (22.66)	31/36	1-year
	No-collar	36	18/18	48.6 (11.14)	25.49 (3.47)	52		20.3 (19.45)	7.36 (11.2)	80.5 (18.7)	28/36	
Abbott et al. [8]	Collar	17	9/8	53.4 (13)		24	31.12 (9.9)		N/E	46.47 (15.32)	24/24	2-years
	No-collar	16	11/5	47.3 (11)		23	33.31 (6.2)		N/E	40.19 (19.41)	23/23	

Values are reported as mean (SD)

<sup>a</sup>Cervical range of motion, measured as flexion–extension in degrees, reported the percentage reduction % (SD) at 1 year compared to preoperative values

first search round, and then, full texts and their references lists (forward search) were evaluated for inclusion.

Two different authors (L.R. and A.S.) were blinded to each other in conducting the systematic review. Any discordance was solved by consensus with a third senior author (N.M.).

In case of inclusion, when part of the data was not suitable for meta-analysis, we tried to contact the corresponding author by e-mail.

## Statistical analysis

Statistical analyses were performed using OpenMeta[Analyst] (Brown University, Providence, Rhode Island, USA) and MetaXL (EpiGear International Pty Ltd.) using the random effect model. Heterogeneity was tested using the  $\chi^2$  test and quantified by calculating the  $I^2$  statistic, in which  $p < 0.05$  and  $I^2 > 50\%$  were considered statistically significant. For the pooled effects, weighted mean difference (WMD) was calculated for continuous variables according to the consistency of measurement units, and odds ratio (OR) was calculated for dichotomous variables. Continuous variables are presented as mean differences and 95% confidence intervals (CI), whereas dichotomous variables are presented as ORs and 95% CI.

## Results

### Systematic review

A total of 356 articles were identified and reviewed (Fig. 1). After duplicate removal, eligibility assessment, inclusion and exclusions with reasons, three studies were finally included in the present investigation [7–9] (Table 1).

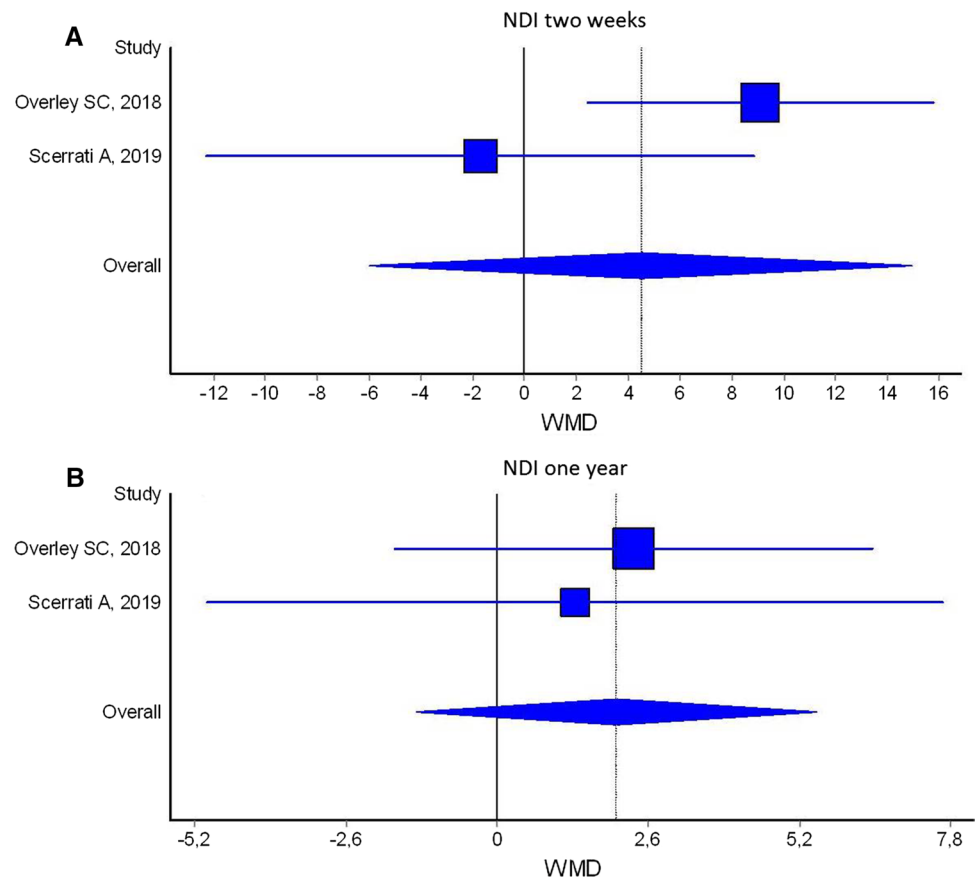
### Neck disability index

This score was analyzed in 58 patients in the collar group and 58 patients in the no-collar group. No significant differences were found comparing the preoperative values ( $p > 0.05$ ).

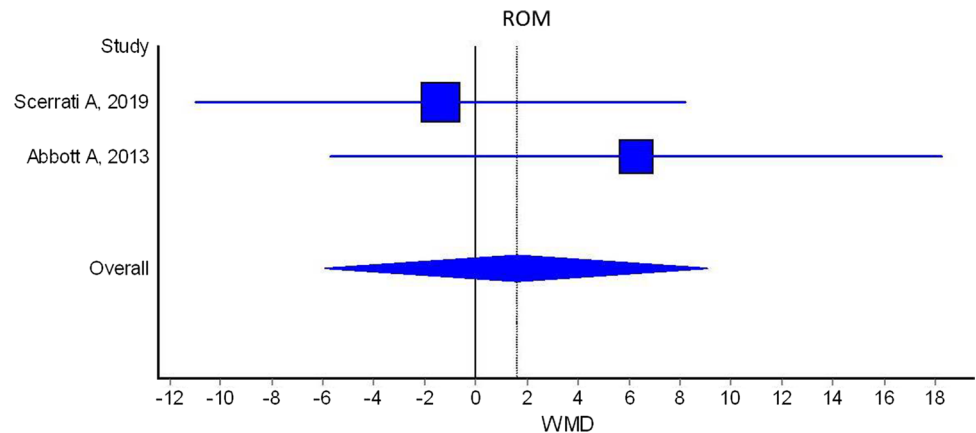
The mean NDI score at 2 weeks was  $22.41 \pm 5.39$  in the collar group and  $18.72 \pm 2.23$  in the no-collar group, and this difference was not statistically significant (WMD = 4.502; 95% CI – 5.953, 14.957;  $p = 0.399$ ; Fig. 2a) ( $I^2 = 65.14\%$ ;  $p = 0.090$ ).

The mean NDI score at 1 year was  $9.0 \pm 0.42$  in the collar group and  $7.15 \pm 0.29$  in the no-collar group. This difference was not significant (WMD = 2.052; 95% CI – 1.386, 5.490  $p = 0.242$ ; Fig. 2b) ( $I^2 = 0\%$ ;  $p = 0.793$ ).

**Fig. 2** Forest plots for NDI at 2 weeks and 1 year



**Fig. 3** Forest plot for RoM



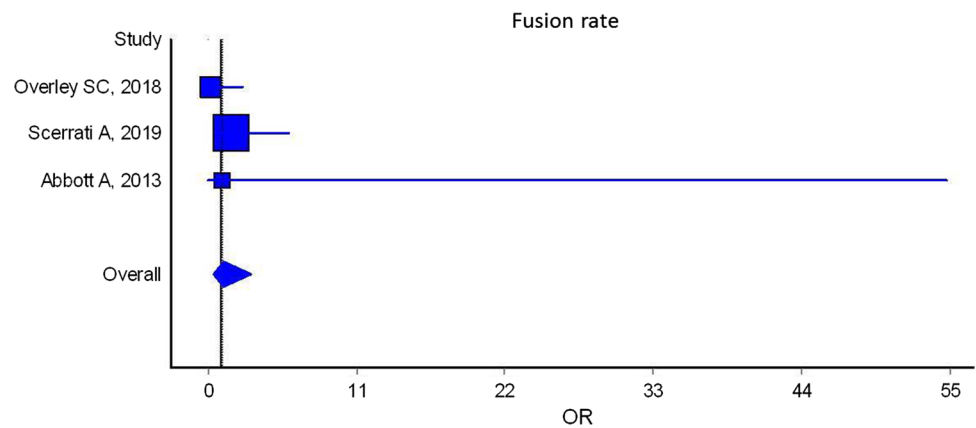
### Cervical range of motion

The cervical RoM was reported as the percentage difference between preoperative and 1-year follow-up values, on 53 patients who wore a CC and 52 patients non-immobilized.

The mean residual RoM was  $62.78 \pm 23.07\%$  in the collar group and  $60.34 \pm 28.50\%$  in the no-collar group. This difference was not statistically significant (WMD = 1.597; 95% CI - 5.886, 9.079;  $p = 0.676$ ; Fig. 3) ( $I^2 = 0\%$ ;  $p = 0.326$ ).

### Fusion rate

The rate of fusion at 1-year follow-up was 90.81% (89/98 operated levels) in those who wear a CC and 90.10% (82/91 operated levels) in those who did not, showing any statistically significant difference (OR = 1.127; 95% CI 0.387, 3.282;  $p = 0.827$ ; Fig. 4) ( $I^2 = 2.166\%$ ;  $p = 0.360$ ). Either the presence of bridging trabecular bone or the lack of qualitative motion on flexion/extension radiographs was used as

**Fig. 4** Forest plot for fusion rate

pathognomonic criteria for fusion, whereas the method was not reported in one out of the three included studies.

## Discussion

This meta-analysis did not show any difference in terms of fusion rate, NDI score or residual RoM after ACDF for cervical spondylosis, at single or double levels without plating, when comparing patients who wore or not a CC. Our results confirm those provided by Karikari et al. [10]. Furthermore, in this investigation, the fusion rate was similar in the two groups and no cases of implant pullout were reported. Thus, the external immobilization seems to not provide any advantages in promoting segmental fusion or preventing implant displacement.

CC has been widely administered as a standard of care in different clinical conditions, such as after whiplash injuries and ACDF surgeries. However, scientific evidence supporting this practice is still lacking. Few comparative studies investigated the role of the CC after ACDF, on single or double levels without plating, for cervical spondylosis. In fact, three studies only were finally included in the present investigation [7–9].

Compared to physical therapy protocols or act-as-usual, it has been associated with worse clinical outcomes after whiplash injuries. Residual neck pain and restricted cervical RoM were more evident in patients who wore a CC, especially in short-term follow-up measurements [12]. This meta-analysis was conducted on 1-year follow-up outcomes only, due to included studies data availability; thus, it was not possible to measure any short-term difference in terms of NDI scores or RoM.

It has been reported that wearing CC may lead to patients' discomfort and specific complications, such as dysphagia, sarcopenia and muscular atrophy [13]. Moreover, cervical spine immobilization has been associated with reduced cervical ROM and higher chances for spondylotic degeneration [13]. Included studies did not report data on patients'

subjective discomfort; furthermore, the clinical follow-up length was probably unable to evaluate long-term specific complications.

## Limitations

Only three studies matched the quality criteria for meta-analysis in this study. The level of evidence of the included studies is not homogeneous. Some modifying factors that could influence the considered outcomes, such as smoking status, were not reported in the included studies. Implants used by the authors were different in two studies (PEEK and allograft) and not reported in one. The method for evaluating the fusion rate was different between two studies and not reported in one out of the three included. Follow-up length was limited to 1 year in two-thirds of the included papers. Finally, patients' samples were relatively small (75 in collar and 74 in no-collar groups).

## Conclusions

The use of a CC after ACDF without plating on single or double levels for cervical spondylosis seems not supported by scientific evidence. Further properly designed clinical trials are needed to confirm these results and investigate the long-term effects of cervical immobilization.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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