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The Impact of Rigid Cervical Collars on Outcome of Patients Who Underwent Posterior Cervical Laminectomy and Fusion: A Retrospective Comparative Study

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Study Design: Retrospective cohort study.

Purpose: This study aimed to investigate the cervical collar impact on the functional outcomes of patients after posterior cervical laminectomy and lateral mass screw fixation (PCLF) surgery.

Overview of Literature: The safety and possible benefits of implementing rigid cervical collars subsequent to PCLF are insufficiently investigated.

Methods: Patients who underwent PCLF and received postoperative cervical collars from 2018 to 2020 were included in this retrospective cohort study. Their data were compared with an age- and sex-matched group of subjects who did not receive collars after PCLF during the same period. Pain intensity (using the Visual Analog Scale), Neck Disability Index, and quality of life (using 36-item Short Form Health Survey) of the patients were compared at baseline, 1, 3, 6, and 12 months postoperatively.

Results: A total of 36 patients who received cervical collars after surgery and 40 controls were included. At baseline and 1-month follow-up, there were no differences in pain intensity, functional status, and quality of life between the groups. However, at 3 months postoperatively, the quality of life of the subjects with no orthosis was higher than those who received cervical collars (p=0.01). At 6- and 12-month follow-up, there were no differences between the groups in pain intensity, functional status, and quality of life.

Conclusions: No difference in the pain intensity and functional status of patients who used cervical collars and controls was shown in our study. Patients who did not wear cervical collars had a higher quality of life during the 3-month postoperative evaluation. Future prospective, well-controlled studies with longer follow-ups are needed to further investigate the effects of cervical orthosis on the clinical outcome of patients after PCLF.

Keywords: Cervical myelopathy; Collar; Lateral mass screw fixation; Posterior cervical laminectomy

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Introduction

The safety and necessity of cervical orthosis use after cervical spinal surgeries have been under debate for many years. Some surgeons believe that prescription of postoperative cervical orthosis might be useful in reducing the axial load on the fusion construct, decreasing pain and providing a sense of security for the patients during routine activities [1,2]. However, reviewing the literature, there is scarce data supporting these hypotheses. Caplan et al. [3,4] examined patients who underwent single and multilevel anterior cervical discectomy and fusion (ACDF) showed that there is no superiority of those who used cervical collars over the controls. Moreover, Overley et al. [5] showed no advantage in wearing a cervical brace following one- or two-level ACDF in a prospective randomized study. Others prefer rigid collars after either anterior or posterior fusions [6-8], while some surgeons prescribe a soft collar as a transition to wearing no collar. The lack of data and discrepancies in clinical approaches is more prominent when it comes to more extensive surgical procedures, such as multilevel corpectomies and 360° approaches, where some authors have advocated the use of a halo or cervicothoracic orthosis after these types of surgeries, and others prefer simple rigid collars or even no cervical collars [9].

Safety of hard cervical collar use remains unclear as there are some reports on skin pressure points and ulcer formation [10], range of motion restriction [11-13], respiratory difficulties [14,15], dysphagia, and nerve palsy [16] after the use of rigid cervical collars early in the postoperative period. Another concern for health systems is the cost effectiveness of cervical collar use and its impact on the global burden of diseases. However, there are some reports that cervical collar administration after ACDF surgery leads to a lower hospital stay length with no significant effect on the total cost of the patient [4].

Posterior cervical laminectomy and fusion surgery (PCLF) has been widely used to approach patients with myelopathic spinal cord symptoms, cervical canal stenosis, and ossified posterior longitudinal ligament over the past decades. There are no published data regarding the safety and possible advantages of implementing rigid cervical collar after PCLF reviewing the literature. The functional, physical, and quality of life-related outcomes of patients who underwent PCLF were retrospectively reviewed at our university hospital in the present study. They were advised to use rigid cervical collars. The results were compared with an age- and sexmatched group of patients with no collars during the postoperative period.

Materials and Methods

This retrospective cohort study included 76 patients (26 females and 50 males) who underwent PCLF from 2018 to 2020 at Shariati and Yas Hospitals. Initially, our center's insurance policy covered postoperative cervical collar prescription. Therefore, all patients operated on or before 2019 were given hard cervical collars and were advised to use the collar for at least 3 months (collar group). Collar group patients were instructed to wear the collar during waking hours and were allowed to remove the collar while sleeping or bathing. The collars were fitted for each subject in the following sizes: small, medium, large, and extra-large. Patients who underwent PCLF later (from 2019 to 2020) were not given cervical orthosis after surgery (control group) due to changes in the insurance policy. In this study, we retrospectively compared the clinical outcomes of the patients in these two groups.

1. Patients

History, physical examination, and magnetic resonance imaging study were used as basis for the diagnosis. Indication for surgery was determined by a senior attending spine surgeon including neurological deficit, myelopathic cervical cord change, gait disturbance, or any other signs or symptoms of hyperreflexia and intolerable pain, which was nonresponsive to conservative management. Inclusion and exclusion criteria were used to include the patients' data in the study analysis. Patients aged 18 to 85 years with a diagnosis of cervical cord myelopathy or cervical canal stenosis between C3 and C6 who were nonresponsive to at least 8 weeks of conservative therapy were included in the study. Patients with a history of previous cervical spine surgery or any trauma related to the cervical spine were excluded from the study. Our institutional ethical committee approved this study, and all the participants provided written informed consent.

2. Intervention

All PCLF surgeries were done with the patient in a prone position, head in Mayfield fixation, and under general an-

esthesia. The senior author incised the skin at the midline and bilaterally dissected the muscles and soft tissues using electrocautery. Thereafter, the lamina and adjacent ligamentum flavum were removed using high-speed burrs, bone rongeur, and a Kerrison punch to achieve complete decompression of the thecal sac and nerve roots. Lateral mass screws were then inserted under C-arm guidance and were connected to the bilateral rods. Posterolateral decortication of lateral masses was done and autologous bones were used for arthrodesis after irrigation of the surgical field and hemostasis. Finally, a drain was fixed and the wound was closed in separate layers.

3. Outcome measures

The patients' demographic characteristics at the time of surgery were extracted from the medical records. Outcomes of the patients at the preoperative and four follow-up sessions (at 1, 3, 6, and 12 months postoperatively) were measured. Pain intensity at the upper extremity or neck was measured using a 10-point Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable). The subjects' functional disability was measured using the Neck Disability Index (NDI) [17]. The NDI questionnaire ranged from 0 to 50, and higher scores showed a higher level of disability. The score from each of the subjects was multiplied by two, ranging from 0 to 100, to report the result of the NDI measurement. Moreover, patients were asked to fill a validated version of the 36-item Short Form Health Survey (SF-36) to report their quality of life (SF-36) [18]. SF-36 ranged from 0 to 100, and higher scores indicated a lower disability.

4. Statistical analysis

The Kolmogorov-Smirnov test was used to test the normal variable distribution. When applicable, baseline data were compared between the two treatment groups using the chi-square test, independent sample *t*-test, or Mann-Whitney *U* test. The outcome measures were also assessed in a repeated measures analysis of variance and data presented as mean±standard deviation. IBM SPSS software ver. 26.0 (IBM Corp., Armonk, NY, USA) was used to perform statistical analyses. A *p*-value of less than 0.05 is considered statistically significant.

Results

A total of 76 patients' data were used in this study. Among them, 36 participants used cervical collars during the postoperative period, while the other 40 did not use them. Table 1 summarizes the demographic and surgical char-

Table 1. Comparison of baseline variables between the groups

Variable	Orthosis group (n=36)	No orthosis group (n=40)	*p*-value
Age (yr)	55.5±20.3	52.7±17.1	0.52
Gender			0.87
Male	24	26	
Female	12	14	
Body mass index (kg/m²)	24.3±4.7	25.6±3.3	0.16
Diagnosis (level)			0.84
C4–C5	2	2	
C4–C6	12	10	
C3–C6	18	20	
C3–C5	3	6	
C5–C6	1	2	
Hospital stay (day)	2.6±1.3	2.3±1.5	0.34
Operation time (min)	126.8±17.7	132.2±18.5	0.20
Postoperative complications			0.82
Wound discharge/infection	1	2	
Temporary/permanent neurological deficit	2	3	

Values are presented as mean±standard deviation or number.

acteristics of the subjects. At baseline, there was no difference in age (p=0.52), gender (p=0.87), body mass index (p=0.16), and the level of operation (p=0.84) between the groups. There were no significant differences in length of hospital stay, operation time, and postoperative complications (p=0.34, p=0.20, and p=0.82, respectively) comparing the intra- and perioperative outcomes between the orthosis and control groups.

There were no significant differences in pain intensity and NDI of the subjects at 1st, 3rd, 6th, and 12th postoperative months comparing the groups (Tables 2, 3). There were no differences between the groups at baseline, 1, 6, and 12 months postoperatively (p=0.05, p=0.1, p=0.46, and p=0.09, respectively) regarding the quality of life of the subjects. However, at the 3rd month postoperatively, the quality of life of subjects with no orthosis was higher than those who used cervical collars (p=0.01).

A G*Power ver. 3.1 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/) was used to perform a post hoc power analysis for the main outcome (disability 3 months after surgery). This analysis showed that the power of the study was 0.79. This

Table 2. Comparison of outcome measurements between the groups

Variable	Orthosis group (n=36)	No orthosis group (n=40)	p-value
Pain intensity (Visual Analog Scale)			
At baseline	67.7±17.7	72.0±14.9	0.25
1st month postoperatively	42.9±10.7	47.5±11.0	0.07
3rd month postoperatively	38.3±9.9	39.4±13.5	0.70
Neck Disability Index			
At baseline	57.0±17.4	54.2±21.5	0.53
1st month postoperatively	37.0±14.6	30.3±15.0	0.05
3rd month postoperatively	28.0±13.0	26.4±10.3	0.55
Quality of life (SF-36)			
At baseline	40.3±9.5	44.4±8.9	0.05
1st month postoperatively	50.7±12.0	55.0±10.6	0.10
3rd month postoperatively	64.6±13.3	71.7±8.0	<0.01*
Return to work (day)	34.5±11.2	29.9±9.9	0.06
Use of analgesics after 2 weeks postoperatively			0.61
Yes	21	21	
No	15	19	

Values are presented as mean±standard deviation or number.
SF-36, 36-item Short Form Health Survey.
*p<0.05 (statistically significant).

Table 3. Comparison of pain intensity (using VAS), functional status (using NDI), and quality of life (using SF-36) between the groups at 6- and 12-month follow-ups

Variable	6 Months			12 Months		
	Orthosis group (n=34)	No orthosis group (n=38)	p-value	Orthosis group (n=32)	No orthosis group (n=37)	p-value
VAS	41.0±11.8	40.8±6.9	0.95	39.1±10.5	42.2±11.7	0.25
NDI	26.6±6.1	24.2±9.7	0.22	23.8±11.5	26.1±15.5	0.49
SF-36	62.6±13.1	64.5±7.4	0.46	56.3±11.2	61.0±11.8	0.09

Values are presented as mean±standard deviation or number.
VAS, Visual Analog Scale; NDI, Neck Disability Index; SF-36, 36-item Short Form Health Survey.

shows that the power of the study was statistically enough to show no significant differences in the clinical parameters between the groups.

In this study, seven patients were lost to follow-up over a period of 1 year (four in the orthosis group and three in the control group) and excluded in the 1-year data analysis (Table 3). In this regard, three subjects (one of the patients in the collar group and two in the control group) underwent reoperation during the follow-up period. The patient in the collar group underwent surgery due to cervical stenosis and cord myelopathic change at the C3 level, while the patient had undergone C4–C6 fusion 5 months before. In the control group, one of the patients was operated on due to a delayed surgical site infection. In this patient, the instruments were removed 4 months after the primary surgery. The other patient in the control group underwent ACDF at the C6–C7 level, while the patient underwent C3–C6 posterior fusion 9 months before. The reasons for the loss of follow-up of the other four subjects were as follows: not filling the outcome measurement tools (three patients) and migrating abroad (one patient).

The time needed for returning to work was compared between the subjects in addition to clinical outcome measurements, and it was found that patients who did not use cervical collars could return to their daily work sooner, although the difference was not statistically significant (29.9±9.9 and 34.5±11.2, p=0.06). Moreover, there were no differences in analgesics 2 weeks postoperatively between the two groups.

Discussion

Effective decompression in patients with multilevel spinal canal stenosis can be provided by posterior cervical laminectomy [19]. Instrumentation and lateral mass fixation prevent iatrogenic instability and post-laminectomy kyphosis [20,21]. This study retrospectively evaluated the outcomes of patients with cervical canal stenosis who underwent PCLF, used cervical collars, and compared the results with a matched group of patients who did not use cervical collars after the same operation. The results demonstrated that the clinical outcomes of both groups were satisfactory and comparable. Patients in both cohorts showed significant improvement in pain. There were no differences in the mean VAS score between the groups at the end of the 12-month follow-up. This might show that cervical collar has a negligible role on pain intensity after PCLF. Furthermore, there was no association between cervical collar use, duration of hospital stay, and rate of postoperative complications. Cheung et al. [22] conducted a prospective randomized controlled trial to evaluate clinical, radiological, and functional outcomes of the individuals who underwent single-door laminoplasty with or without postoperative collar use. The VAS between the two groups, as shown in our study, was similar from week 3 onward even though the VAS measurement showed that postoperative mobilization with a rigid cervical collar lessens axial neck pain over the first 2 weeks of the surgery [22]. Patients who undergo laminoplasty might need cervical collars in the first few weeks after surgery to stabilize the cervical spine and thereby reduce their axial pain according to a study by Cheung et al. [22]. However, our subjects had undergone PCLF surgery and thereby adequate stabilization was achieved for them during the surgery. This might explain the reason of finding no difference in the pain intensity of our patients even during the first weeks after surgery between the collar and control groups.

Caplan et al. [3,4] studied the effect of cervical orthosis after a single and multilevel ACDF. They reported extended hospital stay for the unbraced patients in both single and multilevel ACDF and a higher 30-day readmission rate for unbraced patients after multilevel ACDF. However, we did not observe such an association in our study. These differences can be attributable to different surgical approaches and techniques. Caplan et al. [3,4] investigated the role of cervical collars after ACDF, while we evaluated cervical collar administration after PCLF. Abbott et al. [23] reported decreased initial postoperative pain using a cervical collar after ACDF in contrast to the mentioned studies. A possible reason for postoperative pain improvement in the first month in braced patients might be explained by a sense of security and less avoidance due to fear and other psychological factors.

The NDI considerably decreased after surgery in both cohorts. Remarkably, the mean NDI score was relatively lower at the first month of follow-up in patients without cervical collars than in those with collars, although the difference was not statistically significant. We have to keep in mind that the rigid cervical collar provides approximately 62.9% restriction in the cervical range of motion [24], and this restriction in range of motion might explain the higher NDI of patients who used collars during the postoperative period.

There was significant improvement in the quality of life after the surgery in both cohorts. There was no significant difference in SF-36 scores, between the groups, at baseline and 1 month after surgery. However, after 3 months of follow-up, patients without the use of cervical collars reported a higher quality of life than the patients who were advised to use cervical collars regularly. Parallel to our results, Miller et al. [25] reported that the use of cervical collars restricts patients' daily routine activities and may be unnecessary after procedures with internal fixation and can negatively affect the quality of life. There was no difference in the quality of life of the subjects at the 6- and 12-month follow-up as shown in our data. This might be explained by the instruction of the study, which asked the patients to remove their collars 3 months postoperatively. The time required for returning to work was significantly lower in patients without a cervical collar, while the use of analgesics after 2 weeks postoperatively did not differ between the two groups. This is in accordance with the higher quality of life and lower disability in unbraced patients as mentioned earlier.

The postoperative orthosis utility after both anterior and posterior cervical spine surgeries remains a matter of debate. As Bible et al. [26] reported, most spine surgeons preferred to prescribe a rigid cervical orthosis, especially after multilevel surgeries. However, other studies in recent years have argued that there were no clear advantages of using cervical orthosis after internal fixation and fusion surgery. Camara et al. [27] reviewed the literature on post-ACDF cervical orthosis and reported no clear advantage. Therefore, they concluded that a post-ACDF cervical collar is unnecessary [27] and few other studies supported this notion [3,4]. Similar results were also reported for atlantoaxial fixation and lumbar spine surgeries [28,29]. Another important consideration while using a rigid cervical collar is skin complications such as pressure ulcers [10]. Careful patient selection and avoiding routine use of the cervical collar for all patients are necessary to prevent such complications. To the best of our knowledge, this is the first study to compare the effect of rigid cervical orthosis among patients who underwent PCLF. This data might provide a platform for future prospective and well-controlled studies.

The main limitations of this study were the retrospective design, lack of cervical alignment postoperative assessment, a short duration of patients' follow-up, and a relatively small sample size. One of the important reasons of using cervical collars would be to limit neck motion at the early postoperative period to enhance fusion rate. However, the fusion rate between the groups was not measured and compared in the present study. This can be considered as another limitation of the study, although previous studies have shown that there was no direct correlation between the clinical improvement and fusion rate of the subjects after spine surgery [5,30]. In this study, effect of cervical collars on the clinical outcomes of subjects after surgery was targeted. The correlation of clinical findings with the occurrence of radiological fusion might be addressed in future studies. In addition, subject compliance of the collar group with the study protocol was not measured, although, in postoperative visits, the subjects of the collar group were encouraged to use the collar according to our instructions. Furthermore, wound pain can be considered a contributing factor in early pain changes and this factor was not considered in this study. Therefore, further studies with prospective design and controlled trials are required to assess the benefits and necessity of cervical collars after PCLF. There are also major questions that need to be addressed in future studies such as determination of patient subgroups who might benefit from postoperative cervical collars, such as those with osteoporosis, those who have undergone long segment fusion surgeries, or those who are at risk of non-fusion due to medical comorbidities. All of the above issues show the long path ahead of clinical research on cervical collar at the postoperative course of PCLF surgery.

Conclusions

The results of this study might show that the use of a hard cervical collar has no significant effect on the intensity of pain and disability of patients after PCLF surgery. These findings need to be confirmed in prospective studies.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Conception and design: MK, ME, MS, MR; drafting of the manuscript: MK, NM, SS; analysis of data: FMYK, MFJ; critical revision: MM, MZ, RK; supervision: MR; and final approval of the manuscript: all authors.

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