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COMPARING RESULTS OF POSTERIOR CERVICAL FACET JOINT CAGE STABILIZATION WITH LATERAL MASS FIXATION IN CERVICAL FORAMINAL STENOSIS

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ABSTRACT

Objective: Although neck and arm pain are the most common symptoms of cervical foraminal stenosis, neuromotor deficits are also observed. The most common surgical treatment for cervical foraminal stenosis is cervical decompression and fusion. This process is difficult and invasive. The study evaluates the effectiveness and results of posterior cervical facet cages (PCFC) operation in cervical foraminal stenosis.

Materials and Methods: In this study, 80 patients who underwent PCFC operation and 70 patients who underwent decompression with lateral mass screw fixation (LMSF) between May 2016 and May 2021 were evaluated. Clinical information, laboratory results, and radiological findings were reviewed retrospectively. The patients were divided into two groups PCFC -applied patients in group 1 and LMSF- applied patients in group 2. Pain complaints of the patients were evaluated using a visual analog scale (VAS). Posterior disc height (PDH) (mm) and foraminal height (FH) (mm) were used for radiological evaluation.

Results: The mean hospitalization time of the patients was 27 h in group 1 and 92 h in group 2. There was a statistically significant difference between the groups in terms of mean hospitalization time ($p<0.001$). The mean preoperative and postoperative VAS scores in group 1 were 6.8 and 2.9 for neck pain, and 7.1 and 2.6 for arm pain, respectively. Mean preoperative and postoperative VAS scores in group 2 were 6.7 and 3.8 for neck pain, respectively. There was a statistically significant difference between the groups in terms of a decrease in VAS scores ($p<0.001$). PDH in group 1 was 2.3 mm preoperatively and 2.6 mm postoperatively. The FH was 10.2 mm preoperatively and 10.5 mm postoperatively. In group 2, PDH was 2.4 mm preoperatively and 2.3 mm postoperatively. FH was 10.6 mm preoperatively, and no postoperative change was detected. There was a statistically significant difference between groups 1 and 2 in terms of PDH and FH ($p<0.001$).

Conclusion: It shows that minimally invasive facet cages can be considered as a safe alternative method for root decompression and spinal fusion in cervical foraminal stenosis.

Keywords: Cervical disc degeneration, cervical spondylosis, posterior cervical facet cages, lateral mass screw fixation

INTRODUCTION

Foraminal stenosis is the most important pathology that occurs because of cervical intervertebral disc degeneration or spondylosis. The clinical presentation of this condition manifested as radiculopathy. Although the most predominant symptom is neck and arm pain in patients with foraminal stenosis, neuromotor deficits are also observed[1,2]. In radiculopathy caused by degenerative disc disease or spondylosis, posterior decompression with lateral mass screw fixation (LMSF) together with cervical laminectomy is a standard method considered an effective treatment. The surgical aim is to decompress the nerve with foraminotomy. Minor laminotomy is typically performed. With foraminotomy, the affected nerve root is decompressed. Posterior stabilization should be performed to prevent instability after decompression. For this purpose, posterior lateral mass screw fixation is applied[3-7]. Although this treatment modality has a lower risk of dysphagia than anterior intervention, it typically requires nerve root manipulation and bone resection[8].

In the LMSF method: The risk of neurological complications, osteophytes, kyphosis, muscle atrophy, and disc fusion with reconstruction is high. After the excision of the ligamentum flavum, the dura mater emerges, and consequently the risk of damage to the dura mater increases[4,9]. With minimally invasive cervical posterior surgery, recovery and hospitalization times are shortened due to a significant reduction in intraoperative blood loss and tissue damage[10-12]. Recently, posterior cervical facet cages (PCFC) have been developed as a percutaneous system with minimal incisions in the posterior cervical approach[10,13]. In cervical stenosis-related radiculopathy, positive results after

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surgery with minimally invasive implants placed between the facet joints have been reported for up to two years as an alternative to LMSF. However, few publications are compared the biomechanical effects between LMSF and PCFC[14,15]. Our aim in our study was to compare the clinical and radiological results of a Posterior Cervical Facet Cage Technique with the posterior lateral mass screw fixation technique in cervical foraminal stenosis.

MATERIALS AND METHODS

Between May 2016 and May 2021, 150 patients who were operated on with the diagnosis of C5-6 segment cervical stenosis were included in the study. Eighty patients underwent the PCFC method (group 1) and 70 patients underwent the LMSF method (group 2). A patient's data, including the clinical course, neurological findings, laboratory results, and neuroimaging findings, were reviewed retrospectively. Inclusion criteria were: 1) patients aged between 18 and 75 years, 2) patients who received radiculopathy due to foraminal stenosis and underwent PCFC or LMSF, 3) patients who received an epidural steroid injection and/or who failed at least 6 weeks of conservative treatment. Exclusion criteria were: 1) cervical myelopathy, 2) spondylolisthesis greater than 3.5 mm, 3) cervical kyphosis, 4) metabolic or connective tissue disease, 5) osteoporosis, 6) pregnancy or breastfeeding, 7) systemic inflammatory disease, 8) facet joint pathology. We followed up on 150 patients' clinical information, laboratory results, and radiological findings obtained retrospectively from hospital medical records for 2 weeks, 6 weeks, 3 months, 6 months, and 12 months. In the PCFC application, after the patient is fixed in the prone position and the shoulders are pulled back. Simultaneous lateral and anteroposterior (AP) images were taken using two C-arms. The facet joint to which PCFC will be applied is confirmed by entering with a spinal needle. After the skin incision, Access Chisel is advanced under fluoroscopic guidance until the bone is reached. The Access Chisel is used to locate and cut the tip of the joint capsule. The Access Chisel is advanced into the facet joint space. Decortication Trephine is delivered through the Access Chisel to the distal end of the bone. The Guide Tube is advanced into the facet joint space through the Fork Mallet. Decortication Rasp is advanced. The Guide Tube is locked with the guide tube holder and Rasped up to the upper handle of the decortication. The PCFC cervical cage transport device is advanced into the guide tube until it locks with the guide tube. AP and lateral fluoroscopy were used to confirm the proper placement of the cage. The bone graft material was placed in the upper part of the guide tube. After the cage is confirmed by final AP and lateral fluoroscopy, it is placed in the facet joint space (Figure 1). In the LMSF application group, after the patient was fixed in the prone position, bilateral paravertebral muscles were peeled open to expose the spinous process, bilateral laminae, and lateral mass. The needle insertion point and angle were determined according to the Magerl technique. The lateral mass screw was inserted after sounding. After the screw position was confirmed to be good by fluoroscopy, posterior resection of the posterior wall of the spinal canal at the corresponding segment was performed, paying attention to the protection of the lateral mass bone. The vertebral plate was completely removed to completely decompress the spinal canal. After traction by the contact cranial ring arch, a prebent titanium rod was linked to the screw. All patients were

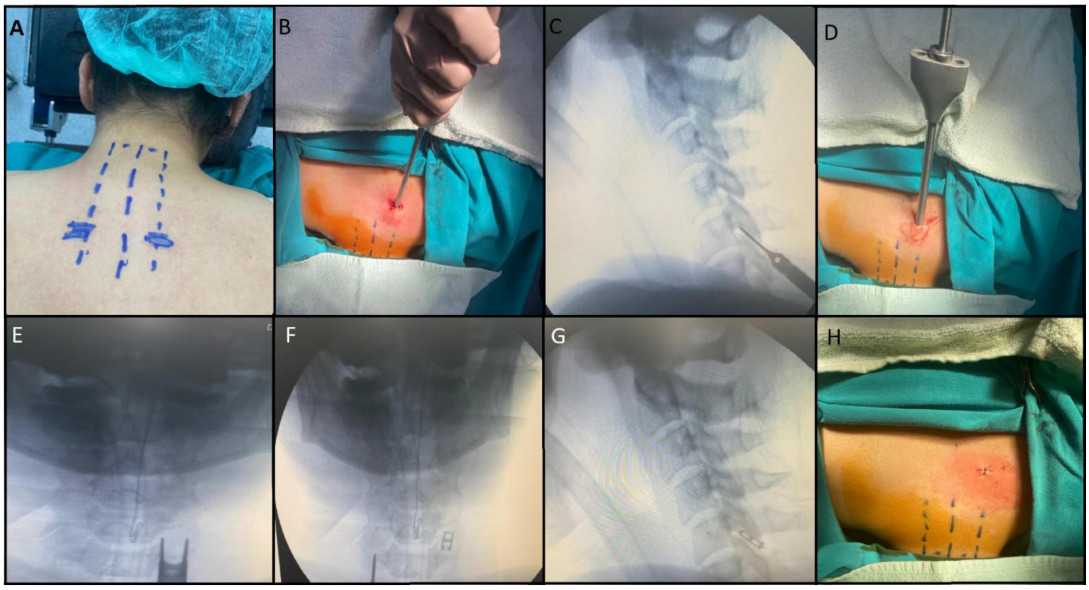

Figure 1. The PCFC process application is shown in **A)** The incision site is planned for the PCFC procedure. **B, C)** Chisel is advanced under fluoroscopic guidance until the bone is reached. **D, E)** PCFC is placed in the facet joint space with guidance. **F, G)** The AP and lateral fluoroscopic images of the PCFC cage placed in the facet joint space are shown. **H)** It has been shown that minimal entry space is required for its application
PCFC: Posterior cervical facet cages, AP: Anteroposterior

routinely given postoperative nonopioid analgesic medication. pain complaints of the patients were evaluated using a visual analog scale (VAS). VAS is 0 to 10-point scale. On the VAS, 0 represents the absence of pain, and 10 represents the worst pain the patient can imagine[16]. For neck pain and arm pain in both group, VAS was evaluated on the day of surgery and at the 2nd week, 6th week, 3rd month, 6th month, and 12th month postoperatively. Preoperative and postoperative radiological images were analyzed in both groups, and posterior disc height (PDH) (mm) and foraminal height (FH) (mm) were measured. For our study, ethics committee approval was received for this study from Sanko University, Sanko Hospital Clinical Research Ethics Committee (decision no: 2022/04-01, date: 24.02.2022), and was performed out following the Declaration of Helsinki. Written informed consent was obtained from all the participants.

Statistical Analysis

In comparisons between the 2 study groups: Student's t-test was used for Gaussian continuous variables, the Mann-Whitney U test was used for non-gaussian non-continuous variables, and χ^2 was used for categorical variables. A value of $p<0.05$ was considered statistically significant. All analyses were performed using R Statistical Software Version 3.3.2.

RESULTS

Seventy nine (53%) male and 71 (47%) female patients were included in the study. The mean age of the patients was 62.3 (25-73) years. The demographic and characteristic features of the patients are given in Table 1. There was no statistically significant difference between the two groups in terms of age and gender. Fifty five (69%) patients in group 1 had a previous operation history. In these patients, the most common operation was anterior cervical discectomy in 39 (71%) patients, anterior cervical fusion surgery in 11 (20%) patients, and posterior cervical fusion surgery combined with laminectomy in 5 (9%) patients. In group 2, 39 (55%) patients had a history of surgery, and posterior decompression surgery was found in these patients. The most frequently affected level was the C5-C6 level in both groups. Then, in the order of frequency in both groups, it was C6-C7, C4-5, and C3-4. The mean hospitalization time was 27.1 h in group 1 and 52.6 h in group 2. There was a statistically significant difference in hospitalization time between the groups ($p<0.001$).

In group 1, preoperative and postoperative VAS scores were 6.8 and 2.9 for neck pain and 7.1 and 2.6 for arm pain, respectively. There was an increase in arm pain in 2 patients and an increase in the neck and arm pain in 1 patient. This was reflected in the VAS scores. There was no change in the neck and arm pain in the four patients. There was a statistically significant difference in VAS reduction ($p<0.001$). The follow-up periods of the patients in group 1 are given in Table 2. In group 2, preoperative and postoperative VAS were 6.7 and 3.8 for neck pain and 6.9 and 2.9 for arm pain. There was an increase in arm pain in 3 patients. Although neck and arm pain increased in 23 patients in the early postoperative period, neck and arm pain increased in only 8 patients during follow-up. There was no change in

Table 1. Demographic and characteristics of the patients

Characteristics	Grup 1 (n=80)	Grup 2 (n=70)	p value
Age (years)	61	63	0.72
Male, n (%)	43 (54)	36 (51)	0.56
Prior cervical spine surgery, n (%)	-	-	0.068
Yes	55 (69)	39 (55)	-
No	25 (31)	31 (45)	-
Cage placement, n (%)	-	-	<0.001
Unilateral	7 (9)	0	-
Bilateral	73 (91)	70 (100)	-
Cage segment, n (%)	-	-	0.84
C3-4	6 (7)	7 (10)	-
C4-5	17 (21)	13 (18)	-
C5-6	35 (44)	32 (46)	-
C6-7	22 (28)	18 (26)	-
Postoperative complications, n (%)	-	-	<0.001
Spinal cord injury	0	2 (3)	-
Vertebral artery injury	0	1 (2)	-
CSF leak	0	6 (9)	-
Wound infection	1 (1)	5 (7)	-
Meningitis	0	2 (3)	-

CSF: Cerebrospinal fluid

the neck and arm pain of 5 patients. Although there was no significant decrease in VAS during the early postoperative period, a statistically significant difference was found in the postoperative VAS reduction (p<0.001). The follow-up periods of the patients in group 2 are given in Table 3. When the VAS between group 1 and group 2 was evaluated, a statistically significant difference was found in the decrease in VAS of the patients in group 1 (p<0.001). The PDH (mm) in group 1 was 2.3 mm preoperatively and 2.6 mm postoperatively. FH (mm) was 10.2 mm preoperatively and 10.5 mm postoperatively. In group 2, the PDH (mm) was 2.4 mm preoperatively and 2.3 mm postoperatively. FH (mm) was 10.6 mm preoperatively, and no postoperative change was detected. There was a statistically significant difference between groups 1 and 2 in terms of PDH and FH (p<0.001). Wound infection was detected in only 1 (1%) patient as a postoperative complication in patients in group 1. In group 2, cerebrospinal leakage (CSF) in 6 (9%) patients, wound infection in 5 (7%) patients, spinal cord injury in 2 (3%) patients, meningitis in 2 (3%) patients, and 1 (2%) patients vertebral artery damage was revealed. When postoperative complications were evaluated, a statistically significant difference was found between group 1 and group 2 (p<0.001). There was no reoperation or readmission in any group.

DISCUSSION

The surgical approach in the surgical treatment of cervical intervertebral disc degeneration or spondylosis can be anterior, posterior, and combined. The most commonly preferred approach is posterior. The choice of the surgical approach is influenced by factors such as the location of pathology, the number of levels , and the degree of the clinical picture. Although cervical laminectomy and foraminotomy effectively decompress neurogenic structures, they can cause segmental instability, kyphosis, and neurologic deficits as well as technical difficulties. LMSF is also added to the decompression to prevent these complications[17-22]. LMSF with laminectomy is effective for cervical mononeuropathy, along with the advantage of preserving stability[6,23].

Despite this, the risk of damage to neurogenic structures and surrounding muscle and bone structures increases. The risk of adjacent segment degeneration is also increased[1]. PCFC performs root decompression and fusion by opening the neuronal foramen in the cervical facet with minimally invasive intervention, without damaging the paraspinal muscles, with negligible bleeding. Due to the increased tissue damage in group 2, additional pain occurs postoperatively in patients depending on the severity of the pain, even if the neurogenic pathology disappears. In our study, this explains the fact that group 2 early postoperative VAS did not decrease as much as in group 1. Minimally invasive percutaneous intervention in group 1 increases the postoperative comfort of the patients due to less tissue damage and shortens the hospitalization period of the patients. PCFC is less invasive, requires a shorter hospital stay, and has fewer potential complications[24,25]. Efficacy data thus far has shown PCFC to be comparable to LMSF for radicular pain, with multiple studies demonstrating significant improvement in symptoms in 95% of patients[26,27]. The favorable outcomes of this study add to the growing literature supporting PCFC as a low-morbidity, high-efficacy alternative for cervical radicular symptoms.

In the study of Maulucci et al.[28] 2 mm facet cage and LMSF surgeries detected an increase in FH and stability, but could not detect statistically significant results in kinematic results. Kasliwal et al.[29] found significant improvements in VAS for the pain neck and arm in a 20-month follow-up study of 19 patients who underwent revision surgery for pseudoarthrosis. However, they did not detect any significant change in cervical lordosis. Other studies in the literature have demonstrated similar stability with PCFC to traditional open LMSF surgery[30,31]. Despite similar stability, it provides decompression of neuropathic structures because of a statistically significant increase in disc height and FH in group 1 compared to group 2. This explains that the decrease in VAS in group 1 is more pronounced than the decrease in VAS in group 2. The study by McCormack et al.[10] including 60 patients who underwent PCF, reported that there was no vertebral artery injury or damage to neural structures and that no patient required reoperation. In our study, wound infection developed in only one patient in group 1, which is consistent with low complication

Table 2. Group 1 scores

Time	VAS for neck pain	VAS for arm pain	PDH	FH
DS	6.8	7.1	2.3	10.2
2 weeks	4.1	3.6	2.6	10.5
6 weeks	3.3	2.8	-	-
3 months	2.4	2.3	-	-
6 months	2.2	2.4	2.4	10.4
12 months	2.3	2.2	-	-

VAS: Visual analog scale, PDH: Posterior disc height (mm), FH: Foraminal height (mm), DS: The day of surgery, 2 weeks: The control visit 2 weeks after surgery and the VAS score at subsequent visits

Table 3. Group 2 scores

Time	VAS for neck pain	VAS for arm pain	PDH	FH
DS	6.7	6.9	2.4	10.6
2 weeks	6.1	3.8	2.3	10.6
6 weeks	4.3	3.1	-	-
3 months	3.4	2.6	-	-
6 months	2.9	2.5	2.3	10.5
12 months	2.6	2.7	-	-

VAS: Visual analog scale, PDH: Posterior disc height (mm), FH: Foraminal height (mm), DS: The day of surgery, 2 weeks: The control visit 2 weeks after surgery and the VAS score at subsequent visits

rates. However, in the seven-month follow-up of the study by Siemionow et al.[32] In 89 patients, the postoperative complication rate of LMSF was found to be 4.3%. The authors reported neurological complications related to C5 palsy in one patient and spinal cord irritation in one patient. The findings of this study evidence the safety of PCFC, and its potential as a low-morbidity alternative to LMSF for radiculopathy. The procedures took an average of 27.1 h and on average required a 52.6-hour hospital stay. In comparison, one study looking at LMSF found an average length of procedure of 204±59 min and an average length of stay of 47.5±38.4 h with LMSF[25]. The authors also reported postoperative parietal stroke in one patient and atrial fibrillation in one patient. The authors found the complication rate to be 3.4% in patients who used a posterior cervical cage. The reason why the complication rates in this study were higher than that in our study may be that our patient exclusion criteria were wider.

Complications included dysphagia, hematoma, worsening myelopathy, recurrent laryngeal nerve palsy, cerebrospinal fluid leaks, wound infection, increased radiculopathy, Horner's syndrome, respiratory insufficiency, esophageal perforation, and instrument failure[24,33]. In the LMSF group, CSF in 6 (9%) patients, wound infection in 5 (7%) patients, spinal cord injury in 2 (3%) patients, meningitis in 2 (3%) patients, and 1 (2%) patients vertebral artery damage was revealed. There were no spinal cord injury, CSF leak, meningitis, and vertebral artery damage in the PCFC group ($p<0.001$). This demonstrates the significantly higher morbidity with LMSF, with most of these complications being avoided with PCFC given the minimally invasive posterior approach.

Study Limitations

This study has limitations. It is retrospective and the study is limited to one year. Longer follow-up and analyzes must understand the effects in the adjacent segment and to understand the long-term effects.

CONCLUSION

Surgical treatment options for cervical intervertebral disc degeneration or spondylosis remain largely invasive. The PCFC technique is a minimally invasive approach that provides a clinically significant improvement in the presence of clinical and radiological findings in patients with cervical radiculopathy. This technique can be considered as a safe alternative to surgical treatment in patients with spinal stenosis, particularly those with comorbidities.

Ethics

Ethics Committee Approval: The study, ethics committee approval was received for this study from Sanko University, Sanko Hospital Clinical Research Ethics Committee (decision no: 2022/04-01, date: 24.02.2022), and was performed out following the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from all the participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.S., Concept: A.S., M.U., C.S., Design: M.U., Data Collection or Processing: A.S., M.U., C.S., Analysis or Interpretation: A.S., M.U., C.S., Literature Search: A.S., M.U., C.S., Writing: A.S., C.S.

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