Anterior cervical discectomy and fusion by polyetheretherketon cage in degenerative disc diseases

Bahaa El Serwi, Mahmoud Mohamed Hadhood, Yasser Allam, Ahmed Shams El Deen, Osama Sherif

Orthopedic Surgery Department, Faculty of Medicine, Menoufia University, Menoufia, Egypt

Correspondence to Osama Sherif, MSc, Orthopedic Surgery Department, Faculty of Medicine, Menoufia University, Maxim Street, Shebin Al-Kom, Menoufia, Egypt.
Tel: 00201005231843;
e-mail: osamasherif3981@gmail.com

Received: 15 May 2018
Revised: 15 June 2018
Accepted: 29 June 2018
Published: 17 November 2021

The Egyptian Orthopaedic Journal 2021, 56:135–139

Background
Anterior cervical discectomy has proven to be a safe and effective procedure for the treatment of degenerative disc disease. The anterior approach allows direct visualization of the entire interspace and wide decompression of the anterior aspect of cervical spinal cord and nerve roots; it may be undertaken in cases of multilevel disease and interbody fusion may be performed if required.
Patients and methods
A total of 20 patients aged from 20 to 65 years, 16 females and four males with symptomatic cervical disc disease, presented in the outpatient clinic, Menoufia University hospital from 2012 to 2014, were examined and followed up prospectively, The mean age was 43.25±9.06 (range: 28–60) years. There were 13 patients (65%) with radiculopathy only, two patients (10%) with mylopathy only, and five patients (10%) with radiculomylopathy; seven cases were affected by mylopathy graded according to Ranawat grading. There were 37 levels affected among the 20 patients. C5,6 was the commonly affected level 1 (40.5%), then C4,5 11 (29.7%), then C6,7 7 (18.9%), and the least one was C3,4 4 (10.8%). Five cases were operated by using a microscope. Anterior cervical discectomy and fusion (ACDF) were performed using polyetheretherketone (PEEK) cages and local bone graft.
Results
The mean operative time per microscopic level was 64.5 min, the nonmicroscopic level was 47 min.The only intraoperative complication was external jugular-vein ligation that occurred in two cases (nonmicroscopic). The only postoperative complication was difficulty in swallowing, which occurred in 13 cases (11 nonmicroscopic and two microscopic). The mean of preoperative interbody ratio was 1.8±0.2, 12 months postoperatively the mean was 1.9± 0.2.There was a statistically significant difference in the mean of the interbody ratio preoperative and at 12 months. The mean preoperative disc space height was 3.3±0.8 mm, 12 months postoperative was 5.8±0.9. There was a statistically significant difference in the mean disc space height preoperative and 12 months postoperative. Rate of fusion at 12 months: three levels were average fusion, 26 levels were good fusion, and eight levels were excellent fusion.
Conclusion
Patients receiving ACDF with local bone graft combined with a PEEK cage had significantly shorter operation time, lower perioperative complication rates, and better radiological results comparing with those with an iliac bone graft alone. It seems that the local bone graft with a PEEK cage appears to be a safe alternative to the iliac bone graft for ACDF.

Keywords:
anterior cervical discectomy, degenerative disc diseases, interbody cervical fusion, polyetheretherketone cage

Egypt Orthop J 56:135–139

1110-1148

Introduction

Disc herniation, disc prolapse, and age-related degeneration of the cervical spine are common conditions in the population. Symptomatic cervical disc diseases may produce neck pain, referred pain, radicular arm pain, or clinical myelopathy. Radicular myelopathy is the common cause of surgical intervention [1].

Anterior cervical discectomy has proven to be a safe and effective procedure for the treatment of degenerative disc disease. The anterior approach allows direct visualization of the entire interspace and wide decompression of the anterior aspect of the cervical spinal cord and nerve roots; it may be undertaken in

cases of multilevel disease and interbody fusion may be performed if required [2].

Even if several authors maintain the performance of a fusion procedure following which an anterior cervical discectomy is not absolutely necessary, spinal cord and nerve root decompression and anterior cervical fusion thereafter are standard procedures for degenerative cervical disc disease accepted almost worldwide [3].

Polyetheretherketone (PEEK) is a semicrystalline aromatic polymer with a modulus of elasticity resembling bone that has been used to create structural spinal implants. PEEK implants combine superior strength and impact resistance with radiolucency and do not produce artifacts on plain films, computed tomography scans, or MRI. Four titanium pins are inserted on both surfaces of the spacer for better bone fixation and for x-ray localization [4].

Patients receiving anterior cervical discectomy and fusion (ACDF) with local bone graft combined with a PEEK cage had a significantly shorter operation time, lower perioperative complication rates, and better radiological results comparing with those with an iliac bone graft alone. It seems that the local bone graft with a PEEK cage appears to be a safe alternative to the iliac bone graft for ACDF [5].

Patients and methods

Twenty patients aged from 20 to 65 years, 16 females (80%) and four males (20%) with symptomatic cervical disc disease presented in the outpatient clinic, Menoufia University Hospital from 2012 to 2014, were examined and followed up prospectively, all cases were operated at Menoufia University Hospital, except microscopic cases at El Hadra University Hospital. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Menoufia University, Egypt. Consent of the patients to do operation was taken.

Age: the mean age was 43.25±9.06 (range: 28–60) years.

Type of affection: there were 13 patients (65%) with radiculopathy only, two patients (10%) with mylopathy only, and five patients (10%) with radiculomylopathy.

Preoperative Ranawat grading of myelopathy: seven cases were affected by mylopathy graded according to Ranawat grading.

Affected levels: there were 37 levels affected among the twenty patients. C5,6 was the commonly affected level 15 (40.5%), then C4,5 11(29.7%), then C6,7 7 (18.9%), and the least one was C3,4 4 (10.8%).

Scoring systems

The preoperative score of neck-disability index (NDI), Visual Analog Pain Scale (VAS), and Ranawat classification of mylopathy was available in the study.

Mean preoperative NDI: preoperative NDI mean was 62.55% and SD: 1.397.

Mean VAS: preoperative VAS mean was 5.85 and SD: 1.387.

Cases operated by microscope: five cases were operated by using a microscope.

Method of treatment

ACDF using PEEK cages and local bone graft.

Methods of assessment

Postoperative evaluation was performed after surgery during follow-up visits at 3, 6, and 12 months. NDI and visual pain analog were used as outcome tools and Odom's criteria for clinical outcome at the final assessment.

Fusion status was evaluated with x-ray. Four planes of x-rays were used, including anterior–posterior, neutral and flexion, and extension lateral views. The criteria for bone fusion were either crossing bony speculae across the fusion level in x-rays or no change in the position of the fused levels on dynamic views (flexion and extension), to assess the fusion (fused, delayed, or not fused) and fusion rate (poor, average, good, and excellent). Interbody ratio, disc space height, cervical lordosis angles, position of the cage, and cage subsidence (>2 mm).

Statistical analysis

The results were collected, tabulated, and statistically analyzed by an IBM-compatible personal computer with SPSS software package (version 20.0; IBM Corp., Armonk, New York, USA).

The type of statistical analysis done was descriptive statistics as follows:

(1) Quantitative data: were presented by a mean and SD
(2) Qualitative data: were presented by number and percentage

Results

The clinical results were assessed according to NDI, VAS of the arm, and Odom's criteria at the final follow-up. All cases fulfilled the inclusion criteria. The radiological results were fusion status, disc space height, interbody ratio, and cervical lordosis angle. The follow-up period was 2 years:

(1) Mean operative time per microscopic level was 64.5 min
(2) Mean operative time per nonmicroscopic level was 47 min
(3) Mean operative time per case, regardless to the number of levels, was 95.75±42.24 min

Intraoperative complications: the only intraoperative complication was external jugular-vein ligation that occurred in two cases (nonmicroscopic).

Postoperative compilations: the only postoperative complication was difficulty in swallowing, which occurred in 13 cases (11 nonmicroscopic and two microscopic).

Radiological parameters

The mean of preoperative interbody ratio was 1.8±0.2, 12 months postoperative, the mean was 1.9±0.2. There was a statistically significant difference in the mean of interbody ratio preoperative and at 12 months as shown in the table *P* value of 0.001 and *t*-test=5.2.

The mean preoperative disc space height was 3.3 ±0.8 mm, 12 months postoperative was 5.8±0.9. There was a statistically significant difference in the mean disc space height preoperative and 12 months postoperative, *P* value of 0.000 and *t*-test=20.9.

The mean preoperative cervical lordosis angle was 16.70 ±7.1, 12 months postoperative was 14.45±5.5. There was a statistically significant difference in the mean cervical lordosis angle, *P* value of 0.001 and *t*-test=7.1.

The rate of fusion at 12 months: three levels were average fusion, 26 levels were good fusion, and eight levels were excellent fusion.

The mean preoperative (NDI) was 62.55%±13.1, 12 months postoperative was 31.55%±8.8. There was a statistically significant difference in the mean NDI *P* value of 0.001 and *t*-test=16.

Progression of VAS preoperative and at 12 months of follow-up:

The mean preoperative (VAS) was 5.85±1.4, 12 months postoperative was 1.55±1.1. There was a statistically significant difference in the mean preoperative VAS and 12 months postoperative VAS *P* value of 0.001 and *t*-test=16.4.

Ranawat classification clinical assessment at the final follow-up:

Preoperatively, there was a case (grade 1) improved to (grade 0), three cases were (grade 2), two cases became (grade 1) and one case still (grade 2), and three cases were (grade 3A), they improved to (grade 2).

Odom's criteria clinical assessment at the final follow-up: there were 12 cases, excellent and eight cases, good.

The relation between the use of microscopy on clinical assessment by Odom's criteria: it was observed that clinical assessment using Odom's criteria was better in patients operated microscopically compared with nonmicroscopic cases.

Effect of use of microscopy on NDI: it was observed that use of microscopy improves the NDI but it was a statistically not-significant *P* value of 0.7 and χ^2=0.58.

Discussion

Good and excellent fusion was 92% and average fusion was 8% at 12 months, these results are comparable with literature:

Sharon and colleagues in a retrospective study reviewed ACDF cases from November 2005 to September 2012 on 48 patients (85th level); using PEEK cage, good fusion was 91.6% and nonunion was 8.4% after 9 months [6].

Jia-Ming *et al.* [5] did a prospective study on 29 patients who underwent ACDF with PEEK cage and the local bone graft fusion rate was 93.1% after a period of a 24-month follow-up.

Galhom [7] did a prospective study to compare between the PEEK cage and iliac graft in ACDF; fusion occurred in 17/20 patients (85%) and 29/34 (85.2%) segments of the PEEK group:

(1) Radiological parameters.
(2) Mean disc space height increased in C3,4 from preoperative 3.5–5.75 mm 12 months postoperatively (60% increase in height), C4,5 from 3.09 to 5.8 mm (53% increase in height),

C5,6 from 3.4 to 5.76 mm (59% increase in height), and C6,7 from 3.33 to 6 mm (55% increase in height).

(3) Interbody ratio according to the percentage of change to every level was 98.6% for C3,4, 94% for C4,5, 91% for C5,6, and 90.6% for C6,7.

(4) Mean cervical lordosis angle increases from 16.70 to 24.45° (68% increase).

(5) These results are comparable to the literature.
   (a) Siddiqui and Jackowski did a prospective randomized study of 42 cervical interbody fusions undertaken with cage-percentage change in the interbody height ratio at 6 months. The mean percentage change in interbody height ratio was 99%, disc space height percentage increased by 54% [8].
   (b) Jia-Ming Liu and colleagues did a prospective study on 29 patients who underwent ACDF with PEEK cage and the local bone graft in this study's preoperative disc space height was 6.13 ±0.57 and in the final follow-up was 9.30 ±0.62 [9].

(6) Mean operative time was 95.75 min, the nonmicroscopic level was 47 min, and the microscopic level was 64,5 min, these results are comparable with literature; Fabio Papacci did a retrospective study on 99 patients who underwent ACDF with cage, the mean operative time was 73.97±22.17 min[10].

(7) Mean NDI preoperatively was 62.55% decreased to 31.55% 12 months postoperative, these results were comparable to the literature.

(8) Fabio Papacci study's preoperative NDI was 50.5 ±12.8 decreased to 15.6±11.7 [10].

(9) Mean VAS preoperative was 5.58, 12 months postoperative was 1.55, this result is comparable with literature.
   (a) Jae-Young Park did a prospective study in a single-level ACDF with a stand-alone PEEK cage: preoperative VAS was 4.27, at the last follow-up was 2.5 [11].
   (b) Jia-Ming Liu's study: the preoperative VAS was 6.69 at the last follow-up: 2.38 [5].
   (c) Papacci and colleagues' study: preoperative VAS was 8.05, at the last follow-up was 1.94 [10].
   (d) Sharon's study: preoperative VAS was 6.5, at the last follow-up was 4.1 [6].
   (e) In this study, microscopic ACDF was done in five cases (25% of all cases), 10 levels of the total 37 levels (27% of all levels); we studied the use of a microscope on clinical outcome; according to Odom's criteria, 80% of the cases were excellent and 20% were good, the nonmicroscopic cases were 53.3% excellent and 46.7% good. According to NDI, 40% of microscopic cases were less than 25% NDI and 60% were 25–50%. In the nonmicroscopic cases, 26.7% were less than 25%, 66.7% were 25–50%, and 6.7% more than 50%. These results showed that there are superior clinical results of microscopic cases.
   (f) In the literature, the intraoperative use of a microscope allows the surgeon good visualization and proper decompression that has an impact on the clinical results [12].
   (g) Owoicho Adogwa in a prospective study compares the surgical outcomes after ACDF: 81 cases nonmicroscopic and 59 microscopic cases, he used NDI and VAS for clinical assessment, and at 2 years postoperatively, both the microscope and nonmicroscope cohorts demonstrated similar improvement from the baseline in NDI, but VAS was significantly different between the cohorts (microscopic cohort 2.22, nonmicroscopic cohort 3.69), but he concludes that the results of his study indicate that it does not improve the overall surgery-related outcomes nor does it lead to superior long-term outcomes in pain and functional disability over a 2-year follow-up period [13].Complications: we had two cases of intraoperative ligation of external jugular-vein ligation that is commonly present in the surgical field and is vulnerable to injury during dissection, there is no drawback for ligation.
   (h) Postoperative complications were only difficulty in swallowing, which occurred in 13 patients of our study (65%), which is a high percentage in contrast with literature, the cause of this high percentage was the use of non-self-retaining retractors that do overtraction to the esophagus and trachea. This difficulty in swallowing did not continue more than 48 h.

(10) Fountas and colleagues in a retrospective study, 1015 patients undergoing first-time ACDF. The mortality rate was 0.1% (1 of 1015 patients, death occurred secondary to an esophageal perforation). The overall morbidity rate was 19.3% (196 of 1015 patients). The most common complication was the development of isolated postoperative dysphagia, which was observed in 9.5% of patients. Postoperative hematoma occurred in

5.6%, but required surgical intervention in only 2.4% of our cases. Symptomatic recurrent laryngeal nerve palsy occurred in 3.1% of our cases. Dural penetration occurred in 0.5%, esophageal perforation in 0.3%, worsening of preexisting myelopathy in 0.2%, Horner's syndrome in 0.1%, instrumentation backout in 0.1%, and superficial wound infection in 0.1% of our cases [14].

Conclusion

ACDF is considered ideal for treating cervical degenerative disc diseases with radiculopathy or mylopathy in terms of clinical improvement, restoration of cervical lordosis, bone fusion, and in long-term follow-up.

Adequate decompression and solid fusion are the success of ACDF.

PEEK cage filled with local bone graft in cervical degenerative disc diseases gives good results with avoidance of iliac graft harvesting or bone substitute usage.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Cho DY, Lee WY, Sheu PV. Treatment of multilevel cervical fusion with cages. Surg Neurol 2004; 62:378–386.

2 Moreland DB, Asch HL, Clabeaux DE, Castiglia GJ, Czajka GA, Lewis PJ, *et al.* Anterior cervical discectomy and fusion with implantable titanium cage. Spine J 2004; 30:23–44.

3 Madawi AA, Powell M, Crockard HA. Biocompatible osteoconductive polymer versus iliac graft, a prospective comparative study for the evaluation of fusion pattern after anterior cervical discectomy. Spine 1996; 21:2123–2129.

4 Malone Q, Lynn J, Lunn J. Surgical outcome for anterior cervical discectomy and fusion using the Signus Rabea PEEK cage. Spine J 2003; 3:129–130.

5 Jia-Ming L, Xu X, Ai-Fen P, Min X, Xuan-Yin C, Xin-Hua L, *et al.* A comparison of local bone graft with PEEK cage versus iliac bone graft used in anterior cervical discectomy and fusion. Clin Neuro Neurosurg 2017; 155:30–35.

6 Pitzen T, Kiefer R, München D, Barbier D, Reith W, Steudel WI. Filling a cervical spine cage with local autograft: change of bone density and assessment of bony fusion. Zentralbl Neurochir 2006; 67:8–13.

7 Galhom EA. Comparison between polyetheretherketone (PEEK) cages versus an iliac-crest autograft used in treatment of single or double level anterior cervical discectomy. Med J Cairo Univ 2013; 81:9–17.

8 Fountas KN, Kapsalaki EZ, Nikolakakos LG, Smisson HF, Johnston KW, Grigorian AA, *et al.* Anterior cervical discectomy and fusion associated complications. Spine 2007; 32:2310–2317.

9 Sharon C, Son Y, Jonathan N, Sembrano E, Rainier G. Comparison of allograft and PEEK cage subsidence rates in anterior cervical discectomy and fusion. J Clin Neurosci 2017; 38:118–121.

10 Siddiqui AA, Jackowski A. Cage versus tricortical graft for cervical interbody fusion. J Bone Joint Surg 2003; 85:1019–1025.

11 Cabraja M. Anterior cervical discectomy and fusion:Comparison of titanium and polyetheretherketone cages. BMC Musculoskelet Disord 2012; 13:172.

12 Papacci F, Rigante L, Fernandez E, Meglio M, Monato N. Anterior cervical discectomy and interbody fusion with porous tantlum implant .Results in a series with long term follow up. J Clin Neurosci 2016; 33:159–162.

13 Jae-Young P, Ki-Young C, Bong JU, Hyuk H. Subsidence after singlelevel anterior cervical fusion with stand alone cage. J Cilin Neurosci 2016; 33:83–88.

14 Min WK, Bae JS, Park BC, Jeon IH, Jin HK, Son MJ, *et al.* Proliferation and osteoblastic differentiation of bone marrow stem cells: comparison of vertebral body and iliac crest. Eur Spine J 2010; 19:1753–1760.