Med. J. Cairo Univ., Vol. 93, No. 2, Accepted 18/5/2025
DOI: 10.22608/MJCU. 945-948, June 2025
www.medicaljournalofcairouniversity.net

A Single Level Anterior Cervical Discectomy and Fusion, it's Impact on Disc Height of Surgical and Adjacent Cervical Levels

WALID E. ELHALABY, M.D.*; AMR A.A.M. ELKATATNY, M.D.** and OMAR ABDELALEEM RAGAB, M.D.***

The Department of Neurosurgery, Faculty of Medicine, Cairo,** and Beni Suef*** Universities*

Abstract

Background: Anterior cervical discectomy and fusion (ACDF) is the gold standard treatment for cervical disc herniation after failure of conservative non-surgical treatment measures, Adjacent segments degenerative changes are a well-known sequel after ACDF. Several theories were discussed to explain this phenomenon.

Aim of Study: The aim of the study was to study the adjacent levels both above and below, as well as the affected discs for height changes during one year follow-up period.

Patients and Method: This is a prospective clinical study conducted on 64 patients who underwent anterior cervical discectomy for one level in the Neurosurgery Department of Cairo University hospitals, in the period from Nov. 2018 till May 2023 cases had a follow-up period ranging from 6 months to 24 months (mean 15 months). Our cases included patients with both cervical radiculopathy and cervical myelopathy syndromes caused by disc disease. The heights of the affected disc space and the two adjacent levels (the next cranial and caudal ones) were assessed preoperatively by measuring a ratio between the disc height and the vertebral body below.

Results: Sixty-four patients with single level cervical disc pathology were evaluated during the period assigned for data collection from Nov. 2019 till May 2023. Data collected from these cases was statistically analyzed. 41 males and 23 females (M/F ratio 1.78). The pre-operative ratio between the affected discs heights and the vertebrae below ranged from 0.24 to 0.34, with a mean ratio of 0.29. These ratios for the adjacent levels ranged from 0.35 to 0.40, with a mean of 0.37. these ratios were recalculated immediately after surgery and along follow-up.

Conclusion: Decrease in disc height is one of the earliest of these changes. It's encountered it almost all cases after surgery by a short period. However, these radiographic changes haven't shown any clinical implication in the short follow-up period. A longer follow-up period is needed.

Correspondence to: Dr. Walid E. Elhalaby, The Department of Neurosurgery, Faculty of Medicine, Cairo University

Key Words: *Adjacent segment – Degenerative cervical disease – Disc height – ACDF.*

Introduction

SINCE Smith and Robinson first introduced the technique of Anterior cervical discectomy and fusion **[1]**, followed by with a lot of technological improvements (such as effective intervertebral distraction with Caspar plating system), ACDF has become one of the established procedures for the surgical treatment of cervical spondylosis **[2].** Anterior cervical discectomy and fusion remains safe and effective treatment for cervical disc diseases causing cervical root or spinal cord compression. The main aims are to decompress the cervical nerve roots and the spinal cord, to restore the height of the disc space as well as the height of the foramen, to restore the normal cervical lordotic curve, and to subsequently cause fusion. Intervertebral Polyetheretherketone (PEEK) cages filled with bone are routinely used for filling of the empty disc space after surgery and to restore the disc heights **[3].**

The restored height of the surgical site may cause subsequent degeneration in the levels adjacent to the operated levels both above and below remains an important issue. Several theories explain the etiology of adjacent segment degeneration following cervical fusion. One suggested theory explains that adjacent level degenerations occur as a part of the natural history of the degenerative spine disease, which is suspected to occur at multiple levels at different times **[4,5].** Another theory refers degeneration to occur because of the intradiscal pressure. The increased intradiscal pressure reduces diffusion of nutrients from the end plates. Impaired nutrition of the disc can lead to early degenerative changes and loss of disc height **[6].** Another theory to explain the adjacent level degeneration is that fusion of a level will increase strains and stresses on the adjacent levels. Those increased stresses may accelerate

degenerative changes or wearing out to occur in the adjacent levels **[7].**

In this retrospective study, we are reviewing a series of cases after single level anterior cervical discectomy and cage fusion. The aim of the study was to study the adjacent levels both above and below, as well as the affected discs for height changes during one year follow-up period, and to detect if there was any clinical influence from these height changes.

Patients and Methods

This is a prospective clinical study conducted on 64 patients who underwent anterior cervical discectomy for one level in the Neurosurgery Department of Cairo University Hospitals, in the period from Nov. 2018 till May 2023 cases had a follow-up period ranging from 6 months to 24 months (mean 15 months). Our cases included patients with both cervical radiculopathy and cervical myelopathy syndromes caused by disc disease. All patients had Intervertebral Polyetheretherketone (PEEK) cages filled with bone are routinely used for filling of the empty disc space after surgery and to restore the disc heights. Preoperative imaging included MRI examination of the cervical spine, as well as, anteroposterior and lateral cervical digital X-rays. All patients had a lateral X-Ray for the cervical spine, immediate postoperatively and at the end of the follow up period.

The heights of the affected disc space and the two adjacent levels (the next cranial and caudal ones) were assessed preoperatively by measuring a ratio between the disc height and the vertebral body below. This ratio is calculated on plain digital lateral X-rays of the cervical spine. These X-rays are examined on a computer, zoomed in, and measured with a ruler. The ratio is calculated by dividing the height of the disc in the midline, by the height of the vertebral body below, also in the midline. We calculated the ratio in the midline to avoid being deflected by anterior or posterior osteophytes. We have chosen to assess the disc height using a ratio rather than just a measurement as the X-Rays lacks a standard scale for measurement, and also to be able to enlarge the X-Ray images for more accurate calculations.

Single level anterior cervical microdiscectomy and fusion (ACDF) was performed for all cases. Adequate decompression of the spinal cord and both nerve foramina was done. A hollow Polyetheretherketone (PEEK) intervertebral cage filled with autologous bone was used for bony fusion. Intraoperative X-Ray was utilized to avoid too much distraction; caused by big sized cages, to reduce the effect on the adjacent disc levels.

A full neurological evaluation was done to all patients preoperative and post-operative using the modified Japanese Orthopedic Association (mJOA) **[7]** score and the visual analogue scale for pain (VAS) **[8]**.

Results

Sixty-four patients with single level cervical disc pathology were evaluated during the period assigned for data collection from Nov. 2018 till May 2023. Data collected from these cases was statistically analyzed. 41 males and 23 females (M/F ratio 1.78). Age of patients ranged between 30 years and 58 years. The mean age was 44 years. All cases included in this study were chosen to have single level pathology. The surgical levels were in level C3/4 9 cases (14%), followed by C4/5 in 13 cases (20%), C5/6 in 23 cases (35%), and finally C6/7 in 19 cases (29.6%).

Neck pain was manifested in all cases, while brachialgia without gait disturbance nor manifestations of myelopathy were present in 44 cases (68% of all cases). Twenty cases (32%) presented with cervical myelopathy. Motor weakness manifested in 18 cases (28% of all cases). Pre-operative mJOA scores ranged from 10 to 18, with a mean of 14. Pre-operative VAS for pain ranged from 20 to 100, with a mean of 60. Duration of symptoms ranged from 6 months to 5 years.

The pre-operative ratio between the affected discs heights and the vertebrae below ranged from 0.24 to 0.34, with a mean ratio of 0.29. These ratios for the adjacent levels ranged from 0.35 to 0.40, with a mean of 0.37. When these ratios were recalculated immediately after surgery, the mean ratio for the affected disc raised to 0.37 (27% increase), ranging from 0.35 to 0.39. While the mean ratios for the adjacent levels became 0.36 (2.7% decrease), ranging from 0.33 to 0.42. At the end of the follow up period, the mean ratios for the affected levels became 0.36 (3% decrease from immediate post operative); while the mean ratios for the adjacent levels became 0.35 (5.4% decrease from initial).

Immediate post-operative mJOA scores ranged from 12 to 18, with a mean of 17.11 (recovery rate 55.5%), and at the end of the follow-up it ranged from 14 to 18, mean 17.48 (recovery rate 74%). Post-operative VAS for pain ranged from zero to 60, mean 18.3 (66.7% improvement), and at the end of the follow-up it ranged from zero to 30, mean 3.1 (94.4% improvement). 44.4% of cases had no pain after one week, while 86.1% of cases had no pain at the end of the follow-up. None of our cases should post-operative deterioration in their mJOA, or VAS scores at the end of the follow-up period.

Discussion

Anterior cervical discectomy and fusion is the gold standard treatment for cervical disc herniation after failure of conservative non-surgical treatment

measures. It can be utilized safely for removal of both nerve root and cord compression. The use of intervertebral cages will enhance cervical fusion, distract the disc space, and preserve the disc height. Also, placement of intervertebral cages leads to indirect foraminal decompression; combined with removal of osteophytes from the unco-vertebral joints this helps to relieve radiculopathy symptoms.

Adjacent segments degenerative changes are a well-known sequel after ACDF. Several theories were discussed to explain this phenomenon, whether it's a part of the degenerative process related to aging, or if it's secondary to the fused level. Disc height changes are one of the earliest adjacent level degenerative changes to occur.

Our study was conducted upon 64 patients with single level cervical disc, managed with anterior cervical discectomy with fusion with PEEK intervertebral cage. Patient's data was analyzed to identify the recovery rates. The heights of the two adjacent disc spaces to the operated level (one from the cranial side, and one from the caudal side) were examined pre and postoperatively. We have chosen to use the ratio between the disc height and the height of the vertebra below for evaluation of disc heights; rather than just measuring the disc height, to eliminate differences in the scale of the X-rays and also to facilitate the use of the computer to enlarge the images for more accurate calculations of the disc height.

The mean age of the cases in our study was 44 years and 64% of our cases were males. The most common level to be affected was C5/6 in 35% of cases, followed by C6/7 in 29% of cases. The mean duration of symptoms was 18.6 months. 68% of cases presented with cervical radiculopathy, while 32% presented with cervical myelopathy. The mean preoperative mJOA score was 14, and the mean VAS score for neck pain was 60. These numbers were matching with many of previous studies and literature review. The study by Lotfinia et al. **[4]** had a mean age of 43.5 years, 61% of cases were males, and most common level was C5/6 in 58% of cases.

The preoperative mean ratio between the height of the diseased disc and the vertebra below was 0.29. This ratio changed to 0.37 and 0.36 (immediate postoperatively and at the end of the follow-up period). This was an increase in height by 27.5 and 24% from the original height. That increase in the disc height goes with the function of the cage to restore the height to the normal levels.

The mean preoperative ratio for the adjacent levels was 0.37. These ratios decreased postoperatively in all cases, to become 0.36 and 0.35 (immediate postoperatively and at the end of follow-up). This was a decrease in height by 2.7 and 5.4% from the original height.

These numbers go with several published researches focusing on similar ideas. Tureyen **[9]** reported disc height reduction in 35.6±9% of his 43 patients; in a follow-up period of 18±5 months. None of these cases had new symptoms at the end of the follow-up. In the study published by Lotfinia et al. **[5]**, they reported 85% increase in the operated disc height at the end of the follow-up. They also reported 3.3% decrease in the height of the adjacent level (the cranial level). Also, none of their cases had new symptoms after a follow up period of 6 to 36 months. Other studies with longer follow up periods have reported higher rates for these adjacent levels to symptomatize. Hilibrand et al., reported that 25.6% had symptomatic adjacent segment disease after follow-up for 10 years. They concluded that there was a constant annual rate of 2.9% for occurrence of adjacent level degeneration **[10]**.

The mean mJOA score at the end of the follow up was 17.48; this shows a mean recovery rate of 74%. The mean VAS score for pain was 3.1, which shows 94.4% improvement. 86.1% of cases had no pain at the end of the follow-up. None of our cases showed worsening in their preoperative mJOA or VAS at the end of the follow-up; and also, none of the cases have shown any new complaints related to adjacent levels at the end of the follow-up. These results go with the generally accepted outcomes following ACDF and several of the previously published papers. Yue et al. **[11]** reported 86%, while Martin et al. **[6]** reported 64% recovery rate.

Conclusion:

Adjacent segment degenerative changes remain a common postoperative sequel of ACDF with intervertebral cages. Several theories have been described as the cause of these changes. Decrease in disc height is one of the earliest of these changes. It's encountered it almost all cases after surgery by a short period. However these radiographic changes haven't shown any clinical implication in the short follow-up period. A longer follow-up period is needed, to evaluate whether these alterations in the disc heights will translate to symptomatic adjacent level disease; that may require further management.

References

1- ROSARIA MAUGERI, LARA BRUNASSO, ANDREA SCIORTINO, et al.: The Impact of Single-Level ACDF on Neural Foramen and Disc Height of Surgical and Adjacent Cervical Segments: A Case-Series Radiological Analysis. Brain Sci., Jan. 4; 13 (1): 101, 2023.

2- WEN Z., LU T., WANG Y., LIANG H., GAO Z. and HE X.: Anterior Cervical Corpectomy and Fusion and Anterior Cervical Discectomy and Fusion Using Titanium Mesh Cages for Treatment of Degenerative Cervical Pathologies: A Literature Review. J. Pharmacol. Exp. Ther., 24: 6398–6404, 2018.

3- CHANG U.K., KIM D.H., et al.: Changes in adjacent level disc pressure and facet joint force after cervical arthroplasty compared with cervical discectomy and fusion. J. Neurosurg (Spine), 7: 33-39, 2007.

4- LOTFINIA I., SAYYAHMELLI S. and GAVAN M.: Efficacy of anterior cervical discectomy and fusion on adjacent disc height. Neurosurgery Quarterly, 21 (2): 137-142, 2011.

5- MARTIN R., CARDA J.R., et al.: Cervical myelopathy: retrospective analysis of surgical results in 53 cases treated by anterior cervical discectomy and interbody fusion. Neurocirugia (Astur), 15 (3): 235-55, 2005.

6- HIRABAYASHI K., MIYAKAWA J., et al.: Operative results and postoperative progression of ossification of the longitudinal ligament. Spine, 6: 354-64, 1981.

7- BENZEL E.C., LANCON J., et al.: Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. J. Spinal Disord, 4: 286-295, 1995.

8- ROBERTSON J.T., PAPADOPOULOS S.M. and TRAYNELIS V.C.: Assessment of adjacent segment disease in patients treated with cervical fusion of arthroplasty: A prospective 2-year study. J. Neurosurg (Spine), 3: 417-423, 2005.

9- TUREYEN K.: Disc height loss after anterior cervical microdiscectomy with titanium intervertebral cage fusion. Acta. Neurochir., 145: 565-570, 2003.

10- HILIBRAND A.S., CARLSON G.D., et al.: Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis. J. Bone Joint Surg. Am., 81: 519-528, 1999.

11- YUE W.M., BRODNER W., et al: Long-term results after anterior cervical discectomy and fusion with allograft and plating. A 5- to 11-year radiologic and clinical follow-up study. Spine, 30: 2138–2144, 2005.

استئصال القرص الفقرى العنقي الأمامي على مستوى واحد ودمجه، وتأثيره على ارتفاع القرص فى المستويات الجراحية والعنقية المجاورة

الهدف من هذه الدراسة هو تقييم التغيرات فى ارتفاعات الأقراص العنقيه المجاورة، بعد جراحات ازاله الغضروف العنقى من الأمام والثبيت بواسطة اقفاص البلاستسكية على مستوى واحد. هّذه دراسة استباقية، تم اجراءها على ٦٤ مريض. اظهرت النتائج حدوث انخفاض فى ارتفاعات الغضاريف المجاورة فى كل الحالات، وكان الأنخفاض فى المتوسط بنسبة ٥.٤٪ من الأرتفاع الأساسى. لم يعانى اى من المرضى من تدهور اكلينيكى ناتج عن تغير ارتفاعات الأقراص المجاورة. تعد هناك حاجة إلى فترة متابعة اطول لتقييم نتائج السريرية لهذه النتيجة الإشعاعى.