

## Anterior Cervical Discectomy (ACD) Versus Anterior Cervical Fusion (ACF), Clinical and Radiological Outcome Study

N. Abd-Alrahman<sup>1</sup>, A. S. Dokmak<sup>1</sup> and A. Abou-Madawi<sup>2</sup>

<sup>1</sup> Department of Neurosurgery, Alexandria University, Alexandria, Egypt

<sup>2</sup> Suez Canal University Hospital, Ismailia, Egypt

### Summary

This study was conducted on 90 patients with symptomatic cervical disc disease with one or two-level disc pathology.

Clinical and radiological outcome was compared to determine which technique was advantageous for patients with disc disease.

Problems related to donor site as well as those related to fusion bed and grafts have stimulated investigators to avoid fusion.

Patients were allocated at random for either the ACF (n = 50) or the ACD (n = 40) procedures. The standard Smith-Robinson technique was performed on all patients in this study. Patients were followed-up clinically and radiologically according to the study protocol.

The clinical long-term outcome was comparable in both groups, though those who had ACF were more satisfied. There was significant incidence of kyphosis in the ACD group (P = 0.02). Osseous union was slow and less satisfactory with ACD (64%) than with ACF (94%). Pain at the donor site was not a significant problem in the long-term. Hospital stay and operative time was shortened in ACD patients though not significantly. Spondylotic patients were less satisfied with ACD though not significantly.

**Conclusions.** The issue of whether to fuse or not to fuse has not come to an end yet. The technique is still in need of more refinement of disc excision and graft harvesting and shaping, as well as more adequately controlled studies. Until that, ACD has to be limited to those patients with a soft single disc without spondylosis.

**Keywords:** Anterior cervical discectomy; anterior cervical fusion; cervical disc disease.

### Introduction

Anterior cervical discectomy with bone fusion (ACF) as has been described by both Cloward and Smith-Robinson [2, 16] has become a routine neurosurgical procedure. Although the technique is ideal for patients with cervical disc disease it has been associated with graft harvesting problems such as pain, infection, haematomas, nerve injury, and iliac crest deformity, as well as graft and fusion problems at the fusion bed such as non-union, graft collapse or dis-

lodgement [7, 8, 13]. In attempts to overcome the graft related problems, anterior cervical discectomy without bone fusion (ACD) was introduced in 1960 by Hirsch [5]. Nevertheless, ACD has usually been associated with postoperative neck pain, cervical curve deformity, and low fusion rate [10, 11]. Hospital stay is an important consideration in the recent era of cost consciousness. Currently there is an ongoing debate between proponents of ACF versus ACD. This debate has stimulated the investigators to conduct this prospective study to determine which technique would be most advantageous for patients with disc disease.

### Patients and Methods

#### Patients

Ninety patients with one- or two-level symptomatic cervical disc disease refractory to adequate conservative treatment were prospectively recruited for this study. Each patient was clinically and radiologically evaluated before scheduling surgery. Cases with multi-level disease, ossification of posterior longitudinal ligament, or those requiring re-operation, or instrumental stabilisation were excluded from this study.

The demographic data of patients shows that both groups were fairly homogeneous (Table 1). Clinically, 65 patients (72%) presented with radiculopathy, 17 patients (19%) with myelopathy, 8 patients (9%) with radiculomyelopathy. Of these patients, 79 (88%) had neck pain. Seventy patients (78%) had one-level disease and 20 patients (22%) had two-level disease (Table 1). The mean duration of symptoms and signs was  $13.7 \pm 12.4$  months. Evidence of cervical spondylosis such as; narrow disc space, sclerosed disc margins, and osteophytes was observed on plain radiography in 58 (64%) of our population. Before surgery, 24 patients (27%) had lost their cervical lordosis, and 9 patients (10%) had a varying degree of kyphosis (Table 2).

#### Surgical Technique

Surgical procedures were carried out through the standard anterolateral approach of Smith-Robinson [16]. Fluoroscopy was used to

Table 1. Demographic Data

Data	ACD	ACF
Number of patients	40	50
Mean age (yr)	40 ± 8.4	49.7 ± 13.2
Gender (Male/female)	28/12	32/18
Presentation (radicular/myelopathic)	32/8	33/17
Mean duration of symptoms and signs (mo)	10.1 ± 6.8	15.9 ± 18
Disc type (soft/hard)	28/12	23/27
Surgical procedure (single-level/two-level)	32 (80%)	38 (76%)
Mean inpatient period (day)	4.2 ± 0.8	4.8 ± 1.4
Mean follow-up period (mo)	14.3 ± 2.4	16.4 ± 6.2

Table 2. Post and Pre-Operative Kyphosis\*

Group	Normal spine	Straight spine	< 15 degrees kyphos	≥ 15 degrees kyphos
ACD (n = 40)	2 (24)	16 (12)	18 (2)	4 (2)
ACF (n = 50)	27 (33)	9 (12)	9 (5)	5 (0)
Total (n = 90)	29 (57)	25 (24)	27 (7)	9 (2)

\* The pre-operative values are in between brackets.

determine the position of skin incision, the target disc level, and the adequacy of graft positioning at the end of the procedure. Posterior longitudinal ligament was excised systematically in every case to ensure adequate neural decompression. Patient allocation to either of the ACD or ACF techniques was done at random.

For ACF procedures, a bicortical iliac crest graft (IG) was harvested using the triple osteotome technique [9], where one osteotome was used to elevate the iliac crest with its muscle attachment intact, and then two osteotomes were used to cut the graft, which was therefore bicortical and a few millimetres larger in height than the decompressed disc space to ensure a “press fit” effect. Working 5 cms behind the anterior superior iliac spine and without dissection of the iliac crest, this avoided cutaneous nerve injury, preserved the iliac crest and was associated with minimal pain.

#### Follow-up

Postoperatively, patients wore a soft neck collar for a month and were followed-up routinely in the outpatient clinic for clinical as well as radiological assessment according to the follow-up protocol (Table 3).

*Clinical.* Patients were examined neurologically and categorised according to Odom’s criteria for outcome evaluation [12]. *Excellent results* = no complaints referable to cervical disease and patients were able to carry on their daily occupation without impairment; *Good results* = intermittent discomfort related to cervical disease which did not significantly interfere with their work; *Satisfactory results* = subjective improvement but patients’ physical activities were significantly limited; *Poor results* = no improvement or worse than before surgery.

The Pain Visual Analogue Scale as described in detail by Scott and Husksson [15] was used for assessment of pre, and postoperative neck, arm, and iliac pain. In this test each patient was asked to allo-

Table 3. Postoperative Follow-up Protocol

Follow-up	1 m*	3 ms	6 ms	12 ms	18 ms	24 ms
1. Clinical	+	+	+	+	+	+
2. Visual analogue	–	–	+	–	–	–
3. X-ray	+	+	+	+	+	+
4. CT-scan	–	±	–	±	–	±

\* m\ s Month\ s.

cate his pain on a horizontal graphic rating scale (0–100) with the descriptions; *severe*, *moderate*, and *mild* at equal intervals along a line that started with *pain as bad as it could be* and ended with *no pain*. This was calculated as percentage where 0% equivalent to no pain, and 100% equivalent to as bad as it could be.

*Radiological.* In this study, *cervical curve*, *graft collapse*, *graft protrusion*, and *fusion pattern*, have been evaluated using plain radiographs P-A, lateral, and dynamic study, CT-scans and/or MRI. A *fusion* was termed solid when bony trabeculae were clearly seen crossing the disc space. A *non-union* was defined as failure of bone to bridge across the disc space and persistence of a lucent line. The postoperative *cervical curve* was considered abnormal if cervical lordosis was lost or reversed. In this study, posterior vertebral borders were used as landmarks to measure the intersegmental angles, as it was difficult to determine the inferior vertebral borders after fusion. A graft was considered *collapsed* if greater than 2 mm loss of height occurred between the per, and postoperative radiographs. A graft was termed *protruded* if more than 2 mm protrusion occurred between the per, and postoperative radiographs.

#### Statistical Analysis

The MINITAB\* mathematical programme was used and the data were evaluated by the Chi squared test. Significance was accepted at P less than 0.05.

## Results

The mean hospital stay was 4.2 ± 0.8, and 4.8 ± 1.4 days for those who have had ACD and ACF respectively with no statistically significant difference in between. Also there was no statistically significant difference in the operative time in both groups with mean operative time of 110 ± 29 and 140 ± 34 minutes for ACD and ACF patients respectively. The mean follow-up was 15.4 ± 4.9 months with a range of 6 to 24 months. All followed patients had plain radiographs routinely according to the follow-up protocol. In addition, 40% had postoperative CT-scans at various intervals to study in detail the operative site.

According to Odom’s criteria, 84.4% of patients of both groups have had good to excellent functional re-

\* Statistical soft ware obtained from MINITAB, INC. State college, USA

Table 4. *Clinical Outcome*

Group	Excellent	Good	Satisfied	Poor
ACD (n = 40)	24	12	2	2
ACF (n = 50)	20	20	7	3
Total (n = 90)	44	32	9	5

According to Odom (1958).

covery with no statistically significant difference between the two groups (Table 4). Also the evaluation of neck and arm pain pre, and postoperatively using the Pain Visual Analogue Scale showed no statistically significant difference between those with ACD and ACF patients.

Forty two of our patients had soft disc lesion without spondylotic changes. Though not significant, patients with evidence of cervical spondylosis at the operated level were less satisfied in the ACD than those in the ACF group. The outcome was not statistically different in either the single-level or two-level surgery cases.

### *Radiology*

The normal cervical lordosis has been reversed postoperatively in 55%, and in 28% of patients with ACD and ACF respectively. The incidence of cervical kyphosis was statistically greater in ACD group than the ACF group ( $P = 0.02$ ) (Table 2). There was a tendency for the fused upper cervical levels to develop kyphosis more than the lower levels, but this was not statistically significant. 24% of the implanted IG showed partial graft collapse. Partial graft protrusion was noticed in 11 patients. Nevertheless, the long-term effects of both phenomena did not seem to cause any problems. Complete graft extrusion occurred in two patients. These patients were revised and “instrumented” with a titanium cervical locking plate (SYNTHES, STRATEC MED. Ltd. 20 Tewin Rd., Welwyn Garden City, Hertfordshire AL7 1LG, UK).

### *Fusion Patterns*

On the immediate postoperative radiograph after ACD, narrowing of the operated disc space was the initial observation. This was usual but the amount of narrowing was dependent on how much of the disc material was removed at surgery. Calcium deposition in the interspace occurred as early as around the third

month and was seen eventually in most of the cases. In cases who went on to complete fusion (64%) there was loss of the “hard line” depicting the superior and inferior cortical margins of the adjacent vertebral bodies commencing around the sixth month.

With ACF group, IG and both cortical endplates at the fused segment could be visualised on the immediate postoperative radiographs. Within 6–8 weeks, and as the IG started to incorporate, the cortical endplates began to disappear. Between 3–6 months, the fusion was complete and the two vertebrae were visualised as one bone block. The rate of fusion was related to the adequacy of endplate decortication. All patients but two (94%), even those with partial graft protrusion and/or collapse, had sound bony fusion.

### *Complications*

The complications included; one neck haematoma which was urgently evacuated, one iliac haematoma treated conservatively, two patients with persistent hip pain of more than 50 at The Visual Analogue Scale at the 6 months follow-up. Two patients with ACF had radiological signs of non-union and persistent neck pain, both were revised with autograft and AO plate.

### **Discussion**

The technique of ACF was introduced in 1950s by both Cloward [2] and Smith-Robinson [16] independently. They used autologous IG to distract the disc space and neural foramina, as well as diminish neural irritation by elimination of motion through sound fusion. Donor site and fusion bed morbidity has been reported as a sequel of ACF by many authors [7, 8, 13]. Since 1960, many authors [1, 16, 4, 5, 10, 11, 14, 18, 19] have reported their experience on ACD with comparable results, only few [10, 11] reported a high incidence of postoperative kyphosis. This series is one of the ongoing attempts to come to an end of the debate of fusion or non-fusion in patients undergoing anterior cervical discectomy.

In the majority of reported series in the literature as well as in our material, although ACD has been associated with a higher incidence of kyphosis yet the outcome was not correlated with the postoperative cervical curve. In this study we used the posterior vertebral borders rather than the inferior borders to measure the intersegmental angles [9]. We believe that this method is more accurate and easy to apply after interbody fu-

sion where one cannot differentiate the fused adjacent vertebral borders.

Kyphosis after ACD tends to become greater if the operation was performed on two levels rather than one level. This could be explained by the following facts; after discectomy the disc space systematically collapses. As the cervical disc is normally wedge shaped, collapse occurs anteriorly more than posteriorly resulting in an inevitable reversal of lordosis or at least straightening of the cervical curve.

Partial graft protrusion was reported in 18% of the ACF group of patients. All patients with graft protrusions had complete osseous union. Interestingly, the protruding part of the graft through the process of bone resorption and remodelling disappeared gradually and the patients had smooth contoured spine on follow-up radiographs. As has been observed with complete graft extrusion, graft protrusion occurred during the very early postoperative days and has never been progressive. However, protruded grafts should be monitored radiographically.

To avoid iliac crest pain other authors [3, 6] have proposed some modification in the harvesting technique. In this study the triple osteotome technique has minimised pain at the donor site, and at six months follow-up iliac crest pain was not a significant problem in our patients.

Currently, the controversial issue in the management of patients undergoing anterior cervical discectomy will continue regarding fusion or non-fusion. Proponents of interbody grafting claim that with ACD, the disc height and the area of the neural foramina at that level will decrease postoperatively with the potential for persistent symptoms and/or the development of a radiculopathy, also the incidence of postoperative kyphosis is high. Whereas, with ACF the fusion rate is high, the neck pain is less, also distraction of disc space stretches the ligamentum flavum and reduces its bucking.

## Conclusions

The issue of fusion or non-fusion in anterior disc surgery has not come to an end yet. The technique is still in need of more refinement in disc excision and graft harvesting and shaping, and more adequately controlled studies are needed. Until then, ACD has to

be limited to those patients with a single soft disc without evidence of cervical spondylosis.

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Correspondence: Prof. Nabil Abd-Alrahman, Neurosurgery Department, Faculty of Medicine, University of Alexandria, Alexandria, Egypt.