

Clinical study

Anterior cervical discectomy and fusion: analysis of surgical outcome with and without plating

Ralph J. Mobbs^{a,*}, Prakash Rao^b, Nadana K. Chandran^b

^a Prince of Wales Hospital, Sydney, New South Wales, Australia

^b The Canberra Hospital, Canberra, Australian Capital Territory, Australia

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Abstract

The aim of this study is to analyse the differences in clinical and radiological outcome of anterior cervical discectomy and fusion for cervical degenerative disease, with and without the addition of an anterior cervical locking plate. Although disc arthroplasty is gaining popularity, the anterior cervical decompression and fusion procedure remains the gold standard. The outcome of 242 cases operated between 1991 to 1998 were analysed. Two groups of patients were operated on by the same surgeon. The only difference in technique between the two groups was the addition of an anterior cervical plate, with all other technical details matching, including the use of iliac crest autograft. The indications for surgery for both groups was identical. We made an attempt to study radiological fusion, clinical outcome and complications between the non-plated and plated groups. Our main finding is that the addition of an anterior plate reduces the number of poor clinical outcomes, but does not increase the number of excellent outcomes. Anterior discectomy and fusion with plating in our series had a significantly higher fusion rate; 98% fusion was noted in the plating group as compared to 93.5% in the non-plating group (Fisher's exact test, $p = 0.029$). Union was faster in the plated group with no significant increase in surgical complications. Although clinical outcomes were superior in the plated group for the radiculopathy cohort, excellent outcomes were not significantly higher as compared to the non-plated group. The non-plated group had a significantly higher rate of poor outcomes, with 10% of patients requiring revision surgery for non-union, kyphosis, graft extrusion and graft collapse with foraminal stenosis. 1.8% of the plated group required revision surgery.

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1. Introduction

Anterior cervical discectomy and fusion (ACDF) is a commonly performed procedure with much controversy surrounding the role of anterior cervical locking plates for patients undergoing ACDF.¹ The indications for ACDF include radiculopathy, myelopathy, myelo-radiculopathy and traumatic instability involving single or multiple levels. Anterior cervical discectomy without interbody fusion is practised by some authors for degenerative dis-

ease;² however many authors now advocate fusion in addition to the discectomy.³ There are various techniques for performing ACDF depending on surgeon preference, including the Cloward technique or discectomy and interposition graft.^{4,5} The interposition graft used may include autologous bone, allograft, synthetic material or metallic cages. ACDF is further modified by using anterior locking plates for stabilisation (ACDFP). There have been numerous anterior cervical plates developed in the last two decades based on initially bicortical, and more recently unicortical screw purchase. The additional costs involved in ACDFP have led investigators to examine for any significant difference in fusion and clinical outcome between ACDF and ACDFP patients. The senior author (NKC) performed ACDF during the early 1990s, then changed

* Corresponding author. Present address: Suite 3, Level 7, Prince of Wales Private Hospital, Randwick 2031, Australia. Tel.: +61 2 9650 4855; fax: +61 2 9650 4902.

E-mail address: ralphmobbs@hotmail.com (R.J. Mobbs).

to ACDFP. This cohort of patients therefore provides an excellent group to study as the techniques and indications for surgery between the two groups (ACDF vs. ACDFP) are identical, with the exception of plate fixation later in the study period.

2. Material and methods

This study includes patients who underwent ACDF or ACDFP during the period 1991–1998 whose files were traceable. During this 8-year period, over 300 anterior cervical decompression procedures were performed by the senior author (NKC). Patients were excluded if information on clinical follow-up and radiological fusion was not obtainable. Acute traumatic cervical spine injuries were also excluded. Two hundred and forty-two patients were included in this study out of which 130 had ACDF (53.7%) and 112 ACDFP (46.3%). The patient age group for ACDF was 30–73 years with a mean age of 48 years, and ACDFP was 23–75 years with a mean age of 50 years. The male-to-female ratio was 118:122 in general; and was 65:65 in ACDF and 54:58 in ACDFP. The indications for surgery were radiculopathy ($n = 212$) and myelo/radiculopathy ($n = 30$). The spinal levels operated varied from single level ($n = 95$), two levels ($n = 140$) to three levels ($n = 7$). A total of 396 cervical levels were operated upon with C5/6 being the most common with a total of 194 and C2/3 being the least common with one surgery only at this level.

The surgical procedure followed in both groups was identical, with the exception of an anterior locking plate. The plates used in the study included: CSLP (Synthes Spine, Solothurn, Switzerland), Orion (Medtronic, Memphis, TN, US) and Atlantis (Medtronic, Memphis, TN, US). A discectomy procedure using the Caspar distractor was performed for radiculopathy at a single level and for two-level disease. Corpectomy and fusion was performed for single or multi-level myeloradiculopathy. In all cases autologous bone graft was obtained from the iliac crest. All patients were reviewed at 4–6 weeks, 4–8 months and at one year. Subsequent reviews depended on necessity. At the time of review, patients were assessed clinically and with X-rays of the cervical spine with AP and lateral views to assess fusion. Independent analysis of the collected radiological and clinical data was performed.⁶

3. Results

We studied the overall radiological fusion for both plated and non-plated groups at <4 months, 4–8 months and 8–12 months. For ACDF the fusion noted at <4 months was 64%, at 4–8 months, 89% and at 8–12 months, 94%. The corresponding figures in ACDFP were 70%, 93% and 98%. The clinical outcomes at the time of radiological fusion were taken into consideration. The outcomes were classified following the criteria by Odom and Finney.⁷ An excellent result includes patients who were asymptomatic

and had no impairment of their daily living and occupations, good with intermittent discomfort but without interference with occupational activities, fair with subjective improvement but still significant limitations of physical activities and poor with no improvement or deterioration.

For the 212 patients in the radiculopathy group, an excellent clinical outcome was more common in the ACDFP group compared with the ACDF group; however this was not significant ($p = 0.31$, $p > 0.05$). However, for poor outcomes, in the radiculopathy group, the ACDFP group had fewer poor results, with 1% having a poor result compared to 7% of the ACDF group, significant at $p = 0.043$ (Fisher's exact test, $p < 0.05$). Therefore the use of a plate may help avoid poor results rather than improve excellent outcomes. The clinical outcome has been analysed for the radiculopathy group (Tables 1, 2). A separate breakdown of clinical outcomes for the 30 patients in the myelo-radiculopathy group is not discussed, as results following decompression for myelopathy are dependant on multiple factors such as severity of myelopathy and the time period prior to decompression.

Various complications encountered were analysed in each group separately and together. Vocal cord dysfunction was minimal for both plated and non-plated groups with a single patient being affected in each group. Transient dysphagia was a more common complication in the plated group with five patients being affected as compared to one in the non-plated cohort. There was a single superficial

Table 1
Clinical outcome for the radiculopathy group, no plate vs. plate ($n = 212$)

	Excellent	Good	Fair	Poor
ACDF	84/116 (72%)	17/116 (15%)	7/116 (6%)	8/116 (7%)
ACDFP	76/96 (78%)	14/96 (14%)	5/96 (7%)	1/96 (1%)

ACDF = anterior cervical discectomy and fusion, ACDFP = anterior cervical discectomy and fusion with anterior locking plates.

Table 2
Complications for radiculopathy group

	ACDF	ACDFP	Total
Vocal cord dysfunction	1	1(improved 3/12)	2
Dysphagia (transient)	1	5	6
Infection	1		1
Neurological deterioration		1(Brown-Sequard)	1
Non union	8	1	9
Kyphosis	3		3
Posterior foraminotomy	4		4
Implant removal		1(dysphagia)	1
Graft extrusion	1		1
Donor site morbidity	4	2	6
Miscellaneous	Lateral femoral cutaneous nerve decompression	Keloid formation	2

ACDF = anterior cervical discectomy and fusion, ACDFP = anterior cervical discectomy and fusion with anterior locking plates.

wound infection in the ACDF group treated successfully with antibiotics. Neurological deterioration was experienced in one patient following ACDFP for myeloradiculopathy. The patient developed a Brown-Sequard syndrome postoperatively, requiring spinal rehabilitation. One case of severe donor site morbidity was noted requiring lateral femoral cutaneous nerve decompression. Persistent donor site discomfort/pain was experienced in a further five patients. The incidence of non-union and kyphosis among ACDF and ACDFP was 8% versus 1% respectively. We experienced implant-related complications in two patients. One ACDFP patient required second surgery for implant removal due to swallowing impairment on barium swallow studies. Autologous graft extrusion was detected in one case of ACDF, requiring reoperation with the addition of plate fixation. Major complications requiring revision cervical surgery were 13/130 (10%) in the ACDF group and 2/112 (1.8%) in the ACDFP group. Reoperation for the ACDF group included eight for non-union/kyphosis, four for posterior foraminotomy and one for graft extrusion. Reoperation for the ACDFP group included one for implant removal and one for non-union.

4. Discussion

Anterior cervical decompression and fusion is a commonly performed spinal procedure. In this study we have attempted to analyse the overall fusion rates and clinical outcome in the radiculopathy group. Many authors consider solid bony fusion essential following anterior cervical discectomy, as non-union may be responsible for poor outcomes.⁸ Bony fusion is considered to prevent delayed angulation deformity and foraminal stenosis, leading to root compression and neck pain.^{9–11}

The senior author considers that autologous bone grafting is an essential part of the procedure. We found that major donor site morbidity (8/242), around 3.3%, is acceptable in comparison with other studies in the literature.¹² The morbidity associated with autologous iliac crest bone graft may be acceptable when compared to complications with the use of allograft, synthetic material and other forms of graft. In a multi-centre study the incidence of pseudoarthrosis with allograft was noted to be 47.4% compared to 26.3% with autografts and graft collapse of more or equal to 3 mm in 19% of allografts compared to 11% of autografts.¹³ Brown reported 28% graft collapse with cadaveric freeze-dried iliac crests as compared to 14% for autologous iliac crest, with extrusion rates of 13% and 4% respectively.¹⁴ There are reports of donor site complications ranging from 1% to 13% with Esparsen reporting 1% and Gore reported 13% donor site morbidity.^{15,16} Our figures demonstrate that fusion rates are superior in the ACDFP group (99%) than in the ACDF group (93%). In addition fusion is at a faster rate. Fusion at less than 4 months in ACDFP are 70% and 63.7% in ACDF, and a similar trend continued in 4–8 months and 8–12 months with 97.2% versus 88.7% and 99% versus 93.5% respec-

tively. We noted non-union in 2.4% of cases with a single level fusion and 4.1% cases with multilevel ACDF. These figures compel us to favour ACDFP, even for single-level procedures.

The overall complications requiring revision cervical surgery is significantly reduced in the ACDFP cohort at two patients. There were 13 revision surgeries in the ACDF group. The complications of radicular pain secondary to late foraminal stenosis are less in ACDFP (nil) than in ACDF at 3.3%. Although there was one case of non-union in the ACDFP group that required revision surgery, we did not see any case of delayed kyphosis in the ACDFP group. In comparison we encountered eight cases of non-union/kyphosis in the ACDF group that required revision surgery. The additional cost of this revision surgery would be significant; however a cost analysis between the ACDFP and ACDF groups was not conducted by the authors. One group has examined the issue of titanium surgical mesh versus iliac crest bone as an interposition graft and found little difference in overall cost analysis;¹⁷ however, there are no studies that directly examine the cost issues of plate versus no-plate for degenerative cervical spondylosis. One case of graft extrusion was experienced in the ACDF group, being a complication not seen in the ACDFP group, as the plate would aid in early stabilization of the interposition graft. With the exception of postoperative dysphagia, other complications are common to both and there is no significant difference among the groups. However, dysphagia is significantly higher in the ACDFP group with five patients reporting this complication. Other authors have experienced this complication with plate fixation,¹⁸ which may be due to additional retraction administered by the surgeon to apply the anterior plate.

The literature was reviewed where studies comparing the results of ACDF and ACDFP are discussed. Bose described 97.9% fusion with plates with acceptable instrumentation-related morbidity, which improves with experience (10.7% instrument-related morbidity in the first 38 cases and 1.69% in last 59 cases).¹⁹ Randle reported 54 patients with acute cervical spine injuries operated by Casper instrumentation showing solid fusion of 100% of patients within 6 months.²⁰ Cauthen reported 348 patients operated by ACDF and found 13% required an additional operation: 7% required revision fusion surgery with the addition of plate fixation, this figure being comparable with our ACDF data. Cauthen further reviewed 23 selected studies of ACDF. Total patients numbered 2037, in which he noted 92% solid fusion. He reviewed another six reports where fusion rates were shown by number of surgical cervical sites rather than number of patients; 847 surgical fusions were evaluated, of which 17% shown pseudoarthrosis. The author found the overall fusion rate for ACDF in the range of 80–92%.²¹ Geisler reviewed the literature and noted 4–26% non-union for ACDF for single level, 17–63% for two-level and 50% for three-level ACDF. His own study included 365 cases of which 147 had ACDFP and 218 ACDF. He had one patient with pseudoarthrosis

out of 147 for ACDFP. Of 218 patients with ACDF, 12 had pseudo-arthrosis, a rate of 10%.²² Caspar reviewed 356 patients out of which 210 had ACDF and 146 ACDFP, and found that 12 out of 210 ACDFs had reoperation for pseudo-arthrosis and one out of 146 ACDFPs had surgery for pseudo-arthrosis.²³ Schneeberger reported solid fusions for 100% in single-level and 87% in multi-level with overall fusion rate of 94% with ACDFP.²⁴

In conclusion, the incidence of fusion is significantly higher in the ACDFP group compared to ACDF for radiculopathy, with no significant increase in complications. Results for the myeloradiculopathy group were not compared due to the range of pathologies treated and difference in techniques (discectomy vs. corpectomy). It is also noted that fusion is faster in the ACDFP group than the ACDF, and the clinical outcome is superior for the radiculopathy cohort; however there is no statistical significance. The higher rate of failures and poor clinical outcomes are significantly higher in the ACDF group. The need for second surgery for various reasons in the ACDF group is around 10%, whereas the ACDFP group is 1.8%. This is another major factor favouring ACDFP over ACDF in our view. These results are in comparison with the other earlier reports favouring ACDFP to ACDF. Although excellent clinical outcomes are not statistically different, the authors feel that ACDFP is a better alternative to ACDF for anterior cervical surgery for radiculopathy to reduce the number of poor outcomes.

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