



Clinical Study

Successful anterior fusion following posterior cervical fusion for revision of anterior cervical discectomy and fusion pseudarthrosis



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ABSTRACT

Pseudarthrosis occurs after approximately 2–20% of anterior cervical discectomy and fusion (ACDF) procedures; it is unclear if posterior or anterior revision should be pursued. In this study, we retrospectively evaluate the outcomes in 22 patients with pseudarthrosis following ACDF and revision via posterior cervical fusion (PCF). Baseline demographics, preoperative symptoms, operative data, time to fusion failure, symptoms of pseudarthrosis, and revision method were assessed. Fusion outcome and clinical outcome were determined at last follow-up (LFU). Thirteen females (59%) and 9 (41%) males experienced pseudarthrosis at a median of 11 (range: 3–151) months after ACDF. Median age at index surgery was 51 (range: 33–67) years. All patients with pseudarthrosis presented with progressive neck pain, with median visual analog scale (VAS) score of 8 (range: 0–10), and/or myeloradiculopathy. Patients with pseudarthrosis <12 months compared to >12 months after index surgery were older ($p = 0.013$), had more frequent preoperative neurological deficits ($p = 0.064$), and lower baseline VAS scores ($p = 0.006$). Fusion was successful after PCF in all patients, with median time to fusion of 10 (range: 2–14) months. Eighteen patients fused both anteriorly and posteriorly, two patients fused anteriorly only, and two patients fused posteriorly only. Median VAS neck score at LFU significantly improved from the time of pseudarthrosis ($p = 0.012$). While uncommon, pseudarthrosis may occur after ACDF. All patients achieved successful fusion after subsequent posterior cervical fusion, with 91% fusing a previous anterior pseudarthrosis after posterior stabilization. Neck pain significantly improved by LFU in the majority of patients in this study.

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1. Introduction

Anterior cervical discectomy and fusion (ACDF) is a common surgical intervention for patients suffering from symptomatic cervical degenerative disc disease (DDD) with myelopathy and/or radiculopathy [1,2]. ACDF procedures typically result in excellent clinical outcomes [3–5]. However, ACDF relies upon the establishment of a solid fusion and is associated with decreased motion at the fused segments and accelerated adjacent segment disease (ASD) [6–10]. Pseudarthrosis may present symptomatically or asymptotically with rates ranging from 0–20% for single-level fusions and greater than 60% for multi-level fusions, and often results in persistent neck pain after surgery [3,11–14].

Surgical revision for pseudarthrosis includes either a repeat anterior approach or posterior cervical fusion (PCF) approach [12,15,16]. There remains considerable debate regarding anterior versus posterior revision surgery for pseudarthrosis following ACDF in the literature. A recent meta-analysis investigated the fusion rate and clinical outcome of cervical pseudarthrosis in patients with either an anterior or posterior revision approach, and revealed the posterior approach resulted in greater fusion rates, but with similar clinical outcomes [17]. Repeat anterior approach revisions have resulted in less patient-reported stiffness compared to posterior approaches, along with good clinical outcomes [2,12,18]. However, anterior revision soft tissue dissection can be complicated by scar tissue, which increases the risk of complications to critical structures such as the esophagus and recurrent laryngeal nerve [19,20].

The posterior approach avoids scar tissue and provides an additional site for fusion to occur. While several prior studies have

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examined the outcomes of posterior revision of ACDF pseudarthrosis, the studies did not assess the fusion of the previous ACDF pseudarthrosis. The objective of this study was to report the outcomes of 22 patients at a single institution who underwent a posterior revision following ACDF pseudarthrosis, with a specific focus on the fusion outcomes of the prior pseudarthrosis.

2. Methods

2.1. Demographics

The clinical and imaging data of all patients who presented to our institution with pseudarthrosis after ACDF between 1995 and 2013, were retrospectively reviewed under an Institutional Review Board approved protocol (NA_00038491). Baseline demographics were collected including age at index ACDF, sex, body mass index (BMI), and smoking history. All categorical data is presented as frequency (percentage) and continuous data as median (range).

2.2. Original ACDF surgery characteristics

Information regarding the patients' index ACDF surgery was reviewed. Operative information included whether the index ACDF surgery was performed internally or at an outside institution, the indication for ACDF (for example, DDD/spondylosis including disc herniation, ASD, or revision of prior pseudarthrosis), whether a graft/plate was used, the number of spinal levels treated, and estimated blood loss (EBL). Patients' presenting symptoms and signs prior to their index ACDF surgery were also identified. Use of a cervical collar at discharge and all postoperative complications within 30 days after surgery were also recorded. In addition, data regarding the time to pseudarthrosis diagnosis from index ACDF, number of levels with failed fusion, highest level of spinal involvement, and evidence of ASD at the time of pseudarthrosis were identified. Likewise, patients' symptoms and signs at the time of pseudarthrosis diagnosis and visual analog scale (VAS) score for neck pain were evaluated.

2.3. Revision surgery characteristics

Operative information regarding the time to revision surgery from index ACDF, procedure(s) performed, number of levels fused, graft material, and adjuvant use of bone morphogenic protein (BMP) and/or a bone growth stimulator, and EBL were collected. All intraoperative and postoperative complications within 30 days after surgery were assessed. Length of hospitalization, post-PCF neck pain VAS score at discharge, and stabilization with a cervical collar were also determined.

2.4. Postoperative characteristics/outcomes

Information regarding new diagnosis of ASD after PCF was collected including the time to diagnosis of ASD from PCF and need for surgical correction of ASD. Length of follow-up was determined from the time of index ACDF and from PCF. Clinical status at last follow-up was assessed by physician report. Degree of neck pain at last follow-up was determined by VAS score.

2.5. Fusion assessment

Anterior and/or posterior spinal fusion was evaluated with static anteroposterior and lateral cervical spine radiographs assessing for bridging bone. If fusion status was unclear or questionable, a CT scan was performed for confirmation.

2.6. Statistical analysis

An evaluation of the factors associated with diagnosis of pseudarthrosis before or after 1 year from index ACDF was also performed. Intergroup comparison of categorical variables was achieved using Fisher's exact test and the Mann–Whitney U test was performed for continuous variables. In addition, the effect of PCF on neck pain VAS scores between pseudarthrosis diagnosis and PCF revision surgery was analyzed using the Wilcoxon signed-rank test. *p* values < 0.05 were considered to be statistically significant.

3. Results

3.1. Demographics

A total of 22 patients presented with symptomatic pseudarthrosis after ACDF over an 18 year period at our institution (Table 1). The majority of patients were female (*n* = 13, 59%) and patients underwent their index ACDF at a median age of 51 (range: 33–67) years. Median BMI at presentation was 29 (range: 21–42) kg/m², and seven (32%) patients had a history of smoking.

3.2. Original ACDF surgery

The majority of ACDF procedures were performed at our institution, with seven (32%) index cases performed at an outside institution (Table 1). The most common indication for ACDF was DDD/disc herniation/spondylosis (*n* = 15, 68%), followed by ASD (*n* = 6, 27%). Of note, one (5%) patient underwent a revision ACDF for a prior pseudarthrosis before presenting to our institution with a second pseudarthrosis after their anterior revision surgery. The most common symptom at original presentation for ACDF was neck pain (*n* = 20, 91%) followed by radiculopathy (*n* = 17, 77%). The median number of levels fused was two (range: 1–4), with a graft used alone in eight (36%) patients, plate alone in one (5%) patient, and both a graft and plate in 13 (59%) patients. Median EBL at index ACDF was 50 (range: 30–100) ml. Eight (36%) patients were discharged with a cervical collar for stabilization after surgery. No known intraoperative complications were encountered during ACDF, and two (9%) patients experienced postoperative complications other than pseudarthrosis. One patient experienced a superficial wound infection shortly after index ACDF requiring a short course of oral antibiotics, and the other experienced osteomyelitis within the treated area over a year and a half postoperatively requiring surgical debridement and wound washout.

3.3. Presentation of pseudarthrosis after ACDF

Pseudarthrosis was diagnosed via radiograph alone in nine (41%) patients and confirmed via CT scan in 11 (50%) patients, at a median of 11 (range: 3–151) months after ACDF (Table 1). Of note, failed fusion was diagnosed intraoperatively during the revision procedure for recurrent neck pain and radiculopathy in two (9%) patients. All patients with pseudarthrosis were symptomatic and the majority presented with progressive neck pain (*n* = 20, 91%), with a median VAS score of 8 (range: 0–10), followed by radiculopathy (*n* = 13, 59%). The majority of non-unions involved a single vertebral level (*n* = 17, 77%), with the most frequent level of involvement at C6/C7 in nine (41%) patients, followed by C5/C6 in seven (32%) patients. Newly diagnosed ASD was present in 11 (50%) patients at the time of pseudarthrosis diagnosis.

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