

The Effect of an Anterior Cervical Operation for Cervical Radiculopathy or Myelopathy on Associated Headaches

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Background: Headaches related to the cervical spine have been reported by various authors, and modalities of treatment are as varied as their speculated causes. The purpose of this study was to determine if anterior cervical reconstructive surgery (cervical arthrodesis and disc arthroplasty) for the treatment of radiculopathy or myelopathy also helps to alleviate associated headaches.

Methods: We conducted a post hoc analysis of study cohorts combined from prospective studies comparing the results of Prestige and Bryan cervical arthroplasty devices and those of anterior cervical arthrodesis with allograft and anterior instrumentation. A total of 1004 patients (51.6% were male) were evaluated with use of the Neck Disability Index questionnaire preoperatively and at five points postoperatively, with the latest evaluation at twenty-four months, resulting in a follow-up of 803 patients.

Results: At the twenty-four-month follow-up, the improvement from baseline with regard to headache was significant in both groups ($p < 0.0001$), with patients who underwent arthroplasty reporting numerically better pain scores. Most arthroplasty and arthrodesis patients (64% and 58.5%, respectively) had improvement in the pain score of at least one grade. Conversely, the pain scores for 8.4% of those who had an arthroplasty and 13.7% of those who had arthrodesis worsened by at least one grade. For the remainder, the score was unchanged. Overall, the patients who had an arthroplasty had significant improvement more frequently than did the patients who had arthrodesis ($p = 0.011$).

Conclusions: At two years postoperatively, patients undergoing anterior cervical operations, both those who have an arthroplasty and those who have an arthrodesis, for cervical radiculopathy and myelopathy can be expected to have significant improvement from baseline with regard to headache symptoms.

Level of Evidence: Therapeutic Level I. See Instructions to Authors for a complete description of levels of evidence.

Patients with cervical spine-related headaches typically report pain in the neck that radiates through the paraspinal muscles into the head. Others report pain in the low occipital and temporal regions that can radiate into the face or the periorbital, frontal, and parietal regions.

In 1983, Sjaastad et al. defined the term *cervicogenic headache* and established criteria for its diagnosis¹. Further revisions of these definitions occurred in 1998², with the establishment of additional headache criteria (Table I). Similar criteria have been established by the International Headache

Society. Their criteria also include clinical, laboratory, and/or imaging evidence of a disorder or lesion within the cervical spine or soft tissues of the neck, which is known to be, or generally accepted as, a valid cause of headache. Even typical migraine-type symptoms (such as nausea, phonophobia and photophobia, dizziness, and blurred vision) have been used as defining features of cervicogenic headaches, although with less importance³.

Typical nonoperative treatments for cervicogenic headaches include noninvasive measures such as medications, phys-

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TABLE I Revised Criteria for Diagnosis of Cervicogenic Headache

Recurrent, long-lasting, and severe headache
Arising from the neck
Unilateral dominance (can be bilateral)
Located in the low occipital region and temporal region
Possibly radiating to the face; periorbital, frontal, and parietal regions; and the ipsilateral shoulder and arm
Accompanied by reduced range of motion of the cervical spine
Can be precipitated by certain neck motions

iotherapy, and transcutaneous electrical nerve stimulation^{4,5}. Invasive treatments such as local anesthetic blocks with steroids, botulinum toxin, radiofrequency procedures, dorsal column stimulators, and surgery have also been reported^{6,7}.

Despite the extensive literature, the efficacy of cervical spine surgery for the treatment of cervicogenic headaches is controversial. Few studies have examined headache relief in patients undergoing anterior cervical discectomy and fusion for radiculopathy. We were able to identify one prospective study that documented long-term outcomes⁷. There is a lack of knowledge regarding the exact anatomical structures that may cause headache. Headache might be caused by the disc, facet joints, paraspinal muscles, both somatic and autonomic neural structures, or the myofascial tissues. The purpose of this study was to determine if anterior cervical reconstructive surgery (cervical arthrodesis and disc arthroplasty) for the treatment of radiculopathy or myelopathy also helps to alleviate associated headaches.

Materials and Methods

We utilized the results from two prospective, multicenter, randomized U.S. Food and Drug Administration (FDA) Investigational Device Exemption studies comparing the Prestige and Bryan cervical arthroplasty devices (both from Medtronic Sofamor Danek, Memphis, Tennessee) with anterior cervical arthrodesis with allograft and anterior instrumentation. This was a post hoc analysis of both study cohorts. All patients who were enrolled in these trials^{8,9} completed the Neck Disability Index, and their responses have been used in this review. Headache was assessed with use of the Neck Disability Index completed at baseline and at all follow-up visits. The Neck Disability Index is a reliable, valid, and sensitive instrument of self-reporting measures¹⁰. Included in the Neck Disability Index is a headache severity index, with use of an ordinal scale (Table II). The headaches were graded as none (grade 0), mild (grade 1 or 2), or severe (grade 3, 4, or 5). The mean headache scores were calculated with use of this scale across the arthroplasty and fusion groups. The location of the headache was not recorded. The purpose was to assess the effect of anterior spine surgery on headaches and not to compare the arthroplasty techniques with the arthrodesis.

To be included in the previously reported Investigational Device Exemption trials, all subjects had to have failed

nonoperative treatment and continued to have radiculopathy or myelopathy arising from a single level from C3 to C7. None of these patients had the operation for the treatment of headaches, and headaches were not their only complaint. Additionally, radiographic findings of up to 50% loss of disc height, no abnormal sagittal balance, continued motion on flexion and extension, and findings on magnetic resonance imaging or computed tomography myelogram of disc herniation with disc disease and no evidence of facet disease (all based on the surgeon's standard diagnostic criteria and interpretation) were mandatory. The details of the study were presented by Mummaneni et al.⁸ and Sasso et al.⁹. All investigation sites had institutional review board approval, and all patients voluntarily provided informed consent. These studies were not registered in a public study registry because, at the time of initiation, registration was not a governmental requirement.

The arthroplasty cohort had 518 patients, and the anterior cervical discectomy and fusion group had 486 patients. One patient did not complete the Neck Disability Index at the initial visit, resulting in the loss of the data for that patient (hence, 1003 patients remained in the study). In the anterior cervical discectomy and fusion group, there were 486 patients preoperatively, 459 at six weeks, 442 at three months, 419 at six months, 419 at twelve months, and 373 at twenty-four months. In the arthroplasty group, there were 518 patients preoperatively, 509 at six weeks, 487 at three months, 482 at six months, 497 at twelve months, and 430 at twenty-four months. The study group included 518 men (51.6%) and 486 women (48.4%). At the time of the index procedure, the mean age was 43.8 years (range, twenty-five to seventy-eight years) for the patients in the arthroplasty group and 44.3 years (range, twenty-two to seventy-three years) for the patients in the anterior cervical discectomy and fusion group.

Statistical Methods

Statistical analysis was performed by the nonparametric Wilcoxon signed-rank test for preoperative to postoperative change on paired observations at each follow-up time interval. Differences in headache scores between study groups were

TABLE II Headache Question from Neck Disability Index

Score	Headaches*
0	I have no headaches at all.
1	I have slight headaches that come infrequently.
2	I have moderate headaches that come infrequently.
3	I have moderate headaches that come frequently.
4	I have severe headaches that come frequently.
5	I have headaches almost all of the time.

*The severity of the headache was graded as none (grade 0), mild (grade 1-2), or severe (grade 3-5).

TABLE III Distribution of Headache Grades Between Groups Preoperatively and at Twenty-four Months

Grade	Group Managed with Arthroplasty		Group Managed with Anterior Cervical Discectomy and Fusion	
	Preop. (N = 518)	24 Mo (N = 430)	Preop. (N = 485)	24 Mo (N = 373)
0	68 (13.13%)	162 (36.67%)	70 (14.43%)	118 (31.64%)
1	85 (16.41%)	123 (28.60%)	83 (17.11%)	108 (28.95%)
2	94 (18.15%)	68 (15.81%)	80 (16.49%)	76 (20.38%)
3	120 (23.17%)	44 (10.23%)	109 (22.47%)	37 (9.92%)
4	91 (17.57%)	21 (4.88%)	78 (16.08%)	22 (5.90%)
5	60 (11.58%)	12 (2.79%)	65 (13.40%)	12 (3.22%)

analyzed by the Wilcoxon rank-sum test, and comparisons between groups involving multiple levels of headache scores combined into categories (such as “mild” or “severe”) were analyzed by the chi-square statistic. Repeated-measures analysis of variance was performed across the entire postoperative period for the postoperative pain score, the percentage of improvement, and average improvement in the pain score from baseline at three months and six months. The level of significance was set at $\alpha = 0.05$.

Source of Funding

There was no funding for this post hoc analysis.

Results

Baseline

Headache was a significant ($p < 0.0001$) component of the patient complaints in the majority of both cohorts. At baseline, 865 patients (86.2%), a surprisingly high percentage, complained of headaches (Table III). A mild (grade-1 or 2) headache was reported in 34.1% (342) of the patients, and a severe (grade-3, 4, or 5) headache was reported in 523 patients (52.1%). The mean headache score (and standard deviation) was 2.5 ± 1.6 . No significant difference between the arthrodesis and arthroplasty patients was identified with regard to headache at baseline.

Mean Postoperative HA Pain

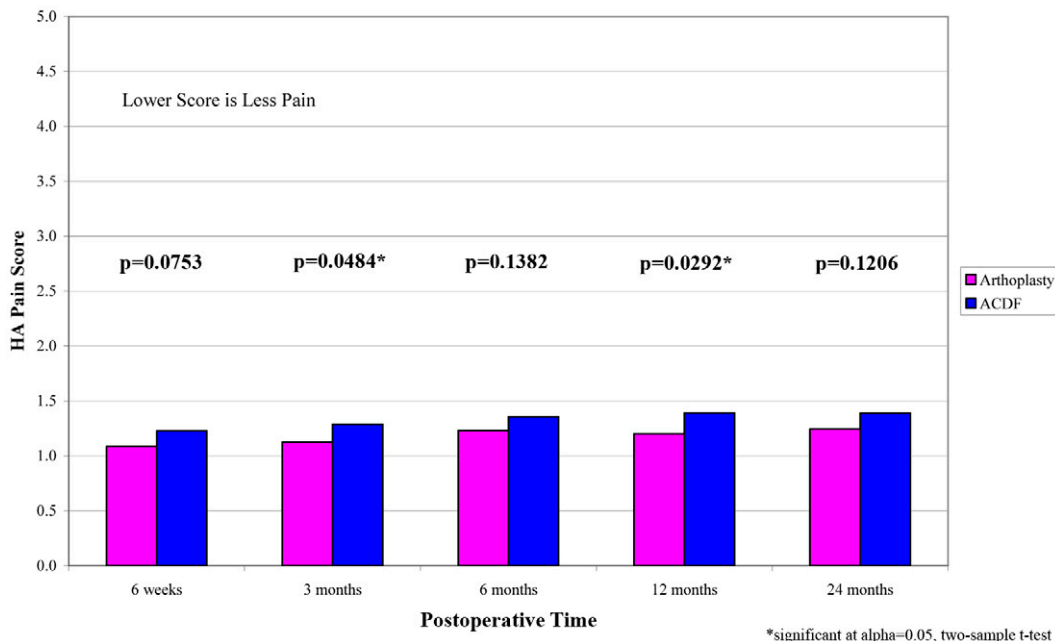


Fig. 1

The mean headache (HA) scores for each group at each time interval postoperatively, showing the associated p values (with use of the two-sample t test) for the comparison between the groups. The lower score represents less headache pain. ACDF = anterior cervical discectomy and fusion.

Outcomes

At the time of the final follow-up (twenty-four months), the headache was absent (grade 0) for 280 (34.9%) of the patients, mild (grade 1 or 2) for 375 patients (46.7%), and severe (grade 3, 4, or 5) for 148 patients (18.4%) (Table III). The improvement from baseline was significant at all follow-up intervals (six weeks and three, six, twelve, and twenty-four months) with p values of <0.0001 at each follow-up interval. A comparison of preoperative and postoperative distributions of headache grades is summarized in Table III for both groups. Most arthroplasty and arthrodesis patients (64% and 58.5%, respectively) had an improvement in the pain score of at least one grade. Conversely, the pain scores for 8.4% of the arthroplasty patients and 13.7% of the arthrodesis patients worsened by at least one grade. For the remainder, the score was unchanged. Overall, the arthroplasty patients had significant improvement more frequently than did the arthrodesis patients ($p = 0.011$). No significant difference in the mean headache scores ($p = 0.1206$) was observed between the arthroplasty and arthrodesis groups at two years (Fig. 1). In addition, the mean overall improvement in headache severity was not significantly different between the arthroplasty and the arthrodesis groups (1.3 and 1.1 grades, respectively; $p = 0.1076$).

Discussion

The diagnosis and management of cervicogenic headaches continue to pose challenges for physicians. To our knowledge, however, no large, prospective, multicenter study has examined the efficacy of cervical spine surgery in relieving headaches^{6,11-21}. The purpose of this study was to determine the prevalence of headaches in patients with cervical radiculopathy or myelopathy and to investigate the effectiveness of anterior cervical surgery in relieving the headaches.

This was a post hoc analysis of two randomized, controlled, multicenter trials with 1004 patients. Over 85% of the patients reported headaches preoperatively. The headaches were not inconsequential, and they were considered to be severe in greater than half of the patients. As expected, because of randomization, there was no difference in the percentage of patients experiencing headaches or in headache severity between the arthrodesis and the arthroplasty groups preoperatively. Postoperatively, both groups had significant headache improvement from baseline at each time point, including the final assessment at twenty-four months of follow-up ($p < 0.0001$). This suggests that adequate anterior surgical decompression, which was common to the two procedures, may be a key component to relieving the headache when combined with either arthrodesis or arthroplasty.

Literature on the surgical treatment of headaches has detailed the procedures directed toward treating pain originating from the upper cervical spine²². This is largely related to the fact that the C2 and C3 (and questionably even C4) nerve roots carry afferent pain fibers whose dermatomal distribution includes the posterior cervical, occipital, and facial regions. Schofferman et al.²² analyzed a series of nine patients with

refractory cervicogenic headaches who underwent anterior cervical discectomy and fusion of the upper cervical spine. Eight of the procedures involved C2-C3 and/or C3-C4, and the other was a C2-C5 anterior cervical discectomy and fusion. All of the patients improved clinically, and the mean visual analog scale (pain score) improved from 8 to 2.7 and the mean Oswestry Disability Index improved from 62 to 35 postoperatively. Recent studies have implicated the middle and lower cervical spine as cervicogenic pain generators as well^{6,7,18,20,21}.

Persson et al.⁷ evaluated a series of 275 consecutive patients with cervical radiculopathy and found that 161 also had daily or recurrent headaches. The C6 or C7 nerve root was determined to be the symptomatic level in $>80\%$ of the patients who had cervicogenic headaches. After nerve root block, 59% of the patients noted $\geq 50\%$ headache relief, with 69% of these noting complete relief. Jansen⁶ performed anterior decompression and arthrodesis in a series of fifty-six patients with cervicogenic headaches, 70% of whom also had a concurrent radiculopathy. Approximately 80% of the patients obtained long-lasting headache relief and functional improvement.

In comparison with other studies that have evaluated anterior cervical arthrodesis in the treatment of headache, the present study offers a large sample size, long and accurate follow-up, a validated outcome measure, and statistical analysis not encountered in the majority of reports^{6,18,20-22}. Additionally, this study examined the effects of cervical arthroplasty—a novel technique that will likely have a future impact on cervical spine surgery—on headache associated with cervical spine disease. Although several reports on cervical arthroplasty have recently been published^{18,9,23}, the effects of artificial disc replacement on headache have not been previously described, to our knowledge.

There are several limitations of this study. Most salient is the fact that although the multicenter data were prospectively collected for the FDA studies, the present study was a post hoc analysis. In particular, data on the presence and severity of the headaches were available, and the headache location and/or other qualitative information were not available. Thus, it is unclear whether all of the headaches described in the cohort were truly cervicogenic or were associated with other etiologies. There is a possibility that the 86.2% of patients with cervicogenic headaches encountered in this study is an overestimation. This weakness is partially muted because there is substantial overlap between headache types, and even clearly separating the different etiologies in clinical practice is a challenging proposition. Another limitation is the fact that this study is limited to a very select, homogeneous cohort of patients with single-level disc disease without facet arthrosis. We cannot overemphasize the fact that this was not a study done to assess the efficacy of anterior cervical arthrodesis for headache, since the primary indication for the operation was cervical radiculopathy or myelopathy. Therefore, our data cannot be used to determine the efficacy of cervical arthrodesis or arthroplasty for the treatment of cervicogenic headaches. Additionally, caution must be exercised in extending the results of this study to patients with more substantial cervical spondy-

losis and degenerative disc disease as such patients were excluded from this study.

Despite the weaknesses outlined above, we believe that our data highlight some clinically important issues. First, although the exact mechanisms of the relationship have yet to be completely elucidated, the study further strengthens the emerging data in the medical literature that patients with cervical radiculopathy and/or myelopathy commonly experience headaches. Second, the effects of headache on patients can be quite substantial. Persson et al.⁷ determined that patients with headache and radiculopathy frequently have more restrictions in the activities of daily living than do those with radiculopathy alone. Not surprisingly, it has been our experience that, when deciding whether to undergo surgery, these patients frequently ask if the headache will be treated by the procedure as well. ■

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