



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

Applies to all products administered or underwritten by Blue Cross and Blue Shield of Louisiana and its subsidiary, HMO Louisiana, Inc. (collectively referred to as the "Company"), unless otherwise provided in the applicable contract. Medical technology is constantly evolving, and we reserve the right to review and update Medical Policy periodically.

Note: Artificial Intervertebral Disc: Lumbar Spine is addressed in medical policy number 00145.

When Services May Be Eligible for Coverage

Coverage for eligible medical treatments or procedures, drugs, devices or biological products may be provided only if:

- Benefits are available in the member's contract/certificate, and
- Medical necessity criteria and guidelines are met.

Based on review of available data, the Company may consider cervical artificial intervertebral disc implantation to be **eligible for coverage**.

Patient Selection Criteria

Coverage eligibility will be considered when all of the following criteria are met:

- The device is approved by the U.S. Food and Drug Administration (FDA); and
- The patient is skeletally mature; and
- Patient has intractable cervical radicular pain and/or myelopathy documented by one of the following:
 - Has failed at least 6 weeks of conservative nonoperative treatment, including an active pain management program or protocol, under the direction of a physician, with pharmacotherapy that addresses neuropathic pain and other pain sources AND physical therapy; OR
 - The patient has severe or rapidly progressive symptoms of nerve root or spinal cord compression requiring hospitalization or immediate surgical treatment.
- Degeneration is documented by magnetic resonance imaging (MRI), computed tomography (CT) or myelography
- Cervical degenerative disc disease is from C3-C7
- Patient is free from contraindication to cervical artificial intervertebral disc implantation

Based on review of available data, the Company may consider simultaneous cervical artificial intervertebral disc implantation at a second contiguous level to be **eligible for coverage** if the above criteria are met for each disc level, and the device is FDA-approved for 2 levels (ie, Mobi-C^{®†}, Prestige^{®†} LP).

Based on review of available data, the Company may consider subsequent cervical artificial intervertebral disc implantation at an adjacent level to be eligible for coverage when all of the following criteria are met:

- ALL of the above bulleted criteria; and
- Device is FDA-approved; and
- Planned subsequent procedure is at a different cervical level than the initial cervical artificial disc replacement; and
- Clinical documentation that the initial cervical artificial intervertebral disc implantation is fully healed.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

When Services Are Considered Investigational

Coverage is not available for investigational medical treatments or procedures, drugs, devices or biological products.

Cervical artificial intervertebral disc implantation when patient selection criteria are not met is considered to be **investigational**.*

Cervical artificial intervertebral disc implantation is considered **investigational*** for all other indications, including the following:

- Disc implantation at more than 2 levels
- Combined use of an artificial cervical disc and fusion
- Prior surgery at the treated level
- Previous fusion at another cervical level
- Translational instability
- Anatomical deformity (eg, ankylosing spondylitis)
- Rheumatoid arthritis or other autoimmune disease
- Presence of facet arthritis
- Active infection
- Metabolic bone disease (eg, osteoporosis, osteopenia, osteomalacia)
- Malignancy

Background/Overview

Several prosthetic devices are currently available for artificial intervertebral disc arthroplasty (AIDA) of the cervical spine. AIDA is proposed as an alternative to anterior cervical discectomy and fusion (ACDF) for patients with symptomatic cervical degenerative disc disease (DDD).

Cervical DDD is a manifestation of spinal spondylosis that causes deterioration of the intervertebral discs of the cervical spine. Symptoms of cervical DDD include arm pain, weakness, and paresthesias associated with cervical radiculopathy. Disc herniation, osteophytes, kyphosis, or instability that compress the spinal cord result in myelopathy, which is manifested by subtle changes in gait or balance, weakness in the arms or legs, and numbness of the arms or hands, in severe cases. The prevalence of DDD secondary to cervical spondylosis increases with age. An estimated 60% of individuals older than 40 years have radiographic evidence of cervical DDD. By age 65, some 95% of men and 70% of women have at least one degenerative change evident at radiographic examination. It is estimated that approximately five million adults in the United States are disabled to an extent by spine-related disorders, although only a small fraction of those are clear candidates for spinal surgery. Cervical DDD is initially treated conservatively using noninvasive measures (e.g., rest, heat, ice, analgesics, anti-inflammatory agents, exercise). If symptoms do not improve or resolve after six weeks or more, or if they progress, surgical intervention may be indicated. Candidates for surgical intervention have chronic pain or neurologic symptoms secondary to cervical DDD and no contraindications for the procedure.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

Anterior cervical discectomy and fusion is currently considered the definitive surgical treatment for symptomatic DDD of the cervical spine. The goals of ACDF are to relieve pressure on the spinal nerves (decompression) and to restore spinal column alignment and stability. Resolution of pain and neurologic symptoms may be expected in 80% to 100% of ACDF patients. ACDF involves an anterolateral surgical approach, decompression of the affected spinal level, discectomy, and emplacement of either autograft or allograft bone in the prepared intervertebral space to stimulate healing and eventual fusion between the vertebral endplates. A metal anterior cervical plate is attached to the adjoining vertebral bodies to stabilize the fusion site, maintain neck lordosis, and reduce the need for prolonged postoperative brace application that is needed following ACDF without an anterior plate. The choice of bone material for interbody fusion in ACDF has important clinical implications. Allograft bone has several drawbacks, including a small (albeit, unproven) risk of infectious disease transmission; possible immunologic reaction to the allograft, and possible limited commercial availability of appropriate graft material. In contrast, the use of autograft bone in ACDF has potentially substantial morbidities at the harvest site, generally the iliac crest. These morbidities include moderate-to-severe, sometimes prolonged pain; deep infection; adjacent nerve and artery damage; and increased risk of stress fracture. Although there may be slight differences between autograft and allograft sources in the postoperative rate of union, clinical studies demonstrate similar rates of postoperative fusion (90–100%) and satisfactory outcomes for single-level, anterior-plated ACDF, using either bone source. Thus, the choice of graft material involves a trade-off between the risks specific to autograft harvest versus those specific to use of allograft material. Biomechanical modeling studies have suggested that altered adjacent segment kinematics following fusion may lead to adjacent-level DDD and need for secondary surgery.

Artificial intervertebral disc arthroplasty is proposed as an alternative to ACDF for patients with symptomatic cervical DDD. In AIDA, an artificial disc device is secured in the prepared intervertebral space rather than in bone. An anterior plate is not placed to stabilize the adjacent vertebrae, and postsurgical external orthosis is usually not required. It is hypothesized that AIDA will maintain anatomical disk space height, normal segmental lordosis, and physiological motion patterns at the index and adjacent cervical levels. The potential to reduce the risk of adjacent-level DDD above or below a fusion site has been the major rationale driving device development and use. Disc arthroplasty and ACDF for single-level disease have very similar surgical indications, primarily unremitting pain due to radiculopathy or myelopathy, weakness in the extremities, or paresthesia. However, the chief complaint in AIDA candidates should be radicular or myelopathic symptoms in the absence of significant spondylosis. Patients with advanced spondylosis or hard disc herniations have a separate pathologic condition and require a different surgical approach.

FDA or Other Governmental Regulatory Approval

U.S. Food and Drug Administration

The Prestige ST Cervical Disc (Medtronic) received U.S. FDA premarket application (PMA) approval as a Class III device on July 16, 2007. The Prestige ST Cervical Disc is composed of stainless steel and is indicated in skeletally mature patients for reconstruction of the disc from C3-C7 following single-level discectomy. The device is implanted via an open anterior approach. Intractable radiculopathy and/or myelopathy should be present, with at least one of the following items producing symptomatic nerve root and/or spinal cord compression as documented by patient history (e.g., pain [neck and/or arm pain], functional deficit, and/or neurologic deficit) and radiographic studies (e.g., CT, MRI, x-rays): herniated disc

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

and/or osteophyte formation. The FDA has required the Prestige disc manufacturer to conduct a 7-year post-approval clinical study of the safety and function of the device and a 5-year enhanced surveillance study of the disc to more fully characterize adverse events in a broader patient population.

The Prestige LP artificial cervical disc was approved by FDA in 2014. The Prestige LP differs from the original Prestige cervical disc in terms of material and fixation. The LP implant is composed of a proprietary titanium-ceramic composite and has 2 rails that press-fit into holes created during the surgical procedure. In 2016, the Prestige LP was approved by FDA for 2 adjacent levels. A postapproval study will follow the investigational device exemption (IDE) patients who received the Prestige LP at 2 contiguous levels for 10 years. Medtronic will also submit to FDA adverse events, device failures, and complaint analysis for 10 years. This includes subsequent surgeries, heterotopic ossification, device malfunction, and other serious device-related complications.

Another disc arthroplasty product, the ProDisc-C^{®†} (Synthes Spine) received FDA PMA approval in December 2007. As with the Prestige ST Cervical Disc, the FDA approval of ProDisc-C is conditional on 7-year follow-up of the 209 subjects included in the noninferiority trial (discussed in Rationale section), 7-year follow-up on 99 continued access subjects, and a 5-year enhanced surveillance study to more fully characterize adverse events when the device is used under general conditions of use. The post-approval study reports are to be delivered to the FDA annually.

The Bryan^{®†} Cervical Disc (Medtronic Sofamor Danek) consists of 2 titanium-alloy shells encasing a polyurethane nucleus and has been available outside of the United States since 2002. The Bryan Cervical Disc was approved by the FDA in May 2009 for treatment using an anterior approach of single-level cervical DDD defined as any combination of the following: disc herniation with radiculopathy, spondylotic radiculopathy, disc herniation with myelopathy, or spondylotic myelopathy resulting in impaired function and at least one clinical neurologic sign associated with the cervical level to be treated, and necessitating surgery as demonstrated using CT, myelography and CT, and/or MRI. Patients receiving the Bryan cervical disc should have failed at least 6 weeks of non-operative treatment prior to implantation of the Bryan cervical disc. As a condition for approval of this device, the FDA required the manufacturer to extend its follow-up of enrolled subjects to 10 years after surgery. The study will involve the investigational and control patients from the pivotal IDE study arm, as well as the patients who received the device as part of the continued access study arm. In addition, the manufacturer must perform a 5-year enhanced surveillance study of the disc to more fully characterize adverse events (AEs) when the device is used in a broader patient population.

In more recent years, continued FDA approval requires completion of 2 post-approval studies. One study provides extended follow-up of the pre-market pivotal cohort out to 7 years. The second study provides 10-year enhanced surveillance of adverse event data. Continued approval is contingent on submission of annual reports, which include the number of devices sold, heterotopic ossification, device malfunction, device removal, or other serious device-related complications, and analysis of all explanted discs. The following have received FDA approval:



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

- The PCM [porous-coated motion] Cervical Disc^{®‡} (NuVasive) received FDA approval in 2012 (P100012). The PCM is a semi-constrained device consisting of 2 metal (cobalt-chromium alloy) endplates and a polyethylene insert that fits between the endplates.
- Secure[®]-C[‡] (Globus Medical) was approved in 2012 (P100003). The Secure-C is a 3 piece semi-constrained device with 2 metal (cobalt chromium molybdenum alloy) endplates and a polyethelene insert.
- The Mobi-C (LDR Spine) received FDA approval in 2013. Mobi-C is 3 piece semiconstrained device with metal (cobalt-chromium alloy) endplates and a polyethylene insert. The Mobi-C is approved for 1 (P110002) or 2 level (P110009) disc replacement.

A number of other devices are under study in FDA IDE trials in the United States.

Table 1. Cervical Disc Prostheses Under Investigation in the United States

Prosthesis	Manufacturer	FDA Status
Kineflex/C [®]	Spinal Motion	FDA IDE trial complete
Freedom [®]	AxioMed	FDA IDE trial recruiting
M6-C	Spinal Kinetics	FDA IDE trial recruiting complete

FDA: U.S. Food and Drug Administration; IDE: investigational device exemption.

Centers for Medicare and Medicaid Services (CMS)

A search of the Medicare National Database (<http://www.cms.gov/mcd/search.asp?from2=search.asp&>) identified a national coverage decision on artificial intervertebral discs for the lumbar spine. There is no national coverage decision on artificial intervertebral discs for the cervical spine.

Rationale/Source

This policy is based on TEC Assessments in 2007, 2009, 2011, and 2013, with additional updates of the literature using the MEDLINE database (most recently performed through June 9, 2016). The 2009 TEC Assessment reviewed the 2-year follow-up of the trials for the FDA-approved Prestige ST discs and ProDisc-C, concluding that AIDA did not meet TEC criteria due to insufficient evidence. Neither the Prestige nor the ProDisc-C trial provided adequate direct evidence over the relevant follow-up period (suggested to be 5-7 years) on subsequent adjacent-level DDD in control and investigational group patients. The 2011 and 2013 TEC Assessments reviewed mid-term outcomes at 4 to 5 years. These Assessments concluded that although results were consistent with continued noninferiority of artificial discs and lower cumulative reoperation rates, uncertainty remained due to the low follow-up rates. Two-year results of the PCM (porous-coated motions), SECURE-C, and Mobi-C discs were also reviewed.

A number of meta-analyses have also been published. In 2016, Hu et al published a meta-analysis of 8 randomized controlled trials (RCTs; total N=2368 patients) reporting mid-term outcomes (at least 48 months). All 8 studies were rated as low risk of bias, despite lack of blinding. Only 2 studies reported on overall success and 3 reported on Neck Disability Index (NDI) success. Six studies reported neurologic success data; pooled data favored the AIDA group to a small degree (relative risk [RR], 1.04; 95% confidence interval [CI], 1.01 to 1.08; p=0.01). Pooled data also showed a significant benefit of AIDA for secondary procedures at the index level (6 studies; RR=0.40; 95% CI, 0.28 to 0.58; p<0.001) and at the



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

adjacent level (5 studies; RR=0.42; 95% CI, 0.26 to 0.70; $p<0.002$). These studies are described in greater detail next.

Single-Level AIDA

Prestige ST

The Prestige ST Cervical Disc received FDA marketing approval in 2007. Information on the Prestige cervical disc is available from a published report of the pivotal trial and from Medtronic's PMA application to FDA. These documents report results from a randomized study comparing anterior cervical fusion (with allograft bone and plate stabilization) to the artificial cervical disc for patients with nonaxial pain and other symptoms secondary to radiculopathy or myelopathy that had not improved over a minimum 6 weeks of conservative therapy. The study was designed as a randomized, nonblinded noninferiority trial with a 10% margin. Results for 137 investigational and 148 control patients evaluated at 2 years postsurgery were presented to FDA in the PMA application. These patients represented about half of the total population (276 and 265, respectively), while the peer-reviewed article reported on about 75% of cases.

Three primary outcome variables were used in the Prestige pivotal trial: the NDI score, neurologic status, and functional spinal unit (FSU) height. The NDI is a validated multidimensional instrument that measures the effects of pain and disability on a patient's ability to manage everyday life. It is a modification of the Oswestry Disability Index, based on the response to 10 questions that focus on neck pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, and recreation. Responses to each question range from 1 to 5, with a lower numeric score representing a better pain and disability status for that variable. A total NDI score is obtained by adding individual question scores and dividing by the maximum total of 50, if all questions are answered. Therefore, NDI scores range from 0% to 100%, with a lower percentage indicating less pain and disability. Neurologic status is a composite measure of motor function, sensory function, and deep tendon reflexes. It is used to judge if patients are within normal parameters for those categories based on physiologic measurement. Neurologic success in the Prestige trial was based on postoperative maintenance or improvement of condition compared with preoperative status for each component. The anterior FSU height is a radiographic measure of interdiscal space. Comparison of the immediate postoperative FSU height with the 6-week postoperative value shows whether the disc space has decreased, which indicates that graft or device subsidence has occurred. Secondary outcome measures include the 36-Item Short-Form Health Survey (SF-36) Mental (MCS) and Physical Component Summary (PCS) scores, neck and arm pain status, patient satisfaction, patient global perceived effect, gait assessment, foraminal compression test, adjacent-level stability and measurements, return to work, and physician's perception.

Both data sources for the Prestige disc trial showed equivalent results. Thus, 81% of both groups showed at least a 15-point improvement for the NDI, demonstrating noninferiority to fusion but not superiority. Similarly, the FSU height measure also demonstrated evidence of noninferiority but not superiority. Neurologic status showed noninferiority and statistical superiority for the disc compared with fusion. This contributed to the overall success composite end point demonstrating superiority for the disc compared with fusion. While maintained or improved neurologic status was more frequent following AIDA, it was unclear whether examiners were blinded. Most secondary outcome measures for the disc were deemed noninferior



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

to ACDF, but none was statistically superior. Perioperative results and AEs were similar in both groups, with very few serious complications.

Five- and 7-year follow-ups of participants in this clinical trial were reported by Burkus et al in 2010 and 2014, respectively. All participants were followed in this FDA-regulated postapproval study (PAS). Outcomes at 60 months were reported on approximately half of the original RCT participants. Patients who had not yet reached that point in their follow-up for the 2010 publication were included in the 2014 report. Follow-up at 84 months was obtained in 73% of study participants (212 AIDA, 183 ACDF). Overall success rates at 78 months were 72.6% for the Prestige disc and 60.0% for ACDF ($p=0.008$), NDI scores improved by 37.5 points for the Prestige disc compared with 31.9 points for ACDF ($p=0.002$), and neurologic success was greater in the Prestige disc group (88.2% vs 79.7%, $p=0.011$). There was no significant difference between the 2 groups in NDI success rates at 84 months ($p=0.109$) or in work status. The rate of secondary surgeries at the initial treatment level was lower for Prestige (4.8%) than for ACDF (13.7%; $p<0.001$), but there was no significant difference in the rate of adjacent-level surgeries (3.9% vs 5.4%).

Prestige LP

Twenty-four-month results from the pivotal trial for the Prestige LP disc were published in 2015. This multicenter noninferiority trial compared 280 patients who received the Prestige LP disc to 265 historical ACDF controls from the Prestige investigational device exemption (IDE) study described above. Primary outcomes were neurologic success, individual success, and overall success. Blood loss and hospital stay were similar between groups, but median return-to-work time was significantly shorter for the Prestige LP group (40 days) than the ACDF group (60 days; $p=0.020$). With a rate of follow-up at 24 months of 97.1% for the Prestige LP group and 84.0% for controls (excluding radiographic assessment of disc height), noninferiority was demonstrated. Neurologic success was superior in the Prestige LP group (93.5%) compared to the control group (83.5%), with a Bayesian probability of about 1.00. Superiority on the composite measure of overall success was supported with a Bayesian probability of 0.994. In addition to statistical analysis by the study sponsor, raw data were provided to Vanderbilt University for independent confirmation of results.

ProDisc-C

Murrey et al reported 2-year results from the pivotal FDA randomized noninferiority trial to determine the safety and efficacy of ProDisc-C compared with ACDF. In this trial, 103 patients received the ProDisc-C implant and 106 were treated with fusion; participants were blinded to intervention until following surgery. Follow-up between 6 weeks and 2 years was reported to be 85% in the summary of safety and effectiveness data presented to FDA. Reasons for the loss to follow-up were not described but appear to have included 2 patients in the ProDisc-C group who had the implant removed and 5 patients in the fusion group who had undergone additional surgical procedures to modify the original implant. Noninferiority was achieved for the FDA-defined combined end point of neurologic examination, NDI score, AEs, and device success, with 72% of ProDisc-C and 68% of fusion patients achieving success in all 4 component end points. Clinical outcomes at 24-month follow-up were reported to be similar in the ProDisc-C and fusion groups for the following: neurologic success (91% vs 88%), NDI score (21.4 points vs 20.5 points), reduction in pain scores (eg, 46-mm vs 43-mm reduction in neck pain on a visual analog scale [VAS]), and patient satisfaction (83 mm vs 80 mm), respectively.

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

Four-year interim follow-up of participants in this clinical trial were reported by Delamarter et al 2010. All participants were followed in this FDA-regulated PAS. At 48 months, follow-up rates for ProDisc-C and ACDF were 63% and 46.2% respectively. It was not reported what proportion of these patients had not yet reached 48 months postsurgery or were lost to follow-up at that time point. Also included in this report was 24-month follow-up on 77% of 136 continued-access patients who received the ProDisc-C after the clinical trial. Clinical outcomes were similar across the 3 groups, with point estimates in favor of ProDisc-C. NDI score at 48 months was 20.3 for ProDisc-C and 21.2 for ACDF. Neurologic success was achieved in 88.9% of ProDisc-C patients compared with 74.4% of ACDF patients ($p=0.067$). There was a cumulative incidence of additional surgeries of 2.9% (3 patients) in the ProDisc-C group and 11.3% (12 patients) in the ACDF group. Two patients were converted to fusion with removal of the device; 1 patient had decompression with supplemental fixation without removal of the device. At 48 months, 5 (7.7%) ProDisc-C patients had bridging bone.

Five-year results of this trial were published in 2013, with follow-up rates of 72.7% for ProDisc-C and 63.5% for ACDF. Outcomes on the NDI were similar (50%-60% improved), along with VAS score for arm pain (18 for both groups) and SF-36 scores. VAS score for neck pain was modestly improved with ProDisc-C (21/100) compared with ACDF (30/100), although the proportion of patients who achieved a clinically significant improvement in neck pain was not reported. Fewer patients with ProDisc-C (2.9%) than with ACDF (14.5%) had secondary surgery at either the index or adjacent level.

Seven-year follow-up on 72.7% (152/209) of patients was reported by Janssen et al in 2015. Between 2 years and 7 years, there was no significant difference between ProDisc-C and ACDF patients for change in pain or function. Neurologic status was improved or maintained in a similar percentage of patients in both groups (ProDisc-C, 88%; ACDF, 89%). Secondary surgical procedures were significantly higher in the ACDF group (18%) than in the ProDisc-C group (7%; $p=0.009$), with an acceleration of secondary surgical procedures after 5 years in the ACDF group.

Single-Level Bryan Cervical Disc

Two- and 4-year results have been published from the IDE trial for the Bryan disc. The trial employed inclusion/exclusion criteria and a composite outcome identical to the ProDisc-C trial. A total of 582 patients were randomized to the Bryan disc ($n=290$) or ACDF ($n=292$). Thirty-seven patients declined surgery in the AIDA group; 80 patients declined surgery in the ACDF group. Twelve patients crossed over from AIDA to ACDF, 1 crossed over from ACDF to AIDA, and 2 patients were excluded from ACDF due to protocol violations, leaving 242 patients who underwent AIDA and 223 who underwent ACDF. In the AIDA and ACDF arms, mean age (44.4 years and 44.7 years), sex (45.5% and 51.1% men), and NDI scores (51.4 and 50.2), all respectively, were similar. All but 1 patient who underwent AIDA and 3 patients in the ACDF arm had documented neurologic abnormalities. After 2-year follow-up, data were available for 230 (95%) patients from the AIDA group and 194 (87%) who underwent ACDF. The overall success outcome was achieved more often after AIDA (82.6% vs 72.7%), with a mean 4.1-point greater improvement in the NDI scores. As measured by the composite end point, AIDA was superior to ACDF. At 24 months, neck pain scores were lower following AIDA, while other secondary outcomes were similar. AE rates were similar in the 2 arms, with 1.7% in the AIDA and 3.2% in the ACDF arms requiring revision.

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

In 2011, 4-year follow-up from the IDE trial was reported for 181 (75%) of 242 patients who received the Bryan disc and 138 (62%) of 223 patients who underwent ACDF. It was reported that 25% of AIDA and 38% of ACDF patients failed to return for follow-up at 48 months, due in part to FDA and institutional review board approvals and the need for additional patient consent for the continuation study. Overall success was defined as an improvement of 15 or more points on the NDI, neurologic improvement, no serious AEs related to the implant or surgical implantation procedure, and no subsequent surgery or intervention that would be classified as a treatment failure. Four-year overall success rates were significantly higher in the Bryan (85.1%) than in the ACDF (72.5%) group. This finding was driven largely by differences in NDI success (90.6% of AIDA, 79.0% of ACDF). Neurologic success rates did not differ between groups. Arm pain was reduced from a baseline of 71.2 in both groups to 16.6 for the Bryan disc and 22.4 for ACDF, the between-groups difference being statistically significant. Reduction in neck pain scores was also significantly better in the Bryan disc group (from 75.4 to 20.7) compared with the fusion group (from 74.8 to 30.6). Improvement in the SF-36 PCS score was also significantly greater in the AIDA group (15.8 vs 13.1). There was no significant difference in the percentage of additional surgical procedures at either the index (3.7% Bryan, 4.5% ACDF) or adjacent (4.1% Bryan, 4.1% ACDF) levels. FDA-required follow-up will continue for 10 years after the index surgery.

Authors' analysis of this trial noted that failure of other joint arthroplasty prostheses typically does not occur until at least 5 to 10 years postoperatively and that spinal arthroplasties also need serial assessments to determine whether complications (eg, wear-related failures, device fatigue, spinal instability) have developed. They concluded that, as with any motion-sparing device, "longer-term follow-up is necessary for assessment of potential problems related to bearing surface wear."

A post hoc subgroup analysis of 199 participants with myelopathy from the Prestige ST (n=111) and Bryan (n=88) trials found similar improvement in postoperative neurologic status and gait at 24 months (Prestige ST: AIDA, 90% [95% CI, 79% to 97%] vs ACDF, 81% [95% CI, 65% to 92%]; Bryan: AIDA, 90% [95% CI, 76% to 97%] and ACDF, 77% [95% CI, 76% to 97%]).²⁶ The authors noted that "although short-term results of cervical disc arthroplasty appear encouraging, studies with at least five to ten years of follow-up are required before cervical disc replacement can be viewed as a standard treatment for disc-based cervical myelopathy."

In 2010, Goffin et al reported 4- and 6-year follow-ups from phase 1 and 2 trials of the Bryan disc. The total potential patient population for long-term follow-up was 98 patients (89 with 1-level, 9 with 2-level); 59 patients were at least 6 years postoperative. Although 4 patients from the phase 1 study declined to participate in the extended follow-up study, their results were included in the safety data. Mean neck pain at 4 and 6 years postoperatively was 2.2 and 2.0, respectively. Mean arm pain at 4 and 6 years was 2.4 and 2.3, respectively. Six patients experienced events believed to be related to the device, including minor device migration, device removal, hoarseness, and vocal cord paralysis, while 3 of the 6 cases involved pain or neurologic symptoms. The prosthesis was removed from 1 patient at 6 years after the index surgery because of progressive spinal cord compression due to recurrent posterior osteophyte formation. About 90% of patients were classified as having excellent or good outcomes at 4 and 6 years. The success rate estimated by Kaplan-Meier analysis was 94% at 7 years postsurgery.

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

Kineflex/C

In 2011, Coric et al reported the 24-month pivotal multicenter randomized IDE trial of the metal-on-metal Kineflex/C artificial disc (n=136) compared to ACDF performed with allograft and anterior plate (n=133). There were no significant differences between the Kineflex/C and ACDF groups for operative time, blood loss, hospital length of stay, or reoperation rate at the index level. The overall success rate was significantly greater in the Kineflex/C group (85%) compared with the ACDF group (71%). (Overall success was defined as a composite measure of neurologic evaluation, >20% improvement in NDI score, no device failure, no reoperation at the index level, and no major device-related AE.) There were 6 (5%) index-level reoperations in the Kineflex/C group, including 1 case of metal sensitivity and 2 for device migration. There were 7 (7.6%) index-level surgeries in the ACDF group, including 3 for pseudarthrosis and 4 for instrumentation failure (removal or revision of the original anterior plate and screw construct). There was no significant difference between groups in VAS pain or NDI scores. Although fewer Kineflex/C patients showed severe adjacent-level radiographic changes (9% vs 24.8%), the between-group difference was not significant for the adjacent-level reoperation rate (7.6% for the Kineflex/C group, 6.1% for the ACDF group) at short-term follow-up.

The need for longer term studies remains to assess device failure and other long-term complications. An accompanying editorial noted that while the 24-month IDE trials of artificial discs were well done, and these new motion-saving mechanical devices may potentially be better than ACDF, a number of complications can occur with arthroplasty that include dislodgement, vertical vertebral body fracture, device failure, and heterotopic ossification (HO). Given that no mechanical device has an infinite lifespan, and we do not know the failure rate, timeframe, or consequences of failure of cervical arthroplasty devices, a longer period of scientific scrutiny was advised to determine the real efficacy of artificial cervical discs.

Mobi-C

Mobi-C is the only artificial disc approved for 1- or 2-level cervical disc disease. The 1-level Mobi-C trial randomized 169 patients to AIDA and 87 to ACDF. Patient characteristics were generally similar to the other trials. Patient with multilevel disease or previously treated cervical disease were excluded from the trial. At 24 months, the follow-up rate was 93%. Designed as a noninferiority trial, noninferiority criteria were met for NDI mean improvement, percent NDI success (≥ 15 -point improvement), and overall success. The overall protocol-specified success rate was higher in the Mobi-C group (73.7%) than the ACDF group (65.3%), which met noninferiority criteria but not superiority criteria. Cumulative subsequent surgical interventions at the index level were numerically lower in the AIDA group (1.2%) than the ACDF group (6.2%).

Hisey et al published 2-, 4- and 5-year results from the single-level Mobi-C trial, with follow-up rates of 85.5% for the Mobi-C group and 78.9% for ACDF at 5 years. The primary outcome was overall success, as defined by a modified FDA-approved measure designed for the PAS. The criteria for success were a minimum of a 30-point improvement in NDI score (100-point scale) compared to baseline; no device-related subsequent surgery; no device-related adverse events; no neurologic deterioration; and no intraoperative changes in treatment. Overall success in the Mobi-C group was noninferior to ACDF but did not achieve superiority, with a success rate of 61.9% for Mobi-C and 52.2% for ACDF. Range of motion was preserved with Mobi-C through 5 years, even though grade 4 HO was observed in 8.5% of Mobi-C patients. Adjacent

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

segment degeneration was significantly lower with Mobi-C, but radiographically determined adjacent-segment degeneration remained above 30% at 5-year follow-up in this group. Throughout the 5-year follow-up, Mobi-C patients had a lower incidence of subsequent surgeries (Mobi-C, 4.9%; ACDF, 17.3%; $p < 0.01$).

Similar results were reported in an independently funded multicenter RCT from Asia of single-level arthroplasty with the Mobi-C device compared to ACDF (N=111). Outcomes for pain and function were similar for the Mobi-C and ACDF groups at 48-month follow-up. There was significantly more radiographically determined adjacent-level degeneration and a higher incidence of secondary surgery with ACDF (1 Mobi-C vs 3 ACDF patients).

Porous Coated Motion Cervical Disc

Results of the 2-year FDA-regulated multicenter randomized noninferiority trial of the PCM (porous coated motion) Cervical Disc were reported by Phillips et al in 2013. Five- and 7-year follow-ups were reported by Phillips et al in 2015.¹⁰ The investigator and surgical staff were not blinded to treatment assignment, and patients were informed of assignment after surgery. Of the 416 patients randomized (224 to PCM, 192 to ACDF), 340 (82% [189 to PCM, 151 to ACDF]) were per protocol for the 24-month primary end point of overall success. Overall success was defined as at least 20% improvement in NDI score; absence of reoperation, revision, or removal; maintenance or improvement in neurologic status; and absence of radiographic or major complications during the 24-month follow-up period. At 24 months, overall success was 75.1% in the PCM group and 64.9% in the ACDF group, which met both the noninferiority and superiority criteria. There was a trend toward a greater neurologic success rate in the PCM group (94.7%) compared with the ACDF group (89.5%, $p = 0.10$). There was no significant difference between the groups for VAS pain scores, SF-36 scores, or implant- or surgery-related AEs (5.2% PCM vs 5.4% ACDF). Patients with prior fusion were included in this study. Overall success for prior fusion subgroups in this analysis was similar (65.4% PCM and 64.3% ACDF).

Follow-up at 5 years included 163 (74.8%) PCM and 130 (70.3%) ACDF patients. At reporting, 68 (31.2%) PCM and 42 (22.7%) ACDF patients had reached 7 years of follow-up. At 5 years, NDI success was modestly better in the PCM group (85.0%) than in the ACDF group (74.2%), and dysphagia was slightly lower (VAS score, 8.8/100 vs 16.9/100). Success on VAS pain scores did not differ significantly between groups for neck pain or worst arm pain, and there was no significant difference between groups for neurologic success rates. There was no significant difference between groups in subsequent secondary surgical interventions (PCM, 8.1%; ACDF, 12.0%). Radiographically determined adjacent-level degeneration was more frequent after ACDF (50.9%) compared with PCM (33.1%, $p = 0.006$). Six percent of patients in the PCM group showed grade IV HO with bony ankylosis, while 94.4% of patients in the ACDF group showed fusion.

SECURE-C

The FDA-regulated SECURE-C trial was a multicenter nonblinded noninferiority trial with 151 patients randomized to receive AIDA and 140 patients randomized to ACDF. An additional 89 nonrandomized patients were included in the published data. Patients with multilevel disease or previously treated cervical disease were excluded from the trial. Overall success was defined by FDA as a 15-point or more improvement in NDI score; absence of reoperation, revision, or removal; stable or improved neurologic



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

status, and absence of radiographic or major complications during the 24-month follow-up period. At 24 months, the follow-up rate was 87%. Noninferiority criteria (AIDA vs ACDF) were met for NDI mean improvement, rate of NDI success (89.2% vs 84.5%), neurologic success (96.0% vs 94.9%), and overall success (83.8% vs 73.2%), all respectively (posterior probability of 98.1% by Bayesian analysis) using FDA-defined criteria. The overall success rate, as specified in the protocol at 24 months (>25% improvement in NDI score, no removals, no complications) was also higher in the SECURE-C group (90.1%) than in the ACDF group (71.1%), which met both noninferiority criteria, as well as superiority criteria (posterior probability of 100% by Bayesian analysis). Cumulative secondary surgical interventions at the treated level were lower in the AIDA group (2.5%) than the ACDF group (9.7%).

Section Summary: Single-Level AIDA

At 2-year follow-up, trials of all artificial cervical discs met noninferiority criteria as measured by the NDI and overall success composite outcome. Mid-term outcomes have been reported on 5 devices (Prestige ST, ProDisc-C, Bryan, Mobi-C, PCM). At 4 to 5 years, the trial results are consistent with continued noninferiority of AIDA for clinical outcomes and lower cumulative reoperation rates. Seven-year follow-up of the Prestige and ProDisc-C pivotal trials continues to show lower secondary surgery rates, although this is not a consistent finding in other reports. Serious adverse events appear to be uncommon. HO can occur in a substantial proportion of spinal segments with artificial intervertebral discs, but does not appear to lead to a decline in clinical outcomes.

Two-Level AIDA

Two-Level Bryan Cervical Disc

In 2009, Cheng et al reported 2-year follow-up from an RCT comparing the Bryan disc to ACDF with autograft in 65 patients with 2-level disc disease. One patient from the arthroplasty group and 2 patients from the ACDF group were lost to follow-up. Neck pain and arm pain measured by VAS tended to be lower in the Bryan group (1.8 and 1.9, respectively) than in the ACDF group (2.5 and 2.4, respectively) at 12-month follow-up and continued to improve at 2-year follow-up (Bryan, 1.5 and 1.4; ACDF, 2.6 and 2.7, respectively). NDI and SF-36 PCS scores were also significantly better in the Bryan group at both 12- and 24-month follow-ups. These results support the short-term safety of the Bryan disc in 2-level disc disease; longer term results are needed to evaluate the safety and efficacy of this device versus ACDF for 2-level disc disease.

Two-Level Mobi-C

Two- and 4-year results from the 2-level Mobi-C IDE trial were reported by Davis et al in 2013 and 2015, respectively. In this noninferiority trial, 225 patients received the Mobi-C device at 2 contiguous levels and 105 patients received 2-level ACDF. At 24 months, the follow-up rate was 98.2% for the AIDA group and 94.3% for the ACDF group. At 48 months, the follow-up rate was 89.0% for AIDA and 81.2% for ACDF. Both groups showed significant improvement in NDI, VAS neck pain, and VAS arm pain scores from baseline to each follow-up point, with Mobi-C meeting the noninferiority margin. Subsequent testing for superiority showed that AIDA patients had significantly greater improvement than ACDF patients in NDI scores and had higher NDI success rates (79.3% vs 53.4% at 48 months, $p < 0.000$) and overall success rates (66.0% vs 36.0% at 48 months) at all time points, respectively. AIDA resulted in significantly greater reduction in VAS neck pain at 3 and 6 months postoperatively but not at 12, 24, 36, or 48 months. Arm pain

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

scores did not differ between the groups. The Mobi-C group had a lower reoperation rate (4.0% vs 15.2% $p<0.001$). At 48 months, adjacent-level degeneration was observed in 41.5% of AIDA patients and 85.9% of ACDF patients with available radiographs, while 25.6% of AIDA patients showed clinically relevant HO.

In 2016, Radcliff et al published 5-year results from the Mobi-C 2-level IDE trial. Follow-up rates were 82.7% of patients for the Mobi-C group (8.9% study failures) and 68.6% for the ACDF group (21.0% study failures). Excluding patients who dropped from the study due to death or device failures, follow-up rates were 90.7% for the Mobi-C group and 86.7% for the ACDF group. Improvement in the Mobi-C group was significantly better than in the ACDF group for the NDI and SF-12 PCS scores. There were no significant differences between groups for VAS neck and arm pain scores, neurologic status, or for SF-36 MCS scores. The FDA-defined composite measure of success was significantly better for the Mobi-C group (61%) than for the ACDF group (31%; $p<0.001$) and there were significantly fewer secondary surgeries in the Mobi-C group (7.1%) compared with the ACDF group (21%; $p<0.001$). This was due to fewer index-level reoperations (4.3% vs 16.2%, $p<0.001$) and adjacent-level reoperations (3.1% vs 11.4%) with the Mobi-C devices. Clinically relevant HO (grade III or IV) was observed in 29.7% of the Mobi-C patients, but the Mobi-C patients had significantly less adjacent-segment degeneration (50.7%) than ACDF patients (90.5%; $p<0.001$).

Post hoc analysis of data from the pivotal 1- and 2-level Mobi-C trials was reported by Bae et al in 2015. Comparison showed no significant differences between 1- and 2-level AIDA on clinical outcomes (NDI, VAS, and SF-12 scores), major complication rates (4.3% for 1-level AIDA, 4.0% for 2-level AIDA), or subsequent surgery rates (3.0% of 1-level, 4.0% of 2-level). Clinically relevant HO was observed in 23.8% of 1-level patients and 25.7% of 2-level patients. Huppert et al compared outcomes between single- (n=175) and multilevel (2-4 levels, n=56) AIDA with the Mobi-C device in a prospective multicenter study from Europe.⁴⁰ The age of patients was significantly higher and the time since symptom onset was significantly longer in the multilevel group. At 2 years, there were no significant differences between groups for the radicular VAS, cervical VAS, and NDI scores. Range of motion was similar in the 2 groups. The overall success rate was 69% in both groups. There was a trend for more patients in the single-level group to return to work (70% vs 46%) and for the return to work to occur sooner (4.8 months vs 7.5 months), respectively. A similar percentage of patients underwent adjacent-level surgery (2.3% for single-level, 3.6% for multilevel).

Two-Level Prestige LP

In July 2016, the Prestige LP received FDA approval for implantation at 2 levels. Approval was based on 24-month data from a noninferiority trial that randomized patients to AIDA (n=209) or ACDF (n=188) at 2 contiguous levels. Data for FDA approval were collected until the last subject enrolled had completed 24-month follow-up. Additional prespecified evaluations are scheduled at 36, 60, 84, and 120 months. The primary outcome was overall success, defined as a 15-point improvement on the NDI, maintenance or improvement in neurologic status, no serious AE classified as implant or surgery related, and no additional surgical procedure classified as a failure, with a noninferiority margin of 10%. Secondary outcomes include the improvement in NDI score, improvement in neck and arm pain, improvement in quality of life, subject satisfaction, medication usage, range of motion, HO, and work status compared to the 2-level ACDF group.

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
 Original Effective Date: 02/20/2008
 Current Effective Date: 12/21/2016

Complete overall success data at 24 months were available for 199 (95.2%) 2-level Prestige LP patients and 160 (88.9%) ACDF controls. Overall success was achieved in 81.4% of Prestige LP patients and in 69.4% of ACDF controls, meeting both noninferiority and superiority with a posterior probability of near 100% and 99.3%, respectively. The average difference in the chance of success between the 2-level Prestige LP group and the 2-level ACDF group at 24 months was 11.3%, with a 95% probability that this difference falls in the range of 2.2% to 20.1%. Based on Bayesian credible intervals (CrI), there were no statistical differences between the 2 treatment groups for adverse events. There were 12 (6.4%) severe device-related adverse events in the 2-level ACDF group compared to 5 (2.4%) in the Prestige LP group. More patients in the 2-level ACDF group underwent subsequent surgical procedures at the index level (8.0%) than in the Prestige LP group (2.4%) (posterior mean, -5.6%; 95% CrI, -10.2% to -1.1%).

Table 2 shows the numbers (percentages) of patients who have reached follow-up at intervals up until 84 months and of those patients who have met criteria for overall success. The difference in success between the Prestige LP and ACDF patients that was achieved at 24 months was maintained through 7 years. However, there was a higher loss to follow-up in the 2-level ACDF group, which may have biased results. Secondary outcome measures were similar between groups at 24-month follow-up. Data on adjacent-level surgeries were not collected prospectively, but assessed through AE documentation. At 24 months, surgery at the adjacent level(s) was 2.4% for the 2-level Prestige LP group and 3.2% for the 2-level ACDF group. Follow-up is continuing.

Table 2. Follow-Up and Success Rates for 2-Level Prestige LP Compared to 2-Level ACDF

Outcomes	24 Months		36 Months		60 Months		84 Months	
	AIDA	ACDF	AIDA	ACDF	AIDA	ACDF	AIDA	ACDF
Follow-up, n (%)	199 (95%)	160 (86%)	185 (89%)	149 (80%)	166 (80%)	138 (74%)	126 (67%)	99 (58%)
Cumulative withdrawal, n (%)	0 (0%)	7 (3.7%)	1 (0.5%)	10 (5.3%)	5 (2.3%)	12 (6.3%)	5 (2.3%)	16 (8.5%)
Overall success n/N (%)	162/199 (81.4%)	111/160 (69.4%)	151/185 (81.6%)	105/149 (70.5%)	132/166 (79.5%)	91/138 (65.9%)	99/126 (78.6%)	62/99 (62.6%)

AIDA: artificial intervertebral disc arthroplasty; ACDF: anterior cervical discectomy and fusion.

Section Summary: Two-Level AIDA

At 2- and 4-year follow-ups, the first artificial cervical disc approved for 2-levels (Mobi-C) was found to be noninferior to ACDF in the IDE trial. Superiority to ACDF was achieved for NDI scores, NDI success rates, and overall success composite outcome. Reoperation rates were significantly lower in the Mobi-C group. At 5 years, trial results were consistent with the continued superiority of 2-level AIDA for clinical outcomes and lower cumulative reoperation rates. Although a third of patients who received the Mobi-C had clinically significant HO, adjacent-segment degeneration with Mobi-C was found in a lower percentage of patients than in ACDF patients.

FDA approval for the Prestige LP disc at 2 levels was based on superiority to 2-level ACDF at 2-year follow-up. Outcome assessments will continue through 10 years. At present, over 80% of patients have reached 3-year follow-up and over 50% of patients have reached 7-year follow-up. The difference in success rates at 2 years has been maintained over the follow-up period. Secondary outcome measures and adjacent-level



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

reoperations were similar between the AIDA and ACDF groups at 2-year follow-up. Continued follow-up will provide important data on longer term safety of the 2-level construct and comparison with ACDF for secondary outcome measures and adjacent-level reoperations.

Registry Data Spine Tango

In 2016, Staub et al evaluated the clinical effectiveness of AIDA from 987 patients in the Spine Tango registry. The primary outcome measures were neck and arm pain relief and the Core Outcome Measures Index (COMI). One analysis evaluated outcomes from a matched pair of patients (190 pairs) who met the selection criteria of published RCTs. With an average follow-up of 17 months, there were small but statistically significant differences in outcomes between AIDA and ACDF. The mean group differences on a 10-point scale for both pain measures was 0.6 points in postoperative neck pain ($p=0.04$) and 0.7 points in arm pain ($p=0.02$); mean COMI score difference was 0.8 points ($p=0.01$). Change scores did not differ significantly. The probability of being a responder (2-point change) was significantly better in the AIDA group for arm pain relief (78.4% vs 67.4%, $p=0.02$) and COMI score (81.6% vs 67.9%, $p<0.01$), but not neck pain relief (62.1% vs 57.9%, $p=NS$).

For patients excluded from the RCTs, most commonly due to age greater than 60 years or spondylosis, there were no significant differences in clinical outcomes between AIDA and ACDF. A third analysis compared outcomes of AIDA and ACDF in patients who had follow-up of more than 2 years (mean, 55.0 months; range, 27.0-76.5 months). After controlling for patient age, patients treated with AIDA had significantly higher responder rates for arm pain relief (80.0%) compared with patients treated with ACDF (64.9%; $p=0.05$), with no significant difference in responder rates between the 2 groups for neck pain relief or COMI. The rate of adjacent-level degeneration and secondary surgeries were not assessed.

Adverse Events Adjacent-Segment Degeneration

A key question is whether cervical disc arthroplasty reduces adjacent-segment degeneration, which is the hypothetical advantage of motion-preserving artificial discs. Five- and 7-year data from the pivotal trials described above suggest a reduction in both index-level and adjacent-level secondary surgeries with AIDA. However, other studies found no difference in adjacent-level degeneration between AIDA and ACDF.

In 2012, Nunley et al published a report that included 170 patients (57 ACDF, 113 AIDA) with a median follow-up of 42 months (range, 28-54 months). There was no significant difference in adjacent-level disease between ACDF (14%) patients and AIDA (17%) patients. The mean period of freedom from adjacent-level disease was 46 months after ACDF and 49 months after total disc arthroplasty. Osteopenia and lumbar DDD significantly increased the risk of adjacent-level disease.

In 2010, Coric et al reported outcomes from 98 patients with 1- or 2-level cervical disc disease who had participated in 1 of 3 IDE studies (Bryan, Kineflex/C and Discover cervical disc). Patients were evaluated with neurologic examinations, radiographs, and clinical outcome indices at 1, 3, 6, 12, 24, 36, 48, and 60 months. A minimum follow-up of 24 months (range, 24-67 months), data were available for 90 patients (53 arthroplasty, 41 ACDF). There were a similar number of reoperations, with 4 (7.5%) in the combined



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
Original Effective Date: 02/20/2008
Current Effective Date: 12/21/2016

arthroplasty group (1 at the adjacent level) and 3 (8.1%) in the ACDF group (all at the adjacent level). A 2013 report from this group reported minimum 48-month follow-up (range, 48-108 months) of 74 patients who had received a Bryan or Kineflex cervical disc. There were 3 (7.3%) reoperations at the index (n=1) or adjacent levels (n=2) in the AIDA group and 1 (3%) adjacent-level reoperation in the ACDF group.

Device Failure

Reports of device failure may emerge with increased use of artificial discs and longer follow-up. One case report has described failure of a Bryan Cervical Disc due to a fatigue fracture of the flexible polyether urethane sheath at 8 years after implantation. Degradation of the sheath, including surface fissures and full-thickness cracks, has been observed in 27% of retrieved Bryan discs. One case of anterior migration of the Mobi-C disc was reported. Another case reported fragmented fracture of the ceramic-on-ceramic Discover (Cervidisc Evolution) at 1 month after implantation.

Dysphagia

A lower incidence of dysphagia has been reported with cervical arthroplasty in comparison with ACDF. As part of the IDE trial for the PCM device, patients who underwent arthroplasty (n=151) or ACDF (n=100) self-reported dysphagia severity using the validated Bazaz Dysphagia Score. The arthroplasty group showed a significantly lower incidence of dysphagia at all time points (6 weeks and 3, 6, 12, and 24 months after surgery). For example, at the 6-week follow-up, moderate-to-severe dysphagia was reported in 18.7% of arthroplasty patients compared with 37.3% of ACDF patients, while at 12-month follow-up, moderate-to-severe dysphagia was reported in 4.3% of arthroplasty patients compared with 13.1% of ACDF patients.

Heterotopic Ossification

HO appears to be common with AIDA, but there is no evidence of a large impact on clinical outcomes. A meta-analysis of HO (McAfee grade 3-4) after AIDA was published by Chen et al in 2012. Included in the meta-analysis were 8 studies (total N=617 patients). The pooled prevalence of any HO was 44.6% at 12 months after AIDA and 58.2% at 24 months after AIDA. The pooled prevalence of advanced HO was 11.1% after 12 months and 16.7% after 24 months. Although no publication bias was identified, there was significant heterogeneity in study results.

The largest study included in the meta-analysis evaluated HO rates in 170 patients who had undergone cervical arthroplasty with 1 of 3 cervical discs (81 Bryan, 61 Mobi-C, 28 ProDisc-C) and had at least 12 months of follow-up. HO was found in 40.6% of patients; the median time without HO was 27.1 months. HO occurred in 21% of Bryan patients, 52.5% of Mobi-C patients, and 71.4% of ProDisc-C patients. Tu et al assessed HO in a series of 36 patients (52 levels) who had received total disc replacement with the Bryan Cervical Disc and had completed clinical and radiologic evaluations. HO was observed in computed tomography images in 50% of patients at a mean of 19 months of follow-up. However, only 2 (3.8%) treated levels showed a loss of segmental motion (<2°) by dynamic radiography. At a mean of 27 months of follow-up, clinical evaluation indicated a similar clinical success rates in patients who had and did not have HO (94.4% in both groups).

Progressive spinal cord compression due to osteophyte formation has been observed with cervical disc arthroplasty.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
 Original Effective Date: 02/20/2008
 Current Effective Date: 12/21/2016

Hypersensitivity Reaction

The first reported case of a delayed hypersensitivity reaction to metal ions after disc arthroplasty was in 2009. Although no intracellular or extracellular metal alloy particles were detected in the tissue, the lymphocyte-dominated response was thought to be similar to reactions reported in patients with metal-on-metal hip prostheses. The patient had complete resolution of symptoms after implant removal and fusion. In 2011, Guyer et al reported 4 cases of a lymphocytic reaction to a metal-on-metal artificial disc (1 Kineflex/C cervical disc and 3 lumbar) that required revision. The mode of failure was compression of neural tissue or other adjacent structures by a soft tissue mass. Three patients had a good outcome after the explantation and revision surgery; 1 patient continued to have residual symptoms related to the neural compression caused by the mass. No hypersensitivity reactions have been reported from devices with a polyethylene/polyurethane insert or from Prestige stainless steel implants, however, periprosthetic tissue explanted after 1 to 7 years commonly showed focal metallosis.

Subsidence

Extensive bone loss in the vertebral body and device subsidence has been reported as a complication in some patients 4 and 6 years after cervical arthroplasty.

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 3.

Table 3. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT00432159 ^a	A Multi-Center, Prospective, Randomized Controlled Trial Comparing Cervical Arthroplasty to Anterior Cervical Discectomy and Fusion for the Treatment of Cervical Degenerative Disc Disease (DISCOVER™ IDE Study)	500	May 2016 (ongoing)
NCT01609374 ^a	Prospective, Concurrently Controlled, Multi-Center Study to Evaluate the Safety and Effectiveness of the Spinal Kinetics™ M6-C Artificial Cervical Disc Compared to Anterior Cervical Discectomy and Fusion (ACDF) for the Treatment of Symptomatic Cervical Radiculopathy	243	May 2017
NCT01763619 ^a	Freedom Cervical Disc Use In The Treatment of Cervical Degenerative Disc Disease	50	Jul 2017
NCT00637156 ^a	A Prospective, Randomized, Controlled, Multicenter Pivotal Clinical Trial of the Artificial Cervical Disc-LP at Two Levels for Symptomatic Cervical Disc Disease	397	Mar 2018
NCT02403453 ^a	RHINE™ Cervical Disc Clinical Study	166	Jun 2021
Unpublished			
NCT00637312 ^a	Clinical Trial Comparing the Blackstone Advent™ Cervical Disc to Anterior Cervical Discectomy and Fusion (ACDF) for the Treatment of One Level Degenerative Disc Disease	108	Terminated (revision rate)
NCT00478088 ^a	A Pivotal, Multi-Center, Randomized, Controlled Trial Evaluating The Safety and Effectiveness of The NeoDisc™ Versus Instrumented Anterior Cervical Discectomy and Fusion (ACDF)	488	Mar 2012 (completed)

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



Blue Cross Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

in Subjects With Single-Level Cervical Disc Disease

NCT: national clinical trial.

^a Denotes industry-sponsored or cosponsored trial.

Summary of Evidence

For individuals who have cervical radicular pain or myelopathy who receive single-level AIDA of the cervical spine, the evidence includes RCTs and meta-analyses of RCTs. Relevant outcomes are symptoms, morbid events, functional outcomes, quality of life, and treatment-related morbidity. At 2-year follow-up, trials of all artificial cervical discs met noninferiority criteria as measured by the NDI and overall success composite outcome. Mid-term outcomes have been reported on 5 devices (Prestige ST, ProDisc-C, Bryan, Mobi-C, PCM [porous coated motion]). At 4 to 5 years, the trial results are consistent with continued noninferiority of AIDA for clinical outcomes and lower cumulative reoperation rates. Seven-year follow-up of the Prestige and ProDisc-C pivotal trials continues to show lower secondary surgery rates, although this is not a consistent finding in other reports. Longer term results for other discs are expected, given the FDA requirement for 7-year postapproval studies of the safety and function of the devices, and 5- to 10-year enhanced surveillance to more fully characterize adverse events in a broader patient population. Serious adverse events appear to be uncommon. Heterotopic ossification can occur in a substantial proportion of spinal segments with artificial intervertebral discs, but does not appear to lead to a decline in clinical outcomes. The evidence to date shows outcomes that are at least as good as the standard treatment of ACDF. There have been no safety signals with discs that have been approved by the FDA for single-level AIDA. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

For individuals who have cervical radicular pain or myelopathy who receive 2-level AIDA of the cervical spine, the evidence includes RCTs. Relevant outcomes are symptoms, morbid events, functional outcomes, quality of life, and treatment-related morbidity. At 2- and 4-year follow-ups, the first artificial cervical disc approved for 2 levels (Mobi-C) was found to be superior to ACDF for NDI scores, NDI success rates, reoperation rates, and overall success composite outcome. At 5 years, trial results were consistent with the continued superiority of 2-level AIDA for clinical outcomes and lower cumulative reoperation rates. Adjacent segment degeneration with Mobi-C was found in a significantly lower percentage of patients compared to 2-level ACDF patients. FDA approval for the Prestige LP was based on superiority to 2-level ACDF in overall success at 2 years. The increase in overall success rates at 2 years has been maintained for those patients who have reached the 5- and 7-year follow-ups. Based on this evidence, it can be concluded that 2-level AIDA with either of these FDA-approved discs is at least as beneficial as the established alternative. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

References

1. Blue Cross and Blue Shield Association, Medical Policy Reference Manual, "Artificial Intervertebral Disc: Cervical Spine", 7.01.108, 09:2016.
2. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Artificial intervertebral disc arthroplasty for treatment of degenerative disc disease of the cervical spine. TEC Assessments. 2007;Volume 22:Tab 12.
3. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Artificial intervertebral disc arthroplasty for treatment of degenerative disc disease of the cervical spine. TEC Assessments. 2009;Volume 24:Tab 3.

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

4. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Artificial intervertebral disc arthroplasty for treatment of degenerative disease of the cervical spine. TEC Assessments. 2011;Volume 26:Tab 5.
5. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Artificial intervertebral disc arthroplasty for treatment of degenerative disc disease of the cervical spine. TEC Assessments. 2013;Volume 28:Tab 13.
6. Mummaneni PV, Burkus JK, Haid RW, et al. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. *J Neurosurg Spine*. Mar 2007;6(3):198-209. PMID 17355018
7. Goffin J, Van Calenbergh F, van Loon J, et al. Intermediate follow-up after treatment of degenerative disc disease with the Bryan Cervical Disc Prosthesis: single-level and bi-level. *Spine (Phila Pa 1976)*. Dec 15 2003;28(24):2673-2678. PMID 14673368
8. Hu Y, Lv G, Ren S, et al. Mid- to long-term outcomes of cervical disc arthroplasty versus anterior cervical discectomy and fusion for treatment of symptomatic cervical disc disease: a systematic review and meta-analysis of eight prospective randomized controlled trials. *PLoS One*. 2016;11(2):e0149312. PMID 26872258
9. Burkus JK, Traynelis VC, Haid RW, Jr., et al. Clinical and radiographic analysis of an artificial cervical disc: 7-year follow-up from the Prestige prospective randomized controlled clinical trial: Clinical article. *J Neurosurg Spine*. Oct 2014;21(4):516-528. PMID 25036218
10. Sasso RC, Anderson PA, Riew KD, et al. Results of cervical arthroplasty compared with anterior discectomy and fusion: four-year clinical outcomes in a prospective, randomized controlled trial. *J Bone Joint Surg Am*. Sep 21 2011;93(18):1684-1692. PMID 21938372
11. Phillips FM, Geisler FH, Gilder KM, et al. Long-term outcomes of the US FDA IDE prospective, randomized controlled clinical trial comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. *Spine (Phila Pa 1976)*. May 15 2015;40(10):674-683. PMID 25955086
12. Coric D, Kim PK, Clemente JD, et al. Prospective randomized study of cervical arthroplasty and anterior cervical discectomy and fusion with long-term follow-up: results in 74 patients from a single site. *J Neurosurg Spine*. Jan 2013;18(1):36-42. PMID 23140129
13. Davis RJ, Nunley PD, Kim KD, et al. Two-level total disc replacement with Mobi-C cervical artificial disc versus anterior discectomy and fusion: a prospective, randomized, controlled multicenter clinical trial with 4-year follow-up results. *J Neurosurg Spine*. Jan 2015;22(1):15-25. PMID 25380538
14. Hisey MS, Bae HW, Davis RJ, et al. Prospective, randomized comparison of cervical total disk replacement versus anterior cervical fusion: results at 48 months follow-up. *J Spinal Disord Tech*. May 2015;28(4):E237-243. PMID 25310394
15. Janssen ME, Zigler JE, Spivak JM, et al. ProDisc-C Total Disc replacement versus anterior cervical discectomy and fusion for single-level symptomatic cervical disc disease: seven-year follow-up of the prospective randomized U.S. Food and Drug Administration Investigational Device Exemption Study. *J Bone Joint Surg Am*. Nov 4 2015;97(21):1738-1747. PMID 26537161
16. Zhang HX, Shao YD, Chen Y, et al. A prospective, randomised, controlled multicentre study comparing cervical disc replacement with anterior cervical decompression and fusion. *Int Orthop*. Dec 2014;38(12):2533-2541. PMID 25209344
17. U.S. Food and Drug Administration (FDA) Center for Devices and Radiological Health. Report of United States Clinical Study Results (G010188) -- Prestige Cervical Disc System. 2006; http://www.fda.gov/ohrms/dockets/ac/06/briefing/2006-4243b1_02.pdf. Accessed November, 2014.
18. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. *J Manipulative Physiol Ther*. Sep 1991;14(7):409-415. PMID 1834753
19. Burkus JK, Haid RW, Traynelis VC, et al. Long-term clinical and radiographic outcomes of cervical disc replacement with the Prestige disc: results from a prospective randomized controlled clinical trial. *J Neurosurg Spine*. Sep 2010;13(3):308-318. PMID 20809722
20. Gornet MF, Burkus JK, Shaffrey ME, et al. Cervical disc arthroplasty with PRESTIGE LP disc versus anterior cervical discectomy and fusion: a prospective, multicenter investigational device exemption study. *J Neurosurg Spine*. Jul 31 2015;1-16. PMID 26230424
21. Murrey D, Janssen M, Delamarter R, et al. Results of the prospective, randomized, controlled multicenter Food and Drug Administration investigational device exemption study of the ProDisc-C total disc replacement versus anterior discectomy and fusion for the treatment of 1-level symptomatic cervical disc disease. *Spine J*. Apr 2009;9(4):275-286. PMID 18774751
22. U.S. Food and Drug Administration (FDA) Center for Devices and Radiological Health. ProDisc-C Summary of safety and effectiveness data. 2007; http://www.accessdata.fda.gov/cdrh_docs/pdf7/p070001b.pdf. Accessed November, 2014.
23. Delamarter RB, Murrey D, Janssen ME, et al. Results at 24 months from the prospective, randomized, multicenter Investigational Device Exemption trial of ProDisc-C versus anterior cervical discectomy and fusion with 4-year follow-up and continued access patients. *SAS J*. 2010;4(4):122-128. PMID 25802660

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

24. Zigler JE, Delamarter R, Murrey D, et al. ProDisc-C and anterior cervical discectomy and fusion as surgical treatment for single-level cervical symptomatic degenerative disc disease: five-year results of a Food and Drug Administration study. *Spine (Phila Pa 1976)*. Feb 1 2013;38(3):203-209. PMID 23080427
25. Delamarter RB, Zigler J. Five-year reoperation rates, cervical total disc replacement versus fusion, results of a prospective randomized clinical trial. *Spine (Phila Pa 1976)*. Nov 2 2013;38(9):711-717. PMID 23124255
26. Heller JG, Sasso RC, Papadopoulos SM, et al. Comparison of BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial. *Spine (Phila Pa 1976)*. Jan 15 2009;34(2):101-107. PMID 19112337
27. Riew KD, Buchowski JM, Sasso R, et al. Cervical disc arthroplasty compared with arthrodesis for the treatment of myelopathy. *J Bone Joint Surg Am*. Nov 2008;90(11):2354-2364. PMID 18978404
28. Goffin J, van Loon J, Van Calenbergh F, et al. A clinical analysis of 4- and 6-year follow-up results after cervical disc replacement surgery using the Bryan Cervical Disc Prosthesis. *J Neurosurg Spine*. Mar 2010;12(3):261-269. PMID 20192625
29. Coric D, Nunley PD, Guyer RD, et al. Prospective, randomized, multicenter study of cervical arthroplasty: 269 patients from the Kineflex|C artificial disc investigational device exemption study with a minimum 2-year follow-up: clinical article. *J Neurosurg Spine*. Oct 2011;15(4):348-358. PMID 21699471
30. Hadley MN. The real value of cervical arthroplasty? [editorial]. *J Neurosurg Spine*. Oct 2011;15(4):345-346; discussion 346-347. PMID 21699472
31. U.S. Food and Drug Administration (FDA) Center for Devices and Radiological Health. Summary of Safety and Effectiveness Data: Mobi-C. 2013; http://www.accessdata.fda.gov/cdrh_docs/pdf11/P110002b.pdf. Accessed November, 2014.
32. Hisey MS, Bae HW, Davis R, et al. Multi-center, prospective, randomized, controlled investigational device exemption clinical trial comparing Mobi-C Cervical Artificial Disc to anterior discectomy and fusion in the treatment of symptomatic degenerative disc disease in the cervical spine. *Int J Spine Surg*. 2014;8. PMID 25694918
33. Hisey MS, Zigler JE, Jackson R, et al. Prospective, randomized comparison of one-level Mobi-C Cervical Total Disc replacement vs. anterior cervical discectomy and fusion: results at 5-year follow-up. *Int J Spine Surg*. 2016;10:10. PMID 27162712
34. Phillips FM, Lee JY, Geisler FH, et al. A prospective, randomized, controlled clinical investigation comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion: 2-year results from the US FDA IDE clinical trial. *Spine (Phila Pa 1976)*. Jul 1 2013;38(15):E907-918. PMID 23591659
35. U.S. Food and Drug Administration (FDA) Center for Devices and Radiological Health. Summary of Safety and Effectiveness Data: SECURE-C. 2012; http://www.accessdata.fda.gov/cdrh_docs/pdf10/P100003b.pdf. Accessed November, 2014.
36. Vaccaro A, Beutler W, Peppelman W, et al. Clinical outcomes with selectively constrained SECURE-C cervical disc arthroplasty: two-year results from a prospective, randomized, controlled, multicenter investigational device exemption study. *Spine (Phila Pa 1976)*. Dec 15 2013;38(26):2227-2239. PMID 24335629
37. Cheng L, Nie L, Zhang L, et al. Fusion versus Bryan Cervical Disc in two-level cervical disc disease: a prospective, randomised study. *Int Orthop*. Oct 2009;33(5):1347-1351. PMID 18956190
38. Davis RJ, Kim KD, Hisey MS, et al. Cervical total disc replacement with the Mobi-C cervical artificial disc compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled multicenter clinical trial. *J Neurosurg Spine*. Nov 2013;19(5):532-545. PMID 24010901
39. Radcliff K, Coric D, Albert T. Five-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter investigational device exemption clinical trial. *J Neurosurg Spine*. Mar 25 2016:1-12. PMID 27015130
40. Bae HW, Kim KD, Nunley PD, et al. Comparison of clinical outcomes of 1- and 2-level total disc replacement: four-year results from a prospective, randomized, controlled, multicenter IDE clinical trial. *Spine (Phila Pa 1976)*. Jun 1 2015;40(11):759-766. PMID 25785955
41. Huppert J, Beaurain J, Steib JP, et al. Comparison between single- and multi-level patients: clinical and radiological outcomes 2 years after cervical disc replacement. *Eur Spine J*. Sep 2011;20(9):1417-1426. PMID 21336970
42. U.S. Food and Drug Administration. Summary of Safety and Effectiveness: Prestige LP Cervical Disc. PMA Number P090029/S003. 2016; http://www.accessdata.fda.gov/cdrh_docs/pdf9/p090029s003b.pdf. Accessed August 29, 2016.
43. Staub LP, Ryser C, Roder C, et al. Total disc arthroplasty versus anterior cervical interbody fusion: use of the Spine Tango registry to supplement the evidence from randomized control trials. *Spine J*. Feb 2016;16(2):136-145. PMID 26674445
44. Nunley PD, Jawahar A, Kerr EJ, 3rd, et al. Factors affecting the incidence of symptomatic adjacent-level disease in cervical spine after total disc arthroplasty: 2- to 4-year follow-up of 3 prospective randomized trials. *Spine (Phila Pa 1976)*. Mar 15 2012;37(6):445-451. PMID 21587111

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

45. Coric D, Cassis J, Carew JD, et al. Prospective study of cervical arthroplasty in 98 patients involved in 1 of 3 separate investigational device exemption studies from a single investigational site with a minimum 2-year follow-up. Clinical article. J Neurosurg Spine. Dec 2010;13(6):715-721. PMID 21121748
46. Fan H, Wu S, Wu Z, et al. Implant failure of Bryan cervical disc due to broken polyurethane sheath: a case report. Spine (Phila Pa 1976). Jun 1 2012;37(13):E814-816. PMID 22210017
47. Kurtz SM, Toth JM, Siskey R, et al. The latest lessons learned from retrieval analyses of ultra-high molecular weight polyethylene, metal-on-metal, and alternative bearing total disc replacements. Semin Spine Surg. Mar 1 2012;24(1):57-70. PMID 22904606
48. Tsermoulas G, Bhattathiri PS. Anterior migration of prosthesis following cervical arthroplasty. Br J Neurosurg. Feb 2013;27(1):132-133. PMID 22817101
49. Nguyen NQ, Kafle D, Buchowski JM, et al. Ceramic fracture following cervical disc arthroplasty: a case report. J Bone Joint Surg Am. Nov 16 2011;93(22):e132(131-134). PMID 22262392
50. McAfee PC, Cappuccino A, Cunningham BW, et al. Lower incidence of dysphagia with cervical arthroplasty compared with ACDF in a prospective randomized clinical trial. J Spinal Disord Tech. Feb 2010;23(1):1-8. PMID 20051917
51. Chen J, Wang X, Bai W, et al. Prevalence of heterotopic ossification after cervical total disc arthroplasty: a meta-analysis. Eur Spine J. Apr 2012;21(4):674-680. PMID 22134486
52. Yi S, Kim KN, Yang MS, et al. Difference in occurrence of heterotopic ossification according to prosthesis type in the cervical artificial disc replacement. Spine (Phila Pa 1976). Jul 15 2010;35(16):1556-1561. PMID 20581764
53. Tu TH, Wu JC, Huang WC, et al. Heterotopic ossification after cervical total disc replacement: determination by CT and effects on clinical outcomes. J Neurosurg Spine. Apr 2011;14(4):457-465. PMID 21294610
54. Cavanaugh DA, Nunley PD, Kerr EJ, 3rd, et al. Delayed hyper-reactivity to metal ions after cervical disc arthroplasty: a case report and literature review. Spine (Phila Pa 1976). Apr 1 2009;34(7):E262-265. PMID 19333091
55. Guyer RD, Shellock J, MacLennan B, et al. Early failure of metal-on-metal artificial disc prostheses associated with lymphocytic reaction: diagnosis and treatment experience in four cases. Spine (Phila Pa 1976). Apr 1 2011;36(7):E492-497. PMID 21252827
56. Hacker FM, Babcock RM, Hacker RJ. Very late complications of cervical arthroplasty: results of 2 controlled randomized prospective studies from a single investigator site. Spine (Phila Pa 1976). Dec 15 2013;38(26):2223-2226. PMID 24335628
57. North American Spine Society. NASS coverage policy recommendations: Cervical artificial disc replacement. 2015; <https://www.spine.org/PolicyPractice/CoverageRecommendations/AboutCoverageRecommendations.aspx>. Accessed July 21, 2016.
58. National Institute for Health and Clinical Excellence (NICE). Prosthetic intervertebral disc replacement in the cervical spine [IPG341]. 2010; <https://www.nice.org.uk/guidance/ippg341>. Accessed July 21, 2016.
59. Matz PG, Holly LT, Groff MW, et al. Indications for anterior cervical decompression for the treatment of cervical degenerative radiculopathy. J Neurosurg Spine. Aug 2009;11(2):174-182. PMID 19769497
60. Mummaneni PV, Kaiser MG, Matz PG, et al. Cervical surgical techniques for the treatment of cervical spondylotic myelopathy. J Neurosurg Spine. Aug 2009;11(2):130-141. PMID 19769492

Policy History

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

02/13/2008	Medical Director review
02/20/2008	Medical Policy Committee approval.
02/04/2009	Medical Director review
02/19/2009	Medical Policy Committee approval. No change to coverage.
02/04/2009	Medical Policy Committee review
02/17/2009	Medical Policy Implementation Committee approval. No change to coverage.
02/03/2011	Medical Policy Committee review
02/16/2011	Medical Policy Implementation Committee approval. No change to coverage.
02/02/2012	Medical Policy Committee review
02/15/2012	Medical Policy Implementation Committee approval. No change to coverage.
02/07/2013	Medical Policy Committee review
02/20/2013	Medical Policy Implementation Committee approval. Coverage changed from investigational to eligible with criteria.
12/12/2013	Medical Policy Committee review

©2016 Blue Cross and Blue Shield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without permission from Blue Cross and Blue Shield of Louisiana.



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229
 Original Effective Date: 02/20/2008
 Current Effective Date: 12/21/2016

12/18/2013 Medical Policy Implementation Committee approval.” Criteria revised to include two contiguous levels from C3 to C7 as eligible for coverage. FDA information updated.
 03/05/2015 Medical Policy Committee review
 03/20/2015 Medical Policy Implementation Committee approval. No change to coverage.
 08/03/2015 Coding update: ICD10 Diagnosis code section added; ICD9 Procedure code section removed.
 03/03/2016 Medical Policy Committee review
 03/16/2016 Medical Policy Implementation Committee approval. Coverage eligibility unchanged.
 12/01/2016 Medical Policy Committee review
 12/21/2016 Medical Policy Implementation Committee approval. Revised existing criteria and coverage statements, added new statement for subsequent disc implantation. New investigational statement added.
 01/01/2017 Coding update: Removing ICD-9 Diagnosis Codes
 Next Scheduled Review Date: 12/2017

Coding

The five character codes included in the Blue Cross Blue Shield of Louisiana Medical Policy Coverage Guidelines are obtained from Current Procedural Terminology (CPT)[®]‡, copyright 2015 by the American Medical Association (AMA). CPT is developed by the AMA as a listing of descriptive terms and five character identifying codes and modifiers for reporting medical services and procedures performed by physician.

The responsibility for the content of Blue Cross Blue Shield of Louisiana Medical Policy Coverage Guidelines is with Blue Cross and Blue Shield of Louisiana and no endorsement by the AMA is intended or should be implied. The AMA disclaims responsibility for any consequences or liability attributable or related to any use, nonuse or interpretation of information contained in Blue Cross Blue Shield of Louisiana Medical Policy Coverage Guidelines. Fee schedules, relative value units, conversion factors and/or related components are not assigned by the AMA, are not part of CPT, and the AMA is not recommending their use. The AMA does not directly or indirectly practice medicine or dispense medical services. The AMA assumes no liability for data contained or not contained herein. Any use of CPT outside of Blue Cross Blue Shield of Louisiana Medical Policy Coverage Guidelines should refer to the most current Current Procedural Terminology which contains the complete and most current listing of CPT codes and descriptive terms. Applicable FARS/DFARS apply.

CPT is a registered trademark of the American Medical Association.

Codes used to identify services associated with this policy may include (but may not be limited to) the following:

Code Type	Code
CPT	0095T, 0098T, 0375T, 22856, 22858, 22861, 22864
HCPCS	No codes
ICD-10 Diagnosis	All related diagnoses

*Investigational – A medical treatment, procedure, drug, device, or biological product is Investigational if the effectiveness has not been clearly tested and it has not been incorporated into standard medical practice. Any determination we make that a medical treatment, procedure, drug, device, or biological product is Investigational will be based on a consideration of the following:

- A. Whether the medical treatment, procedure, drug, device, or biological product can be lawfully marketed without approval of the U.S. FDA and whether such approval has been granted at the time the medical treatment, procedure, drug, device, or biological product is sought to be furnished; or
- B. Whether the medical treatment, procedure, drug, device, or biological product requires further studies or clinical trials to determine its maximum tolerated dose, toxicity, safety, effectiveness, or effectiveness as compared with the standard means



BlueCross BlueShield of Louisiana

An independent licensee of the Blue Cross and Blue Shield Association.

Artificial Intervertebral Disc: Cervical Spine

Policy # 00229

Original Effective Date: 02/20/2008

Current Effective Date: 12/21/2016

of treatment or diagnosis, must improve health outcomes, according to the consensus of opinion among experts as shown by reliable evidence, including:

1. Consultation with the Blue Cross and Blue Shield Association TEC or other nonaffiliated technology evaluation center(s);
2. Credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant medical community; or
3. Reference to federal regulations.

****Medically Necessary (or "Medical Necessity")** - Health care services, treatment, procedures, equipment, drugs, devices, items or supplies that a Provider, exercising prudent clinical judgment, would provide to a patient for the purpose of preventing, evaluating, diagnosing or treating an illness, injury, disease or its symptoms, and that are:

- A. In accordance with nationally accepted standards of medical practice;
- B. Clinically appropriate, in terms of type, frequency, extent, level of care, site and duration, and considered effective for the patient's illness, injury or disease; and
- C. Not primarily for the personal comfort or convenience of the patient, physician or other health care provider, and not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of that patient's illness, injury or disease.

For these purposes, "nationally accepted standards of medical practice" means standards that are based on credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant medical community, Physician Specialty Society recommendations and the views of Physicians practicing in relevant clinical areas and any other relevant factors.

‡ Indicated trademarks are the registered trademarks of their respective owners.

NOTICE: Medical Policies are scientific based opinions, provided solely for coverage and informational purposes. Medical Policies should not be construed to suggest that the Company recommends, advocates, requires, encourages, or discourages any particular treatment, procedure, or service, or any particular course of treatment, procedure, or service.