Illustration by Jaime Chiluisa, CST

Cervical Arthroplasty

Elia V Smalls, cst, and Jaime Chiluisa, cst

For decades, anterior cervical discectomy and fusion (ACDF) has been the golden standard in treating cervical spine disease. An ACDF requires that the surgeon completely remove the intervertebral disc of the affected level, insert a cortical-cancellous allograft in the intervertebral space and secure it with a plate and screws that are implanted into the adjacent vertebral bodies. Although ACDF has demonstrated positive outcomes, concern remains about adjacent segment disease (ASD). In recent years, cervical disc replacement (CDR) has become an alternative to ACDF when treating disease of the cervical spine to maintain the patient's range of motion (ROM) while avoiding ASD.

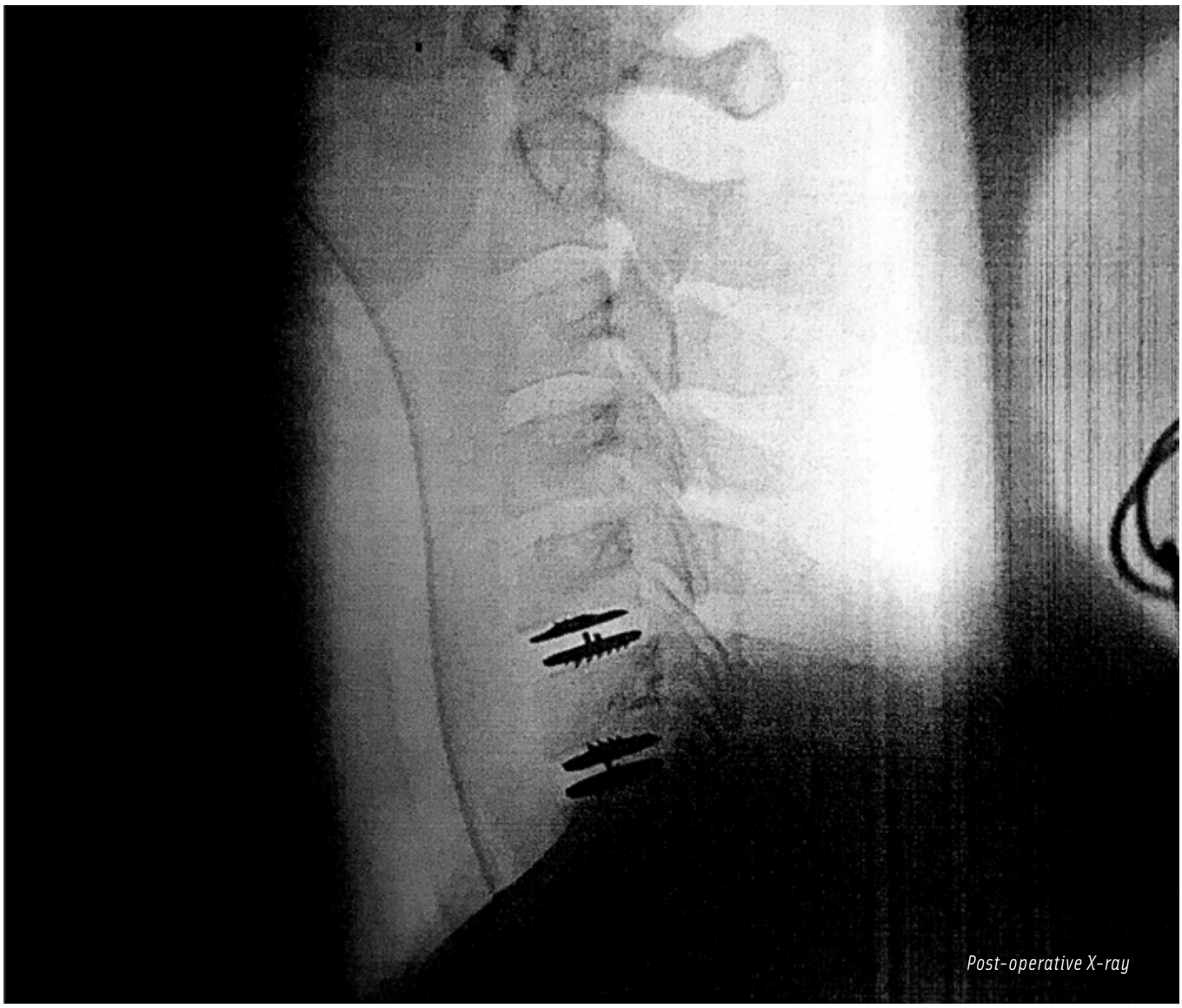
Cervical artificial disc replacement or cervical disc arthroplasty is a joint replacement procedure that removes the natural intervertebral disc and inserts an implant in its place. These procedures represent a relatively new area in spinal surgery for degenerative cervical disease with the first cervical disc arthroplasty being was performed in the United States only 10 years ago in 2008. The cervical artificial disc is designed to maintain the natural movement of the cervical spine while avoiding stress on adjacent levels in the spine, which can occur with a traditional ACDF.

HISTORY OF CERVICAL DISC ARTHROPLASTY

Cervical disc replacement implants originated in Europe in the mid-1960s. In 1966, Ulf Fernstrom was credited with implanting the first cervical and lumbar disc replacement devices. The original implant

LEARNING OBJECTIVES

- Examine the role of the Certified Surgical Technologist during a cervical disc replacement procedure
- Compare and contrast between cervical disc arthroplasty and anterior cervical discectomy and fusion
- List the contraindications for performing a CDR
- Review the anatomy and pathophysiology discussed in this article
- Recall the equipment and supplies needed for a cervical disc replacement



Post-operative X-ray

was a stainless-steel ball bearing prosthesis. Fernstrom implanted 191 lumbar spheres and 13 cervical spheres; however, these first cervical implants had unacceptable failure rates. Interest in them faded until the 1980s and 1990s when their popularity and widespread use of lumbar arthroplasty devices rose.[1] One of the first prototypes for the cervical spine was designed by BH Cummins in 1989. It was described as a two-piece, metal-on-metal device made of stainless steel. The articulating surface was a ball and socket design with two anterior anchoring screws that fixed each piece of the device to the adjacent vertebral bodies. These were implanted in 18 patients but yielded poor results. Due to these outcomes, the device was completely redesigned and reintroduced as the Frenchay design. A pilot study performed in 2002 demonstrated better results with fewer complications than seen with the Cummins model. The Frenchay design was later called the Prestige Cervical Disc and was approved for use in the United States in 2007. The first clinical trial in the US was performed in 2007 to compare the outcomes of the Prestige Cervical Disc versus traditional fusion. The results found that a patient's ROM was maintained at 24 months, clinical outcomes were improved and the rate of secondary surgeries were reduced when compared with ACDF.[1] After this trial, subsequent prototypes would soon follow: the Bryan cervical disc, PRODISC®C, the Porous Coated Motion Disc Prothesis (PCM) and the Mobi-C®, to name a few.

The Bryan cervical disc was designed by neurosurgeon, Dr Vincent Bryan, in 1992. It is described as a metal-on-metal titanium implant with a polyurethane core contained

in a single-piece implant. The endplates have a porous coating that allows for bone in-growth to help secure the implant in place. Like the Prestige disc, it's considered an unconstrained device. This device is not held in the disc space with any hardware, and it requires a tight fit of the prosthesis into a milled concavity.[1]

The PRODISC®C cervical disc implant, invented by Dr Thierry Marnay, was approved by the FDA in December 2007. It is a two-piece device made of cobalt-chrome alloy endplates and a central keel for anchoring to the adjacent vertebrae. The PRODISC®C has an ultra-high-molecular-weight (UHMW) core that articulates with the endplates providing a wide ROM.[1]

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The PCM prosthesis was designed by Dr Paul McAfee. The PCM device features cobalt-chrome endplates with a UHMW core. Similar to the previous implants, the PCM also has a porous coating on the endplates that encourage bony in-growth to secure the implant to the adjacent vertebral bodies.

The Mobi-C® implant was designed by a team of French surgeons and was first implanted in France in November 2004. It was approved by the FDA for use in the US in August 2013. The Mobi-C® cervical disc implant is made of a cobalt chrome molybdenum alloy with a UHMW polyethylene core. The surface of each endplate has a porous coating with a row of teeth that helps secure it to the bone of the adjacent levels.[10] The Mobi-C is approved for one- and two-level disc replacement.

ANATOMY AND PATHOPHYSIOLOGY

The cervical spine consists of seven vertebrae separated by intervertebral discs comprised of fibrocartilage. The seven vertebrae are referred to as C1 to C7. The first and second cervical vertebrae are called the atlas and axis, respectively, and they provide a wide ROM for the head. Approximately half of the flexion extension of the neck happens between the occipital bone and the atlas, and half of the rotation happens between the atlas and axis. The discs also allow movement of the cervical spine such as flexion and extension. As the body ages, the intervertebral discs begin to break down, which causes a narrowing of the disc space in-between the vertebrae. The narrow disc space then begins to limit the movement of the cervical spine and may cause symptoms such as neck pain and tingling in the shoulder, arm or hand. This condition is called cervical degenerative disc disease. Another condition that can occur in the cervical spine is disc herniation. A disc herniation occurs when the gel-like center breaks or bulges through the fibrous outer layer of the disc. The herniated disc places pressure on the spinal cord and/or nearby nerves, which causes neck pain and stiffness as well as pain or numbness in the shoulder, arm or hand. Symptoms will vary from patient to patient and both conditions result in cervical radiculopathy, which is a general term to describe any pain and/or neurological symptoms related to degenerative disc disease or

COMPARISON BETWEEN CERVICAL DISC ARTHROPLASTY AND ACDF

	Cervical Disc Arthroplasty	Anterior Cervical Discectomy and Fusion
Bone Graft	Not used-eliminates risk of nonunion	Required for fusion of levels; risk of nonunion
Hardware complication	Patients may have trouble swallowing, but studies show it is resolved quicker with cervical disc arthroplasty than ACDF	
Adjacent segment disease	Risk is reduced since ROM is maintained	Higher risk since the adjacent levels suffer more stress due to the fused level(s)
Recovery	2-4 weeks, depending on the patient; no bracing required	6-12 weeks; bracing required during healing

EQUIPMENT

- Suction
- Electric drill
- Standard OR table
- Electrocautery machine
- C-arm fluoroscopy machine and monitor

SUPPLIES

- Basin set
- 0.9% normal saline
- 20-gauge x 3.5-inch spinal needle
- Laparotomy pack that includes 4x4 Ray-tec sponges; laparotomy incise drape; #10 and #15 blades; absorbable sutures; chlorhexidine-alcohol prep stick; Steri-strips; and benzoin.

INSTRUMENTS

- Anterior cervical fusion instrument set that includes the following:
- Curettes
- Nerve hooks
- Needle holder
- Bipolar forceps
- Cushing forceps
- Pituitary rongeur
- Cervical distractor
- US Army retractors
- #4 Penfield dissector
- Metzenbaum scissors
- Richardson retractors
- Cervical disc spreader
- Straight Mayo scissors
- Adson forceps with teeth
- Cloward handheld retractor
- 1mm, 2mm, and 3mm Kerrison rongeurs

disc herniation. These conditions also may result in cervical myelopathy or compression of the spinal cord.

CONTRAINDICATIONS

The contraindications for performing CDR include:

- Known allergy or sensitivity to metals or plastic;
- Systemic infection or infection at the surgery site;
- A cervical spine that shows an unhealthy amount of instability;
- Damage of the cervical vertebrae due to trauma at one of the anatomical levels;
- Severe disease or degeneration in the facet joints in the back of the cervical vertebrae;
- A deformity of the cervical vertebrae at one of the anatomical levels, such as ankylosing spondylitis or rheumatoid arthritis;
- Osteoporosis or osteopenia, as these conditions could increase the risk of bone fractures or cause an implant to loosen.

PATIENT POSITIONING, PREPPING AND DRAPING

The patient will be transported into the operating room (OR) and placed in the supine position on the OR table. They will be intubated with the endotracheal tube taped to the left side of their mouth as the surgeon usually stands on the patient's right side. A roll will be placed under the patient's shoulders to hyperextend the neck. The patient's arms will be tucked in by their sides and wrapped with the draw sheet while the safety belt will hold their arms in place. The surgeon will use silk tape to place it on the patient's shoulder and pull down to expose the surgical site and maximize the ability of radiology to capture the cervical levels. These steps will be repeated on the other side. The circulating nurse or surgical technologist will prep the neck with a chlorhexidine-alcohol or iodine povacrylex/isopropyl alcohol prep stick in a circular motion from the incision site to the patient's chin and shoulders. Once the prep is dry, the Certified Surgical Technologist (CST) will place four towels around the incision site followed by a laparotomy incise drape. The CST will secure the suction tubing, Bovie cords and drill cord to the drape using an Allis clamp.

SURGICAL PROCEDURE

Once the time out is completed, the surgeon will inject a local anesthetic. The surgeon will make a skin incision and dissect the soft tissues to expose the cervical disc space. During dissection, the surgeon will incise the platysma muscle along the plane of the skin incision. The space between the sternocleidomastoid muscle and the internal jugular vein is opened by sharp dissection using the Metzenbaum scissors and Cushing forceps. Hemostasis will be performed using the bipolar forceps. The sternocleidomastoid muscle, trachea, esophagus and nearby blood vessels will be retracted laterally with a Cloward handheld retractor. A 20-gauge x 3.5-inch spinal needle will be placed into the disc being excised. The CST will cover the fluoroscope with a C-arm

cover and the level will be confirmed by radiology. A cervical distractor will be used to open the disc space in preparation for removal. Caspar pins will be placed on the adjacent vertebral bodies. The frame will be placed over the pins and opened to distract the space. The disc will be incised with a #15 blade on a #7 knife handle followed by a small pituitary rongeur, Kerrison rongeur and curettes. The disc will be removed and the sizers will be used to determine the size of the implant that best fits the patient's disc space. A trial implant will be placed in the disc space and the fluoroscope will be used to confirm its proper fit. The implant will be selected by the circulating nurse and the size will be verified by both the surgeon and the surgical technologist. The surgical technologist will receive the correct size of implant from the circulating nurse and will load it onto an inserter. The implant, along with a mallet, will be passed to the surgeon. Under the guidance of the fluoroscope, the surgeon will tamp the implant into the disc space until the images show the implant in an acceptable position. The wound will be irrigated with normal saline and an antibiotic, and the surgeon will ask anesthesia to perform a Valsalva maneuver to confirm hemostasis and that no air leak is present in the trachea.

On rare occasions where the patient continues to have some bleeding, the surgeon may opt to place a Jackson-Pratt drain to avoid a hematoma from developing. The surgical incision will be closed with an absorbable multifilament synthetic suture followed by an absorbable monofilament synthetic suture. Steri-strips will be placed over the incision site followed by 4x4 gauze and tape.

POST-OP

Following the surgery, the patient will be extubated and transferred to the PACU. The patient will be monitored by a PACU nurse until they recover from the general anesthetic for about five hours. The patient's neck area also will be observed as swelling can occur in this area causing the patient to have problems with breathing and/or swallowing. Once the patient is alert and stable, they will be discharged. Recovery time runs from four to six weeks before the patient will be allowed to return to their normal activities.

COMPLICATIONS

The two immediate and common complications that may occur are hemorrhage and swelling of the surrounding tissues. These complications can interfere with the patient's ability to breathe or swallow. If hemorrhaging is suspected, the surgeon may require the patient to be returned to the OR to control the bleeding. Another complication that may occur soon after surgery is a surgical site infection (SSI). If the patient develops an infection, their surgeon may perform an irrigation and debridement to remove the infected tissue and, in the worst-case scenario, the implant itself. Although rare, an allergic reaction to the implant materials may occur. In 2015, Lagier, Briere, et al, published a case study in which a patient presented with symptoms that were determined to be an allergic reaction to the cervical disc implant she had received four years prior. Removal of the implant was required and replaced with a polyetheretherketone (PEEK) implant and her symptoms were resolved.[10] Occasionally, some patients also may not obtain any relief from their original symptoms.

Cervical disc arthroplasty is still considered a relatively new procedure used to treat cervical spine disease in the US. There is a variety of cervical disc implants used throughout the country, but all are quite similar in design with a few variables to differentiate one from another. Up to this point, data shows this procedure helps to maintain a patient's ROM as well as help them avoid adjacent segmental disease. Although initial studies show the procedure to be a better option for patients than the traditional ACDF, more post-operative data needs to be gathered.

> As the body ages, the intervertebral discs begin to break down, which causes a narrowing of the disc space in-between the vertebrae. The narrow disc space then begins to limit the movement of the cervical spine and may cause symptoms such as neck pain and tingling in the shoulder, arm or hand. This condition is called cervical degenerative disc disease.

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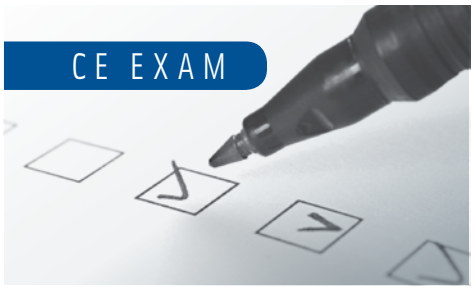

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Cervical Arthroplasty

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1. Cervical disc arthroplasty is a relatively new area of spinal surgery. When was the first cervical disc arthroplasty performed in the United States?
a. 2004
b. 2006
c. 2008
d. 2010

2. The original cervical disc replacement implant was made of what material?
a. Stainless steel
b. Plastic
c. Cobalt chrome
d. Titanium

3. Which implant was approved by the FDA in 2013?
a. PCM prothesis
b. Bryan cervical disc
c. PRODISC®C
d. Mobi-C®

4. The cervical spine consists of ____ vertebrae.
a. 6
b. 7
c. 8
d. 9

5. The space between the sternocleidomastoid muscle and the internal jugular vein is opened by sharp dissection using the _____.
a. Metzenbaum scissors
b. Cushing forceps
c. Straight Mayo scissors
d. Both a and b

6. The two most common complications of this procedures are:
a. SSI, swelling
b. Swelling, shortness of breath
c. Hemorrhage, swelling
d. Hemorrhage, allergic reaction

7. What is placed on the adjacent vertebral bodies and used to hold up the frame?
a. Caspar pins
b. Cervical distractor
c. Cushing forceps
d. Curettes

8. Hemostasis will be performed using the _____.
a. Bipolar forceps
b. Kerrison rougeur
c. Cervical distractor
d. Cervical disc spreader

9. One of the first prototypes for the cervical spine was designed in _____.
a. 1966
b. 1972
c. 1989
d. 2000

10. What is used to confirm the proper fit of the disc once it has been placed?
a. Richardson retractors
b. Fluoroscope
c. Electrocautery machine
d. Adson forceps with teeth

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