Ruptured Artificial Disc (Bryan Cervical Disc)

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Because arthroplasty with artificial disc has advantages to preserve motion, avoid limitation of motion and allow patients to quickly return to routine activities, it gains popularity among spine surgeons. We report the case of a ruptured artificial cervical disc. A 40-year old male patient underwent a cervical spinal surgery at C4/5 twice. The first operation, a cervical arthroplasty of C4/5, was performed at another hospital in November 2008. At that time, a Bryan artificial disc prosthesis (Medtronic Sofamor Danek, Memphis, TN, USA) was implanted between C4/5. In January 2010, the patient felt more severe pain and was diagnosed with a ruptured disc at C3/4 on MRI. We planned anterior cervical discectomy and fusion of C3/4 and performed the second cervical operation. During the surgery, we incidentally discovered and removed the ruptured Bryan artificial disc prosthesis and removed the ruptured artificial disc. Ruptures of Bryan artificial discs are very rare, and this represents the first description of a such case.

Key Words: Cervical spine • Cervical disc prosthesis

INTRODUCTION

The current standard care for degenerative disc disease of the cervical spine is anterior cervical discectomy and fusion (ACDF)^{1,10}. Since the introduction of ACDF in the 1950s by Robinson, Smith and Cloward, excellent results have been reported for the use of ACDF in the treatment of degenerative disorders of the spine⁹. Anterior cervical fusion provides excellent symptomatic relief via direct decompression along with disc height and neuroforaminal restoration^{9,10}. ACDF achieves high rates of successful pain relief after surgery^{8,9}. However, in some cases, ACDF results in increased biomechanical stress and accelerated degeneration of adjacent spinal motion segments in long term follow-up, and evidence of adjacent-segment disease (ASD) has been detected in many biomechanical studies^{1,8,9}. In the ASD, the removal of segmental motion increases stiffness at the fused segment, resulting in elevated stress at adjacent levels, where degeneration is potentially accelerated⁸. Long-term outcome data (5-10 years) suggest that

inpatients who undergo ACDF later display significant radiographic changes at adjacent levels, such as narrowing of the disc space or the development of new posterior osteophytes, and such osteophytes often manifest clinically as new onset radiculopathy or myelopathy referred to the adjacent degenerated level⁹. Arthroplasty with artificial discs has some advantages in that it may be more likely to preserve motion, avoid fusion and allow patients to quickly return to routine activities^{5,9}. Preservation of segmental motion is believed to prevent the development of adjacent segment degeneration^{1,8,10}. Arthroplasty of cervical discs provides spinal stability and balances this stability with flexibility^{1,8,10}. Therefore, a major benefit of cervical arthroplasty instead of fusion is the preservation of motion in both the functional spinal unit and the overall cervical spine⁸⁻¹⁰. The Bryan disc (Medtronic Sofamor Danek, Memphis, TN, USA) arthroplasty device was developed to preserve the kinematics of the functional spine unit (FSU), thus preventing adjacent level disease⁹, and has gained popularity among spine surgeons^{1,9,14}. Artificial disc devices must be strong and long lasting to preserve segmental motion and to resist being broken down by excessive movements^{8,14,15} and ruptures of artificial discs are relatively rare. In this report, we describe the case of a ruptured artificial Bryan cervical disc.

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CASE REPORT

After experiencing a slip down fall in 2006, a 40-year old

Fig. 1. Radiologic findings before the third operation. The artificial disc is seen in C4/5 on preoperative AP (A) and lateral (B) X-rays. Sagittal T2 MRI (C) showed abnormal finding at C4/5. At axial T2 MRI, C3/4 ruptured disc (D, white arrow) and cord compression finding at C4/5 (E, white arrow) was observed.

male patient reported intolerable right arm pain and was diagnosed with a ruptured, herniated cervical disc at C5/6. The patient underwent on an anterior cervical discectomy and fusion of C5/6 at another hospital in June 2006. Two years after the operation, the patient complained of right arm pain that had gradually increased during the past 2-years period which he was diagnosed with a ruptured right HCD at C4/5 and was surgically treated with an anterior cervical discectomy followed by implantation of the Bryan artificial disc prosthesis according to the recommendation of the manufacturer (Fig. 1A, B). After the second operation, the patient reported pain relief, but also mild posterior neck pain and right shoulder pain that lasted for 2 years. He had worn a neck brace for over 1 month after the operation and also rested for 1 month. The patient reported no history of trauma or hard physical work during the 2 years after the second surgery.

In January 2010, the patient felt severe posterior neck pain,

Fig. 2. Ruptured cervical artificial disc (Bryan cervical disc) in the surgical field. Flexible polyurethane outer sheath had opening hole.

Fig. 3. Removal of the ruptured polyurethane outer sheath and 2 upper/lower titanium plates. Smooth black-gray gel around the Bryan artificial disc prosthesis was found.

and right shoulder and arm pain of the C3/4/5 dermatome along with numbness of both feet. From MRI, we diagnosed a ruptured C3/4 disc at right (Fig. 1C, D) and a bulging artificial disc that compressed the spinal cord at C4/5 on MRI (Fig. 1C, E). We decided to treat the patient by ACDF of C3/4 and to remove the artificial disc at C4/5. During the surgery, we incidentally found the abnormal Bryan artificial disc prosthesis. Flexible polyurethane outer sheath had opening hole (Fig. 2) and an empty inter-plate space (in the normal device, the space was filled by a polyurethane nucleus) with black particles and smooth black-gray gel around the Bryan artificial disc prosthesis (Fig. 3). Inside the removed Bryan artificial disc prosthesis, we could find black particles and pathological examination revealed synovial hyperplasia and foreign body reaction (Fig. 4). Because these black particles were located inside the Bryan artificial disc prosthesis, we identified the black

Fig. 4. Black particles from the ruptured Bryan cervical disc prosthesis. Pathological examination revealed synovial hyperplasia and foreign body reaction.

particles as the ruptured polyurethane nucleus of the prosthesis. Inflammation tissue was observed around the ruptured artificial disc. After the removal of the Bryan cervical disc prosthesis, we cleaned out the black-gray gel and performed an anterior interbody fusion of C4/5 with a left iliac crest autograft.

DISCUSSION

ACDF achieves success rates of over 75-90%, typically with resolution of symptoms and return to normal daily activities after the surgery^{1,2,7-9}. However, immobility of the fused level is associated with accelerated degeneration at levels adjacent to the fused site, which is a major long-term concern after ACDF surgery^{1,2,9,10}. ACDF is associated with additional complications, as there are reports of pseudoarthrosis and implant failure after ACDF⁹. Therefore, artificial disc arthroplasty is believed to decrease the propensity for adjacent-segment disease (ASD) by preserving segmental motion and alleviating the stress burden at adjacent levels^{1,10,14}. Cervical arthroplasty has therefore become popular with spine surgeons^{1,16}.

Artificial cervical discs have normal cervical spinal kinematics and offer the surgical benefits associated with the anterior approach to the cervical spine as well as symptomatic relief due to decompression^{1,9,10}. Cervical artificial disc replacement techniques implement joint motion preservation to replicate natural disc dynamics and load transfer through motion segments⁷⁻¹⁰.

Cervical artificial discs are used by spinal surgeons around the world^{1,8}. The era of cervical total disc replacement (TDR) in the United States was ushered in with the FDA approval of the Prestige ST cervical disc system (Medtronic Sofamor Danek) in 2007, followed by the Prodisc-C (Synthes Spine,

Fig. 5. A Bryan artificial disc, including the upper and lower titanium plates and polyurethane inner nucleus and outer sheath.

Paoli, PA, USA) in 2008, and most recently the Bryan disc in 2009⁸.

The Bryan cervical disc is one of the most commonly used cervical artificial discs worldwide⁹. The Bryan artificial cervical disc is thought to be safe and effective for the treatment of patients with cervical disc disease, and has safety undergonetesting in Europe and the United States⁹. After in vitro and in vivo testing demonstrated feasibility and adequate durability, a European prospective clinical trial that began in 2000 demonstrated acceptable results at 2- and 4-year follow-up^{1,5}. Subsequently, in the United States, a prospective, randomized, controlled clinical trial was undertaken to evaluate the safety and effectiveness of the Bryan cervical disc^{1,5}.

The Bryan disc is constructed of a titanium alloy shell, flexible polyurethane outer sheath and polyurethane inner nucleus⁹ (Fig. 5). After the surgery, cervical motion is enabled by the strong, long lasting polyurethane outer sheath and inner nucleus⁹. The normal range of motion of the cervical spine (C4/5) is 20° (flexion/extension), 11° (lateral bending) and 7° (rotation)^{4,16,17}. The normal loading on C4/5 (during axis compression) is about 60-80N (Newton, 1N=0.102 kg)^{4,11,12,16,17}. The polyurethane outer sheath is rarely torn by the normal range of motion^{8,9}, and the inner nucleus supports compression loading (6-8 Kg)^{4,8,9,12,16,17}. However, in our patient, the inter plate space was empty, and therefore the polyurethane outer sheath might have torn and allowed the inner nucleus to rupture and leak out. During the surgery, the two plates of the Bryan cervical disc prosthesis were appropriately located in disc space C4/5. Therefore, migration or displacement of the artificial disc did not occur. We hypothesized that the artificial disc was ruptured.

There are several possible explanations for the ruptured artificial disc. One is that a small injected site may have ruptured upon overloading of the artificial disc^{1,5,10,12,15}. This conclusion is drawn from mechanical analysis^{4,5}. When the Bryan cervical disc prosthesis was inserted into the inter disc space, normal saline was injected into the polyurethane nucleus to reduce the friction caused by the surgical devices^{6,12-14}. The injected site may have been torn, and the polyurethane inner

nucleus subsequently ruptured due to overloading on C4/5^{4,6)}.

Another possible explanation is drawn from chemical analysis of the outer sheath and inner nucleus^{4,6,10,16)}. The polyethylene cores of Prodisc-C prostheses (Synthes Spine, Paoli, PA, USA) may become oxidated due to aging, gamma sterilization (especially in air), and other factors^{3,5,9,15)}. Oxidation accelerates wear and abrasion of the polyethylene core^{7,9,15)}. The polyurethane outer sheath is vulnerable to wear and abrasion by chemical irritants such as oxidation^{7,9,15)}. We hypothesize that such chemical irritants also associated with the polyurethane outer sheath was torn, allowing the inner nucleus to rupture out.

The risk of cervical disc prosthesis rupture is minimized by avoiding overloading of the cervical spine after the surgery^{12,15)}. Patients should avoid trauma and hard physical movement during daily activity, and should wear neck braces during recovery (about 1 month)^{12,15)}. In addition, it is of course necessary to perform careful injection of normal saline into the polyurethane core⁹⁻¹¹⁾.

There are a number of other complications in cervical arthroplasty with artificial discs^{14,15)}. Early complications include transient radiating pain and sensory loss¹⁵⁾. MRI may be used to demonstrate adequate neural decompression and lack of residual disc material^{9,15)}. No new motor or sensory symptoms and signs were associated with our patient's transient worsening of arm pain, which gradually improved during the next several weeks after the surgery¹⁵⁾. Possible complications include vascular and visceral lesions, venous bleeding and retropharyngeal hematoma, esophageal or tracheal injuries and cerebrospinal fluid leakage¹⁵⁾. There are some late-onset complications, such as heterotopic ossification, but this complication is rare. Prosthesis migration is known to occur, but is also very rare^{14,15)}.

CONCLUSION

We report a case of a ruptured Bryan cervical disc prosthesis. Pathological examination of black particles from the ruptured artificial disc indicated synovial hyperplasia and foreign body reaction.

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