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CASE REPORT

Metallosis after traumatic loosening of Bryan cervical disc arthroplasty: a case report and literature review

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Abstract

Purpose Cervical disc arthroplasty has been a popular alternative to traditional arthrodesis treatment for maintaining postoperative cervical spine mobility. However, certain adverse reactions to cervical disc arthroplasty have emerged during the last few decades.

Methods Metallosis or metalloma is a rarely reported complication after spinal fusion or spinal arthroplasty surgery. We report on the first metallosis case occurring in a patient who received Bryan Disc implantation approximately 8 years earlier. She was involved in a traffic accident and sustained a whiplash injury to the cervical spine one and a half years ago. The traumatic Bryan Disc loosening developed after the traffic accident, causing metallosis.

Results To the best of our knowledge, this is the first reported case of spinal metallosis caused by the Bryan Disc. A series of metallosis cases reported in the literature are also reviewed.

Conclusions Although uncommon, intraspinal metallosis or metalloma should be considered as an infrequent cause of delayed neurological symptoms after spinal surgery involving metallic instrumentation, especially after disc arthroplasty. Once metallosis is suspected, immediate metallic implant removal is mandatory for definite diagnosis and treatment.

Keywords Cervical disc arthroplasty · Bryan Disc · Metallosis · Metalloma

Introduction

Metallosis (or metalloma) is the infiltration of periprosthetic soft tissue and bone by metallic wear debris. Metallosis is often associated with significant osteolysis around the implant and has been of concern in cases involving total hip, total knee, and total shoulder arthroplasties. Once metallosis is clinically suspected, prompt revision is necessary to prevent severe loss of bone stock and implant loosening. However, few metalloma have been reported after spinal disc arthroplasty or spinal instrumentation. A case of metallosis is presented involving a patient who received Bryan Disc implantation with artificial disc migration after trauma.

Case presentation

A 56-year-old female was admitted to the Department of Neurosurgery at the Neurological Institute of our hospital with a 1 month history of gait disturbance. Her past medical history was notable for more than 10 years of neck and bilateral shoulder pain radiating to the upper back. 8 years

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ago she was diagnosed with cervical radiculopathy due to a herniated disc involving C6-C7 (Fig. 1a, b) and was treated with anterior discectomy with cervical disc replacement with an artificial disc (Bryan Disc; Medtronic Sofamor Danek, Memphis, TN). Her symptoms were relieved after the operation and the patient recovered well. Postoperative cervical spine CT and radiograph, 6 years after initial surgical intervention, showed the proper position of the Bryan Disc with mild heterotopic ossification (Fig. 2a, b). Her past surgical history was also significant for two titanium dental implants 3 years ago and spinal fusion involving L4–L5–S1 and iliac bone with titanium instrumentation 5 years ago.

Unfortunately, the patient was involved in a traffic accident and sustained a whiplash (hyperflexion-extension) injury to the cervical spine one and a half years ago. Progressive neck pain and bilateral numbness in both hands were noted nearly 1 year later. This symptom deteriorated to numbness in all four limbs and eventually evolved into a gait disturbance. The abnormal gait was described as stiffness

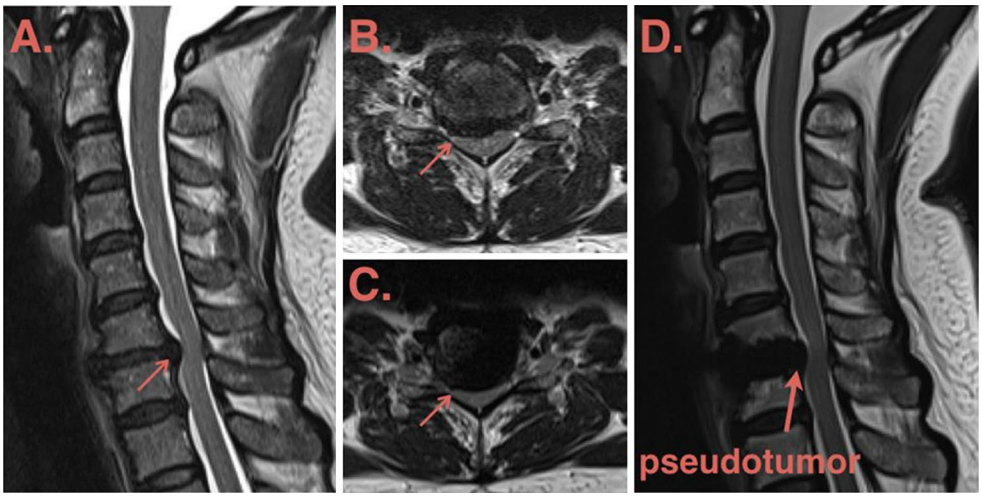

Fig. 1 Cervical spine MRI, T2-weighted, before Bryan Disc implantation (**a**, **b**) and after traumatic loosening of Bryan Disc arthroplasty (**c**, **d**). **a** Sagittal view, arrow indicates herniated disc at C6–C7 level with diminished CSF space. **b** Coronal view, arrow shows protruded disc with predominant cord compression at right side. c Coronal view, significant spinal cord compression noted at C6–C7 level, arrow indicates posterior edge of pseudotumor mass. **d** Sagittal view, arrow points to the pseudotumor lesion, which is suspected as clinical metallosis

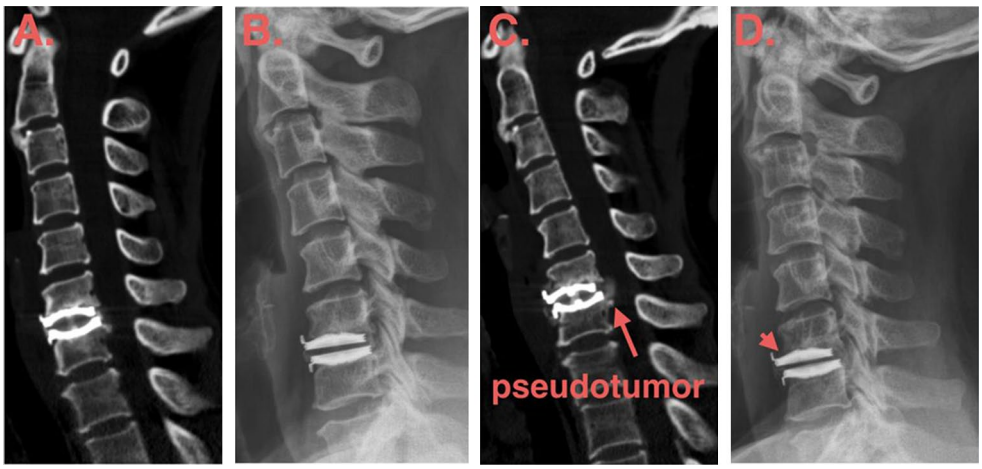

Fig. 2 **a** Postoperative cervical spine CT (on bone window), 6 years after initial surgical intervention, shows the proper position of the Bryan Disc with mild heterotopic ossification. **b** Cervical spine radiograph at 6 years after initial cervical arthroplasty. **c** Cervical spine CT one and a half years after the traffic accident shows high-density mass (long arrow) at the dorsal aspect of the Bryan Disc with cord compression. Focal bony erosion with sclerotic change is noted at the lower end plate of C6. **d** Cervical spine radiograph one and a half years after traffic accident discloses anterior migration of the upper titanium shell of the Bryan Disc (short arrow)

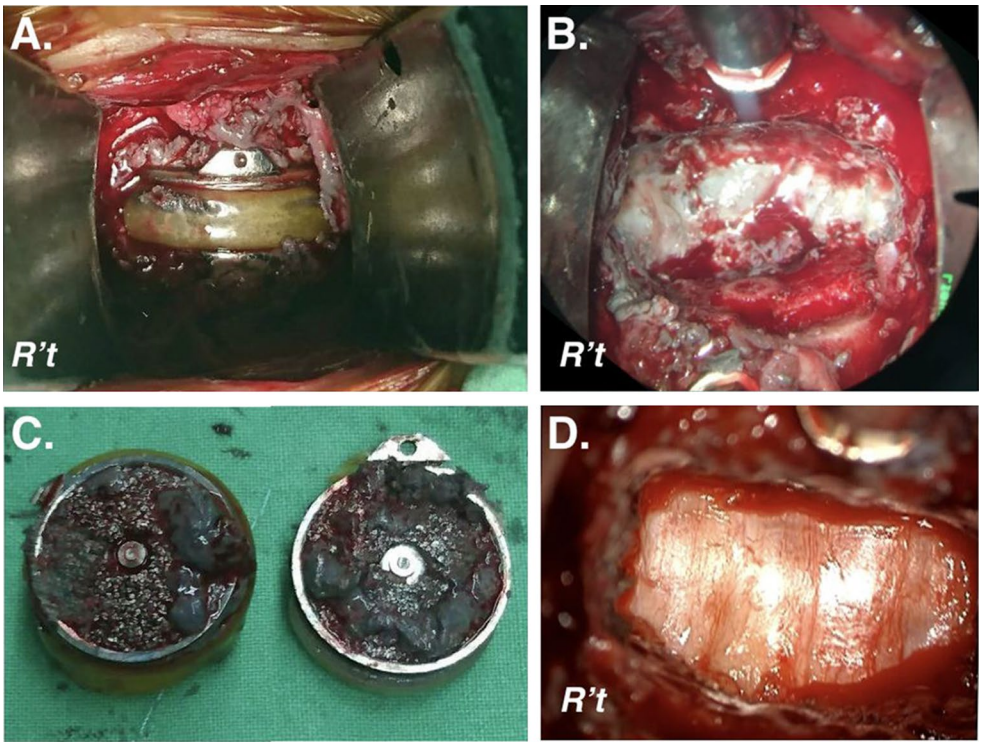

Fig. 3 **a** Metallic stain in periprosthetic soft tissue is noted once the Bryan disc is exposed. **b** After Bryan disc removal, thick, gray-like inflammatory soft tissue appears attached to the dura matter with subsequent spinal cord compression. **c** The removed Bryan disc displays a dark gray corrosive film and tissue surrounding the titanium shells. **d** Dural sac bulge is again noted after completion of decompression surgery. R't: right side of the patient

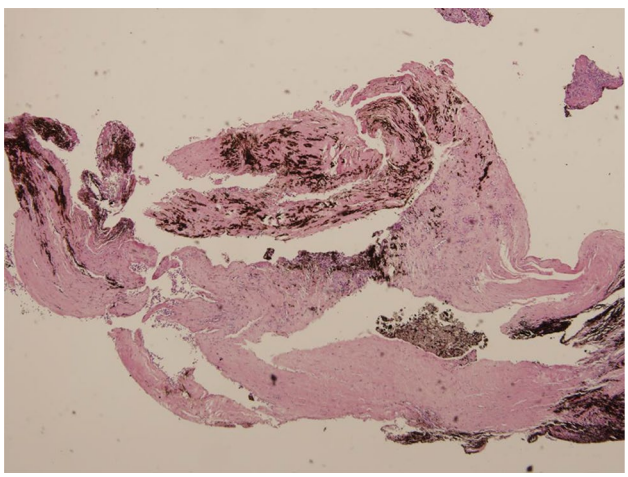

Fig. 4 Microscopic image (hematoxylin–eosin, × 10) of an intraspinal metalloma reveals abundant brown to black pigment deposition in the soft tissues due to iron-containing particles which are distributed intracellularly and extracellularly throughout the granulation tissue

in both legs with difficultly in lifting the legs leading to a propensity for falls.

On admission, her physical exam revealed a negative Spurling's sign, decreased muscle power in both lower limbs, and elevated deep tendon reflexes in the knees. Cervical spine radiograph revealed anterior dislodgement of the Bryan disc at C6–C7 (Fig. 2d). A protruding mass at the dorsal aspect of C6–C7 with cord compression was also identified on the cervical spine MRI (Fig. 1c, d). Cervical spine CT also showed a focal, high-density lesion over C6–C7 with cord compression. Focal bony erosion with sclerotic change was noted at the lower endplate of C6 (Fig. 2c).

Preoperative work-up revealed an erythrocyte sedimentation rate (ESR) of 35 mm/hr and a CRP (C-Reactive Protein) of 0.579 mg/dL. All other laboratory data were within normal limits. To evaluate for possible metallosis due to metallic release from the implant, inductively coupled plasma mass spectrometry (ICP-MS, Agilent 7500ce) was performed 1 day prior to the revision surgery to measure the titanium ion concentrations in the patient's blood. The detection limit of the instrument was 1.80 ppb. The mass spectrometry results revealed slight concentrations of titanium ions in the serum at 20.81 ppb of the patient.

Removal of the Bryan Disc with interbody fusion at C6–C7 using a PEEK (polyetheretherketone) cage with integrated screws (Prevail; Medtronic Sofamor Danek, Memphis, TN) was performed to treat the cervical myeloradiculopathy. The patient's limb symptoms and gait disturbance

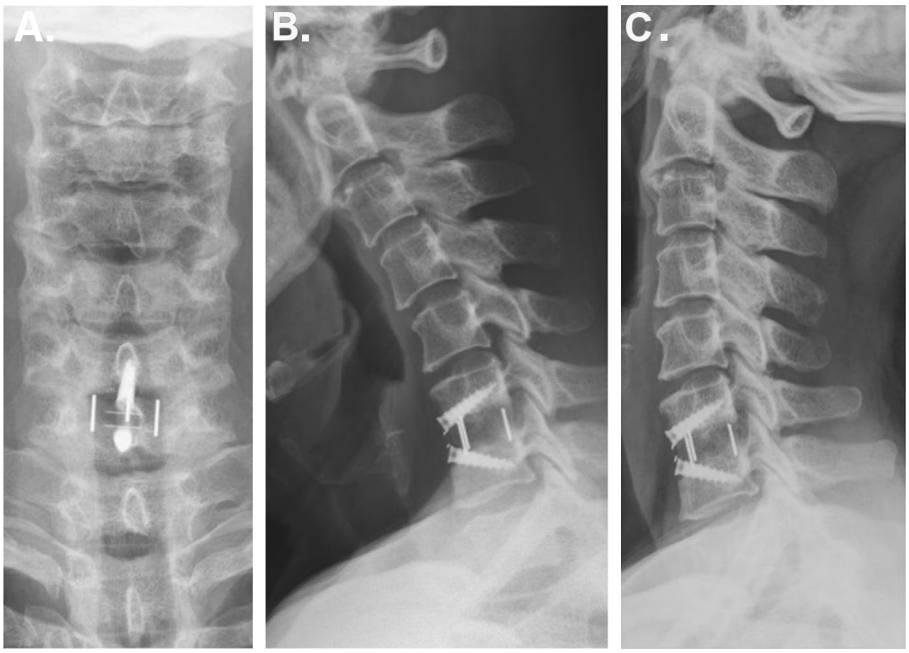

Fig. 5 Postoperative cervical spine radiographs, one month after revision operation, shows the proper cervical cage position with stable alignment. (**a** anteroposterior view, **b** lateral view in flexion, **c** lateral view in extension)

significantly improved after surgery with almost complete resolution of her symptoms.

Radiologic studies

Cervical spine radiographs revealed anterior migration of the upper titanium shell of the Bryan Disc (Fig. 2d). The flexion/extension view also identified loss of range of motion at the C6–C7 level. Cervical spine MRI revealed a mass lesion along the dorsal aspect of the Bryan Disc with spinal cord compression (Fig. 1c, d). Cervical spine CT showed a focal, high-density soft tissue mass at both ventral and dorsal aspects of the artificial disc, with kissing between the titanium shells of the Bryan Disc (Fig. 2c).

Intraoperative findings

During the revision surgery for Bryan Disc removal, thick inflammatory soft tissue was found at the prevertebral fascial layer opened for Bryan Disc exposure, followed by efflux of gray fluid. The periprosthetic soft tissues were also stained dark gray (Fig. 3). The upper titanium shell of the Bryan Disc was found to be loose and was easily removed. The lower titanium shell was firmly attached to the C7 vertebral body. This lower shell was carefully detached using drill and Rongeur force. Once the Bryan Disc was removed, the periprosthetic soft tissues were clearly identified and had characteristic gray and yellowish corrosive debris (Fig. 3). Metallosis was the preferred diagnosis.

Pathological findings

An intraspinal metalloma was noted containing abundant brown to black pigment deposition within the soft tissues, as shown in Fig. 4.

Postoperative course

The patient's postoperative recovery was uneventful with nearly complete resolution of her symptoms. The postoperative cervical spine radiographs 1 month after revision operation showed proper cervical cage position with stable alignment, as shown in Fig. 5. At 6 months post-revision surgery, her serum titanium level was reduced to 9.470 ppb.

Discussion

Metallic-related complications caused by orthopaedic implants have been of clinical concern for many years. The potential adverse effects associated with implants used in internal fracture fixation and degenerative joint arthroplasty include bacteriologic, immunological, and neoplastic effects as well as local effects such as bone resorption, metallosis, and mechanical compression of the surrounding soft tissues [1].

Metallosis (or metalloma) is a rare complication reported in patients after spinal surgery involving implantation. The estimated incidence of metallosis is 5.3% for total hip arthroplasty [2], 0.3% for lumbar and 0.54% for cervical arthroplasty [3], while the incidence after total knee is not well reported.

Table 1 Review of the literature regarding metallosis after spinal disc arthroplasty

References	Age (year), sex	Index diagnosis	Interval	Instrument and levels	Recurred symptoms	Treatment	Feature
Francois et al. [15]	36, F	Herniated lumbar disc of L4-5	1 year	L5–S1 TDR (Maverick)	Lower back pain	Removal of implant 23 months later with ALIF/PSF	Black mass, severe facet arthrosis between L5 and S1
Cavanaugh et al. [14]	38, F	C5-6 herniated disc	6 months	Cervical artificial disc (Keel-based design)	Paresthesia of left hand and arm	Discectomy of C4–C5, C5–C6 with removal of TDR 7 months later	Yellowish mass
Guyer et al. [16]	45, M	Not mentioned	10 months	L5–S1 TDR (Kineflex-L)	Right leg pain	TDR removal 14 months later with spinal fusion	Yellow mass
	56, F	Discogenic back pain	1 year	L4–L5 TDR (Kineflex-L)	Lower back pain with sciatica	Laminectomy for excision of epidural mass first, with TDR removal 23 months later	Yellow mass, metal hypersensitivity is impressed
	45, F	C6 radiculitis	1 year	C5–C6, TDR (Kineflex-C)	Arm pain	TDR removal 14 months later	Metal debris around TDR
	45, M	Not mentioned	18 months	L5–S1 TDR (Maverick)	Left leg pain with weakness	Discectomy of L4–L5 firstly, followed by TDR removal 37 months later	Black mass, with extension to retroperitoneal space

ALIF anterior lumbar interbody fusion, *PSF* posterior spinal fusion, *TDR* total disc replacement

Foran et al. [4] reported one case of metalloma in 62 total knee arthroplasties during 10-years of follow-up. Several case reports of spinal metallosis have also been reported. Corrosion of an internal spinal fixator system was first reported for a variety of spinal fixators by Vieweg et al. [5]. They found that spinal fixators are prone to corrosion due to construction constraints. The first intraspinal metallosis causing delayed neurologic symptoms after spinal instrumentation was reported by Takahashi et al. [6]. Intraspinal metalloma resulting in late paraparesis was also reported by Tezer et al. [7]. A case of intraspinal metallosis adjacent to the pedicular hook, which developed after thoracic vertebral fracture treatment, caused paraparesis at the 3rd postoperative year. Another case described by Fernandez et al. [8] showed intraspinal metalloma formation after exclusive interbody fusion at L4–L5 using titanium cages. Richman et al. [9] recently reported a case of a 19-year-old male who presented with sudden onset of a neurologic deficit and pain 4 years after posterior spinal fusion for adolescent idiopathic scoliosis. A review of several cases of spinal metallosis after spinal fusion showed that most incidents involved invasion of the spinal canal leading to neural compression (except for one case reported by Botulin et al. [10] as persistent back pain).

Generally, spinal metallosis usually presents months to years after spinal instrumentation surgery and is a potential cause of recurrent neurological symptoms. This process appears to be independent of the instrument composition, as metallosis has now been demonstrated in both titanium and stainless steel implants [11]. The lower end of an instrumented fusion is the area of stress concentration [12], which is predisposed to the presence of micromovements and pseudoarthrosis after multilevel spinal fusion. Coincidentally, we noticed that half of the metallomas which formed after spinal fusion were located primarily at the lowest end of the instrumented level. Abnormal motion at the bone–metal or metal–metal interface is a common characteristic in these multilevel spinal fusion cases.

Most metallosis cases have been associated with total hip arthroplasty (THA). The contemporary bearing surfaces in THA are cobalt–chromium–molybdenum (CoCrMo) alloy articulated with ultrahigh molecular weight polyethylene (UHMWPE) or CoCrMo. It is said that metal on metal designs in hip arthroplasty have the advantage of decreased volumetric wear rates and, theoretically, increased implant longevity. The same materials are also used in spinal arthroplasty devices. The wear debris from the bearing surface contributes to systemic ion elevation, debris corrosion, hypersensitivity, soft tissue pseudotumor formation, osteolysis, and aseptic loosening [3]. Lumbar and cervical total disc replacement (TDR) could have similar complications and clinical sequelae from metallosis as has been shown with hip arthroplasty.

To the best of our knowledge, this is the first reported case of spinal metallosis caused by Bryan Disc implantation. Although the bearing surface of a Bryan Disc is titanium-aluminum-vanadium alloy (Ti_6Al_4V), Hallab et al. [13] found that titanium particles can induce cellular apoptosis, increased osteoclast activity, enlarged osteolytic absorption area, and can promote pro-inflammatory response via TNF-alpha. We believe that the anterior migration of the upper titanium shell of Bryan Disc in this case report occurred after the traffic accident, leading to titanium shell wear.

Metalloma development could be expected after such traumatic injury. The periprosthetic soft tissues involved with metallosis are usually stained black. However, the case described by Cavanaugh et al. [14] involved a yellowish mass without staining of the periprosthetic soft tissues. This latter case was likely due to a delayed hypersensitivity reaction rather than a metalloma induced by metallic wear debris. Few metalloma have been reported after spinal disc arthroplasty, as shown in Table 1 [14–16].

The author has implanted 430 Bryan Discs into 289 patients from 2006 to 2016. This is the first case of metallosis that we have encountered. Although uncommon, intraspinal metallosis (or metalloma) should be considered as an infrequent cause of delayed neurological symptoms after spinal surgery with metallic instrumentation, especially after disc arthroplasty. Once metallosis is suspected, immediate removal of the metallic implants is mandatory for definite diagnosis and treatment.

Compliance with ethical standards

Conflict of interest All authors declare no conflict of interest.

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