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CASE REPORT

Osteolysis after cervical disc arthroplasty with artificial cervical disc

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Abstract

Purpose Cervical total disc arthroplasty (TDA) is a motion-preserving alternative to anterior cervical discectomy and fusion that has gained popularity among spine surgeons. Although generally effective, TDA has been associated with rare cases of progressive osteolysis, a complication whose natural history and impact on clinical outcomes are not well understood. This case report aims to present a case of progressive osteolysis following cervical TDA with the SpinalKinetics® M6-C Artificial Cervical Disc and to discuss the clinical approach and implications for patient management.

Methods We reviewed the clinical course of a patient who underwent cervical TDA with the SpinalKinetics® M6-C Artificial Cervical Disc and subsequently developed progressive osteolysis. The patient's symptoms, diagnostic findings, and treatment progression were documented, with a focus on the timing of symptom onset, imaging, and the therapeutic interventions applied.

Results The patient demonstrated a delayed onset of symptoms related to osteolysis, which was identified through CT imaging as a progressive complication. The slow progression of osteolysis in this case underscores the need for careful monitoring, as early symptoms may be subtle but can lead to significant clinical implications if unaddressed.

Conclusion This case highlights the potential for progressive osteolysis as a complication following cervical TDA, emphasizing the importance of ongoing surveillance and increased awareness among spine surgeons. Early identification and monitoring of osteolysis may mitigate the risk of severe outcomes and guide timely intervention.

Keywords M6-C Artificial Cervical Disc · Cervical total disc arthroplasty (TDA) · Osteolysis · Non-inflammatory bone loss · Anterior bone loss

Introduction

Cervical total disc arthroplasty (TDA) was introduced as a motion-preserving alternative to anterior cervical discectomy and fusion (ACDF) by addressing the problems associated with fusion. This is achieved through the maintenance of functional spinal kinematics, prevention of adjacent segment degeneration and elimination of pseudarthrosis [1–3]. TDA has demonstrated a lower rate of revision and secondary surgery when compared to ACDF. However, it has also introduced new complications, similar to those observed in larger synovial joints [3, 4]. Short-term, non-inflammatory bone loss is commonly observed after TDA but rarely requires revision. On the other hand, osteolysis, despite less frequently reported, tends to progresses and may lead to device removal [3]. We present a case of progressive osteolysis following TDA with SpinalKinetics® M6-C Artificial Cervical Disc.

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Case presentation

A woman in her 40s, a smoker with no prior conditions, experienced left cervicobrachialgia and underwent double-level TDA with M6-C disc implants at C5-6 and C6-7 at another hospital. She reported an uneventful surgery but had no imaging follow-up. Five years later, she developed morning neck pain, neck weakness, minor left cervicobrachial pain, and occasional episodes of "choking on her saliva." After persistent symptoms, she was evaluated by our neurology department, revealing limited neck strength (grade 4) and reduced left arm abduction due to shoulder pain (later diagnosed as calcifying tendinosis and acromioclavicular synovitis). No other deficits were observed.

Electromyography only showed chronic cervical myotome changes, leading to a differential diagnosis of dropped head syndrome. Tests for creatine kinase, anti-acetylcholine receptor, and anti-muscle-specific kinase antibodies were negative and a CT imaging was ordered showing osteolysis around the implants at the endplates, though MRI ruled out myeloradicular compression. After multidisciplinary discussion, a watch-and-see approach was adopted.

Follow-up CTs over the next four years showed progressive osteolysis (Fig. 1), which, in association with worsening cervicalgia, prompted surgical intervention. Preoperative bone scintigraphy showed slight osteoblastic activity around the implants, without hypervascularization, ruling out infection.

During the revision surgery, the previously right-sided incision was used for the approach. Upon examination, we observed a significant reaction with a greyish color surrounding both implants, particularly pronounced at the upper level (Fig. 2A and B). We proceeded to identify the C5-C6 and C6-C7 implants. At the upper level, the implant was completely destroyed (Fig. 2C), which explained the intense inflammatory reaction. At C6-C7 implant we noticed an 8-mm tear along the anterior upper border of the annular sheath, with nylon tread extrusion. The nylon tread was in clear relation with the osteolytic cavity (Fig. 2C). Subsequently, we performed a C6 corpectomy and removed the implants (Fig. 2D). Considering the likelihood of an inflammatory reaction to the implant components, we decided to perform an anterior iliac crest bone graft with titanium plate fixation (C5-C7) to minimize the exposure to foreign materials.

Cultures were negative, and histology confirmed a foreign body reaction. Postoperative recovery was favorable, with the patient discharged two days later, achieving full left arm strength. She was instructed to wear a hard collar, specifically a sterno-occipito-mandibular immobilizer (SOMI). During the follow-up CT evaluation taken approximately two months after surgery, we observed discreet subsidence in the anterior construct. To enhance stability of the construct, a second surgery was performed at that time, involving posterior fixation to the lateral masses of C5-C6-C7 and a crosslink. The patient was discharged two days after this surgery without experiencing any complications. Subsequent CT scans confirmed successful fusion without complications (Fig. 3B).

The patient reported significant neck pain relief and resumed work and daily activities without difficulty.

Discussion

Cervical TDA is becoming increasingly favoured by spine surgeons due to its numerous benefits, including to its ability to preserve motion at the treated segment, potentially reducing adjacent segment degeneration and low rates of surgical complication (1.5%) and revision (0–0.4%) after long-term follow-up [2, 5]. Comparative studies between ACDF and TDA have shown that the latter has statistically superior clinical outcomes in terms of overall success (78.6% in TDA vs. 62.7% in ACDF), Neck Disability Index (NDI) success (87.0% in TDA vs. 75.6% in ACDF), and neurological success (91.6% in TDA vs. 82.1% in ACDF) [5]. However, it is important to note that cervical disc replacements are not without complications, and there is limited information available on long-term complications [2, 6]. Adverse events associated with TDA include heterotopic ossification, recurrent/persistent stenosis, postoperative kyphosis, implant migration, and iatrogenic vertebral body fractures. There have also been reported cases of osteolysis following TDA, although data on wear and failure of cervical total disc replacements are limited. Mechanisms of failure in larger synovial joint arthroplasty are well-documented, with wear between articulating surfaces leading to the release of particulate debris into the surrounding tissues. This debris triggers an innate inflammatory response, ultimately resulting in osteolysis [2, 3].

In a review conducted by *Wahbeh et al.*, it is highlighted the importance of using standardized terminology to differentiate between non-inflammatory and inflammatory bone changes in order to accurately identify the nature and severity of the reported bone loss and to assess these complications in preclinical trials. Non-inflammatory bone loss refers to a short-term adaptation process to mechanical changes, which is commonly observed following TDA. This type of bone loss rarely leads to the need for revision surgery. On the other hand, osteolysis is characterized by lesions that result from an inflammatory response. Although less frequently reported, osteolysis tends to progress and can potentially implicate device removal. Inflammatory osteolysis often manifests as large lesions that appear to scooped

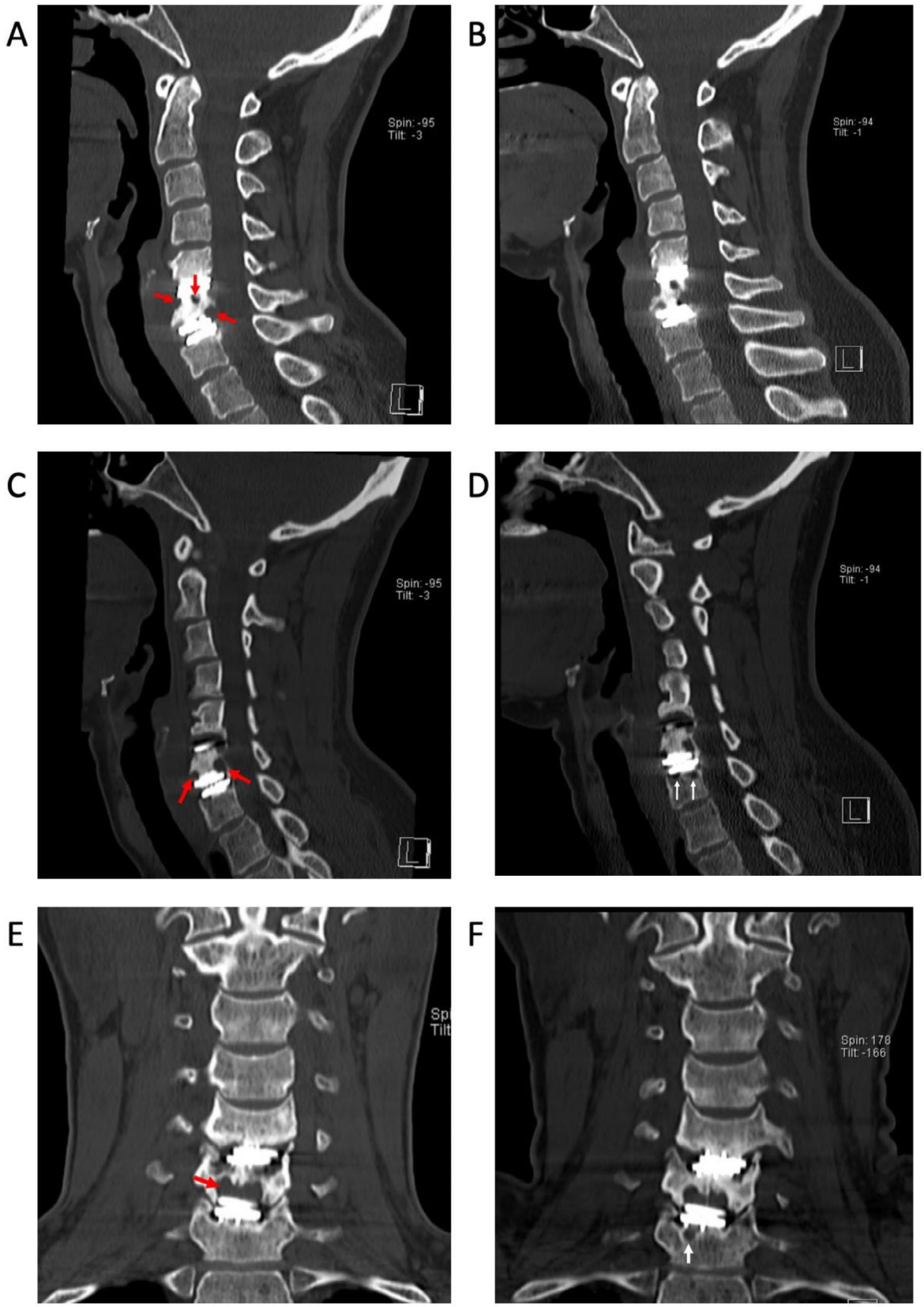

Fig. 1 CT images of the patient taken at the time of admission to our hospital (left) and the most recent preoperative scan (right), showing initial areas of osteolysis (red arrows) and their progression (white arrows)

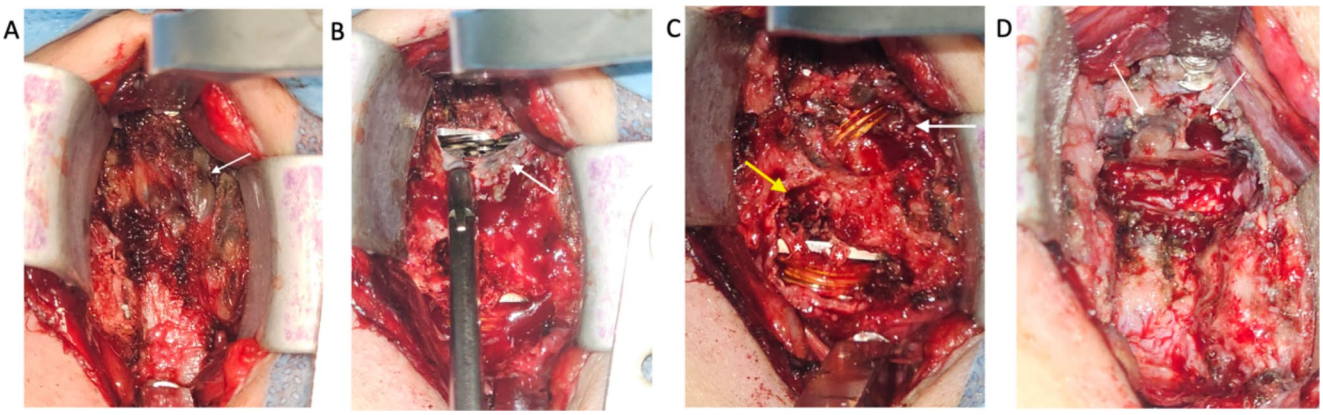

Fig. 2 Intraoperative views. **A**: Foreign body reaction with a greyish color surrounding both implants, particularly pronounced at the upper level (white arrow). **B**: Foreign body reaction at the upper level (white arrow). **C**: Completely destroyed implant at the upper level (white arrow) and the nylon thread extrusion at the lower level(*) in clear relation to the osteolytic cavity (yellow arrow) **D**: After removal of both implants, the nearly completed C6 corpectomy, and two areas of osteolysis (white arrows)

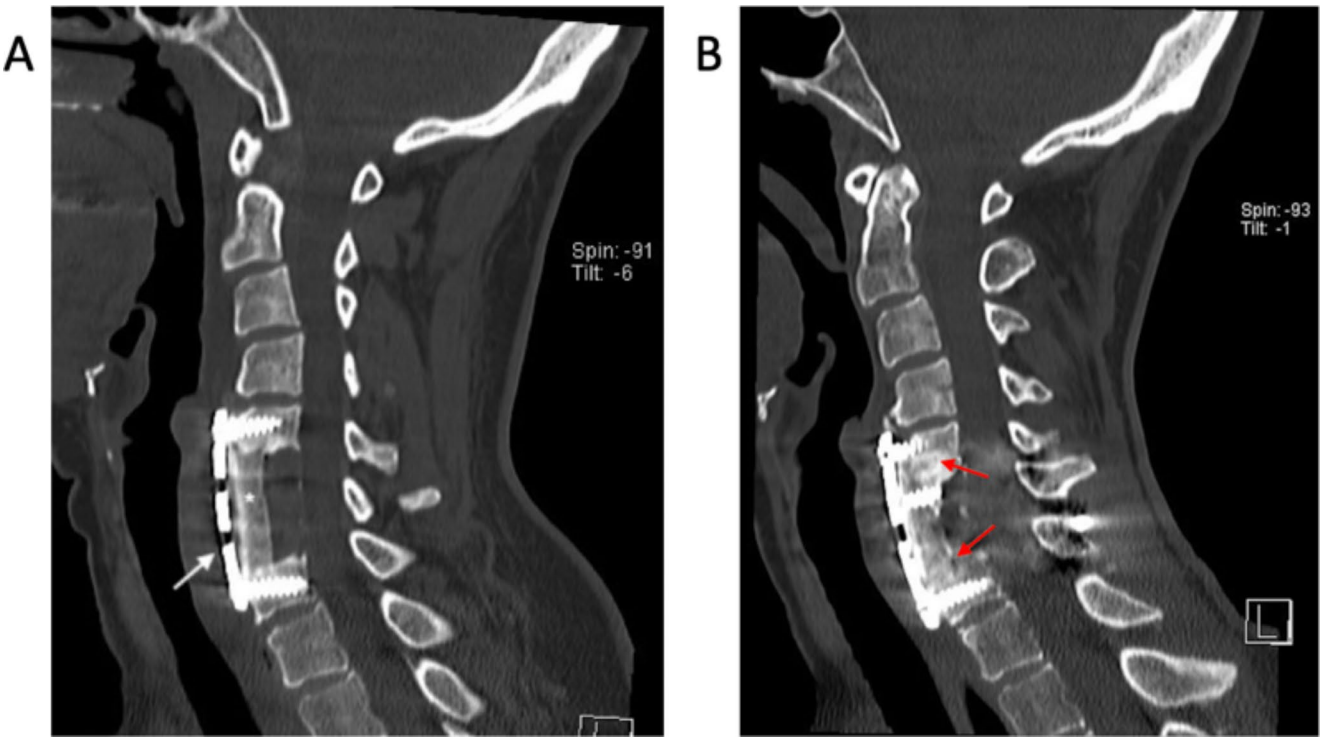

Fig. 3 **A**: Immediate postoperative CT showing the anterior iliac crest bone graft (*) with titanium plate fixation from C5 to C7 (white arrow). **B**: CT scan acquired 9 months after the second surgery showing adequate fusion and the previously described subsidence of the construct (red arrows), which led to the posterior fixation

out of the bone surrounding the implant. In contrast, non-inflammatory bone loss presents as erosive remodelling of the vertebral body, typically observed around the peripheral or anterior side (also known as anterior bone loss) [3, 7].

The most common symptom of osteolysis is neck pain, followed by radicular pain and paraesthesia. However, more serious secondary effects such as dysphagia, respiratory compromise and neurologic deficits have also been reported [3, 4].

The M6-C artificial cervical disk prosthesis incorporates an artificial nucleus made of polycarbonate urethane polymer (PCU) and a fibrous annulus composed of ultra-high-molecular-weight-polyethylene fibres (UHMWPE). The core and endplate are not bonded, which helps distribute stresses between the PCU core and UHMWPE fibers, eliminating peak stresses at the interface. The prosthesis is anchored to the vertebral body bone by two titanium plates with keels coated with titanium plasma spray to promotes

bony ingrowth. This design allows for physiological motion characteristics similar to natural disc, including compressive deformation under axial load [1, 2, 4, 6]. The polymer sheath surrounding the PCU core and UHMWPE construct was intended to limit soft tissue ingrowth and contain wear debris. However, it has proven to be ineffective in preventing the generation of wear particles. These wear particles activate a biological cascade in the surrounding tissues, leading to phagocytosis of the particles and subsequent release of inflammatory proteins. This inflammatory response results in osteolysis, which can eventually lead to a foreign-body granulation tissue response invading the bone implant interface, causing mechanical instability and neurological symptoms [1, 4].

In July 2020, the Australian Therapeutic Goods Administration issued an Implant Hazzard Alert about the M6-C, recommending routine long-term clinical and radiographic monitoring of patients implanted with the device. Changes in disc position, loss of height, and periprosthetic bone loss may indicate the onset of osteolysis [4].

This case report highlights a complication that is still relatively uncommon in the literature but may become more frequent with the widespread use of TDA in recent years.

Conclusion

- **Short-term vs. long-term bone loss**: While short-term, non-inflammatory bone loss is common after TDA and rarely necessitates revision, osteolysis, a less frequent complication, often progresses and can lead to severe issues requiring device removal.
- **Slow onset, devastating consequences**: The slow onset of symptoms associated with osteolysis, coupled with its potentially devastating consequences, underscores the need for long-term follow-up and heightened awareness among surgeons.
- **Balancing intervention**: Osteolysis can be asymptomatic, posing a treatment dilemma. Careful consideration must be given to the potential risks of revision surgery compared to the potential for osteolysis to progress and cause complications.
- **Standardized terminology**: Adopting consistent terminology, as advocated by Wahbeh et al., to differentiate between non-inflammatory and inflammatory bone changes is vital for accurate diagnosis and assessment.
- **Pre-clinical evaluation and follow-up protocols**: Further research is required to evaluate osteolysis in pre-clinical trials of artificial disc implants. Establishing standardized protocols for both clinical and imaging follow-up (e.g., MRI, CT scans) is crucial for early detection of osteolysis. Determining the optimal frequency and type of imaging is necessary.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

References

1. Cedric Baltus E, Costa G, Vaz, Raftopoulos C (2019) Granulomatous reaction on a double-level cervical total disc arthroplasty. World Neurosurg 122:360–363
2. Nicholas J, Clark EL, Francois, Brett A, Freedman (2020) and Bradford Currier. Early Implant Failure of a 2-Level M6-Cervical Total Disc Replacement: A Case Report. *JBJS Case Connector* 10, 3: e19.00644-e19.00644
3. Jenna M, Wahbeh S-H, Park P, Campbell E, Ebramzadeh, Sophia N, Sangiorgio (2022) The lexicon for periprosthetic bone loss versus osteolysis after cervical disc arthroplasty: a systematic review. Eur Spine J 31:4: 830–842
4. Rathbone MS-YE, Grierson L (2022) Midterm osteolysis-induced aseptic failure of the M6-C™ cervical total disc replacement secondary to polyethylene wear debris. Eur Spine J 31:5: 1273–1282
5. Shin JJ, Kim K-R, Son DW et al (2022) Radiological changes in adjacent and index levels after cervical disc arthroplasty. Yonsei Med J 63:1: 72
6. Harati A, Oni P, Oles L, Reuter T, Hamdan M (2020) Vertebral body osteolysis 6 years after cervical disk arthroplasty. J Neurol Surg Part A: Cent Eur Neurosurg 81:02: 188–192
7. Wang X-F, Meng Y, Liu H, Ying Hong, and, Bei-Yu W (2020) Anterior bone loss after cervical disc replacement: a systematic review. World J Clin Cases 8:21: 5284–5295