



Staged surgical treatment for infection of total disc arthroplasty: three cases and a narrative review of the literature

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Abstract



Although total disc arthroplasty (TDA) is a common procedure for selected cases of degenerative disc disease, until today there are only two cases of TDA infections reported in the literature. We report three cases of postoperative TDA infections, two developed cutaneous fistulas. To eradicate the infectious site, a staged removal of the device, resolute debridement, and stabilization plus fusion is proposed. Surgeons are challenged by (1) major retroperitoneal vessels adherent to the device, (2) surrounding scar tissue, (3) accompanying retroperitoneal abscess, and (4) technical issues when removing and replacing the implant. A staged multidisciplinary team approach involving vascular and plastic surgery as well as spine specialists is mandatory to achieve good results.

Keywords Lumbar · Total disc arthroplasty · Disc prosthesis · Infection · Surgical treatment

Introduction

Lumbar total disc arthroplasty (TDA) is used for motion-preserving replacement in degenerative disc disease (DDD). Infection of TDA is a seemingly rare, nonetheless serious complication. Management is clearly based on “expert

opinion”. We contribute three cases of TDA infection and describe our treatment recommendations.

Presentation of cases

Common to all three cases is a latency between index surgery and onset of new symptoms caused by the infection. Table 1 summarizes the principal clinical data. All patients underwent their initial TDA procedures at other institutions via anterior retroperitoneal approaches (one single-level and 2 two-level TDAs, all keel-type devices M6-L, Spinal KineticsTM). Two of them developed cutaneous abdominal fistulas,

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which had been revised surgically 6 and 8 times, respectively, in the pre-treating hospitals. Upon first presentation in our department, leukocyte counts were all within normal range; however, C-reactive protein levels were elevated in two patients. All of our patients were neurologically intact, the primary symptoms being the cutaneous fistula and lumbar tenderness. Pain was present to a significant amount, with scores for back pain ranging between 7 and 10 points, and for leg pain between 3 and 5 points on the 10-point visual analogue scale.

Preoperative diagnostic imaging included standing X-rays, flexion–extension X-rays, CT and MRI scans, and CT angiograms for all patients. Figure 1 shows exemplary images of cases. Loosening of the TDA device and malfunction was seen on X-rays and dynamic studies in all three cases. MRI scans reveal the extent of paraspinal abscess; epidural empyema was not present in any of our cases. CT scans revealed bony erosion of adjacent vertebrae in case 2. Contrast media was injected into the cutaneous fistula in cases 1 and 2 to delineate the tract of the fistula, however failed to do so in case 2, so an additional PET-CT scan was obtained. Here, the splitting of the tract into two ducts connecting with the two affected disc levels can be appreciated.

All patients were treated surgically and antibiotics after intraoperative collection of infectious material for microbiological assessment. As a means to better identify the ureter intraoperatively, a double-J stent was placed into the left ureter preoperatively by the urologist in case 1.

The procedures for our three cases were divided into several steps, with the aim to eliminate the infectious process completely, stabilize the spine, and achieve fusion.

Fig. 1 Exemplary preoperative diagnostic imaging: **a** plain standing X-ray (case 1) showing slight kyphotic position of the TDA and subsidence into end plates. **b** Sagittal cut of bone window CT scan (case 2) reveals erosive changes in adjacent end plates. **c** CT angiogram (case 1) presenting location of major retroperitoneal vessels in relation to the prostheses. **d** post-contrast parasagittal CT reconstruction of cutaneous fistula (case 2). **e** PET-CT scan showcasing the double duct of the proximal fistula indicating infection of both TDA devices. **f** sagittal STIR and contrast enhanced axial T1-weighted MRI demonstrate adjacent bone oedema and left transpsoatic abscess extent

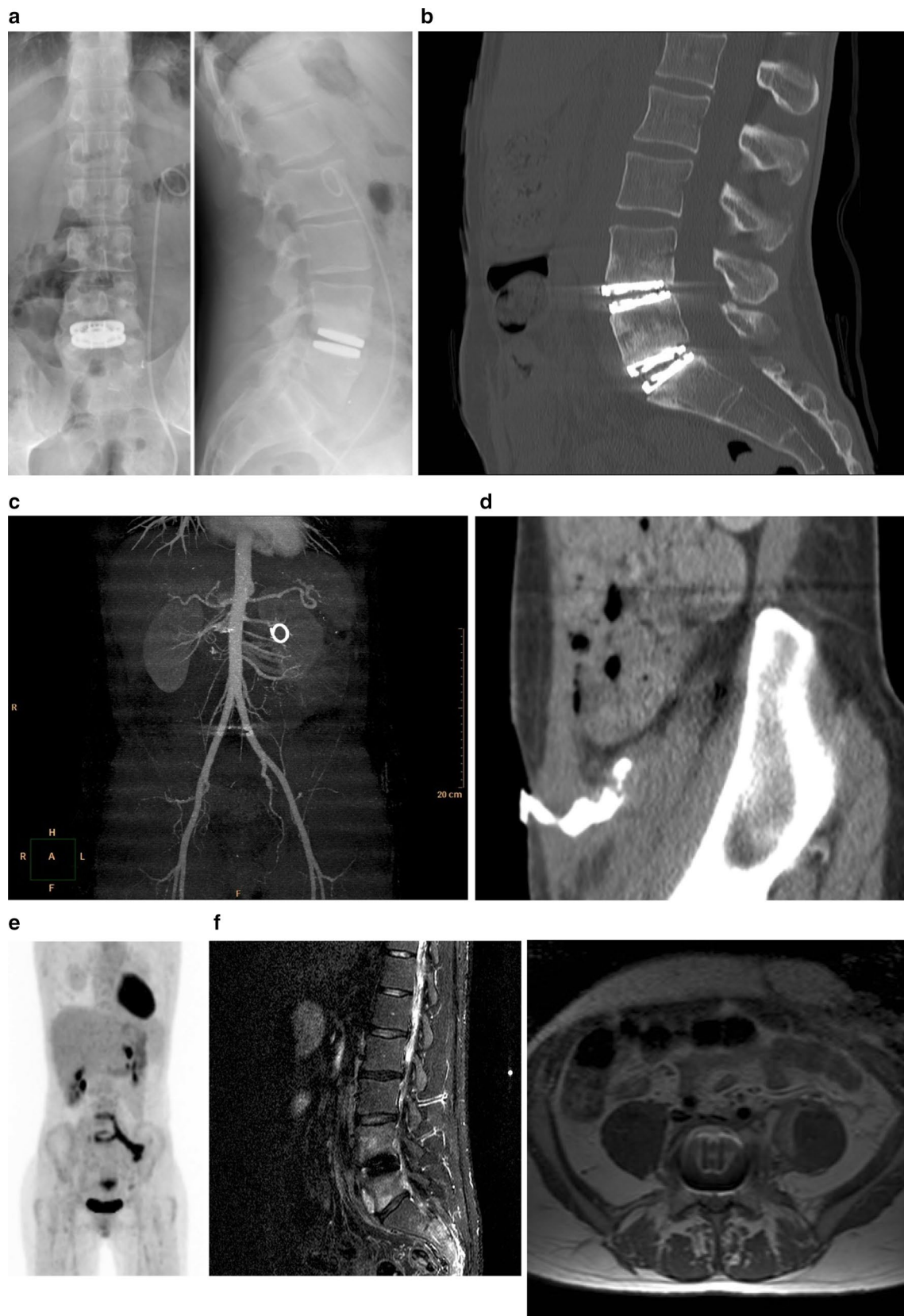
Depending on the activity of infection, the procedure was done either in one stage (case 1) or two stages (cases 2 and 3).

We used a modified left lateral XLIF approach with transpsoatic removal of the prosthesis in case 1. Following vigorous debridement of the psoas abscess and obtaining multiple samples for microbiological cultures, the keel-based prosthesis was dislodged anterolaterally from the disc space by a limited partial corpectomy of the L4 and L5 vertebrae. This left the major retroperitoneal vessels untouched. An antibiotic containing polymethylmethacrylate (PMMA) spacer was modelled and inserted into the debrided disc defect as a preliminary placeholder. A Gore-Tex membrane was left as a guidance cue for the second operation. The deep abdominal part of the fistula was fully excised. Then, the cutaneous abdominal wound was excised as well and debrided. The central parts of the fistula were not excised. A Vacuseal™ sponge was used for vacuum wound closure. This step was immediately followed by a typical dorsal percutaneous pedicle-based stabilization L4–L5.

Table 1 Clinical case parameters

Case	1	2	3
Age (years)/gender	28/male	41/female	55/male
Initial approach	pr-rp	anterior rp	pr-rp
TDA levels	L4/5	L4/5 and L5/S1	L4/5 and L5/S1
No. operative revisions	6	8	0
Interval index surgery to presentation (months)	9	21	72
Initial leukocyte count (/mm ³)	8200	7500	7900
Initial CRP (mg/dl)	6.14	0.18	5.7
Initial VAS leg/back pain	5/7	5/10	3/8
Culture	<i>Staphylococcus aureus</i>	<i>Staphylococcus aureus</i>	No growth
Overall surgery time (min)	366	314	410
Overall Blood loss (ml)	1250	1400	2200
Hospital length of stay (days)	28	21	14
Radiologic fusion (1-year f/u)	Yes	Yes	Yes
VAS leg/back pain (last f/u)	0/0	0/0	2/0
Follow-up period (months)	60	12	16

pr pararectal, rp retroperitoneal, n/a not applicable, f/u follow-up



Twelve days later, following normalization of CRP levels with antibiotic drugs sensitive to *Staphylococcus aureus*, which had been isolated from the specimen, the patient returned to the operating room for removal of the temporary PMMA spacer and the Gore-Tex membrane along the predefined XLIF route as well as placement of an expandable cage together with fusion using autologous bone graft taken from the iliac crest. In the same operative session, the Vacuseal™ sponge was removed and the abdominal wound was closed by the plastic surgeon using a rotational flap technique, including the XLIF approach. Figure 2 shows the wound management and pre- and postoperative appearance.

In cases 2 and 3, the first stage was to debride and remove the prostheses via retroperitoneal approaches. Massive scarring was met in the abdominal wall; several lesions of the peritoneum had to be repaired using running sutures. In case 2, the fistulous ducts were injected with methylene blue for better visualization. The fistula was then excised completely. With the help of the vascular surgeon, the arterial and venous vessels were then dissected, which proved to be difficult due to scar tissue. In case 2, the left common iliac artery and vein were mobilized to the right; the iliolumbar vein was sacrificed. During the course of dissection, a 3-mm tear of the common iliac vein and another 5-mm tear of the distal vena cava had to be sutured by the attending vascular



Fig. 2 **a** Preoperative appearance of former incision scar and triangular-shaped cutaneous opening following superficial cleaning. **b** Wound appearance after step 1: vacuum pump draining the fistula,

posterior wound aspect after percutaneous stabilization. **c** Plastic reconstruction of abdominal wound

surgeon. In case 3, two venous lesions had to be sutured, at the inferior vena cava and the left common iliac vein. The removal of all keel-based prostheses was achieved via partial corpectomies of L4 for the L4/5 devices, and S1 for the L5/S1 devices, using an ultrasound bone scalpel. Intensive debridement and antiseptic irrigation of the emptied disc spaces was followed by inspection of the anterior aspect of the dura and insertion of either fixed or expandable cages to bridge the created bony gaps completely. Figure 3 shows the intraoperative aspect of case 3 with both cages in place. Wound drains were placed into the retroperitoneal space and subcutaneously. Owing to the infection, bone grafts were not used during the anterior approach. Instead, before (case 3) or after (case 2) the anterior step, an open dorsal

pedicle-based stabilization was performed at L4–L5–S1, and both segments were fused via decortication of laminae and facet joints with interlaminary, interfacet, and intertransverse process autologous bone grafts harvested from the iliac crest.

All patients were mobilized on postoperative day one and made an uneventful recovery. Hospital length of stay varied between 14 and 28 days. Outcome was assessed radiologically and clinically with a follow-up of 12, 16, and 60 months. Signs of bony fusion were present on CT scans of all patients (Fig. 4), and VAS pain scores were reduced to 0, with the exception of one patient, who was still complaining of some residual back pain with a score of 2.

Fig. 3 Case 3: intraoperative photograph: the L5/S1 cage can be seen in place and the L4/L5 TDA has been removed, the left common iliac artery and vein crossing in between

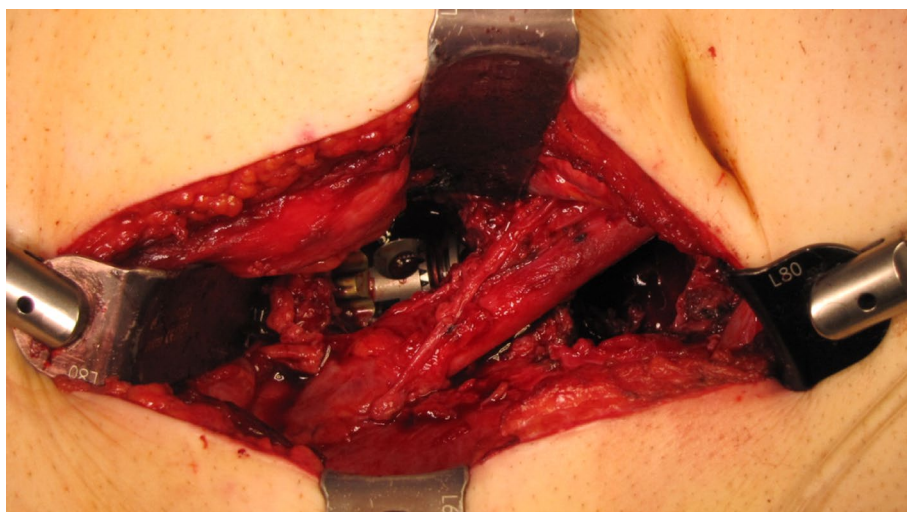


Fig. 4 Postoperative lumbar spine X-ray (case 2) and 1-year postoperative sagittal and coronal reformatted CT scans (case 3) showing complete bony fusion and correct alignment of implants

Rationale for treatment and evidence-based literature

Although TDA is a common treatment for DDD, to date, only two publications describe actual management of post-operative TDA infection. In their case report, Spivak et al. [1] describe a 35-year-old male who presented 8 months after his index two-level TDA procedure (L4/L5 and L5/S1) with abdominal pain and recurrent back pain and elevated serum infection parameters. A CT scan diagnosed him with retroperitoneal abscess, and a CT-guided abscess aspiration of 150 ml was successfully performed. A drain was placed and left until no secretion was found for two consecutive days. Blood cultures revealed *Staphylococcus aureus*, and microbiologic specimen from the abscess revealed *Streptococcus intermedius*. The patient was treated using suppressive antibiotics given intravenously for 6 weeks followed by oral antibiotics, and C-reactive protein levels, leukocyte rate and ESR returned to normal. However, due to his strong desire to have both implants removed, the patient underwent a revision surgery with removal of both devices via a retroperitoneal (L4/L5) and transperitoneal (L5/S1) route after 5 months following his first presentation. At follow-up during 4 subsequent years, he made an uneventful recovery leaving him with only little residual back pain.

In another publication by Flouzat-Lachianette et al. [2], a 38-year-old woman treated with TDA for DDD via a retroperitoneal approach, presented 1 month following the index procedure at L4/L5 with acute abdominal and back pain, fever up to 39 °C and elevated C-reactive protein level, but normal leucocyte counts. CT scans showed a left psoas-based retroperitoneal abscess. Since interventional radiologists were unable to percutaneously drain the abscess, an open surgical debridement was performed using a left lumbotomy. Dissection of the great vessels seemed too difficult to access the TDA, so the implant was left in place. Cultures were taken from the abscess wall and drainage fluid. All of them yielded *Mycoplasma hominis* as causative agent, a commensal bacterium of the urogenital tract. As the patient had worn an intrauterine device and experienced uterine outflow, endometritis could have been a source of colonization of the peritoneum, which was lacerated during the index procedure. Alternatively, the infection could have occurred by hematogenous spread of the *Mycoplasma hominis*. The patient had been given cefotaxime and fosfomycin initially, but this was stopped and doxycycline 100 mg BID was given instead owing to the culture results. At 2 months, the serum infection parameters were normalized and the wound had healed completely. At follow-up 1.5 years later, radiographic examinations including conventional X-ray, CT scans, and MRI scans, showed full functioning of the TDA device, no migration or subsidence, and no residual collection.

Another publication by Gerometta et al. [3] summarizes the results and conclusions of the first report in light of a broader spectrum of TDA revisions and theoretical assumptions.

The scarcity of published management reports led us to review the results of our own series of TDA infections, which comprises three cases. Common to all of our cases is the late manifestation of the infection (9, 21 and 72 months, respectively). As a peculiarity, two cases developed cutaneous fistulas connective to the infected TDA devices. Typically, late infections are caused by low-pathogenic microorganisms, which may be difficult to cultivate. Accordingly, cultural specimen revealed no causative microorganism in one of our cases. Nevertheless, aggressive antibiotic treatment is a mainstay of TDA infection management. Intravenous antibiotic treatment should start immediately after collection of samples (serum, superficial wound, deep wound/abscess and implant). The choice of the antibiotic drug depends on the probability of the underlying microorganism and should be evaluated together with microbiologists, according to the microbiological results. There are no explicit recommendations for the length of medical treatment. At our institution, a course of at least 3 months of treatment has been judged advisable. With sufficient bioavailability as a precondition, antibiotics might be given orally later in the postoperative course, if C-reactive protein and leucocyte count decrease. Antibiotic drugs should be discontinued only when serum infection parameters have completely returned to normal values.

In cases, where microbiological cultures remain negative, metallosis should be included in differential diagnosis, as metal-on-metal TDA devices have been shown to evoke perilesional lymphocytic reaction, which might mimic bacterial infection [4]. However, in our cases, the presence of fistulas and psoas abscess formations were highly indicative of chronic bacterial infection.

CT-guided abscess drainage will reduce the load of bacteria and pus and thus change the environment for immunologic responses of the host to the better. However, in chronic infectious states, abscess aspiration alone may prove insufficient to completely stop the inflammatory process.

Surgical eradication of the infection is probably warranted even more than antibiotic medication in cases with late manifestation of infection, complicated wound healing (e.g. cutaneous fistulas) and comparatively small increases in serum infection parameters. As shown in our cases, aggressive debridement, removal of the infected implant and fusion is mandatory for successful surgical healing. To accomplish all three goals, the procedure might be split into several steps or even two stages, depending on the condition of the patient, the intraoperative blood loss, the extension and severity of the infection, and the technical possibility

to remove the implant and replace it effectively at the same time.

Meticulous planning of the procedure is important, which involves preoperative exhaustive radiologic diagnostics to clearly delineate all affected tissues, and an interdisciplinary approach is recommended using the expertise of the vascular and plastic surgeon. Retroperitoneal approaches are technically demanding in revisions of TDA. Due to tight scar tissue vascular lesions are frequent, but can be handled together with a vascular surgeon. Keel-type devices (as in our three cases) can be extracted more easily via a lateral (XLIF) approach, making use of a partial osteotomy to gain access to the device and dislodge it into the bony defect. Other devices might not need this manoeuvre, although pre-tension of the prosthesis might also be a reason for partial corpectomy. Abnormal courses of the major vessels should be precluded by preoperative CT angiograms. In cases of cutaneous fistulas, complete resection of the fistulous ducts is advised wherever achievable, sometimes leading to preliminary wound closure techniques using vacuum pumps. Aggressive debridement of the surrounding infected soft tissue including residual disc material is obligatory. To obtain immediate sufficient stability for mobilization of the patient, the gap must be filled with either a suitable cage or bone graft. However, we prefer using cages. Bony fusion should be accomplished either immediately at remote spinal locations (posterolateral, posterior fusion, together with

stabilization) or anteriorly at later stages, when infectious activity has decreased demonstrably.

We vigorously endeavour individual case planning, as revision of infected TDAs is a challenging situation associated with a high complication rate. However, complications such as vessel lacerations can be handled oftentimes through an interdisciplinary team approach.

Compliance with ethical standards

Conflict of interest None of the authors has any potential conflict of interest.

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