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GRAND ROUNDS

Revision of a lumbar disc arthroplasty following late infection

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Abstract

Anterior removal of a lumbar total disc replacement implant is often a very technically demanding procedure. The anterior retroperitoneal anatomy is prone to scarring, limiting remobilization and making a direct anterior exposure above the L5–S1 level difficult if not impossible to achieve safely. Anterolateral approach strategies can be more safely achieved at L4–L5 and above, but may require vertebral osteotomy in order to remove a keeled prosthesis. Successful conversion to a fusion with implant removal can be achieved, even when osteotomy is needed for implant removal. This Grand Rounds case presentation involves an unusual late retroperitoneal abscess following two-level TDR with direct extension to one of the implants, and the subsequent nonoperative and operative management. Removal of a well-fixed keeled implant at the L4–L5 level following nonoperative treatment of a surrounding retroperitoneal abscess and conversion to fusion represents close to, if not a 'worst-case' scenario for revision TDR. However, with proper preoperative planning and surgical experience, a safe and successful procedure can be the end result.

Keywords Lumbar disc arthroplasty · Anterior lumbar revision surgery · Prodisc-L · Late Infection

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Introduction

Lumbar total disc arthroplasty (TDA) for the treatment of discogenic low back pain has been shown to relieve pain and restore function while maintaining segmental motion in randomized clinical trials [1–4]. Advantages of TDA over spinal fusion include restoring or maintaining segmental range of motion, allowing for natural segmental alignment, and the potential for limiting adjacent-segment degeneration commonly seen following fusion. Currently available implants in the US involve a direct anterior approach for placement of the prosthesis, although other implants are currently available and in development for placement through other directions of approach.

The main disadvantage of lumbar TDA, especially those placed through a direct anterior approach, is the difficulty of the revision approach to the anterior lumbar spine, especially at the L4–L5 level, due to scarring and adherence of the overlying vessels following their mobilization for the index procedure. Several recent reports have focused on revision strategies for accessing a lumbar total disc prosthesis [5–9]. Prostheses with a sagittal keel pose an additional challenge for removal when needed,

potentially requiring a partial vertebral osteotomy if direct anterior exposure cannot be achieved. The Prodisc-L prosthesis (Synthes Paoli, PA) is composed of a polyethylene inlay with surrounding cobalt–chrome–molybdenum (CoCrMo) endplates which are coated with a plasma-sprayed titanium alloy designed to facilitate bone incorporation to the components. This second generation Prodisc has a single central keel on each endplate that provide immediate rotational stability and facilitates bone on growth [10].

Our institution was part of the US FDA multicenter, prospective randomized trial comparing Prodisc-L with circumferential fusion in patients with one and two-level discogenic disc disease. This study uses validated standardized functional scales such as the visual analog scale (VAS), Oswestry disability index (ODI), and Short Form Health Survey (SF-36). These studies attempt to quantify the impact of a disease on the performance of common daily activities. These functional scales were obtained at specific pre-operative and post-operative points in time. Our data have been published independently as well as collaborated with multiple centers. Infection of a TDA is very uncommon and not previously reported. As such, evidence-based treatment algorithms have yet to be developed. However, all mobile joint replacements in the body have some incidence of late infection, and are generally treated by removal and either secondary exchange arthroplasty or joint fusion. Although there is no standard algorithm for approaching an infected spinal implant, there are trepidations regarding repeat surgical approaches to the anterior spinal column. Several papers describe revision strategies for accessing a total disc prosthesis [5–9]. These studies highlight avoiding repeat access into the abdomen and if necessary altering the approach to attempt to minimize mobilizing scarred vessels. The presence of a keel as part of the prosthesis is an additional consideration for removal.

In this Grand Rounds, we present a case of late infection of a keeled-TDA and its treatment, including implant removal and fusion.

Case presentation

The patient is a 35-year-old male who underwent an uncomplicated two-level TDA L4–L5, L5–S1 as part of FDA-approved continued access following enrollment completion of the two-level arm of the Prodisc-L multicentered IDE study (Fig. 1). His anterior access was via a left retroperitoneal approach using a transverse incision curved cephalad at its left extent. No anti-adhesion barriers were used. His recovery from surgery was uneventful, and he had returned to work as a mechanic 6 months after surgery with a 44% improvement in his ODI and

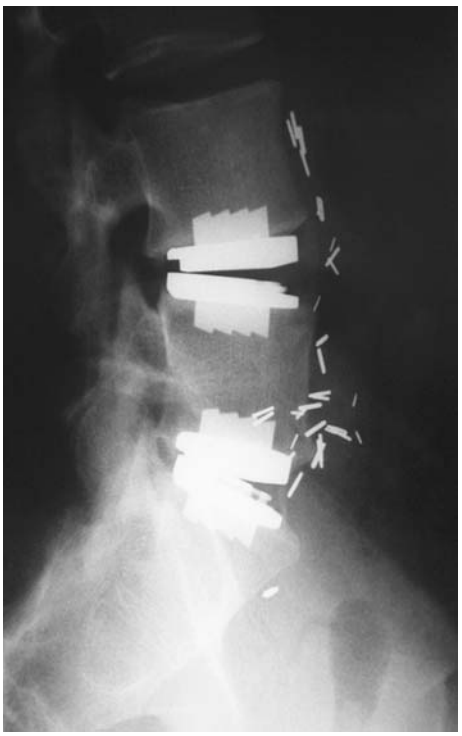

Fig. 1 Nine months following Prodisc-L TDA L4–L5 and L5–S1 levels

improvements in both VAS back and leg pain scores. He presented again 8 months after surgery complaining of severe, sharp back, abdominal, and left thigh pain of acute onset. He was febrile to 102 with complaints of nausea and vomiting, and had not moved his bowels for the preceding 8 days. There was no history of any recent skin, respiratory tract, or genitourinary infections. Pertinent laboratory values on admission included a leukocytosis of 16.2, erythrocyte sedimentation rate (ESR) of 101, and a C-reactive protein of 301. A left psoas-based retroperitoneal abscess was diagnosed by CT scan (Fig. 2), and it was percutaneously drained by the interventional radiologists. 150 cc of purulent exudate was evacuated and sent for culture and sensitivity, and a pigtail catheter was left in situ until there was no drainage for two consecutive days. Prior to catheter removal, the abscess cavity was injected with contrast and found to communicate with the nearby L4–L5 prosthesis only (Fig. 3). Cultures from the blood revealed *Staphylococcus aureus* and his abscess cultured *Streptococcus intermedius*. Following abscess drainage, he experienced 85% relief of his symptoms and his ESR improved to 45. He was discharged on post hospital day 15 with a PICC line and appropriate IV antibiotics. He received a 6-week course of IV antibiotics followed by oral suppressive antibiotics and all blood work inflammatory markers normalized with a white blood cell count of 6.6; ESR was 17 and C-reactive protein reduced to 0.5. His severe abdominal pain improved, but low back persisted.

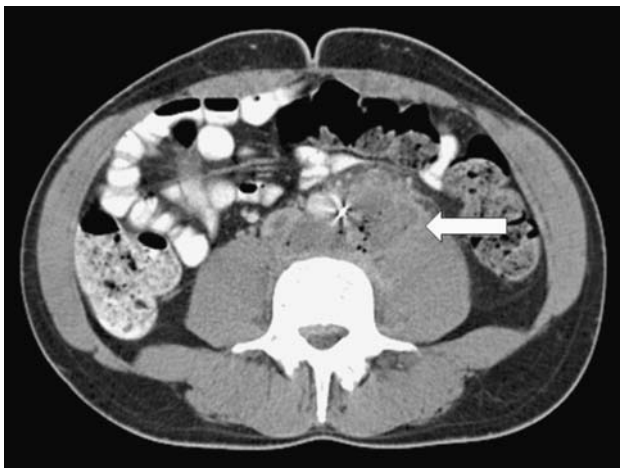

Fig. 2 CT scan showing left psoas abscess at the L4–L5 disc level (*arrow*)

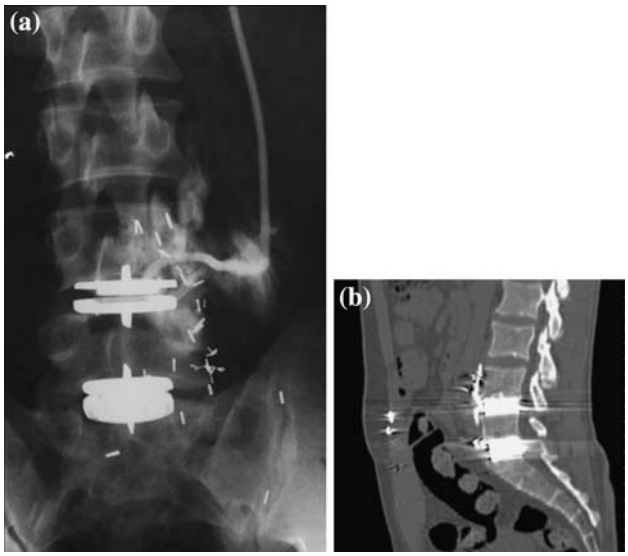

Fig. 3 Dye injection study following percutaneous abscess drainage and pigtail catheter insertion (**a** AP radiograph, **b** CT scan reconstruction, both following dye injection). The abscess cavity is seen communicating only with the L4–L5 disc level

The initial treatment recommended to the patient consisted of suppressive antibiotics for 4–6 months followed by close observation and blood tests to monitor for recurrence of infection. The patient had a strong desire to have both of his implants removed and converted to a fusion. He understood the added risks of a revision anterior procedure and also the fact that the L5–S1 level was not felt to be involved with the infection.

Rationale for treatment and review of the literature

Revision surgery in the anterior lumbar spine has become more common in recent years, mainly due to the increase in anterior lumbar fusion surgery in general and the surgical treatment of adjacent-segment disease. Typically in this scenario, the adjacent segment can be fairly easily approached from more normal tissue planes above or below, and direct lateral or anterolateral approaches can utilized as well. Direct anterior approach even of adjacent segments can still be difficult due to vessel scarring, making adjacent segment TDR difficult. Implants designed for placement via anterolateral and lateral approaches can make placing adjacent segment TDRs much less technically demanding and decrease overall operative risk.

A number of authors have described repeat surgical approaches to the anterior spine when revising or removing a total disc prosthesis. In 2005, Bertagnoli et al. [9] discussed a strategic approach to TDA by suggesting a right-sided approach for the index surgery. This was suggested in consideration of the potential need for a revision procedure which could more easily be approached from the left. We commonly perform all index L5–S1 approaches from the right side for this same reason. He also suggested insertion of an anti-adhesive membrane between the prosthesis and the great vessels during the primary surgery. Though other experts have suggested this as well, no good evidence exists to support this additional cost. It was also suggested in this review that due to the high vascular risk in anterior revision surgeries they should only be performed in specialized spine centers with a large experience in anterior approaches. We agree and have reported similar conclusions [11].

In 2006, McAfee [6] attempted to quantify the rate of revision anterior exposures following a multicenter study of the Charite prosthesis. In this study, the authors also reported that the anterior approach was abandoned in 8% of the patients due to the inability to mobilize the great vessels. They also reported a 16.7% rate of vascular injuries during the anterior revisions.

Wagner et al. [5] reported on their series of revising the Charite disc prosthesis. In their series of 21 patients, 2 out of the 3 patients had a staged removal of the prosthesis at the two levels. The authors recommended that revision approaches be performed through an alternate approach unless performed within 2 weeks of the index procedure. They suggested a contralateral retroperitoneal approach for L5–S1 and a transpsoas or lateral approach from either the right or left side for the L4–L5 level.

Patel et al. [7] published a literature review of revision strategies. They also reported on the vascular as well as ureteral injuries which can occur during this revision approach. The authors also highlighted consideration of an adhesion barrier between the implant and the great vessels may help minimize these complications.

Removal of a keeled prosthesis such as the Prodisc-L poses an additional surgical consideration as compared to a

nonkeeled device, such as the Charite (Depuy Spine). A direct anterior exposure is optimal, and more readily achievable at L5–S1. However, at other levels, especially L4–L5, it is often difficult if not impossible to safely achieve because the retraction of the vessels may be impossible or dangerous. At these levels, we prefer to approach anterolaterally with psoas retraction as needed, and can remove even well-fixed prostheses with a small controlled osteotomy that is easily reconstructable. The modular nature of the Prodisc-L is helpful in this approach, with removal of the polyethylene core first making subsequent endplate removal straightforward. Removal of two-piece implants inserted en-block initially, such as the Maverick (Medtronic) and Flexicore (Stryker Spine) may be more difficult as they need to be removed en-block as well.

There is a lack of data regarding management of an infected disc arthroplasty. Lumbar disc arthroplasties are similar in structural composition to a total joint prosthesis. There is a theoretical similarity in adhesion properties of the bacteria. Basic science studies show local factors such as the materials surface composition and characteristics, the bacteria's ability to elaborate a protective polysaccharide coating, and the medium's composition have been reported to affect bacterial antibiotic sensitivity and host defense systems [12]. However, the environment of the intervertebral disc is not necessarily comparable to that of a peripheral synovial joint [13]. The role of prolonged oral immunosuppressive antibiotics is not well investigated. One review article suggested that antibiotics in the presence of an infected TDA is unlikely to be of any long term value [14]. This article cautioned against debridement and replacing additional instrumentation near the infected site and suggested bone grafting and posterior instrumentation about 1 week after the prosthesis removal and debridement operation.

Treatment

As the patient insisted to have both his TDR removed and replaced and after thorough discussion and informed consent, decision was made to remove the total disc replacement at the two levels.

The patient was revised at 5 months following presentation of the infection, or 13 months following his index TDR surgery.

The revision anterior surgery was performed with the patient positioned supine on a radiolucent flat operating table. His anterior lower abdomen was widely prepped and draped exposing the pubic symphysis to the xyphiod process. No preoperative stenting of the ureter or vessels was utilized, but a vena cava filter was placed prophylactically before the day of surgery. Separate incisions were used for the two levels reapproached. For L4–L5, a new oblique left anterolateral incision was used, with L4 vertebral access achieved beginning in more normal tissue cephalad and then developed caudally to the L4–L5 disc space. The anterior vessels were not able to be mobilized safely, so an anterolateral disc space approach was continued with lateral retraction of the left psoas muscle. Bursal tissue and the anterolateral annulus were removed, exposing both metallic endplates; 4 mm of the inferior L4 vertebra was removed with an osteotome, exposing the keel centrally. A disc spreader was used to tilt the superior endplate into the bony defect, exposing the polyethylene insert. The insert was removed piecemeal, creating enough space to easily free the endplates into the central portion of the disc and remove them. The disc space defect was then grafted with a fresh frozen femoral shaft allograft step-cut cephalad to fill the osteotomy defect (Fig. 4c). Infuse-BMP2 was placed within the graft, which was held in position with a 6.5 mm screw and washer.

The L5–S1 level was then approached using the original Pfannenstiel incision from in the index procedure. A right-sided retroperitoneal approach was attempted, but significant lateral adhesions required conversion to a transperitoneal approach. Once dissection was carried down to the disc space, the anterior bursal tissue was removed

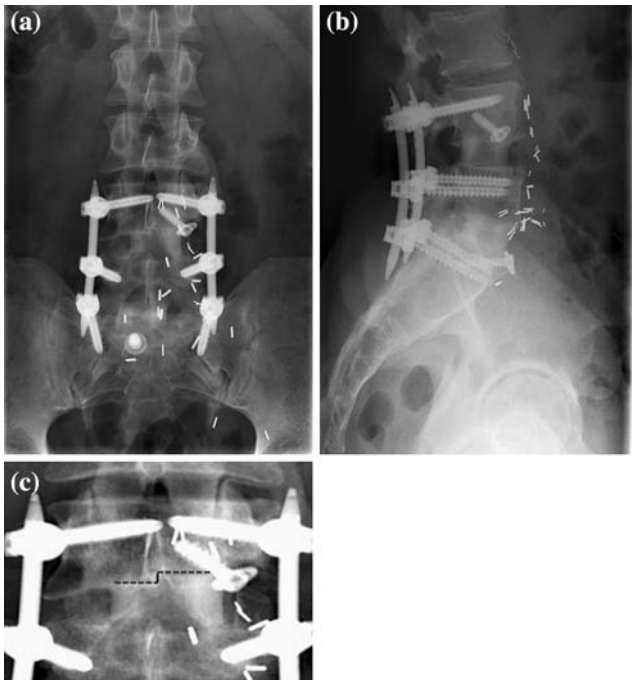

Fig. 4 AP (**a**) and lateral (**b**) radiographs showing solid fusion 1 year following the revision surgery. **c** Close-up view that shows in *dotted lines* the step-off cut of the allograft that matches the resection of the inferior end plate of L4 to get access to the keel from the lateral approach

exposing the disc directly anterior. Removal of the implant began with dissociation and removal of the polyethylene insert. The endplates were freed of bony attachments using a thin osteotome, delivered easily into the disc space, and removed. A fresh femoral allograft was cut to fit the disc space, packed with Infuse-BMP2, inserted, and fixated using a 6.5 mm screw and washer. At both disc space levels, the endplates were well fixated to bone without any sign of active infection. Intraoperative cultures taken at both levels were negative. Following the dual anterior approaches, percutaneous posterior pedicle fixation was performed (Fig. 4). Overall, the reoperation was uneventful.

Outcome of surgery

The patient is currently 4 years following the revision surgery with an excellent fusion of L4–S1 and no sign of recurrence of infection. He has persistent retrograde ejaculation that happened after the revision surgery. He has some persistant low back pain with an ODI down to 42 (was 64 before the index surgery).

Conclusion

To our knowledge, this is the first report of deep TDA infection in the lumbar spine. Although a late presentation, we believe this was an acute infection as there was no bony erosion seen on plain films or CT scan. While the infection seemed to improve clinically with percutaneous drainage and intravenous antibiotics, explantation was performed in accordance with patient wishes and was successfully converted to a two-level fusion. Special consideration must be given to the removal of a keeled prosthesis from a nondirect anterior approach, but explantation and conversion to fusion is certainly achievable. Despite his postoperative retrograde ejaculation, our patient did experience subjective as well as objective improvement in his pain symptoms following surgical removal of the prostheses and conversion to a successful solid fusion.

Conflict of interest statement Dr. Spivak is a paid consultant of Synthes Spine (since US Prodisc-L approval) serving as a member of the Prodisc teaching faculty. Dr. Petrizzo has no relevant conflicts.

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