Vertebral body split fracture after a single-level cervical total disc replacement

Case report

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Cervical total disc replacement (TDR) is a viable option for the surgical treatment of degenerative disc disease. This 67-year-old nonsmoking male patient underwent single-level ProDisc-C cervical TDR at C5–6 without any intraoperative problem. His radicular pain improved and he had no neck pain immediately after the operation. However, on postoperative Day 3, a radiograph demonstrated a vertical split fracture of the C-5 vertebra. This fracture was managed conservatively, and 2 years postoperatively a follow-up CT scan demonstrated stable device position and fusion of the fracture. Although the linear fracture caused no neurological symptoms or device migration, the authors advocate prudence in selection and installation of keel-design prostheses, even in a single-level cervical TDR scenario. (DOI: 10.3171/2011.11.SPINE11210)

Key Words • split fracture • cervical spine • total disc replacement • arthroplasty

Cervical TDR has recently been regarded as an alternative surgical treatment for degenerative disc disease. Compared with the standard ACDF, cervical TDR preserves segmental motion, and the theoretical potential to decrease adjacent-segment disease is thus anticipated. Randomized controlled clinical trials of a number of cervical TDR devices, with a maximum follow-up duration of 5 years, have been published.2–4,6,8–11,13 These trials all concluded that cervical TDR is a safe and effective alternative to ACDF for single-level cervical spondylolisthesis. However, the actual long-term results, adverse reactions, and device-related complications have been less frequently reported, and in reports that have covered long periods the theoretical advantage of a reduced risk of adjacent-segment disease has not been proven.1,12,15,16 Furthermore, each device has its unique biomechanical design, material features, and insertion technique, requiring surgical expertise to achieve optimal outcome. Device-specific complications certainly exist, but seldom have they been reported. As the TDR procedure is now common, surgeons should be cautioned about each of the complications. This is the first report of a vertebral split fracture after a single-level cervical TDR.

Case Report

Presentation and Examination. This 67-year-old nonsmoking male patient presented with soreness and numbness in his shoulders and arms bilaterally, with the right side worse than the left. His condition had been managed conservatively with medical treatment for 6 months, but had responded only partially. He had no other systemic diseases such as hypertension, diabetes, osteoporosis, or malignancy. Upon physical examination, the flexion and extension strength of his right elbow was noted to be mildly diminished. There were no Hoffman signs or abnormal deep tendon reflexes of the 4 extremities, including knee and ankle jerks, demonstrating normal active responses on both sides equally. Both CT and MR imaging demonstrated severe spondylotic changes at the C5–6 level.
with marked sclerotic change of the C-5 inferior endplate (Figs. 1 and 2). Bulging disc and spur formation caused severe canal and bilateral foraminal stenosis with compression of the C-6 nerve roots. Similar radiographic findings were demonstrated at the C4–5 and C6–7 levels, but they were milder and did not correlate with the patient’s symptoms. Therefore, we recommended anterior cervical discectomy and disc replacement at C5–6.

**Operation.** The surgery followed the established specific instructions for ProDisc-C (Synthes). After standard anterior discectomy of the C5–6 disc and decompression of the osteophytes under microscopic visualization, a trial implant of size L (depth 14 mm, width 17 mm) with 5-mm height was found to best fit the intervertebral space. The slots for keels were created with a keel-cutting chisel, followed by a box-cutting chisel. The endplate preparation procedures went smoothly under intraoperative fluoroscopic guidance, without any abnormal tactile sensations or need for any excess force during the keel cutting. Subsequently, the ProDisc-C, of the same size profile as the optimal trial implant, was inserted. Gentle tapping was exerted until the desired position, confirmed by fluoroscopy, was attained with reasonable tightness. The position of the device and its stability were double-checked by fluoroscopy. The entire surgery was uneventful. Stepwise intraoperative monitoring of anteroposterior and lateral fluoroscopic images demonstrated no abnormalities. No fracture line was observed under gross inspection, or even in the intraoperative coronal images. Routine wound closure was applied with a drainage catheter left in place. The patient awoke without any neurological deficit.

**Follow-Up.** The preoperative symptoms of C-6 radiculopathy improved after the operation, and the patient was satisfied. However, an anteroposterior radiograph obtained on postoperative Day 3 indicated a 1-mm-wide linear lucency in the C-5 vertebral body along the central keel of the artificial disc. This finding was confirmed by CT as a vertical split fracture of the C-5 vertebral body (Fig. 3). The patient had no neck pain or related symptoms, and dynam-
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Vertebral body fracture was confirmed by CT scan 2 years postoperatively (Fig. 4).

Discussion

This is the first report in the literature of a vertically splitting vertebral body fracture after a single-level cervical TDR. In 2007, however, Datta et al.7 did report a case of intraoperative vertebral split fractures during “multilevel” cervical TDR with ProDisc-C. Multilevel ProDisc-C insertion inherently increases the risk of vertebral splitting because the middle vertebral body is chiseled both superiorly and inferiorly for the central keels. The case reported by Datta et al. involved a 34-year-old woman who underwent a 2-level cervical TDR at C5–7; the fractures were found by inspection during the operation and were managed conservatively, with acceptable outcomes. In our study, the vertebral body split occurred postoperatively in the vertebral body above the stand-alone ProDisc-C device.

In lumbar TDR, this undesired vertical vertebral splitting was reported only once in a patient who received the ProDisc-L (Synthes).14 The ProDisc-C, specifically manufactured for the cervical spine, is a miniature version of the ProDisc-L, which is manufactured for the lumbar spine, and the devices share the common design element of large central keels. Theoretically, the primary stability is enhanced by the distinct design of central keels to be fitted into the prechiseled slots in the vertebral bodies. According to this case report, the beneficial stability provided by the keel design might be undermined by a weakening of the vertebral body integrity, which could increase the risk of a vertical split fracture.

The true cause of this fracture is uncertain, but it is reasonable to infer that the disruption of endplate integrity for the keel by the chiseled slot is a factor. Also, in Oriental patients, lower vertebral body height could cause the chiseled slot to be proportionally more disruptive of the vertebrae. Excessive force conveyed via a dull osteotome could also account for such a fracture. Shim et al.15 reported posterior avulsion fractures of the adjacent vertebral bodies that occurred during chiseling procedures in cervical TDR with ProDisc-C. Such a potentially catastrophic event was directly related to the chiseling procedures for the central keel–design prosthesis. Excessive attempts to insert the box-cutting chisel beyond the predetermined depth resulted in the fractures. Consequently, the authors advocated that if the depth of the slot is not sufficient for the prosthesis, a keel-cutting chisel rather than a box-cutting chisel should be employed.

Several precautions could be taken to decrease the risk of these vertebral split fractures. First, patients with poor bone quality or low vertebral body height are not appropriate candidates for this kind of keeled artificial disc. This caveat reflects an inherent limitation of an artificial disc with such keel design. Second, a markedly sclerotic endplate, which requires excessive force to create the slot with the chisel, requires special attention. Care must be taken not to disrupt the bony strength while creating the slot. A sharp chiseling instrument should be used to prevent the need for forceful mallet impaction. Third, avoiding the use of the retraction post can minimize vertebral body disruption and the risk of continuous fracture extension from the chiseled slot. If the retraction post is required for decompression, it could be inserted in a different sagittal plane from the central keel to prevent excessive inline weakening of the vertebral body. Furthermore, only mild distraction should be applied while inserting the trial, chisel, or prosthesis to decrease the force exerted on the vertebrae.

Although the keel design of the artificial disc contributed to this complication, patient selection might have played an equal or even greater role. The patient was not a smoker and had no risk factors for osteoporosis, but there was no preoperative documentation of bone mineral density. Selection of appropriate indications is the cornerstone of a successful cervical TDR. The commonly accepted indication for cervical arthroplasty includes symptomatic 1- or 2-level cervical disc disease in patients in whom nonsurgical management has failed. Those who are relatively
poor candidates include patients who have cervical spondylosis with incompetent facets, immobile intervertebral discs (due to osteophytes and autofusion), osteoporosis (poor bone quality), trauma with ligamentous or facet injury, and kyphotic deformity. The typical candidate for a single-level cervical TDR is a young patient with soft disc herniation and normal facet joints. Given the uncertain benefit with respect to preservation of motion in elderly patients with advanced cervical spondylosis, the risk and management of complications of cervical TDR must not be overlooked. For instance, an instrumented ACDF rather than TDR could have spared our patient the need to wear a collar for 3 months and take teriparatide.

In the present report, the split vertebral fracture was found on postoperative Day 3 without evidence of instability (on dynamic radiographs). Therefore the case was managed conservatively, and the patient wore a neck collar for 3 months. If there had been any signs of instability (for example, kyphosis) or dislodgement of the device during follow-up, we would have suggested instrumented fixation and fusion (that is, an instrumented ACDF or a cephalad cervical vertebral corpectomy and reconstruction).

The aim of this report is not to undermine any specific device, but to provide practical information related to the use of such central keel–design prostheses. Although the current outcome, at 2 years’ follow-up, appears acceptable, we do not know if there will be longer term adverse effects. As the frequency of cervical TDR increases, more attention is necessary to address related adverse events, which might also be expected to increase.

Conclusions

A vertebral split fracture occurred in our patient after a single-level cervical TDR and was managed conservatively with an acceptable outcome at 2 years’ follow-up.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Fig. 4. Follow-up images obtained 2 years after surgery. A and B: Lateral dynamic flexion (A) and extension (B) radiographs demonstrating preserved segmental motion at C5–6 without instability. C: Anteroposterior radiograph demonstrating blurring edges of the fracture line, which indicate bone fusion. D and E: Axial CT image (D) of the C-5 inferior endplate and a coronal CT image (E) of the cervical spine demonstrating bridging bone formation (black arrowheads) at the fracture line, which confirms healing.
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Author contributions to the study and manuscript preparation include the following. Conception and design: Ko, Tu, Wu. Acquisition of data: Ko, Tu, Wu, Fay. Analysis and interpretation of data: Ko, Tu, Wu, Fay. Drafting the article: Ko, Tu, Wu. Critically revising the article: Ko, Wu, Huang, Cheng. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Ko. Administrative/technical/material support: Wu, Huang, Cheng. Study supervision: Wu, Huang, Cheng.

References