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Clinical Study

Clinical and radiologic comparison of dynamic cervical implant arthroplasty and cervical total disc replacement for single-level cervical degenerative disc disease

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ABSTRACT

Anterior cervical discectomy and fusion, to date the most successful spine procedure for the surgical treatment of cervical radiculopathy, has limitations that have led to the development of non-fusion cervical procedures, such as cervical total disc replacement (TDR) and dynamic cervical implant (DCI) arthroplasty. We compared the clinical and radiological results of DCI and cervical TDR for the treatment of single-level cervical degenerative disc disease in Chinese patients. A retrospective review of 179 patients with cervical spondylotic myelopathy who underwent DCI or TDR between April 2010 and October 2012 was conducted, and 152 consecutive patients (67 patients single-level DCI and 85 single-level TDR) who completed at least 2 years of follow-up were included. Clinical and radiological assessments were performed preoperatively and at 1 week and 3, 6, 12, and 24 months postoperatively. The most common operative level was C5/C6 (49.3%). The differences in blood loss, duration of surgery, and duration of hospitalization were not statistically significant. The Japanese Orthopaedic Association scale, Visual Analog Scale, Neck Disability Index, and Short Form-36 scores improved significantly after surgery in both the DCI and TDR groups ($P < 0.05$), but the differences were not statistically significant at the final follow-up. The rate of occurrence of heterotopic ossification was 22.4% and 28.2% in the DCI and TDR groups, respectively. As an effective non-fusion technique, DCI is a more economical procedure. Further prospective, randomized studies with long-term follow-up periods are needed to determine the long-term effects.

1. Introduction

Anterior cervical discectomy and fusion (ACDF) is to date the most successful spine procedure for the surgical treatment of cervical radiculopathy. However, ACDF increases motion and intradiscal pressure at adjacent segments [1–3]. It has been reported that as a consequence of ACDF, the rate of adjacent segment degeneration (ASD) is between 2.9% and 8.0% per year [3–5]. The limitations associated with ACDF have led researchers to develop motion-preserving techniques. As the most common of the cervical non-fusion techniques, cervical total disc replacement (TDR) arthroplasty provides good range of motion (ROM) in the cervical spine. But in the TDR technique, high axial strength, low flexibility, and concussion buffering may lead to heterotopic ossification (HO) and spontaneous fusion around the treated segment [6–9].

The first generation of dynamic cervical implant (DCI) was designed by Matgé in 2002. The second generation was developed by Paradigm Spine (New York, NY, USA) in 2005 and has been used in clinical practice since 2008. From April 2010 to October 2012, DCI and TDR arthroplasty were performed in 152 patients at our institution. The objective of this study was to compare the clinical and radiological results of DCI replacement and cervical TDR for the treatment of single-level cervical degenerative disc disease. To our knowledge, this is the first study to report on the incidence of adjacent level disease and HO in DCI, and compared it with cervical TDR. In addition, we believe this review is the largest comparison study between single-level DCI and TDR in Asian patients.

2. Materials and methods

2.1. Patient population

From April 2010 to October 2012, 179 patients with cervical spondylotic myelopathy (CSM) underwent DCI or TDR at a single level. Out of these patients, 152 who had at least 2 years of

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follow-up were included in this study (67 single-level DCI and 85 single-level TDR). There were 38 men and 29 women in the DCI group, and 37 men and 48 women in the TDR group. The mean age was 42.6 years and 46.3 years in the DCI and TDR groups, respectively (Table 1). Fifty-eight patients had radiculopathy and 94 patients had myelopathy. All patients were evaluated using static and dynamic radiographs, CT scans, and MRI. Cervical lateral radiographs were obtained at scheduled time points before and after surgery. HO was classified according to the McAfee classification [10]. Degeneration of the adjacent unfused segment was assessed using the Goffin score [4]. All patients were evaluated using a Japanese Orthopaedic Association (JOA) scale, Visual Analog Scale (VAS), Neck Disability Index (NDI), and the Short Form-36 (SF-36) before surgery. Radiological investigations were performed at 1 week and 3, 6, 12, and 24 months postoperatively.

2.2. Inclusion criteria

The inclusion criteria were patients aged between 18 and 60 years with radiculopathy or myelopathy from single-level cervical disc herniation (C3–C7), which was confirmed using CT scans and MRI, and had not responded to non-operative treatment for at least 3 months.

2.3. Exclusion criteria

Absolute contraindications included infection, trauma, loss of disc height >50%, marked reduction or absence of intervertebral motion, abnormal alignment and instability, ossification of the posterior longitudinal ligament, severe spondylosis, metal allergy, and previous cervical spine surgery.

Relative contraindications included use of preoperative corticosteroids, and presence of ankylosing spondylitis, osteoporosis, rheumatoid arthritis, pregnancy, diabetes mellitus, and cancer.

2.4. Surgical technique and postoperative management

The surgical techniques for arthroplasty and fusion surgeries have been described in detail in previous publications. The surgical technique included the use of a conventional anterior cervical approach and discectomy. All procedures were performed through a transverse skin incision on the right side of the neck. Discectomy and decompression were performed using a surgical approach similar to previous publications [11–13]. The Luschka joints were preserved if possible. To reduce the formation of new bone at bleeding sites, soft tissue bleeding was meticulously controlled, and damaged bone was covered with bone wax. The posterior longitudinal ligaments were completely removed only when they were found to be torn preoperatively.

2.4.1. DCI group

An implant from Scient'x (Villers-Bretonneux, France) was used. After decompression, the model was tested using the DCI-specific tool under fluoroscopy, by placing a matching DCI model in the intervertebral space. The distance between the anterior/posterior edge of the DCI and the vertebral body endplates was controlled to be within 2–3 mm, and the lateral boundary of the DCI was not allowed to exceed the Luschka joints.

2.4.2. TDR group

The arthroplasty group used a Prestige LP device (Medtronic Sofamor Danek, Memphis, TN, USA). After decompression, appropriate-sized trials were placed into the disc space intraoperatively to determine the appropriate implant footprint, disc height, and position. Templates of various sizes were selected and placed in the intervertebral space until the size of the prosthesis and location of the implantation were satisfactorily determined under C-arm guidance. Then, the prosthesis of appropriate size was implanted into the intervertebral space. Surgeries were performed under fluoroscopic guidance. The major difference between the two surgical techniques was that TDR requires grinding of the upper and lower endplates so that they are parallel to each other. Because there is an arc in the DCI design, a suitable prosthesis can be selected after mould testing, and the upper and lower endplates do not require grinding to be made parallel to each other. In addition, DCI uses its upper and lower back teeth to achieve initial stability and does not need a slot in the endplate, so the operation is relatively simple.

Table 1
Demographics and surgical data of patients undergoing dynamic cervical implant arthroplasty and cervical total disc replacement for single-level cervical degenerative disc disease

	DCI group	TDR group	*P* value
Number of patients	67	85	
Age (mean ± SD, range, years)*	42.6 ± 9.6 (38–58)	46.3 ± 8.2 (41–60)	0.351
Male	56.7%	43.5%	0.106
Operated level			0.794
C3/C4	7	8	
C4/C5	28	33	
C5/C6	37	38	
C6/C7	5	6	
Follow-up (mean, months)	42.7 (36–51)	46.1 (36–54)	0.647
BMI*	25.7 ± 5.6	26.8 ± 5.2	0.393
Smoking status (n,%)			0.698
Never	31 (46.2)	44 (51.7)	
Former	17 (25.5)	16 (18.8)	
Current	19 (28.3)	25 (29.5)	
Alcohol status (n,%)			0.892
Never	36 (53.7)	51 (60.0)	
Former	25 (37.3)	18 (21.1)	
Current	6 (9.0)	16 (18.8)	
Intake of NSAID for >3 months	34	42	0.870
Duration of surgery (minutes)*	55.7 ± 13.3	58.1 ± 12.6	0.469
Loss of blood (mL)*	55.3 ± 12.8	59.7 ± 13.0	0.714
Duration of hospitalization (days)*	7.3 ± 2.8	8.4 ± 3.6	0.827
Total cost of hospitalization (RMB:¥)*	55,372 ± 2170.6	77,994 ± 2609.4	<0.001

* Data is given as mean ± SD.

BMI = body mass index, DCI = dynamic cervical implant (Scient'x, Villers-Bretonneux, France), NSAID = non-steroidal anti-inflammatory drug, RMB = Chinese Yuan, TDR = total disc replacement (Prestige LP, Medtronic Sofamor Danek, Memphis, TN, USA).