Journal of Clinical Neuroscience 21 (2014) 942–948

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Clinical Study

Clinical and radiologic comparison of dynamic cervical implant arthroplasty versus anterior cervical discectomy and fusion for the treatment of cervical degenerative disc disease

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ARTICLE INFO

Article history:
Received 1 July 2013
Accepted 12 September 2013

Keywords:
Adjacent segment degeneration
Anterior cervical discectomy and fusion
Cervical degenerative disc disease
Complications
Dynamic cervical implant
Surgical outcome

ABSTRACT

This study compared the clinical and radiological outcomes of dynamic cervical implant (DCI; Scient'x, Villers-Bretonneux, France) arthroplasty *versus* anterior cervical discectomy and fusion (ACDF) for the treatment of cervical degenerative disc disease. This prospective cohort study enrolled patients with single-level cervical degenerative disc disease who underwent DCI arthroplasty or ACDF between September 2009 and June 2011. Patients were followed up for more than 2 years. Clinical evaluation included the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36), Neck Disability Index (NDI), Japan Orthopedic Association (JOA) score, and visual analog scale (VAS) scores for neck and arm pain. Radiological assessments included segmental range of motion (ROM), overall ROM (C2–C7), disc height (DHI), and changes in adjacent disc spaces. The VAS, SF-36, JOA, and NDI scores improved significantly after surgery in both the DCI and ACDF groups. The VAS, JOA, and SF-36 scores were not significantly different between the DCI and ACDF groups at the final follow-up. The segmental ROM at the treated level and overall ROM increased significantly after surgery in the DCI group, but the ROM in the adjacent cephalad and caudal segments did not change significantly. The mean DHI at the treated level was significantly restored after surgery in both groups. Five patients (12.8%) in the DCI group showed new signs of adjacent segment degeneration. These results indicate that DCI is an effective, reliable, and safe procedure for the treatment of cervical degenerative disc disease. However, there is no definitive evidence that DCI arthroplasty has better intermediate-term results than ACDF.

1. Introduction

The anterior approach to surgical treatment of cervical degenerative disease was first described by Robinson and Smith and popularized by Cloward in the 1950s. Currently, anterior cervical discectomy and fusion (ACDF) is considered to be the definitive surgical treatment for symptomatic, single-level, cervical degenerative disc disease (DDD). Many studies have reported that ACDF is highly effective in terms of resolving symptoms, improving nerve function, and restoring the physiological curvature of the cervical spine [1–4]. However, fusion alters the normal biomechanics of the spine, which may result in acceleration of adjacent segment degeneration (ASD) and a need for subsequent reoperation. Limitations and problems with ACDF have led some investigators to explore motion-preserving procedures such as artificial cervical disc arthroplasty [5–8]. In recent years, dynamic or non-fusion stabilization of the cervical spine has attracted attention as a possible treatment for cervical DDD [9–11].

The dynamic cervical implant (DCI; Scient'x, Villers-Bretonneux, France) is a new device designed to achieve anterior decompression without cervical fusion, and is mainly used to treat cervical DDD (Fig. 1) [12]. The first generation DCI products were developed in 2002, but the clinical efficacy of these products has not been reported. Paradigm Spine (New York, NY, USA) made improvements to the first generation products in 2005, and the second generation DCI products have been used in clinical practice since 2008. Three heights and four models are available. The main features of the device are as follows: (1) implantation does not result in the generation of debris; (2) it fits well on the vertebral endplate, resulting in immediate postoperative stability; (3) placement is relatively non-invasive, thereby avoiding heterotopic ossification; (4) it maintains the height of the intervertebral gap; (5) the

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http://dx.doi.org/10.1016/j.jocn.2013.09.007

Fig. 1. Photograph showing the dynamic cervical implant (Scient'x, Villers-Bretonneux, France).

axial compliance and ability to absorb vibrations can avoid accelerated degeneration of the intervertebral discs of the adjacent segments; and (6) the inverted teeth on the leading edges are embedded in the upper and lower vertebral bodies to achieve axial stability and reduce the tension and pressure forces during flexion and extension of the neck. The device results in some limitation of rotation and translation, thereby preventing further degeneration of the small joints. DCI arthroplasty has developed over the last two decades to enable normal motion and preserve biomechanics in an attempt to overcome the disadvantages of fusion, while providing sufficient stability to restore normal segmental kinematics, control abnormal motion, enable greater physiological load transmission, and reduce or eliminate ASD. DCI arthroplasty could potentially replace cervical fusion for the treatment of selected patients with cervical DDD.

From September 2009 to June 2011, we performed resection of the anterior cervical intervertebral discs and DCI arthroplasty in 39 patients. To our knowledge, this is the first reported study of clinical and radiological outcomes in patients who underwent DCI arthroplasty for cervical DDD. The aims of this study were to compare the safety and efficacy of DCI arthroplasty *versus* ACDF in patients with single-level cervical DDD by evaluation of the clinical and radiological data, and to assess the role and limitations of DCI arthroplasty for the treatment of cervical DDD.

2. Materials and methods

2.1. Patient population

This prospective cohort clinical trial compared ACDF and DCI arthroplasty. The study included 86 consecutive patients who underwent surgery for single-level cervical DDD by a single surgeon in our spine surgery center. Five patients were excluded because their 1 year follow-up data were incomplete. All patients were diagnosed based on preoperative radiograph, CT scan and MRI findings.

All patients were older than 18 years and had single-level symptomatic DDD between C3 and C7 with intractable radiculopathy or myelopathy. Thirty-nine patients (48.2%) had radicular pain, 18 (22.2%) had myelopathy, and 24 (29.6%) had both radiculopathy and myelopathy. Most patients had a history of incapacitating neck and arm pain lasting longer than 6 weeks which was unresponsive to non-surgical management such as physical therapy and anti-inflammatory medication, or had a new neurological deficit resulting from myelopathy. The exclusion criteria were ossification of the posterior longitudinal ligament, severe facet arthritis, lack of motion or instability at the level of surgery, narrowing of the spinal canal, fracture, infection, tumor, and osteoporosis. All patients enrolled in the study were suitable candidates for both DCI and ACDF. Finally, 81 patients (44 men and 37 women) were deemed eligible for inclusion in the study. The mean age of patients was 47.8 years (range 36–61 years) and the mean duration of symptoms was 25.2 months (range 2–86 months).

Thirty-nine patients underwent resection of the anterior cervical intervertebral disc and DCI arthroplasty (DCI group), including three at C3–C4, 15 at C4–C5, 18 at C5–C6, and three at C6–C7. The remaining 42 patients underwent ACDF (ACDF group) (Table 1). After surgery, radiological investigations were performed at 1 week, 3 months, 6 months, and at 6 month intervals thereafter.

2.2. Surgical technique

All patients received preoperative intravenous antibiotics. 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 that described by Smith and Robinson [11], with preservation of the uncovertebral joints to minimize soft tissue damage and bleeding and to avoid damage to the bony end-plates. To reduce new bone formation 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. ACDF procedures were performed using a titanium mesh cage and Slim-Loc plate (DePuy Spine, Johnson & Johnson, Piscataway, NJ, USA). Operations were performed under fluoroscopic guidance. All patients were immobilized in a Philadelphia collar for 4 weeks postoperatively.

2.3. Data collection and outcome evaluation

The data collected included age, sex, operative segment, intraoperative blood loss, operation time, complications, and clinical and radiological parameters. Perioperative information was collected from the anesthesia records.

The self-reported measures used were the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [13], Neck Disability Index (NDI) [14], and visual analog scale (VAS) scores for neck and arm pain. All patients were asked to complete questionnaires before surgery and at each follow-up examination. The NDI and VAS scores ranged from 0 to 100. Odom's grading system (poor, fair, good, or excellent) was used to evaluate patient satisfaction with the surgery [15]. Outcomes were graded as excellent if all preoperative symptoms were relieved and patients were able to perform their daily activities without impairment; good if they had minimal persistence of preoperative symptoms and were able to perform their daily activities without significant impairment; fair if they had relief of some preoperative symptoms, but their physical activities were significantly limited; and poor if their symptoms and signs were unchanged or worse. Myelopathy was graded using the Japanese Orthopedic Association (JOA) score [16].

Table 1
Demographic data of patients who underwent surgery for single-level cervical degenerative disc disease

	DCI group	ACDF group
Patients, n	39	42
Male, %	53.8	54.8
Age in years, mean ± SD (range)	45.3 ± 8.6 (36–55)	49.5 ± 9.3 (41–61)
Operated level		
C3–C4	3	3
C4–C5	15	18
C5–C6	18	20
C6–C7	3	1
Follow-up in months, mean (range)	26.7 (24–36)	35.4 (24–45)

ACDF = anterior cervical discectomy and fusion, DCI = dynamic cervical implant.