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Revision surgery for cervical artificial disc: Surgical technique and clinical results

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ABSTRACT

Objective: Cervical artificial disc replacement (C-ADR) was developed with the goal of preserving mobility of the cervical segment in patients with degenerative disc disease. So far, little is known about experiences with revision surgery and explantation of C-ADRs. Here, we report our experience with revision the third generation, Galileo-type disc prosthesis from a retrospective study of two institutions.
Patients and methods: Between November 2008 and July 2016, 16 patients with prior implantation of C-ADR underwent removal of the Galileo-type disc prosthesis (Signus, Medizintechnik, Germany) due to a call back by industry. In 10 patients C-ADR was replaced with an alternative prosthesis, 6 patients received an ACDF. Duration of surgery, time to revision, surgical procedure, complication rate, neurological status, histological findings and outcome were examined in two institutions.
Results: The C-ADR was successfully revised in all patients. Surgery was performed through the same anterior approach as the initial access. Duration of the procedure varied between 43 and 80 min. Access-related complications included irritation of the recurrent nerve in one patient and mal-positioning of the C-ADR in another patient. Follow up revealed two patients with permanent mild/moderate neurologic deficits, NDI (neck disability index) ranged between 10 and 42%.
Conclusions: Anterior exposure of the cervical spine for explantation and revision of C-ADR performed through the initial approach has an overall complication rate of 18.75%. Replacements of the Galileo-type disc prosthesis with an alternative prosthesis or conversion to ACDF are both suitable surgical options without significant difference in outcome.

1. Introduction

Cervical disc herniation was treated with ACDF for the last decades in patients that have not responded to non-surgical treatment options and suffered from significant affected quality of life and ability to function [1]. As ACDF stands for elimination of motion at the operated cervical level resulting in decreased neck mobility and risk of adjacent segment degeneration, alternative surgical strategies were warranted. This led to the development of cervical disc replacement and implantation of the first cervical artificial disc in 1960s [2,3]. The theoretical advantages of the cervical artificial disc replacement (C-ADR) over a fusion included maintaining normal neck motion and reducing degeneration of adjacent segments of the cervical spine [4]. Despite the popularity of C-ADR, multiple studies could not proof superiority of C-ADR towards ACDF [5,6]. So far both procedures remain equivalent regarding patients outcome [7]. The implantation of C-ADR was reported as a save procedure with a surgical complication rate of 1.5% [8]. Revision rates ranged between 0 and 0.4% after 60 month of follow up [9,10]. Due to these low official revision rates little is known about the feasibility, surgical techniques as well as risk potential of revision surgery and explantation of artificial disc prosthesis [11,12]. Indications for removal or revision of the prosthesis were multifactorial and were related to implant failure, dislocations and use of the prosthesis for non- approved indications such as multilevel disease.

Different generations of C-ADR carry individual risks at explantation due to their specific construction. The older generation of C-ADRs was either anchored with a keel in a slot of the cranial and caudal vertebral body (i.e. ProDisc CTM, Spine Solution, Paoli, USA) or fixed by milling of the vertebral end plates (Bryan Disc, Medtronic Sofamor Danek, Memphis, USA) [13]. Implanta-

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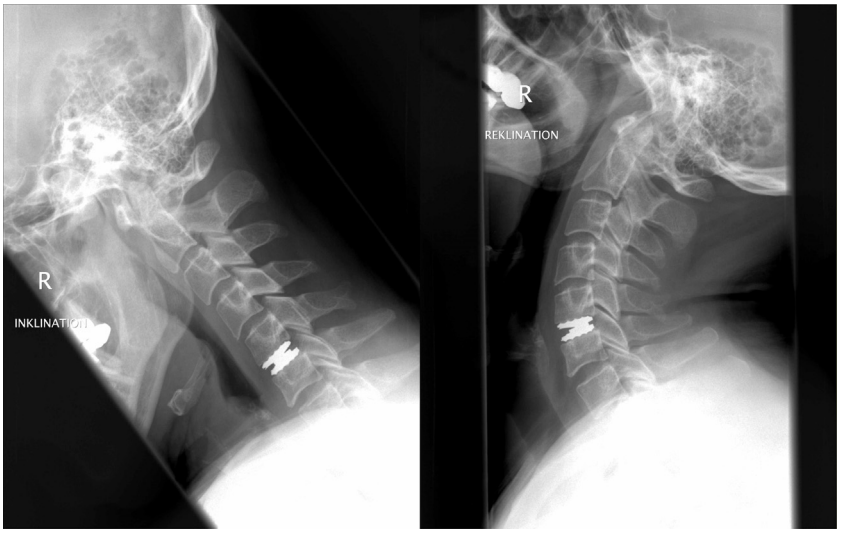

Fig. 1. X-ray of Galileo-type disc prosthesis in flexion (left image) and extension (right image).

tion required ground plate damage, which led to higher frequency of heterotrophic ossification making explantation of these devices more difficult. With the next generation prosthesis the era of new C-ADRs had begun. They are characterized by blunt shape, which ensures smooth implantation and bolting, preserving the surface of the end plates of the vertebra. The complex functioning of the prostheses leads to a nearly perfect imitation of the physiological movements at the price of a higher susceptibility to material problems. In 2008, the Galileo-type disc prosthesis was called back by the producing company following an accidental spontaneous dislocation of one implant due to hardware failure one year after its market introduction [14]. Due to the relevant risk of further device dislocations, each patient with a Galileo-type disc prosthesis was advised to undergo explantation and revision surgery. This allowed for the first time to gain more experience with revision surgery for C-ADRs of the third generation. The Galileo-type disc prosthesis is a semi-constrained, consisting of 3 pieces with a variable center of rotation and a dorsal core allowing translation of the prosthesis (Fig. 1). The implant-bone interface consists of a BONIT-coated teeth fixation. The prosthesis is constituted of a rough surface insuring primary position stability.

Here, we report our experience with the explantation of the Galileo-type disc prosthesis (Signus Medizintechnik, Germany), focusing on the surgical technique of prosthesis mobilization and explantation, as well as the clinical results. Furthermore, the histopathological analysis of the disc space following disc explantation provides interesting insight into the degree of disc incorporation into the bony surrounding of the host (Table 1).

2. Material and methods

2.1. Patients

We performed a retrospective study including 16 patients, who received explantation and revision of a Galileo-type disc prosthesis in two institutions from December 2008 to July 2016. Patient information included initial diagnosis before C-ADR, symptoms at presentation, pain control according to visual analog scale (VAS) after initial C-ARD, pre- and postop X-Ray, neurological presentation and the NDI (neck disability index) [15]. Corresponding data is listed in Table 3. Surgical data included time to revision, duration of revision surgery, intraoperative handling and surgical strategy after removal of the C-ADR (Table 2). Scare and bone samples were gathered during surgery in four patients for histological examination. Follow up was completed in 14 patients; two patients were lost to follow up.

2.2. Neurological examination

Neurological examination included the assessment of motor and sensory functions, presence of long tract signs and abnormality in reflex status. Neurological impairment was classified as mild in cases of subjective weakness, hyperreflexia or dysesthesia, as moderate with objective findings of weakness and long-tract signs and as severe when the patient was unable to walk around independently. The NDI was assessed at follow up.

2.3. Operative procedure for implantation of C-ADR

After induction of anesthesia, the patient was placed in supine position. The skin incision was performed as appropriate for anterior cervical decompression with a straight incision along the fluoroscopic identified cervical segment. The platysma was incised along the direction of its fibers. Under blunt dissection the carotid artery was retracted laterally. Exposure of the cervical level required detachment of the musculus longis colli on both sides of the cervical column. The disc spaces at each level were widely exposed with retractor blades positioned laterally on the downward slope of the vertebral bodies. Cervical disc was incised and removed. The implant was placed under fluoroscopic control. This was followed by hemostasis and wound closure.

2.4. Operative procedure for explantation of C-ADR

All revisions were performed through the original anterior approach. The target disc space was identified with fluoroscopy and marked on the skin. The former wound was re-opened followed by blunt dissection to the spine. The implant was exposed. Retractors were positioned. Scar tissue and ossifications were carefully removed from the end plates. Surgical instruments like high-speed drill, chisel, dissector and forceps were used for explantation. Usually the implant was removed in two pieces. End plates were freed from bone spurs and granulation tissue. The implant (cage or C-ADR) was then placed without additional milling of the endplates to the usually well-preserved disc interspace. An implant size was selected that best fit the height and depth of the interspace. We have not experienced any difference in both techniques conversion to ACDF or implantation of an alternative C-ADR. Finally wound