Promising experiences with lumbar disc functional replacement have led investigators to develop mobile disc prostheses for the cervical spine. The search for dynamic devices was initiated following reports by Hilibrand and Goffin, who described adjacent segment overload after cervical fusion procedures during a long-term follow-up (see Figure 1). These findings were also supported by biomechanical studies demonstrating increased motion and/or intradiscal pressure at levels adjacent to fusion in the cervical spine. On the other hand, the overall results of anterior cervical disectomy and fusion (ACDF) are very positive, while the theoretical role of the natural course of cervical disc degeneration to ‘adjacent segment disease’ remains unclear. Despite such arguments supporting the advocates of ‘gold standard’ fusion techniques, the evolution of motion preservation in spinal care cannot be stopped. The strongest motivator for the development of mobile implants for cervical total disc replacement (CTDR) is the natural desire of surgeons to preserve – at least in part – spine segment motion, thus simply adapting our surgical efforts to the normal behaviour of the human spine.

The indications for CTDR in cervical degenerative disc disease (cDDD) have changed since the initial clinical success of the first generation of CTDR implants. A simplified introduction technique and advanced design of the second generation of cervical prostheses resulted in increased frequency of implantations, with thousands of CTDRs being implanted worldwide. An increasing number of publications are reporting very good clinical and morphological results. Complications after CTDR are also being described in the literature; these include dislocation of implants, neck pain, heterotopic ossification or fusion at the operated level during follow-up. Despite a special tools are used, the groove should not be chiselled but rather gently drilled using motion and/or intradiscal pressure at levels adjacent to fusion in the cervical spine. When devices with keel are used, the groove should not be chiselled but rather gently drilled using special tools.

In nearly all of the current types of prosthesis, the contact surfaces are covered by various osteo-conductive materials. Among these, titanium plasmapore appears to have the best historical track record, in particular when used in non-cemented total hip prostheses. Solid, long-term implant stability is dependent on bony ingrowth through contact surfaces.

Another important biomechanical property of CTDR devices is their ability to mimic natural characteristics and range of motion. So far, no mechanical device has come close to the complicated coupled motion of a cervical spine segment. Most of the existing implants are constrained or semi-constrained. The natural axis of rotation is often not respected. The third generation of prosthesis is constructed with a dorsally located centre of rotation to imitate its physiological position (see Figure 3), at least as far as flexion–extension is concerned.

Despite these improvements, an ongoing critical appraisal of our results is absolutely essential. The technique is in its infancy and uncritical enthusiasm could hinder further development of promising CTDR technology.

The third generation of cervical disc replacement devices, such as activ C™ (Aesculap, Germany), is widely used in clinical practice today, with more than 1,000 implantations being registered worldwide. Ten selected spine centres in Europe have been continuously monitoring the results since the market launch of activ C in order to critically appraise the product and surgical outcome. We present here our preliminary 10-centre experience with the first 89 patients treated with the activ C prosthesis, including a detailed analysis of clinical data during a six-month follow-up in 31 patients.

Material and Methods
Between January 2007 and April 2008, we performed anterior cervical disectomy and CTDR implantation in 89 patients (21–60 years of age) with cDDD. All of the included surgeries were single-level: C3/4 (n=3), C4/5 (n=6), C5/6 (n=52) and C6/7 (n=28). Eighty-nine activ C mobile disc prostheses were implanted.
The indication for surgery was based on compatible clinical and radiographic findings. Most of our patients suffered from radiculopathy and/or myelopathy. Purely axial pain was an indication in one case only. Soft disc herniation with or without spondylosis was the main reason for total disc replacement in our series. Well-preserved motion in the target segment on dynamic radiographs and a disc height greater than 3mm were the main pre-operative indication criteria in the decision-making process. Conversely, contraindications to the procedure included mechanical segmental instability and patient age below 20 or above 65 years. Other contraindications were similar to those for cage implants (osteoporosis, allergy, etc.).

At the time of writing, 31 patients (31 implants) were available for six-month follow-up, and the clinical results of this group have been analysed further in detail. The average age of these patients was 45 years (range 21–60 years) and 56% were female. All patients, except those with rapidly progressing neurological deficits, were treated conservatively for at least eight weeks prior to operative intervention.

Surgery
A standard anterolateral approach was used in all cases. After a total anterior discectomy, posterior osteophytes were removed when necessary. The posterior longitudinal ligament was at least partially resected in the majority of cases. A trial implant was used to determine the proper height and size of the implant. Primary stability of the activ C implant is achieved by means of three anchoring, self-cutting spikes superiorly and a small central keel inferiorly in the bone of the neighbouring endplates (see Figure 2). The keel groove was cut with a specialised drill guided by the trial implant. Finally, the implant was simply introduced into the disc space using an implant holder, similar to any other interbody device placement. All steps of the disc implantation were monitored with the aid of lateral fluoroscopy.

An external semi-rigid collar was used only for the duration of the recovery from general anaesthesia. All patients were mobilised immediately thereafter.

Outcome Measurements
Clinical, neck disability index (NDI) and visual analogue score (VAS) data were collected immediately after surgery, at discharge and six weeks and six months after the operation. Neurological status and VAS scores were assessed by an independent neurologist. All patients included in this prospective long-term study signed an informed consent.

Results
activ C implants are available in three heights (5–7mm). However, in this series only 5 or 6mm disc prostheses were used, with the majority of them (90%) being 5mm high. Excessive peri-operative bleeding occurred in one case. Other procedures were uneventful. Patients were discharged from hospital on post-operative day four on average (range one to seven days), and collars were not used. There were no infections, recurrent laryngeal nerve palsies or re-operations due to implant failure in this series. The mean VAS value for neck pain...
activ C
Pioneering Motion Preservation

Combination of Spikes and Keel:
- Low risk of vertebral body split
- Save anchorage
- Low risk of dislocation or rotation

Adapted to the Anatomy (Convex Shape):
- High primary stability
- Fast osteointegration
intensity improved from 48.7 to 20.3% and the VAS for neck pain frequency from 54.8 to 19.5%. VAS for arm pain intensity decreased from 48.4 to 18.2% and VAS for arm pain frequency from 55.1 to 21.5% (see Figure 4). The mean pre-operative value of NDI (39.5) was reduced to 21.6 at six-month follow-up (see Figure 5).

Preliminary Conclusions
Despite the preliminary nature of these results, activ C seems to be a suitable disc prosthesis with a simplified implantation technique. No significant complications occurred in this series. Longer follow-up and morphological evaluation of the results are necessary to evaluate long-term implant mobility and clinical outcome.


Forthcoming Events

2008

9–11 October
Geriatric Orthopaedic
Trauma Summit
Minneapolis, US
www.cme.umn.edu

10–11 October
European Federation of National
Associations of Orthopaedics
and Traumatology (EFORT)
Instructional Course
Prague, Czech Republic
www.efort.org

22–25 October
International Conference on
Osteoporosis and Bone Research
Beijing, China
www.chinamed.com.cn

2009

11–14 March
International Society for Clinical
Densitometry Annual Meeting
Orlando, US
www.iscd.org

23–26 May
8th World Congress of the
International Cartilage
Repair Society (ICRS)
Miami, US
www.cartilage.org

21–25 June
International Society for
Posture and Gait Research
(ISPG) Conference
Bologna, Italy
www.ispgr.org