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The impact of total lumbar disc replacement on segmental and total lumbar lordosis

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Abstract

Background. One of the goals of total lumbar disc replacement is restoration of the physiological sagittal alignment. There is little evidence if this goal is reached in vivo and further affects the clinical outcome.

Methods. In 29 patients segmental lordosis and total lumbar lordosis were measured on X-rays pre- and postoperatively. The functional outcome was evaluated prospectively with the Visuell Analogue Scale, Oswestry Low Back Pain Disability Questionnaire and Short Form 36 Health Survey Questionnaire.

Findings. Total disc replacement increased segmental lordosis significantly while total lumbar lordosis remained unchanged. Preoperative segmental/total lumbar lordosis was physiological in 52%/91% of the patients. Postoperatively these values changed to 72% for segmental- and 94% for total lumbar lordosis. No difference could be observed in clinical outcome measures in patients with physiological and unphysiological segmental lordosis.

Interpretation. Monosegmental total disc replacement increases the segmental lordosis in most of the cases while preserving the total lumbar lordosis which produces a decrease of lordotic angle in the adjacent segment(s). Although short term clinical results are not affected, the segmental lordosis increase and adjacent segment(s) alteration may influence long term outcome.

Keywords: Intervertebral disc replacement; Arthroplasty; Lumbar lordosis; Sagittal alignment

1. Introduction

There has been an increasing recognition of the importance of sagittal plane contour in the normal function of the lumbar spine in various disease states. Von-Lackum (1924) postulated an increase in the shearing strain at the lumbo-sacral junction due to an increase in the lordotic angle with concomitant poor posture and back strain. Splithoff (1953) comparing patients with and without back pain, concluded that those with pain had a decreased angle. Magora and Schwartz (1980) found that loss of lumbar lordosis is a good indicator of low back pain. With regard to the literature both extremes, hypo- and hyperlordosis, seem to be more often associated with low back pain than physiological lumbar lordosis. Therefore one of the main goals of spinal surgery is to restore or maintain a physiological alignment of the spine. Several studies dealed with the subject of coronar or sagittal alignment of the spine after different operative procedures (La Grone, 1988; Shufflebarger and Clark, 1992). An exception are "non-fusion procedures", which are one of the last developments in spinal surgery. "Non-fusion technology" includes, beside other devices, the total disc replacement (TDR). There is little evidence if the goal of physiological sagittal alignment is achieved by TDR and if it further affects the clinical outcome.

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The aims of this study were therefore (1) to evaluate the segmental and total lumbar lordosis before and after total disc replacement (2) to analyze the relevance of the measured values for the clinical outcome.

2. Methods

2.1. Patients selection

Patients were treated with TDR for symptomatic degenerative disc disease (DDD) or postdiscectomy syndrom (PDS). The inclusion criteria were as follows:

(1) Low back pain for at least 12 months.
(2) Minimum 6 months of conservative therapy.
(3) Absence of facet joint arthrosis confirmed by CT.
(4) No pain relief after facet joint infiltration.
(5) Disc degeneration (black disc) confirmed by MRI.
(6) Absence of intraspinal scar tissue in MRI after PDS.
(7) Discography with positive "Memory pain".
(8) Monosegmental degenerative disc disease.

2.2. Implant design

The implant (ProDisc®, Synthes–Spine Solutions, NY, USA) consist of three implant components (2 plates, 1 polyethylene inlay) with a ball-and-socket joint principle. The forged cobalt–chrome plates, coated with pure titanium, are anchored with keel and spikes to the endplates. The inlay consist of ultra-high molecular weight polyethylene with three different heights (10 mm, 12 mm and 14 mm). Two different plate sizes (*M*; *L*) with two different angulations (6°, 11°) are available. The implant allows 13° of flexion and 7° of extension from the neutral position.

2.3. Operative technique

Surgery is performed through a retroperitoneal approach using a pararectal incision for level L3–L4 and L4–L5 or a horizontal incision for level L5–S1. After access to the anterior part of the disc space (Fig. 1A) the anterior longitudinal ligament and the anterior and posterior part of the anulus fibrosus is excised while preserving the lateral anulus (Fig. 1B). The TDR is inserted after preparation of the endplates to ensure a proper alignment of the prosthesis endplates on the vertebral endplates (Fig. 1C).

2.4. Computer-based X-ray study

X-ray films were taken using standard radiographic technique with the subject standing with his or her hands resting on a bar in front of the subject at the shoulder level pre- and postoperatively. The distance between the radiographic tube and the film was 110 cm, with a known magnification of 1.15. The radiographs were stored by a video camera-based image capture system (DiagnostiX, Basis 2048, GEMED, Freiburg, Germany) in digital format on a personal computer. The software allows the examiner to draw separate lines through the endplates of the superior and inferior vertebrae of the curve. After these lines are drawn, the software automatically displays the angle formed by the lines. Standard Cobb measurements were made of the segmental lordosis (SL) at the operated level and the total lumbar lordosis (LL) pre- and postoperatively. The LL was measured from the upper vertebral endplate of L1 to the superior endplate of S1. From L1 to L5 the SL was measured from the upper vertebral endplate of the cranial vertebrae to the lower vertebral endplate of the caudal vertebrae (Fig. 2A and B). At L5–S1 the SL was measured from the upper vertebral endplate of L5 to the superior endplate of S1.

The classification of SL and LL with regard to the literature (Gelb et al., 1995; Jackson and McManus, 1994; Wood et al., 1996) was as follows for SL/LL: insufficient: <16°/<41°; normative: 16–30°/41–75°; excessive: >30°/>75°.

Two independent orthopedic surgeons evaluated the X-rays for any evidence of loosening, subsidence/migration of the TDR endplates and spontaneous fusion of the operated segment.

2.5. Clinical follow up

All patients had a minimum follow up interval of 12 months. Only 6° angulated prosthesis were included in

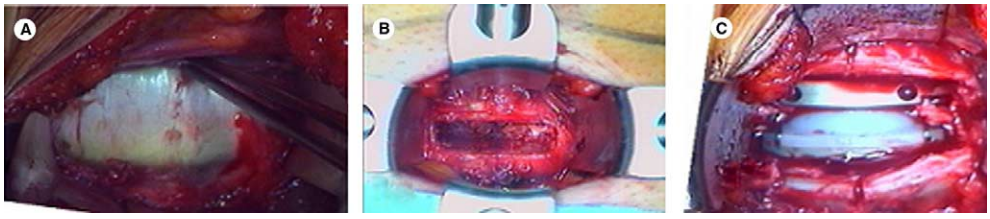

Fig. 1. Operative technique. Access to the anterior part of the segment (A). Excision of the anterior longitudinal ligament, anterior and posterior anulus of the disc by preserving the lateral anulus (B). Situs after insertion of the prosthesis (C).