

# Total Lumbar Disc Replacement in Athletes

a report by

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Prospective, randomised studies controlled by the US Food and Drug Administration (FDA) Investigational Device Exemption (IDE) have shown promising results comparing total lumbar disc replacement (TDR) with spinal fusion in a highly selected patient population. Following FDA approval of the SB Charité III (Waldemar-Link GmbH, Germany) and the ProDisc L (Synthes, Paoli, US), a further increase in the number of disc replacement procedures is expected over the next few years and decades. TDR is predominantly performed in younger patients engaged in various physical and sporting activities and with high subjective expectations regarding their post-operative performance. However, the subsequent impact on the implants from sporting activities such as repetitive axial/rotational stress or sudden exposure to high external forces has not yet been addressed. Mechanical concerns remain and the implant's resilience in terms of load-bearing capacity during sporting activities is unknown.

In a recently performed study we described our experiences with TDR (ProDisc II; Synthes, Paoli, US) in a selected group of athlete patients with varying sporting exposure and different biomechanical demands, from hobby athletes to professional athletes and patients practising extreme sports.

## Study Protocol and Patient Selection

39 patients – 21 male (53.8%) and 18 female (46.2%) – out of a series of 215 fulfilled inclusion criteria for this study (see *Table 1*), with significant participation in sporting activities. The minimum frequency of participation in athletic activity required was two times a week. All patient data were collected and patients examined pre-operatively, at three, six and 12 months post-operatively and annually from then on.

The pre-operative diagnoses are outlined in *Figure 1*. The average age of the patients was 39.8 years (range: 26.2–58). Forty-two disc replacements were performed in 39 patients. The operations were performed either monosegmentally (n=36; 92.3%) or bisegmentally (n=3; 7.7%). Monosegmental disc replacements were performed at the lumbosacral junction (L5/S1; n=26; 66.7%), as well as at the level above the lumbosacral junction (L4/5 and L5/6; n=10; 25.6%). Bisegmental disc replacements were performed at levels L4/5 and L5/S1.

Thirty-eight out of 39 patients were available for follow-up (follow-up rate 97.4%), with a mean follow-up of 26.3 months (range: 9–50.7). All patients received a questionnaire that focused on multiple sport-related issues. Patients subjectively evaluated the success of the disc replacement operation into three categories: “completely satisfied”, “satisfied” or “not satisfied”. At each follow-up, radiographs of the lumbar spine were taken, digitalised and assessed for proper implant positioning.

## Results

### Clinical Outcome

The average reduction in Visual Analogue Scale (VAS) of pain from the pre-operative level of 7.1 was 5.7 (range 0.8–9.1), and the average pre-operative Oswestry Disability Index (ODI) score of 37.7% was reduced by a mean of 15–30% (range: 8–60) at the last follow-up examination. Patient satisfaction rates in this cohort were significantly superior to our previously reported overall results. Asked for their subjective evaluation of TDR, 33 patients (84.6%) were “completely satisfied” at the time of their last follow-up and recorded their result as “excellent”; four patients (10.3%) were “satisfied” and recorded “good” results; and two patients (5.1%) were “not satisfied” with their outcome. Therefore, 94.9% of the patients were satisfied or highly satisfied overall.

### Resumption of Sporting Activity

Fourteen patients (35.9%) were disabled to an extent that did not allow any athletic activity pre-operatively, while 25 patients (64.1%) participated in sport but at a reduced level up until the time of surgery. The average duration of pre-operative absence from sport due to low-back pain (LBP) was 2.5 years (range: 0–8). The majority of patients (69.2%) resumed physical activity within the first three months (n=15; 38.5%) and three to six months (n=12; 30.7%) following TDR. According to the patient's subjective evaluation, full recovery and peak fitness was achieved after 5.2 months (range: 1.5–24) post-operatively.

Two patients (5.1%), both with disc replacements performed at the lumbosacral junction, were not able to participate in physical/athletic activity due to unsatisfactory results with persisting LBP, leaving an overall



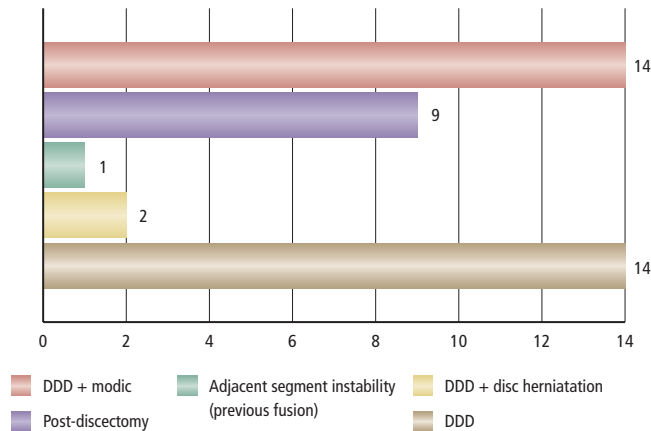
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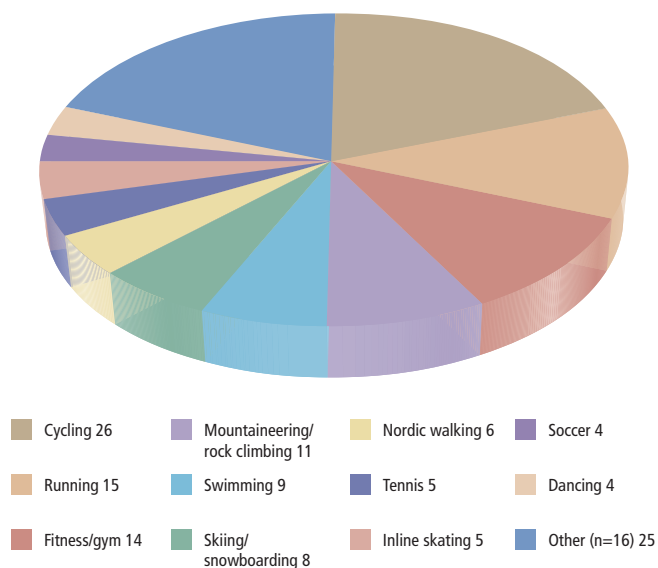
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**Figure 1: Pre-operative Diagnoses and Patient Distribution**



DDD = degenerative disc disease.

**Figure 2: Frequency and Distribution of Participation in Various Athletic Activities**



return-to-sport rate of 94.9%. Of this group, reduced athletic activity was recorded in four patients, in three of whom the reasons were unrelated to the surgery. Reduced athletic activity due to persisting LBP following TDR was therefore observed in three patients overall (7.7%). Excluding one of these unsatisfactory results, the remaining 24 patients from the patient cohort that was still actively engaged in sports before surgery (n=25) were able to resume athletic activity post-operatively (96% return-to-sport rate in this cohort). Overall, 17 patients (43.6%) reported improved physical performance with only minor complaints during athletic activities, while another 16 patients (41.0%) felt completely unrestricted when participating in sport. At last follow-up the duration of athletic training averaged 6.1 hours/week, with 12 patients (30.1%) practising for

**Table 1: Inclusion Criteria**

Patients had to meet at least one of the following criteria:

Frequency of athletic performance $\geq 2$ times a week pre- or post-operatively
Participation in contact sports (e.g. soccer)
Exposure to high-impact external forces/extreme sports (e.g. parachute jumping, wild-water rafting, etc.)
Athletic performance required for professional life (e.g. sports teacher, skiing instructor)
Professional athlete

5–10 hours/week and six patients (15.4%) exceeding a duration of 10 hours/week. Finally, at last follow-up the majority of patients participated in a variety of athletic activities. On average, each patient was engaged in 3.3 types of sport. The most popular athletic activities included cycling, running, fitness (gym), swimming and outdoor sports such as mountaineering, rock climbing, skiing and snowboarding (see Figure 2).

**Analysis of Different Motion Patterns**

When asked which motions were most difficult to perform following disc replacement surgery, the majority of patients marked jumping, remaining in a fixed position (n=12; 30.8% for both) and rotational movements (n=10; 25.6%) (multiple answering was allowed). Another six patients (15.4%) felt limitations during running, while two patients (5.1%) marked heavy lifting as most limiting. Interestingly, only three patients (7.7%) marked limitations for flexion/extension movements.

**Radiological Evaluation**

According to our previously described definition of the terms ‘dislocation’ and ‘subsidence’, we did not observe any implant dislocations. Subsidence was noted in 13 patients overall (30%), but was not clinically relevant.

**Conclusion**

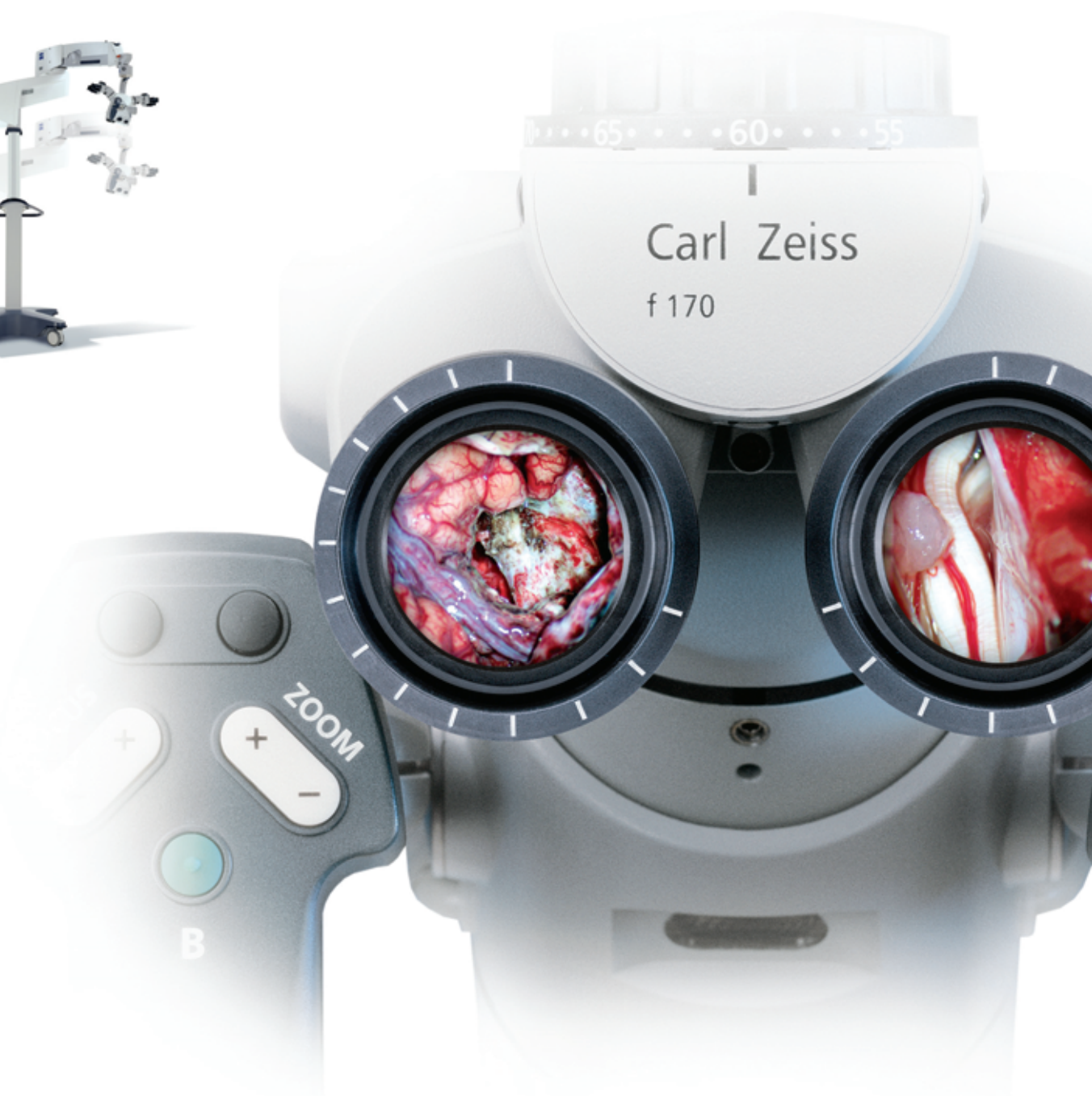
Athletes and hobby athletes treated with TDR for degenerative lumbar disc disease showed highly satisfactory results. Patients were able to perform a variety of sporting activities up to the level of competitive sports, extreme sports and professional athletics. Pre-operative ability to participate in sporting activity proved to be a strong positive predictor for satisfactory post-operative results. However, pre-operative absence from sporting activities due to LBP did not imply inability to resume sport at a satisfactory level following the disc replacement procedure in a pre-selected group of patients.

Minor implant subsidence was observed in 30% of patients during the first three months with no further implant migration thereafter, and was therefore not attributed to sporting activity. No evidence of implant wear was seen in radiological follow-up evaluations. However, due to the young age of the patients and the significant load increase during athletic activities, concerns about the future of the implant will remain a matter of debate, requiring larger patient cohorts, longer follow-up evaluations and modified examination techniques. ■

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