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Effect of lumbar spinal fusion surgery on the association of self-report measures with objective measures of physical function

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ABSTRACT

Background: Self-report measures are used to evaluate surgery outcome but are not necessarily indicative of actual disabilities.
Research question: The aim of the present study was to determine the association between self-report assessments of quality of life and objective measures of function in patients with symptomatic lumbar degenerative disease. Additionally, we evaluated the effect of lumbar spinal fusion surgery on this relationship.
Methods: Before and 6 month after surgery 26 patients completed self-report questionnaires and assessments of 3D gait analysis and trunk range of motion (ROM) during standing.
Results: Before surgery, questionnaires were not correlated with any of the gait parameters and with only 2 trunk ROM parameters. Six month after surgery, the questionnaires showed 12 significant correlations with gait parameters and 19 with trunk ROM parameters. A better Oswestry Disability Index (ODI) ($r = 0.464$, $p = .026$), EQ-5D ($r = -0.440$, $p = .036$), and EQ VAS ($r = -0.472$, $p = .023$) score were correlated with a reduced anterior thorax tilt during walking. Maximum forward flexion of the trunk during standing was correlated with a better EQ-5D ($r = 0.684$, $p = .001$) and ODI ($r = -0.560$, $p = .008$) score as well as with reduced pain scores.
Significance: The lack of association between self-reported questionnaires and objective measures of function before surgery was likely due to psychological distress, correlating with emotional and cognitive function rather than true functional capacities. The influence of these psychological factors might be reduced after surgery due to a reduction of low back pain. To obtain an accurate assessment of impairment, there is a need to evaluate function by measuring objective physiologic parameters that are unsusceptible to voluntary or affective influences.

1. Introduction

Due to low back and leg pain, lumbar degenerative disease has a negative effect on physical function, including reduced gait velocity, reduced step length, and reduced trunk range of motion (ROM) [1]. If conservative treatment fails and a deformity, pain, and disability progresses, the surgeon may perform a spinal fusion surgery as ultimate way to achieve a pain relief. The aim of the surgical intervention is to decompress the spinal canal and nerve roots and to reconstruct the height of the affected disc space via interbody fusion and stabilization.

Self-report measures such as the Oswestry Disability Index (ODI), the EQ-5D questionnaire, and the Numeric Rating Scale (NRS) are routinely used in the clinical setting to evaluate surgery outcome and to capture data related to lumbar pain symptoms, function and perceived disability. However, these questionnaires assess patient perception and are not necessarily indicative of actual disabilities [2–4]. Moreover, subjective self-report measures are easily influenced by socioeconomic or psychological factors and dominated by pain, especially prior to surgery [[5],6]. Regarding the effect of a surgery on this relationship, Terwee et al. [5] has shown in patients with knee osteoarthritis that the correlations between performance-based and self-reported physical functioning were higher after knee replacement, when the pain had diminished. Therefore, it is important that research considers other methods of assessing functionality. Gait analysis has widely been accepted as an objective measure of physical function, allowing researchers and clinicians to better understand biomechanical alterations. A recent study evaluated the effect of a mono- or bisegmental spinal fusion surgery in a group of adults with symptomatic lumbar degenerative disease on physical function, including gait pattern and trunk ROM [7]. It could be shown that surgery is not disruptive for habitual functional activities such as walking. The pain-free walking distance, walking speed, and step length significantly increased and the sagittal alignment of the pelvis and thorax during walking was normalized after surgery. Regarding the kinetics, a significant increase in maximum

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ankle plantarflexor power generation during push-off phase (50%–62% of the gait cycle) was detected compared with the preoperative conditions. In contrast, trunk ROM during an upright position remained only partially unchanged after surgery. The spinal fusion surgery limited the flexion of the trunk in the sagittal plane [7]. Nevertheless, the associations between self-report measures and objective measures of physical function in patients with symptomatic lumbar degenerative disease are not well characterized. Therefore, the aim of the present study was to determine the correlation between self-report assessments with the above described objective biomechanical measures of function including gait analysis and trunk ROM during standing derived from a previous study [7] with the same group of patients. In addition, we evaluated the effect of a lumbar spinal fusion surgery on this relationship. It is hypothesized that objective functional measures such as gait parameters and trunk ROM are not correlated with subjective self-assessment preoperatively. In contrast, we expected that this relationship increases after surgery due to a reduction of low back and leg pain.

2. Methods

2.1. Subjects

Thirty patients with a radiological diagnosis of a degeneration of the lumbar spine were initially selected during clinical visits in our hospital. Measurements were performed before surgery and 26.8 (± 2.5) weeks after surgery. Before the indication for surgery, patients underwent a conservative treatment for at least 6 month including injections and physiotherapy without improvement of symptoms. Two experienced, senior orthopedic surgeons of the department of spine diseases of our hospital set the indication for the fusion and performed the surgery. In line with our treatment standard, all patients were treated with a mono- or bisegmental interbody fusion between L3-S1 either from posterior (PLIF) or transforaminal (TLIF) (Table 1). In particular, TLIF procedures were not accepted at the level L5-S1. If the patient was suffering from unilateral symptoms and the main pathology was above the level L5-S1, than we performed the TLIF-technique from the symptomatic side. In both techniques the vertebral disk of the affected segment was replaced by intervertebral cages filled with bone graft material and the segment was stabilized with a screw-rod-system to induce spinal fusion. The analyzed patients did not show any complications regarding the surgery during the postoperative follow up period.

Patients were excluded if they were unable to stand or walk without an assistive device and/or suffered from inflammatory rheumatic disease, as well as neurological disorders (e.g., Parkinson's disease, stroke, epilepsy, Alzheimer's disease). Further exclusion criteria included: morbid obesity with a body mass index ≥ 30, total joint replacement in the hip-, knee-, or ankle joint, previous orthopedic surgery in the past 6 month, and previous spinal fusion surgery. Of the initially screened 30 patients, 4 were excluded due to the following reasons: two patients had a modified procedure with three level spinal fusion that was decided intraoperative and 2 patients missed the postoperative follow up gait analysis and trunk ROM measurements. Twenty-six patients with a mean age of 59.3 (± 10.1) years matched all criteria and were included in the study (Table 1). Patients were thoroughly familiarized with the study design before giving written informed consent to participate in this study, as approved by the local ethics committee and in accordance with the Helsinki Declaration.

2.2. Questionnaires

On the day of the gait analyses, all patients had to fill out three questionnaires (Table 2). The ODI has become one of the principal condition-specific outcome measures used in the management of spinal disorders and was used in the present study to quantify disability for low back pain [8]. A high score reflects a high rate of pain-indicated limitations. It has been shown to have excellent test, re-test reliability in patients with lumbar spinal stenosis [9]. According to Conrad et al. [10], the ODI shows high correlations with patient's walking ability suffering from lumbar spinal stenosis. A measure of health-related quality of life was assessed with the validated EQ-5D questionnaire [11]. The EQ-5D descriptive system measures health-related quality of life on five dimensions (mobility, selfcare, usual activities, pain/discomfort, and anxiety/depression). A high EQ-5D index score reflects a

Table 1
Patient characteristics including sex, age at surgery, technique of surgery, type and level of fusion, and diagnoses.

Patient no.	Sex	Age (yr)	Surgery technique	Type and level of fusion	Diagnoses
01	F	55	PLIF	Bi (L4-S1)	Spinal stenosis L4/L5, postnucleotomy syndrome L5/S1, osteochondrosis L4-S1
02	F	48	PLIF	Mono (L4/L5)	Spinal stenosis L4/L5, degenerative spondylolisthesis L4/L5
03	F	75	PLIF	Mono (L4/L5)	Degenerative spondylolisthesis L4/L5
04	F	75	PLIF	Mono (L4/L5)	Spinal stenosis L4/L5, degenerative spondylolisthesis L4/L5
05	M	53	PLIF	Mono (L5/S1)	Postnucleotomy syndrome L5/S1, osteochondrosis L5/S1
06	M	49	PLIF	Mono (L5/S1)	Postnucleotomy syndrome L5/S1
07	M	73	TLIF	Mono (L4/L5)	Spinal stenosis L4/L5, degenerative spondylolisthesis L4/L5
08	F	77	PLIF	Bi (L3-L5)	Degenerative spondylolisthesis L4/L5, osteochondrosis L3/L4
09	F	55	PLIF	Bi (L4-S1)	Osteochondrosis L4-S1
10	M	58	PLIF	Mono (L5/S1)	Osteochondrosis L5/S1
11	F	53	PLIF	Mono (L5/S1)	Osteochondrosis L5/S1
12	M	40	PLIF	Mono (L5/S1)	Degenerative spondylolisthesis L5/S1, osteochondrosis L5/S1
13	M	67	PLIF	Mono (L5/L6)	Isthmic spondylolisthesis L5/L6
14	M	70	TLIF	Mono (L4/L5)	Osteochondrosis L4/L5, spinal stenosis L4/L5
15	F	61	PLIF	Mono (L5/L6)	Degenerative spondylolisthesis L5/L6, osteochondrosis L5/L6
16	M	55	PLIF	Mono (L4/L5)	Isthmic spondylolisthesis L4/L5
17	F	60	PLIF	Mono (L5/S1)	Osteochondrosis L5/S1, spinal stenosis L5/S1
18	M	68	TLIF	Mono (L4/L5)	Spinal stenosis L4/L5
19	M	49	TLIF	Mono (L2/L3)	Spinal stenosis L2/L3, osteochondrosis L2/L3
20	F	68	PLIF	Bi (L4-S1)	Spinal stenosis L4-S1, degenerative spondylolisthesis L4/L5
21	F	52	PLIF	Mono (L5/S1)	Spinal stenosis L5/S1, osteochondrosis L5/S1
22	M	51	PLIF	Bi (L4-S1)	Osteochondrosis L4-S1
23	F	66	PLIF	Bi (L4-L6)	Spinal stenosis L5/L6, osteochondrosis L4-L6
24	M	46	PLIF	Mono (L5/S1)	Degenerative spondylolisthesis L5/S1
25	F	62	TLIF	Mono (L4/L5)	Degenerative spondylolisthesis L4/L5, osteochondrosis L4/L5
26	M	56	PLIF	Bi (L4-S1)	Spinal stenosis L4-S1, osteochondrosis L4-S1

PLIF, posterior lumbar interbody fusion; TLIF, transforaminal lumbar interbody fusion; F, female; M, male.