Predictive outcome factors in the young patient treated with lumbar disc herniation surgery

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OBJECTIVE The aim of this study was to evaluate predictive factors for outcome after lumbar disc herniation surgery in young patients.

METHODS In the national Swedish spine register, the authors identified 180 patients age 20 years or younger, in whom preoperative and 1-year postoperative data were available. The cohort was treated with primary open surgery due to lumbar disc herniation between 2000 and 2010. Before and 1 year after surgery, the patients graded their back and leg pain on a visual analog scale, quality of life by the 36-Item Short-Form Health Survey and EuroQol-5 Dimensions, and disability by the Oswestry Disability Index. Subjective satisfaction rate was registered on a Likert scale (satisfied, undecided, or dissatisfied). The authors evaluated if age, sex, preoperative level of leg and back pain, duration of leg pain, pain distribution, quality of life, mental status, and/or disability were associated with the outcome. The primary end point variable was the grade of patient satisfaction.

RESULTS Lumbar disc herniation surgery in young patients normalizes quality of life according to the 36-Item Short-Form Health Survey, and only 4.5% of the patients were unsatisfied with the surgical outcome. Predictive factors for inferior postoperative patient-reported outcome measures (PROM) scores were severe preoperative leg or back pain, low preoperative mental health, and pronounced preoperative disability, but only low preoperative mental health was associated with inferiority in the subjective grade of satisfaction. No associations were found between preoperative duration of leg pain, distribution of pain, or health-related quality of life and the postoperative PROM scores or the subjective grade of satisfaction.

CONCLUSIONS Lumbar disc herniation surgery in young patients generally yields a satisfactory outcome. Severe preoperative pain, low mental health, and severe disability increase the risk of reaching low postoperative PROM scores, but are only of relevance clinically (low subjective satisfaction) for patients with low preoperative mental health.

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KEY WORDS lumbar disc herniation; outcome; prediction; PROM; surgery; patient-reported outcome measures; sex

LUMBAR disc herniation (LDH) has been thoroughly evaluated in adults, in respect to epidemiology,²⁸ natural history,⁶⁰ and surgical outcome.^{42,49,61} Due to the low incidence of LDH in children, few studies have evaluated pediatric cases. Most young patients with LDH are treated nonoperatively, and in Sweden, LDH surgery is only performed at a rate of approximately 20 per 100,000 individuals per year (www.4s.nu). Furthermore, only 3% of

all LDH surgery is done in individuals below the age of 20 years, and in only 0.5% in those younger than 16 years.^{2,5,14,17–19,22,26,39,41,45} With this background, it is not surprising that the surgical outcome in young patients is sparsely described.^{8,9,11,13–15,18,22–24,26,27,29–32,35,40,41,46,47} Published studies are mainly retrospective, which makes the preoperative evaluation uncertain; only 1 study uses validated outcome scores,¹⁵ and only 1 includes more than 100 patients.⁸ In

ABBREVIATIONS EQ-5D = EuroQol-5 Dimensions; LDH = lumbar disc herniation; MCS = Mental Component Summary; ODI = Oswestry Disability Index; PROM = patient-reported outcome measures; SF-36 = 36-Item Short-Form Health Survey; VAS = visual analog scale.

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young patients, if there are any predictive factors for an inferior surgical outcome, to our knowledge they are not known.

In contrast, there are studies in adults that have identified risk factors for an inferior LDH surgical outcome.^{34,37} The aim of our study was to use a prospective study design to evaluate if young patients have a risk-factor profile for an inferior surgical outcome similar to that in adults. We hypothesized that this would be the case when we asked the following: could an inferior outcome of primary surgery for LDH during youth be predicted by 1) age and sex, 2) severity of the pain, 3) duration of the pain, 4) distribution of the pain, 5) health-related quality of life, 6) mental health, and 7) grade of disability?

Methods

The National Swedish Spine Register (SweSpine) is a patient-based surgical register that includes data on a variety of lumbar spine diagnoses, including LDH. The register has previously been described in detail, and validation of the register has been found with good outcome.^{50–53,55} The register has no exclusion criteria and is open to all Swedish units that perform low-back surgery to register data. Today, SweSpine covers approximately 90% of all departments performing spine surgery in Sweden. SweSpine includes pre-, peri-, and 1-, 2-, 5-, and 10-year postoperative data. The evaluations include specific questions regarding pain and function in addition to patient-reported outcome measures (PROM). In the 1-year postoperative evaluation, the subjective rate of satisfaction is registered as well as change in pain compared with the preoperative level. Surgical data are reported by the surgeon. Participation in SweSpine is voluntary for the patient and when included, patients accept that data will be used anonymously for scientific research.

In this study, we included patients 20 years or younger in whom primary LDH surgery was performed during the period between 2000 and 2010 ($n = 352$). Eight patients with previous back surgery, 72 patients with only perioperative data, and 92 patients who did not complete the 1-year follow-up questionnaire were excluded, leaving 180 patients for this study with pre-, peri-, and 1-year postoperative data. In a drop-out analysis, we compared the pre- and perioperative data in those included in the study ($n = 180$) with those 92 patients with no 1-year follow-up data. We found no group differences (data not shown). All patients were treated with open discectomy, with or without microscopic assistance.

In this report, we registered sex, age at surgery, level of back and leg pain by a visual analog scale (VAS), duration of preoperative pain, consumption of analgesics, walking distance, and subjective health by the PROM, 36-Item Short-Form Health Survey (SF-36), EuroQol-5 Dimensions (EQ-5D-3 Levels), and, from 2002, also the Oswestry Disability Index (ODI). The Mental Component Summary (MCS) score in SF-36 is a summoned component for the subdomains in SF-36 that evaluate mental health. The MCS is therefore the measure used in this study to estimate mental health.

The VAS pain level is rated from 0 to 100 (where 0 rep-

resents no pain and 100 the most severe pain imaginable), SF-36 from 0 to 100 (where 0 represents worst imaginable health and 100 best imaginable health), EQ-5D index from 0 to 1 (where 0 represents death and 1 full health), Euro-Qol visual analog scale from 0 to 100 (where 0 represents worst imaginable health and 100 best imaginable health,²⁰ and ODI from 0 to 100 (where 0–20 represents minimal or no disability and 80–100 a bed-bound [or exaggerating] patient). The surgical data included diagnosis, operated level, operated side, and postoperative complications. At the 1-year postoperative follow-up, we registered the same data as preoperatively but also the subjective estimation of change in back and leg pain by the use of a 5-point Likert scale (pain free, pronounced improvement, slight improvement, unchanged, or deteriorated) and patient satisfaction by the use of a 3-point Likert scale (satisfied, undecided, or dissatisfied). We defined our primary outcome measurement as patient satisfaction.

We used SPSS statistics version 22 (IBM Corp.) for the statistical calculations. Descriptive data are presented as numbers, median values with ranges, mean values $\pm$ SDs, or proportions (%). We then divided the patients into quartiles depending on preoperative status, and compared the outcome in the different quartiles. Group comparisons were performed with the chi-square test, the Student t-test between means, and ANOVA. A p value < 0.05 is regarded as a statistically significant difference.

Results

Preoperative background data and general outcome data are presented in Tables 1 and 2. The patients were markedly impaired before the operation, with female patients consuming more analgesics than male patients ($p < 0.05$). Most operations were performed on the left side and at the 2 lowest levels of the lumbar spine, with no sex differences. One patient (0.4%) sustained a nerve root injury and 6 patients (2.2%) a dural lesion. Surgery conferred significant improvement in all registered parameters, and to an extent that only 4.5% of the patients were unsatisfied with the outcome 1 year after surgery. No patient younger than age 18 years was unsatisfied with the surgical outcome. Outcome was virtually unchanged between 1- and 2-year follow-up.

Severe preoperative leg pain (Table 3), severe back pain (Table 4), low mental health (Table 5), and pronounced disability (Table 6) were all associated with inferior surgical outcome according to PROM. The subjective satisfaction rate was lower in patients with low preoperative mental health, whereas duration of leg pain (Supplemental Data), preponderance of leg or back pain (Supplemental Data), and health-related quality of life (Supplemental Data) were not.

Discussion

This study shows that, in general, LDH surgery in young patients yields a satisfying outcome both regarding patient satisfaction and according to PROM, where data reveal a normalized status according to SF-36.⁵⁶ Improvement in PROM (VAS back and leg pain, quality of life by EQ-5D and ODI) meets previously reported predefined

TABLE 1. Preoperative background data for age, anthropometry, operated level, and duration of pain in young patients with LDH surgery

Variable	All Patients	Male	Female	Sex Comparison*
Age in yrs, median (range)	19 (13–20)	19 (15–20)	19 (13–20)	0.83
Length in cm, mean (SD)	176 (10)	184 (6)	169 (6)	NA
Weight in kg, mean (SD)	72 (14)	78 (13)	67 (12)	NA
BMI in kg/m ² , mean (SD)	23 (4)	23 (3)	24 (4)	NA
Smoking, %	10	6	14	
Operated level, %				0.32
L3–4	1	1	0	
L4–5	52	56	48	
L5–S1	47	43	52	
Operated side, %				0.98
Rt	47	46	48	
Lt	50	50	49	
Bilat	3	3	3	
Consumption of analgesics, %				<0.05
None	27	35	18	
Intermittent	35	31	40	
Regular	38	34	42	
Walking distance in meters, %				0.14
0–100	14	12	16	
101–500	14	16	13	
501–1000	24	18	31	
>1000	48	54	41	
Duration of preop leg pain, %				0.21
Had no leg pain	1	0	1	
0–3 mos	10	13	7	
>3–12 mos	54	56	53	
>12–24 mos	24	19	30	
>24 mos	11	12	9	

BMI = body mass index; NA = not applicable.

* Group differences tested by chi-square, Fisher's exact, and Student's t-tests; $p < 0.05$ is regarded as a statistically significant difference.

criteria defining successful outcome after LDH surgery in adults,⁴⁸ and the outcome is virtually unchanged between 1- and 2-year follow-up. However, preoperative severe pain, low mental health, and severe disability were factors associated with postoperative outcome in the PROM, but only low preoperative mental health was of clinical significance as the only factor also associated with an inferior postoperative subjective grade of satisfaction.

Studies have also previously evaluated the outcome of LDH surgery in children and young adults, ranging from

case reports to review articles.^{1–7,10,13–15,17,19,22,23,26,27,30,31,33,40,41,45,47,59,62} Most of these reported good or excellent outcome in 75%–100% of the cases. But despite this, the general recommendation is to start with a nonoperative approach, except in patients with a cauda equina syndrome, progressive neurological deficits, or intractable pain, where surgery is the primary recommended treatment.⁵⁴ When nonoperative treatment has been unsuccessful for months, surgery is contemplated.³⁴ But there are also surgeons who infer that surgery should be considered earlier¹⁷ because nonoperative treatment in young patients is reported with less favorable results than in adults, with a reported success rate as low as 13%–45%.^{13,23,30,31,58,62}

Therefore, it would be of great interest to be aware of any preoperative factors that could predict an inferior outcome. Female sex, smoking, previous surgery, severe preoperative pain, pain duration longer than 12 months, and low mental health are known risk factors for an inferior outcome in adults, but it should be determined whether these also account for children.

In this study, a higher preoperative pain level was 1 factor associated with greater postoperative leg pain, inferior SF-36 MCS scores, and inferior ODI scores. It could, however, be debated whether these deficits are of clinical relevance because there were no postoperative group differences in EQ-5D index (the postoperative EQ-5D index was identical to or higher than that of a Swedish reference population 18–24 years old),⁵⁷ all ODI levels were below 20 (usually regarded as being a deficit of no clinical significance²¹), and there was no difference in subjective grade of satisfaction.

Mental health, as measured by SF-36 MCS, was another preoperative factor that was associated with postoperative inferiority in most registered PROM. This was also the only preoperative risk factor that was associated with inferiority in subjective satisfaction. It is therefore of interest to note that most postoperative PROM scores in the children with the lowest preoperative mental health as measured by the SF-36 MCS were no different than in the children with the greatest preoperative pain or disability. But despite the similarity in the postoperative PROM scores, the subjective satisfaction rate was only lower in the children with low preoperative mental health (SF-36 MCS). This clearly indicates that factors beyond residual pain (VAS) or residual disability (ODI) are of importance when subjectively rating the surgical outcome during growth or adolescence.

Preoperative disability (ODI) was another predictive factor that was associated with statistically significant inferiority in most PROM scores. But the clinical relevance of categorizing young patients by grade of ODI disability should also be questioned because all young patients had a preoperative disability EQ-5D index similar to the Swedish reference population,⁵⁷ all ODI levels were below 20,²¹ and there was no difference in subjective grade of satisfaction.

Nygaard et al. reported in adults³⁷ a less favorable outcome after LDH surgery in patients with pain duration longer than 8 months. Inferior outcome has also been reported in patients with 6–12 months of pain duration compared with individuals with less than 6 months of

TABLE 2. Preoperative, postoperative, and 2-year follow-up data on level of pain, perceived health, and disability in young patients with LDH surgery*

Variable	All 180 Patients			
	Preop	Postop	Improvement	2 Yrs Postop (99 patients)
VAS score				
Leg pain	63 (59–67)	13 (10–17)	50 (45–55)	13 (9–18)
Back pain	40 (35–45)	16 (13–20)	25 (19–31)	18 (13–22)
EQ-5D index	0.35 (0.29–0.41)	0.82 (0.78–0.86)	0.48 (0.41–0.54)	0.80 (0.76–0.85)
EQ VAS score	52 (48–55)	79 (76–83)	28 (24–32)	79 (75–83)
SF-36 score				
PCS	38.8 (36.9–40.8)	47.3 (45.6–49.1)	8.5 (6.1–11.0)	47.2 (45.2–49.2)
MCS	34.8 (33.1–36.5)	49.5 (47.9–51.0)	15.5 (13.8–17.3)	49.1 (47.4–50.9)
ODI score	34 (32–37)	11 (9–13)	24 (21–27)	11 (9–14)

PCS = Physical Component Summary.

* Data are presented as mean values with 95% CI in parentheses, with changes between pre- and postoperative values tested by paired Student's t-tests. Statistically significant improvements are presented in boldface type.

duration.³⁸ Similar conclusions have been drawn by others,²⁵ and LDH surgery in adults is in general reported with a superior outcome if being conducted with less than 12 months of pain duration.^{12,16,25,36,43,44} In contrast, the preoperative duration of pain seems to be of no clinical relevance in younger patients. That is, long-standing pain in children, adolescents, and young adults should not be a contraindication for surgery.

Study strengths include the evaluation of LDH surgery in children, adolescents, and young adults with the largest

study population included to date, the first to prospectively include preoperative data, and the second to use validated PROM that make comparison across studies possible. The study also captures the outcome in the general health care system, because the cohort includes children operated on in various hospitals, with different techniques, and by different surgeons with varying levels of competence and experience. By using this study design, we could present the outcome of pediatric LDH surgery nationwide versus only in highly specialized pediatric units.

TABLE 3. One-year postoperative outcomes in level of back and leg pain, perceived health, and disability in relation to preoperative severity of leg pain*

Variable	Preop Quartiles of Leg Pain (VAS)				p Value for Group Comparisons
	Quartile 1 (worst)	Quartile 2	Quartile 3	Quartile 4 (least)	
No. of patients	43	44	43	44	
Median age at op, yrs (range)	19 (15–20)	18.5 (16–20)	19 (16–20)	19 (13–20)	0.90
Sex, %					0.40
F	49	55	58	41	
M	51	45	42	59	
Postop 1-yr outcomes					
VAS score					
Leg pain	18 (9–26)	16 (10–23)	10 (4–15)	7 (2–12)	<0.05
Back pain	18 (10–26)	21 (14–28)	12 (5–18)	12 (5–18)	0.06
EQ-5D index	0.80 (0.71–0.88)	0.78 (0.70–0.86)	0.89 (0.82–0.95)	0.85 (0.77–0.92)	0.19
EQ VAS score	80.6 (74.3–87.0)	74.4 (66.6–82.2)	82.2 (76.3–88.2)	80.4 (73.9–86.9)	0.26
SF-36 score					
PCS	48.4 (45.0–51.9)	46.6 (43.1–50.1)	49.0 (45.6–52.5)	46.2 (41.8–50.5)	0.60
MCS	49.1 (46.5–51.7)	46.8 (43.5–50.0)	51.0 (47.7–54.3)	52.2 (49.1–55.2)	<0.05
ODI score	12 (8–16)	14 (9–19)	8 (4–12)	7 (4–11)	<0.05
Satisfaction rate, %					0.16
Satisfied	81	77	91	95	
Undecided	12	16	9	2	
Unsatisfied	7	7	0	2	

* Data are presented as numbers, mean values with 95% CI in parentheses, or proportions, with group differences tested by ANOVA. $p < 0.05$ is regarded as a statistically significant difference.

TABLE 4. One-year postoperative outcomes in level of back and leg pain, perceived health, and disability in relation to preoperative severity of back pain*

Variable	Preop Quartiles of Back Pain (VAS)				p Value for Group Comparisons
	Quartile 1 (worst)	Quartile 2	Quartile 3	Quartile 4 (least)	
No. of patients	43	44	44	44	
Median age at op, yrs (range)	19 (14–20)	19 (16–20)	19 (13–20)	18 (16–20)	0.54
Sex, %					0.08
F	61	57	36	43	
M	39	43	64	57	
Postop 1-yr outcomes					
VAS score					
Leg pain	16 (9–24)	17 (9–25)	8 (4–11)	9 (4–15)	<0.05
Back pain	21 (12–30)	19 (12–26)	12 (7–18)	10 (4–17)	<0.05
EQ-5D index	0.80 (0.72–0.88)	0.80 (0.72–0.88)	0.85 (0.79–0.91)	0.86 (0.78–0.94)	0.51
EQ VAS score	76.7 (69.2–84.2)	73.8 (66.0–81.6)	83.9 (79.6–88.3)	83.9 (78.2–89.5)	0.05
SF-36 score					
PCS	46.0 (42.4–49.7)	47.8 (44.3–51.2)	48.3 (44.9–51.7)	47.9 (43.6–52.2)	0.32
MCS	47.9 (44.6–51.1)	47.4 (44.3–50.4)	51.0 (48.0–54.0)	53.0 (50.1–55.8)	<0.001
ODI score	14 (9–19)	11 (7–15)	10 (6–14)	7 (3–10)	<0.05
Satisfaction rate, %					
Satisfied	84	80	91	88	
Undecided	7	16	9	7	
Unsatisfied	9	5	0	5	

* Data are presented as numbers, mean values with 95% CI in parentheses, or proportions, with group differences tested by ANOVA. $p < 0.05$ is regarded as a statistically significant difference.

TABLE 5. One-year postoperative outcomes in level of back and leg pain, perceived health, and disability in relation to preoperative mental health*

Variable	Preop Mental Health (evaluated by SF-36 MCS)				p Value for Group Comparisons
	Quartile 1 (worst)	Quartile 2	Quartile 3	Quartile 4 (best)	
No. of patients	42	43	43	43	
Median age at op, yrs (range)	19 (16–20)	19 (14–20)	19 (15–20)	18 (16–20)	0.33
Sex, %					0.06
F	62	49	51	67	
M	38	51	49	33	
Postop 1-yr outcomes					
VAS score					
Leg pain	18 (10–26)	11 (5–16)	10 (5–16)	12 (5–20)	0.07
Back pain	23 (14–32)	14 (7–21)	15 (9–22)	9 (5–14)	<0.05
EQ 5D index	0.72 (0.63–0.82)	0.86 (0.80–0.92)	0.84 (0.76–0.92)	0.88 (0.84–0.93)	<0.05
EQ VAS score	69.7 (62.1–77.3)	81.6 (74.5–88.6)	82.8 (77.3–88.4)	86.7 (82.8–90.6)	<0.001
SF-36 score					
PCS	44.0 (39.5–48.4)	49.1 (45.7–52.4)	49.0 (45.7–52.3)	49.1 (46.3–51.9)	<0.05
MCS	43.3 (40.0–46.5)	51.6 (49.5–53.8)	51.0 (48.0–54.0)	54.6 (51.9–57.3)	<0.001
ODI score	17 (12–21)	8 (5–12)	9 (6–13)	6 (3–8)	<0.001
Satisfaction rate, %					
Satisfied	71	91	84	95	
Undecided	15	7	14	5	
Unsatisfied	15	2	2	0	

* Data are presented as numbers, mean values with 95% CI in parentheses, or proportions, with group differences tested by ANOVA. $p < 0.05$ is regarded as a statistically significant difference.

TABLE 6. One-year postoperative outcomes in level of back and leg pain, perceived health, and disability in relation to preoperative disability*

Variable	Preop Disability (evaluated by ODI)				p Value for Group Comparisons
	Quartile 1 (worst)	Quartile 2	Quartile 3	Quartile 4 (least)	
No. of patients	37	36	36	36	
Median age at op, yrs (range)	18 (16–20)	19 (17–20)	19 (14–20)	18 (15–20)	0.25
Sex, %					0.25
F	57	47	44	33	
M	43	53	56	67	
Postop 1-yr outcomes					
VAS score					
Leg pain	16 (9–25)	13 (6–20)	12 (6–19)	11 (4–17)	0.57
Back pain	27 (17–37)	15 (8–21)	11 (6–15)	12 (5–19)	<0.001
EQ-5D index	0.74 (0.65–0.84)	0.77 (0.67–0.86)	0.88 (0.84–0.93)	0.88 (0.82–0.94)	<0.05
EQ VAS score	71.6 (63.7–79.6)	79.0 (71.3–86.7)	83.1 (77.7–88.4)	82.9 (77.1–88.8)	0.06
SF-36 score					
PCS	45.3 (41.5–49.1)	44.7 (40.2–49.3)	49.1 (45.6–52.6)	49.6 (46.6–52.5)	0.09
MCS	45.6 (42.6–48.6)	49.2 (45.6–52.7)	51.2 (48.4–54.0)	51.9 (48.8–55.1)	<0.05
ODI score	17 (12–22)	11 (7–16)	8 (5–11)	7 (3–10)	<0.001
Satisfaction rate, %					0.70
Satisfied	78	83	89	80	
Undecided	11	14	8	14	
Unsatisfied	11	3	3	6	

* Data are presented as numbers, mean values with 95% CI in parentheses, or proportions, with group differences tested by ANOVA. $p < 0.05$ is regarded as a statistically significant difference.

Weaknesses of this study include the incomplete postoperative data collection. However, the drop-out analyses indicate that there was no selection bias. It was also advantageous to have data from even younger children and outcome in nonoperatively treated patients. Another weakness is that the EQ-5D index is only validated in adults, but because the mean age in our cohort was 18–19 years, it seems acceptable to compare our data with existing normative EQ-5D data in individuals 18–24 years old. It would have been of interest to have age- and country-specific normative data for comparison in ODI (however, these have never been reported in any study) and other possible risk factors such as smoking, alcohol consumption, psychosocial risk factors, and/or previous surgery registered. It could also be debated whether the MCS score in SF-36 is the best measure of mental health. It would have been beneficial to have information on radiological findings, type and length of nonoperative treatment before surgery was performed, reason for selecting the patient for surgery, and surgeon-specific factors such as specialty of the operating surgeon, experience, and annual surgical volumes; however, such data are not available in SweSpine.

Conclusions

Lumbar disc herniation surgery in young patients generally yields a satisfactory outcome. Low preoperative mental health is a risk factor for reaching a subjective unsatisfying outcome. Severe preoperative pain, low mental health, and severe disability are risk factors for reaching lower postoperative PROM scores.

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Disclosures

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Conception and design: F Strömqvist, Gerdhem, Karlsson. Acquisition of data: Karlsson. Analysis and interpretation of data:

all authors. Drafting the article: all authors. Critically revising the article: B Strömqvist, Jönsson. Reviewed submitted version of manuscript: B Strömqvist, Jönsson, Gerdhem, Karlsson. Approved the final version of the manuscript on behalf of all authors: F Strömqvist. Statistical analysis: F Strömqvist, Gerdhem. Study supervision: Karlsson.

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