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SYMPOSIUM: CURRENT APPROACHES TO THE MANAGEMENT OF LUMBAR DISC HERNIATION

Which Variables Are Associated With Patient-reported Outcomes After Discectomy? Review of SPORT Disc Herniation Studies

John D. Koerner MD, Jordan Glaser MD, Kristen Radcliff MD

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Abstract

Background The Spine Patient Outcomes Research Trial (SPORT) evaluated the effects of surgery versus nonoperative treatment for lumbar intervertebral disc herniation (IDH), among other pathologies. Multiple subgroup analyses have been completed since the initial publications, which have further defined which patient factors lead to better or worse patient-reported outcomes; however, the degree to which these factors influence patient-reported outcomes has not been explored.

Questions/purposes We reviewed the subgroup analyses of the SPORT IDH studies to answer the following questions: (1) What factors predicted improvement in patient-reported outcomes after operative or nonoperative treatment of lumbar IDH? (2) What factors predicted worse patient-reported outcomes compared to baseline after operative or nonoperative treatment of lumbar IDH? And (3) what factors influenced patient-reported outcomes of surgery in patients with lumbar IDH?

Methods We conducted a MEDLINE® search to identify the subgroup analyses of the SPORT IDH data that were responsive to our study questions. Eleven articles were identified that met our search criteria.

Results The patient factors associated with larger improvements in Oswestry Disability Index at 4 years with either surgical or nonoperative treatment included a higher baseline Oswestry Disability Index, BMI of less than 30, not being depressed, being insured, having no litigation pending, not having workers compensation, and having symptoms for less than 6 weeks, though there were others. Factors leading to improvement with surgical treatment were mostly related to anatomic characteristics of the disc herniation such as posterolateral and sequestered herniations. There were no patient or clinical factors identified that were associated with worse patient-reported outcomes compared to baseline after either operative or nonoperative treatment. At 2-year followup, the treatment effects were greater for those patients with upper-level herniations, patients not receiving workers compensation, and nondiabetic patients. In a 4-year multivariate analysis, being married, without joint problems, and having worse symptoms at baseline resulted in greater treatment effect with surgery.

Conclusions While most patients with IDH will likely see improvement with either surgical or nonoperative treatment, there are patient-related factors that can help predict which subgroups will demonstrate a greater improvement with surgery, such as not having joint problems, being married, having worsening symptoms at baseline, and not having diabetes. These results can help providers and patients when discussing treatment options.

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J. D. Koerner, K. Radcliff (✉)
Rothman Institute, Thomas Jefferson University, 925 Chestnut Street, 5th Floor, Philadelphia, PA 19107, USA
e-mail: radcliffk@gmail.com

J. Glaser
Department of Orthopedics, Drexel University College of Medicine, Philadelphia, PA, USA

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Introduction

The Spine Patient Outcomes Research Trial (SPORT) was a multicenter prospective randomized controlled trial evaluating three of the most common spine conditions: lumbar intervertebral disc herniation (IDH), spinal stenosis, and degenerative spondylolisthesis. For patients with lumbar IDH, the as-treated and observational cohorts have demonstrated the benefits of surgery over nonoperative treatment, with up to 8-year followup now available [10, 21–23]. While almost all patients with IDH will improve over time, evaluating specific patient factors can help predict which patients will improve with surgery or nonoperative treatment, which is helpful for surgeon decision making and patient counseling.

The SPORT methodology also enabled comparison of groups of similarly treated patients to determine whether patient or clinical factors influenced patient-reported outcomes. Multiple subgroup analyses have been completed with the SPORT data to evaluate patient factors that predict which patients do better with operative or nonoperative treatment. These studies generally present data as differences in one of the primary or secondary patient-reported outcome measures at various time points or as treatment effect, which is the mean difference in the patient-reported outcome measure from baseline between the surgical group and nonsurgical group (for example, the treatment effect for the outcome SF-36 bodily pain = change in SF-36 bodily pain of operative group − change in SF-36 bodily pain for nonoperative group). Recently, comparative analysis of the treatment effect for the Oswestry Disability Index (ODI) was calculated for 37 variables for this group of patients and for the spinal stenosis cohort [12, 13]. However, there is no single study reviewing the findings and treatment effects of the SPORT subgroup analyses. It is important for clinicians to have a comprehensive understanding of these analyses when discussing treatment options with patients with IDH. Subgroup analyses may help physicians to have more precise prognoses by determining how particular patient factors (such as age, obesity, duration of symptoms, or herniation level) may affect particular outcome.

We reviewed the predictors of patient-reported outcomes after discectomy and nonoperative treatment for lumbar IDH using SPORT-related studies by asking the following three questions: (1) What factors predicted improvement in patient-reported outcomes after operative or nonoperative treatment of lumbar IDH from the SPORT data? (2) What factors predicted worse patient-reported outcomes compared to baseline after operative or nonoperative treatment of lumbar IDH from the SPORT data? And (3) what factors influenced patient-reported outcomes (SF-36 bodily pain, SF-36 physical functioning, and ODI) in patients with lumbar IDH in the SPORT studies?

Table 1. SPORT studies reporting on predictors of outcomes for patients with IDH

Study	Groups
Pearson et al. [14]	Central herniation (n = 131)
	Lateral herniation (n = 1059)
	Protrusion (n = 322)
	Extrusion/sequestration (n = 868)
Lurie et al. [9]	L2–L3 or L3–L4 (n = 88)
	L4–L5 (n = 456)
	L5-S1 (n = 646)
Altas et al. [3]	Workers compensation (n = 113)
	No workers compensation (n = 811)
Freedman et al. [6]	Diabetes (n = 40)
	No diabetes (n = 1145)
Rihn et al. [17]	Symptoms $<$ 6 months (n = 927)
	Symptoms $>$ 6 months (n = 265)
Olson et al. [11]	High school or less (n = 287)
	Some college (n = 321)
	College graduate or above (n = 563)
Desai et al. [5]	Durotomy (n = 25)
	No durotomy (n = 774)
Radcliff et al. [16]	ESIs within 3 months after enrollment (n = 154)
	No ESIs (n = 453)
Radcliff et al. [15]	Nonopioid group (n = 520)
	Opioid group (n = 542)
Rihn et al. [18]	Nonobese (n = 854)
	Obese (n = 336)
Kang et al. [8]	No retrolisthesis (n = 96)
	Retrolisthesis (n = 29)

SPORT = Spine Patient Outcomes Research Trial; IDH = intervertebral disc herniation; ESIs = epidural steroid injections.

Search Strategy and Criteria

We performed a systematic review using a MEDLINE® search to identify all subgroup analyses of the SPORT IDH group. Search criteria included "SPORT" AND "disc" AND "Spine Patients Outcomes Research Trial," which returned 36 articles. Of these, we identified 11 articles that analyzed subgroups of the SPORT patients with IDH [3, 5, 6, 8, 9, 11, 14–18] (Table 1). A listing of SPORT-related papers published through 2011 can also be found on the Dartmouth website (http://www.dartmouth.edu/sport-trial/Related_Papers/default.htm). These articles reported results using SF-36 bodily pain, SF-36 physical functioning, ODI, Sciatica Bothersome Index (SBI), and Low Back Pain Bothersomeness Index. Improvement in patient-reported outcomes after treatment was defined as a significant difference ($p < 0.05$) in the outcome measure of interest. A worse outcome was defined as an increase in ODI or decrease in SF-36 measures over the period of evaluation. A significant difference in treatment effects ($p < 0.1$) for SF-36 bodily pain, SF-36 physical function, and ODI among the subgroups defined what factors were associated with the treatment effect of surgery. We chose to present and interpret the major patient-reported outcomes for 1-, 2-, and 4-year followup, as these data were available for most of the studies.

The inclusion criteria for the SPORT were patients older than 18 years, with radicular pain for at least 6 weeks despite nonoperative treatment, a positive nerve root tension sign and/or neurologic deficit, and confirmatory imaging corresponding to their symptoms. Exclusion criteria included prior lumbar spine surgery, cauda equine syndrome, scoliosis of more than 15°, segmental instability, fractures, infection, tumor, spondyloarthropathy, pregnancy, comorbidities prohibiting surgery, or inability to have surgery within 6 months [21, 23]. SPORT patients were able to participate in a randomization process or an observational cohort. In total, there were 1244 participants, with 501 in the randomized cohort and 743 in the observational cohort. In the randomized group, 43% of patients assigned to surgery ended up not having surgery, and 41% of those assigned to the nonoperative group had surgery at 1 year [23]. Time-weighted averages of outcomes for each group (operative and nonoperative) were calculated to evaluate the two arms across the study periods. Further details of statistical analyses can be found in the original manuscripts [1–5, 7, 10–14, 21, 23].

Results

Factors Associated With Improvement in Patient-reported Outcomes

There were many patient factors associated with improvement in patient-reported outcomes after either operative or nonoperative treatment, including increasing ODI, white race (versus black, other), no missed work, no antidepressant use, lower SBI, income of greater than USD 50,000, no opioid use, no lifting at work, lower BMI, problem getting better, no prior injections, no workers compensation, no joint problems, baseline SF-36 mental component summary score of greater than 35, being insured, nonsmokers, not being depressed, having symptoms less than 6 months, no litigation, at least some college or more, no other comorbidities, and less than 6 weeks' duration of symptoms (Table 2). The patient factors

Table 2. Factors leading to improved 4-year outcomes (greater ODI change) based on treatment method ($p < 0.05$) [12, 17, 18]

Treatment	Factor	p value	
		Surgery	Nonoperative
Nonoperative	No hypertension		0.042
	Single		< 0.001
Surgery	Predominantly leg pain (vs back pain)	0.002	
	Sensation intact (vs sensory deficit)	0.046	
	Posterolateral herniation (vs other location)	< 0.001	
	No physical therapy	0.036	
	Sequestered herniation (vs extruded or protruding)	0.004	
	Married (vs divorced/widowed)	< 0.001	
Either surgery or nonoperative	Increasing ODI	< 0.001	< 0.001
	Lower SBI (≤ 16)	0.001	0.006
	Lower BMI (< 30), nonobese	< 0.001	0.034
	No joint problems	< 0.001	0.005
	Not depressed	< 0.001	< 0.001
	No other comorbidities	< 0.001	< 0.001
	No stomach problems	< 0.001	< 0.001
	Problem getting better	< 0.001	< 0.001
	No opioid use	0.001	0.005
	No antidepressant use	< 0.001	0.002
	Nonsmoker	< 0.001	< 0.001
	White race (vs black, other)	0.004	< 0.001
	Income > USD 50,000	< 0.001	< 0.001
	Baseline SF-36 MCS >35	< 0.001	< 0.001
	Symptoms ≤ 6 months	< 0.001	0.006
	≤ 6 weeks' duration	< 0.001	< 0.001
	No missed work	0.015	0.04
	No prior injections	< 0.001	0.001
	Insured	< 0.001	0.019
	No litigation	< 0.001	<0.001
	No lifting at work	< 0.001	<0.001
	No workers compensation	< 0.001	<0.001
	At least some college or more	< 0.001	<0.001

ODI = Oswestry Disability Index; SBI = Sciatica Bothersomeness Index; MCS = mental component summary.

associated with improvement only with surgical treatment included predominantly leg pain (versus back pain), sensation being intact (versus sensory deficit), having a posterolateral herniation, not undergoing physical therapy, and sequestered/extruded disc. The only patient factor that predicted better patient-reported outcomes only in the nonoperative group was not having hypertension.

Factors Associated With Worse Patient-reported Outcomes

There were no patient factors or subgroups identified that predicted worse patient-reported outcomes compared to baseline after either operative or nonoperative treatment of lumbar IDH. The mean change from baseline for SF-36 and ODI improved for all subgroups after both nonoperative and surgical treatment. Of note, there were also no differences in ODI, SF-36 bodily pain, SF-36 physical functioning, or SBI in patients with and without durotomy at all time points up to 4 years [5].

Factors Influencing Treatment Effect of Surgery

Overall, patients with workers compensation had similar improvement with surgery and nonoperative treatment at early time points, but the benefits of surgery diminished over time. For the SF-36 bodily pain measure at 2 years, patients receiving workers compensation improved more with nonoperative treatment compared to patients not receiving workers compensation (treatment effect: −5.9 [95% CI : −16.7 to 4.9] versus 11 [95% CI : 7.7–14.4], respectively) ($p = 0.003$) [3]. The minimum clinically important difference for SF-36 physical component summary has previously been defined as 4.9 points [4]. Therefore, the effect size exceeded a commonly used minimum clinically important difference in lumbar pathology, although this value may not be specific for patients with lumbar IDH and lumbar discectomy. All other time points demonstrated a positive treatment effect for SF-36 bodily pain for both patients receiving and not receiving workers compensation. Patients with diabetes did not benefit from surgery relative to nonoperative treatment. At 2-year followup, patients with diabetes improved more with nonoperative treatment compared to surgery based on SF-36 physical functioning (treatment effect: −2.7 [95% CI: −16 to 10.7]) and ODI (treatment effect: 2.1 [95% CI: −8.8 to 13]) [6]. Obese patients did not improve as much as nonobese patients in both the operative and nonoperative groups. However, there was not a difference in the level of improvement with nonoperative treatment versus surgical treatment at 4 years based on obesity (p values for treatment effect of SF-36 bodily pain, SF-36 physical functioning, SF-36 mental component summary, and ODI of 0.35, 0.64, 0.77, and 0.50, respectively) [18].

At 2-year followup, based on herniation location and morphology, there were no differences in treatment effects of surgery (back pain bothersomeness) ($p = 0.62$ and $p = 0.82$, respectively) [14] (Table 3). For herniation level, patients with upper levels compared to L5-S1 had greater improvements with surgery than nonoperative management based on SF-36 bodily pain, SF-36 physical functioning, and ODI ($p = 0.002$, $p = 0.014$, and $p = 0.033$, respectively) [9]. There were no differences in patient-reported outcomes for patients with duration of symptoms of less than or greater than 6 months for SF-36 bodily pain, SF-36 physical functioning, and ODI ($p = 0.14$, $p = 0.86$, and $p = 0.5$, respectively) [17]. Based on education, there were no differences in improvement for SF-36 bodily pain, SF-36 physical functioning, and ODI ($p = 0.54$, $p = 0.26$, and $p = 0.088$, respectively) [11]. There were also no differences based on durotomy or no durotomy ($p = 0.47$, $p = 0.08$, and $p = 0.68$, respectively) [5] or for those receiving or not receiving epidural steroid injections ($p = 0.33$, $p = 0.81$, and $p = 0.81$, respectively) [16]. There were also no differences in level of improvement for patients using or not using opioids ($p = 0.89$, $p = 0.89$, and $p = 0.89$, respectively) [15].

After controlling for potential confounding variables, there were three variables independently associated with a greater improvement with surgery: being married (versus being single) (treatment effect: −15.8 versus −7.7; $p < 0.001$), not having joint problems (versus having joint problems) (treatment effect: −14.6 versus −10.3; $p = 0.012$), and having worsening symptoms at baseline (versus stable symptoms) (treatment effect: −15.9 versus −11.8; $p = 0.032$) [8]. For patients undergoing L5-S1 discectomy, those with retrolisthesis (versus no retrolisthesis) demonstrated less improvement for SF-36 bodily pain and SF-36 physical functioning at 4 years ($p = 0.043$ and $p = 0.059$, respectively) with no change in ODI or SBI [8].

Discussion

Many subgroup analyses of the SPORT have been completed since the original study to determine the patient-reported outcomes of specific, clinically relevant patient subgroups. The patient factors that lead to better or worse patient-reported outcomes have been previously defined; however, identifying the degree to which these factors influence outcomes can be difficult to interpret. We reviewed these studies to answer the following questions: (1) What factors predicted improvement in patient-reported outcomes after operative or nonoperative treatment of

Table 3. One- and 2-year treatment effect by group studied

Group	Treatment effect (95% CI)					
	ODI		SF-36 bodily pain		SF-36 physical functioning	
	1 year	2 years	1 year	2 years	1 year	2 years
Upper levels (L2–L3 or L3–L4)	−19.7 (−28.6, −10.8)	−19 (−27.7, −10.2)	24.5 (13, 36)	24.6 (13.2, 36)	24 (12.4, 35.7)	23.4 (11.9, 34.9)
L4–L5	−14.6 (−18.1, −11.1)	−13.8 (−17.3, −10.3)	13.6 (9.1, 18)	11.6 (7, 16.1)	17.4 (13.2, 21.6)	17.1 (12.8, 21.4)
L5–S1	−13.4 (−16.4, −10.4)	−10.3 (−13.4, −7.2)	10.6 (6.7, 14.4)	7.1 (3.1, 11.1)	14.5 (10.9, 18.1)	9.9 (6.2, 13.6)
p value (for upper vs L5–S1) [9]	NA	0.033	NA	0.002	NA	0.014
Workers compensation	−2.2 (−9.9, 5.5)	−2 (−10.3, 6.3)	2.2 (−7.7, 12.2)	−5.9 (−16.7, 4.9)	5 (−4.2, 14.2)	5 (−4.9, 15)
No workers compensation	−14.4 (−17, −11.8)	−12.5 (−15.2, −9.9)	12.2 (8.9, 15.5)	11 (7.7, 14.4)	16.4 (13.3–19.5)	13.4 (10.3, 16.5)
p value [3]	0.003	0.018	0.06	0.003	0.02	0.11
Diabetes	−3.3 (−14, 7.5)	2.1 (−8.8, 13)	6.8 (−7.7, 21.3)	0.1 (−14.6, 14.8)	1.2 (−11.9, 14.4)	−2.7 (−16, 10.7)
No diabetes	−14 (−16.1, −11.9)	−11.9 (−14, −9.7)	12.7 (9.9, 15.5)	10.1 (7.2, 13)	15.5 (13, 18.1)	13 (10.4, 15.6)
p value [6]	0.054	0.013	0.43	0.19	0.036	0.024
Symptoms < 6 months	−17.2 (−19.9, −14.6)	−15 (−17.7, −12.3)	15.6 (12.1, 19)	12.8 (9.3, 16.3)	20 (16.8, 23.3)	16.8 (13.5, 20.1)
Symptoms > 6 months	−18.1 (−22.2, −14)	−16.7 (−20.8, −12.5)	17.5 (12.1, 22.9)	17.7 (12.2, 23.2)	17 (12, 22)	16.3 (11.2, 21.4)
p value [17]	0.72	0.5	0.55	0.14	0.31	0.86
High school or less	−17.1 (−21.3, −12.9)	−16.6 (−20.9, −12.3)	16.8 (11.1, 22.4)	14.9 (9, 20.8)	18.6 (13.5, 23.7)	17 (11.7, 22.3)
Some college	−17.3 (−21.2, −13.3)	−11 (−15.1, −7)	17.7 (12.4–23.1)	11 (5.5, 16.5)	19.7 (14.8, 24.5)	11.3 (6.3, 16.3)
College graduate or above	−11.8 (−14.7, −9)	−11.4 (−14.3, −8.5)	11.9 (8, 15.7)	11.3 (7.3, 15.2)	12.7 (9.2, 16.3)	12.8 (9.3, 16.4)
p value [11]	0.004	0.088	0.13	0.54	0.032	0.26
No ESIs	−15.3 (−19, −11.7)	−13.7 (−17.3, −10.1)	15.4 (10.4, 20.4)	15 (10, 20)	18 (13.5, 22.5)	14.4 (9.9, 19)
ESIs	−16.3 (−21.1, −11.5)	−13 (−17.7, −8.2)	15.4 (8.4, 22.3)	10.8 (3.9, 17.7)	15.7 (9.6, 21.8)	15.4 (9.3, 21.4)
p value [16]	0.75	0.81	0.99	0.33	0.54	0.81
Nonopioid	−6.2 (−10, −2.4)	−4.8 (−8.6, −1)	4.2 (−0.5, 9)	5.3 (0.5, 10.1)	6.7 (2.2, 11.3)	6.4 (1.8, 10.9)
Opioid	−8 (−11.9, −4)	−5.1 (−9.2, −1.1)	7.6 (2.7, 12.6)	5.7 (0.7, 10.8)	8.3 (3.5, 13)	5.9 (1.1, 10.7)
p value [15]	0.48	0.89	0.28	0.89	0.60	0.89
Nonobese	−13.3 (−15.8, −10.8)	−13.6 (−16.1, −11.1)	13.4 (10, 16.7)	13.1 (9.7, 16.5)	14.8 (11.8, 17.9)	13.4 (10.4, 16.5)
Obese	−18.5 (−22.2, −14.7)	−10.1 (−14, −6.2)	17.5 (12.3, 22.6)	10.2 (4.8, 15.6)	19 (14.4, 23.7)	13.1 (8.3, 18)
p value [18]	0.021	0.13	0.18	0.36	0.13	0.91

ODI = Oswestry Disability Index; ESIs = epidural steroid injections; NA = not applicable.

lumbar IDH from the SPORT data? (2) What factors predicted worse patient-reported outcomes compared to baseline after operative or nonoperative treatment of lumbar IDH from the SPORT data? And (3) what factors influenced treatment effect of surgery in patients with lumbar IDH in the SPORT studies?

There are limitations to this review. While it is beneficial to review data from the same group of patients, it is difficult to interpret the results in aggregate, as each study may have controlled for different variables in its analyses, which may give the appearance of different results for the same patient-reported outcomes. Pearson et al. [12] studied the treatment effect for ODI at 4 years, which included many of the variables that had been analyzed individually in previous studies. Their multivariate analysis identified three variables associated with a greater treatment effect for ODI: being married, not having joint problems, and worsening symptom trend at baseline [12]. Furthermore, subgroup analyses should be interpreted with caution, as they may be susceptible to Type II error and be underpowered to detect a true negative result, in addition to other limitations [19]. One limitation of the SPORT, and therefore this study, is the high crossover rate observed between the operative and nonoperative groups. However, because previous authors found consistencies between cohorts, the data have been combined into an as-treated analysis in many of the studies included in this review [3, 5, 6, 8, 9, 11, 14–18]. Also, the 8-year followup rate was 63% of the initial subjects, and baseline demographics tended to be favorable to a better outcome in both the surgical and nonoperative groups [10]. This may overestimate the effects of treatment in both groups. Also, it should be noted that the SPORT was not powered to assess the subgroup analyses included in this review.

Treatment effect is a useful way to compare the relative benefit of surgery to nonoperative treatment between patients with two conditions; however, other factors should be considered when discussing the treatment plan with a patient. The magnitude of the treatment effect must be taken into consideration with the potential risks of the proposed surgery. A small treatment effect in favor of surgery at 1-, 2-, or 4-year followup may not be worth a prolonged recovery for some patients. The treatment effect should be studied in conjunction with individual surgical and nonsurgical outcomes to understand whether this difference is coming from the surgical group doing extraordinarily well, the nonoperative group not improving at all, or vice versa. An example of this is seen with the effect of education on patient-reported outcomes, which Olson et al. [11] explained in their discussion. While the treatment effect is greater in patients with a high school education or less than in the college graduate or above group (−17.1 versus −11.8, respectively), both groups had similar ODI changes after surgery (−36.2 versus −37.7, respectively), but the college graduate or above group did very well with nonoperative treatment as well (−25.9), making their relative treatment effect lower [11].

Based on the mean change from baseline for SF-36 and ODI, there were no subgroups identified in either the surgical or nonoperative group that became worse compared to baseline. These findings are similar to those of previous studies with 5- and 10-year patient-reported outcomes that have found good results and improvement in predominant symptom compared to baseline in both surgical and nonsurgical groups [1, 2, 20]. The level of improvement does vary based on the subgroups analyzed, as well as by the treatment method, which is further described in the treatment effects.

All subgroups in the SPORT IDH study improved more with surgery than with nonoperative treatment based on mean treatment effects for ODI, SF-36 bodily pain, and SF-36 physical functioning at all time points, with the exception of patients receiving workers compensation, where the initial benefits of surgery decreased over time to a nonsignificant difference at 2 years (SF-36 bodily treatment effect of −5.9 at 2 years [95% CI: −16.7 to 4.9]), and patients with diabetes [6]. These findings are similar to those of previous studies demonstrating that surgically treated patients tend to improve more than nonsurgically treated patients [1, 2, 20]. The minimum clinically important differences for ODI and SF-36 physical component summary have previously been defined as 12.8 and 4.9 points, respectively [4]. For the workers compensation analysis, the authors reported that this difference came from worsening patient-reported outcomes in the surgically treated workers compensation group over time [1]. Previous studies have also demonstrated an association between workers compensation status and patient-reported outcomes after surgery [7]. Most of the ODI changes for surgery were associated with anatomic characteristics of the disc herniation (ie, posterolateral, sequestered herniation) or direct effects of the disc herniation (predominantly leg pain, intact sensation). Surgical intervention did not demonstrate a benefit over nonoperative treatment for patients with diabetes, although there were baseline differences between the two groups, including older age, higher BMI, and a higher incidence of hypertension and stroke in the group with diabetes [6].

Based on this review, patients who see more benefit from surgical intervention for IDH include those with an upper lumbar IDH (L2–L3, L3–L4), those who are married, those without joint problems, and those with worsening symptom trend at baseline. Patients with college education or more do very well with operative or nonoperative treatment but do better than less educated patients with nonoperative treatment, leading to a lower treatment effect.

Patients with diabetes or with workers compensation should be counseled about the possibility of not improving more with surgical treatment compared to nonoperative treatment over time. In patients undergoing L5-S1 discectomy, retrolisthesis may lead to worse postoperative patient-reported outcomes, compared to patients without retrolisthesis. Obese patients do not benefit as much as nonobese patients, but both groups benefit from surgery over nonoperative treatment. While there are limits to the subgroup analyses from the SPORT, the results can provide clinicians and patients with valuable information for informed decision making and lead to good outcomes in carefully selected patients.

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