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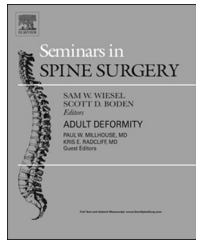

Evidence-based approach to lumbar disc herniation: Findings from the SPORT trial (primary and subgroup analyses)

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ABSTRACT

The SPORT disc herniation study was the largest study ever performed comparing surgical and nonoperative outcomes for lumbar disc herniation. The study demonstrated that patients improved significantly with both surgery and nonoperative treatment; however, patients treated surgically improved faster and to a greater degree. These results were maintained through 8 years of follow-up. Subgroup analyses demonstrated that many patients and disease characteristics were associated with both surgical and nonoperative outcomes; however, very few predicted surgical treatment effect. All examined subgroups improved more with surgery than nonoperative treatment over 4 years of follow-up. Complications were relatively rare and tended not to affect long-term outcomes.

Introduction

The Spine Patient Outcomes Research Trial (SPORT) was performed to compare nonoperative treatment and surgery for lumbar intervertebral disc herniation (IDH) in an attempt to create higher quality evidence around treatment of this common problem.[1–3] Prior studies on this topic included Weber's classic randomized controlled trial (RCT) and the Maine Lumbar Spine Study (MLSS), both of which had methodological limitations.[4,5] Both operative and nonoperative treatment had showed benefit for patients, with long-term studies showing that many individuals with symptomatic disc herniation improve over time without intervention.[6] The SPORT was performed with both a randomized and an observational design in order to maximize enrollment and generalizability. Since its original publication in 2006, numerous articles have been published following the SPORT IDH cohort in the long-term along with multiple subgroup analyses to identify patient factors associated with surgical and nonoperative outcomes.

Methods and characteristics of SPORT

The SPORT involved 13 centers and included strict inclusion criteria for IDH.[2] All patients had radicular pain for at least 6 weeks prior to enrollment, cross-sectional imaging demonstrating a disc herniation consistent with their symptoms, and a positive nerve root tension sign or corresponding neurologic deficit. The exclusion criteria were prior lumbar surgery, cauda equina syndrome, scoliosis, fracture, infection, tumor, inflammatory arthropathy, and comorbidities that precluded surgery. Patients meeting the enrollment criteria were encouraged to participate in the RCT, and those who declined randomization were asked to enroll in the observational arm of the study.

Surgical treatment was open discectomy with examination of the involved nerve root, performed in the prone or knee chest position using loupe magnification or a microscope. Nonoperative treatment was specified as "usual care" and included a minimum of active physical therapy, education

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with home exercise instruction, and non-steroidal anti-inflammatory drugs if tolerated. The use of other nonoperative treatments such as epidural steroid injection, narcotic pain medication, modality-based physical therapy, and acupuncture was at the discretion of the patient and provider.

The primary outcome measures were the changes from baseline in the 36-Item Short Form Health Survey (SF-36) bodily pain and physical function scales as well as the American Academy of Orthopaedic Surgeons (AAOS) version of the Oswestry Disability Index (ODI). Outcomes were measured at 6 weeks, 3 months, 6 months, 12 months, and then yearly out to 8 years following enrollment.

Primary results

In the randomized component of the SPORT trial, the intent to treat analysis did not reveal any statistically significant outcome differences between the operative ($n = 140$) and nonoperative groups ($n = 92$). Both treatment groups improved significantly compared with their baseline as within the first 2 years (Fig. 1).[2] However, by 2-year follow-up, 45% of patients assigned to nonoperative treatment had been treated surgically, and 40% of patients assigned to surgery had not undergone surgery.

In the observational cohort, both the groups improved significantly from baseline, but the surgery group ($n = 528$) improved significantly more than the nonoperative group ($n = 191$) on all primary outcome measures. At 2 years, the treatment effect of surgery (i.e., the difference in change scores between the surgery and nonoperative groups) was 10.2 points on the SF-36 bodily pain scale, 12.0 points on the physical function scale, and 13.4 points on the ODI (Fig. 2). Secondary outcome measures, including sciatica bothersomeness, patient satisfaction, and self-rated improvement, also significantly favored surgery. Work status was the one exception, and there were no significant differences in return to work rates out to 2 years. At that point, over 85% of surgery and nonoperative patients were working full or part-time.

At 4 years, the intent to treat analysis from the RCT favored surgery for all primary outcome measures, but the differences were not statistically significant.[7] Only 59% of patients assigned to surgery had undergone discectomy by 4 years, and 45% randomized to nonoperative treatment had undergone surgery. Given these high levels of protocol nonadherence, an as-treated analysis including patients from both the RCT and observational cohort was performed. Similar to the 2-year data from the observational cohort, this analysis demonstrated that surgery resulted in significantly greater improvements on the SF-36 bodily pain (treatment effect of surgery = 15) and physical function (treatment effect of surgery = 14.9), subscales and the ODI (treatment effect of surgery = 13.2). Secondary outcome measures also continued to significantly favor surgery (sciatica bothersomeness, satisfaction, and self-rated improvement) throughout the 4-year mark. However, work status was not statistically significant different between the operative and nonoperative groups at 4 years, with 84% of the operative group having returned to work compared to 78% from the nonoperative group. The positive treatment effect of surgery persisted out to 8 years in the SPORT as-treated analysis, similar to the findings of the MLSS that showed a persistent advantage to surgery out to 10 years.[4,8] The smaller Weber RCT showed more convergence of the surgical and nonoperative results beyond 4 years, and the advantage of surgery was no longer significant in the long-term follow-up.[5] The treatment effect of surgery through 8 years was 10.9 points on the SF-36 bodily pain scale, 10.6 points on the physical function scale, and 11.2 points on the ODI (Fig. 3).[8]

Subgroup analyses

While the primary analyses demonstrated a clear benefit of surgery compared with nonoperative treatment for disk herniation patients meeting strict indications for surgery, spine surgeons are well aware of the effect of patient characteristics and comorbidities on outcomes.[9] As such, multiple post-hoc subgroup analyses were performed in an effort to determine if certain variables were associated with the treatment effect of surgery. If some subgroups had a greater or diminished benefit of surgery relative to nonoperative treatment, these patients could be counseled about their likely outcomes at the individual level rather than

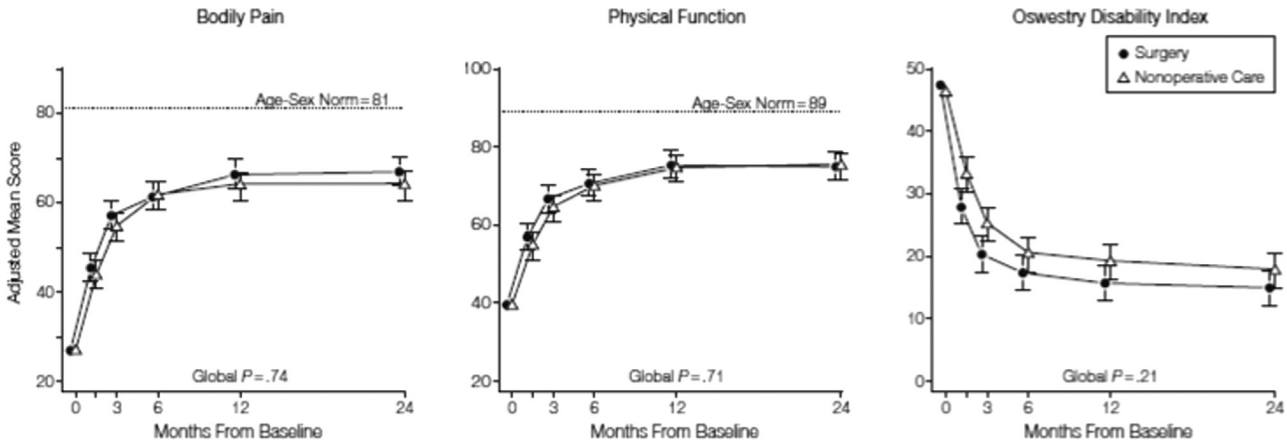

Fig. 1 – Main outcomes from the SPORT disk herniation RCT (intent to treat analysis).

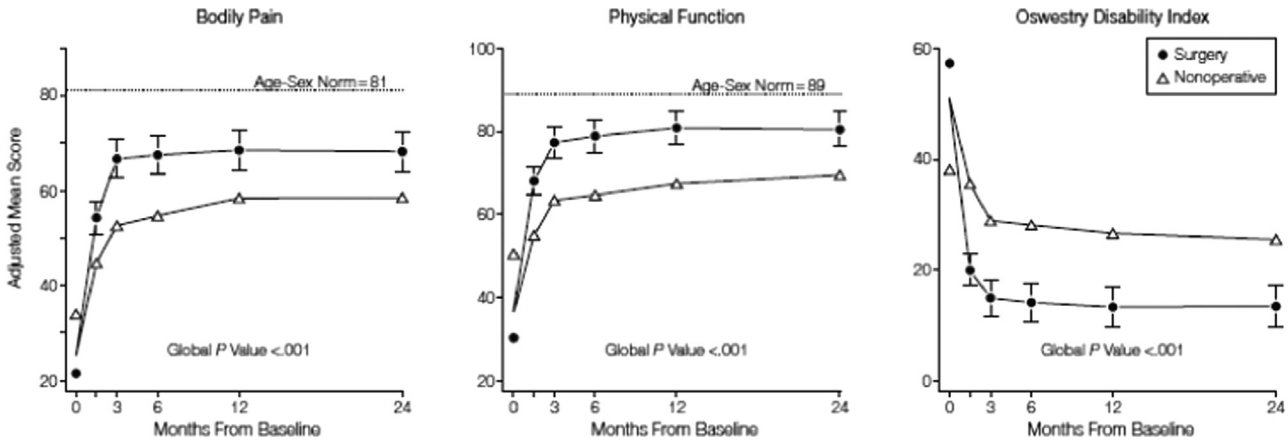

Fig. 2 – Main outcomes from the SPORT disk herniation observational cohort study (as-treated analysis).

assuming all patients would have results similar to the "average" patient described in the primary analyses.

One subgroup analysis of SPORT examined educational attainment and its effect on patient outcomes.[10] The authors separated the SPORT study intervertebral disk herniation group into 3 cohorts based on attained educational level: (1) high school diploma or lower, (2) some college, and (3) college degree. Age, gender, ethnicity, and race will similar for all 3 groups. Those in the lowest education group had significantly less household income, higher rates of workers' compensation, were less likely to have full-time employment, and reported greater disability and pain at baseline compared with the higher education groups.

The primary outcome measures of bodily pain, physical function, and Oswestry disability index were examined and, regardless of education, operative treatment was associated with better outcomes than nonoperative treatment for all of the primary outcomes across all time periods. Interestingly, this analysis found that within the nonoperative treatment group, the more educated cohort experienced significantly greater improvement. This more pronounced benefit served to attenuate the treatment effect of surgery in the higher education group. For example, at 4 years, surgical patients improved about 48 points on the SF-36 bodily pain scale regardless of education. However, the college-educated patients improved 36 points with nonoperative treatment compared with 26 points for the patients with a high school education or less. This resulted in a significantly greater treatment effect of surgery for the group with the least education. Other studies have shown similar results, with worse baseline and post-operative pain and disability scores in spine surgery patients with less education.[9] Interestingly, this is the first article to document that the effect is more pronounced on nonoperative treatment. If anything, the results indicate that surgery could be considered a better treatment option for patients with less education as their nonoperative treatment outcomes tend to be worse.

Anecdotally, surgeons have felt that central disk herniations tend to be associated with greater back pain, whereas more lateral herniations tend to be associated with more leg pain. Additionally, extrusions or sequestrations have been thought to respond better to surgery than protrusions. As

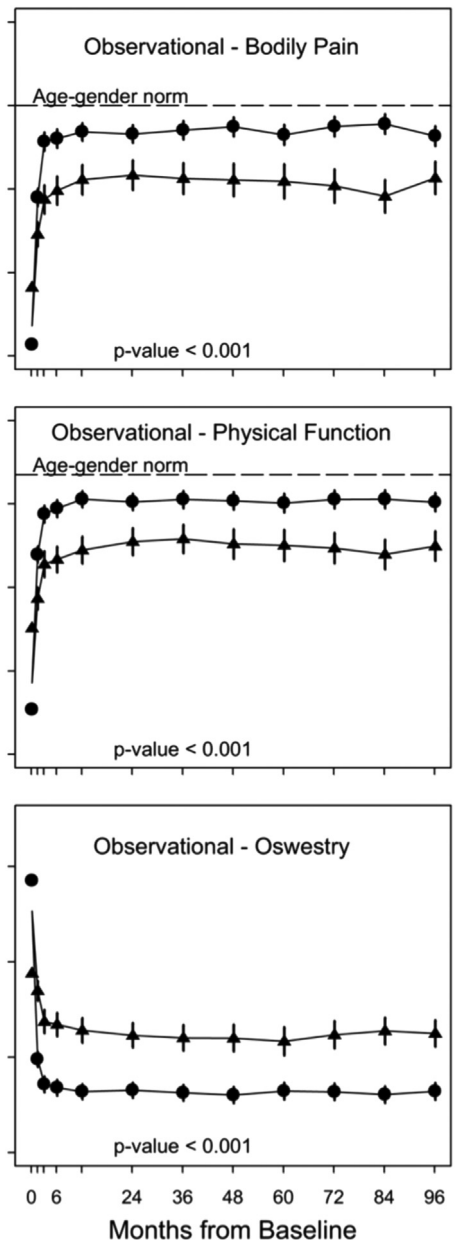

Fig. 3 – The 8-year outcomes from the SPORT disk herniation observational cohort study.

such, a subgroup analysis evaluated the effect of herniation location (central vs. lateral) and morphology (protrusion vs. extrusion/sequestration) on low back pain.[11] Overall, leg pain improved more than back pain in both the nonoperative ($n = 416$) and surgical groups ($n = 775$), regardless of location of herniation or morphology. Surgery resulted in greater relief of back and leg pain than nonoperative treatment for all location and morphology subgroups. At baseline, patients with central disk herniations had significantly greater back pain than patients with more lateral herniations, though both groups improved to a similar degree with surgery or nonoperative treatment. Patients with protrusions had less severe symptoms at baseline compared with those with extrusions or sequestrations, though herniation morphology did not affect outcomes.

The effect of herniation level on outcomes was also evaluated in a subgroup analysis with 2-year follow-up.[12] The levels were stratified into the following groups: (1) L5–S1 ($n = 646$), (2) L4–L5 ($n = 456$), and (3) L2–3 and L3–4 ($n = 88$). Patients improved more with surgery than nonoperative treatment regardless of herniation level. However, the treatment effect of surgery was significantly greater at the more cephalad levels than at L5–S1. At 2 years, the upper lumbar herniation group had a treatment effect of surgery of 19 points on the ODI compared with 10 points for the L5–S1 group. The L4–L5 group had intermediate results. The main driver of the differences was a greater degree of improvement with nonoperative treatment in the patients with herniations at L4–5 or L5–S1. It is possible that the decreased space in the spinal canal at the more cranial levels limited the degree of improvement with nonoperative care.

Another analysis evaluated the effect of workers' compensation on outcomes.[13] A total of 113 workers' compensation patients were enrolled, with 76 in the operative group and 37 in the nonoperative group. The non-claim patients totaled 811, with 470 in the operative group and 341 in the nonoperative group. Among RCT patients at 6 weeks, workers' compensation patients assigned to surgery were significantly more likely to have undergone surgery (84%) compared with the non-claim patients randomized to surgery (70%). A similar phenomenon was also observed among the RCT patients assigned to nonoperative care, with workers' compensation patients crossing over to surgery at significantly higher rate (46%) than those without claims (31%). The workers' compensation patients were younger, included more men, more cigarette smokers, and more patients with a high school education or less. Additionally, the workers' compensation patients had more self-reported pain and disability at baseline. From 6 months onward, the workers' compensation patients improved significantly less with surgery compared with the non-claim patients and had no significant benefit from surgery compared with nonoperative treatment on most outcome measures.

The association between obesity and outcomes was examined in another subgroup analysis.[14] Obese patients with a BMI greater than 30 had worse baseline scores for all three primary outcome measures (ODI, physical function, and bodily pain). Obese patients tended to improve less with both surgery and nonoperative treatment compared with the nonobese group, though the treatment effect of surgery was similar for the 2 groups. Obesity was associated with significantly greater operative time (87 vs. 72 min), greater blood loss (83 vs. 56 mL), and greater length of stay (1.2 days vs. 09 days). Interestingly, obesity was not associated with infection rate or re-operation, though the rates of these events were very low, which likely precluded meaningful statistical comparisons.

As can be seen, many subgroup analyses were performed in order to determine if certain patient characteristics were associated with the treatment effect of surgery. The selection of variables to analyze in these papers tended to be based on prior literature and the anecdotal experience of the investigators. In order to perform a more systematic analysis of the association between patient and disease characteristics and outcomes, over 50 variables were evaluated as potential treatment effect predictors in univariate and subsequently multivariate models.[15] Over 4 years of follow-up, all evaluated subgroups improved significantly more on the ODI with surgery than with nonoperative treatment. This study demonstrated that many factors were associated with both surgical and nonoperative outcomes; however, relatively few predicted differences in the treatment effect of surgery. In the final multivariate model, being married, the absence of joint problems, and worsening symptoms remained as independent predictors of a greater treatment effect of surgery.

Surgical complications

Complications were relatively rare. The most common complication was dural tear, occurring in 3% of patients overall.[8] While durotomy resulted in prolonged operative time and increased length of stay, it had no effect on patient reported outcomes.[16] By 8 years, 15% of surgery patients had undergone a re-operation, and 85% of these reoperations were for recurrent disc herniation. One death occurred within 90 days of surgery, and this occurred in the setting of heart surgery at another institution and was judged not related to the discectomy. No cases of significant neurological decline were reported with nonoperative care.

Conclusion

The SPORT disc herniation study was the largest study ever performed comparing surgical and nonoperative outcomes for lumbar disc herniation. All patients met strict inclusion criteria, and this must be kept in mind when generalizing the results. While significant protocol nonadherence (i.e., crossover between assigned groups) precluded a meaningful intent to treat analysis in the RCT, the observational as-treated analysis provided strong evidence that patients improved with both surgery and nonoperative treatment; however, patients treated surgically improved faster and to a greater degree. These results were maintained through 8 years of follow-up. The SPORT disc herniation study should be considered Level 2 evidence, and all observational studies are at risk for confounding by unmeasured variables. However, robust statistical analysis adjusting for potential

confounders likely mitigated most of this risk. Subgroup analyses demonstrated that many patient and disease characteristics were associated with both surgical and nonoperative outcomes; however, very few predicted treatment effect. All examined subgroups improved more with surgery than with nonoperative treatment over 4 years of follow-up. Complications were relatively rare and tended not to affect long-term outcomes. Based on these results, lumbar disc herniation patients should be advised that they will likely improve with either surgery or nonoperative treatment, but surgery will likely result in faster recovery and a greater degree of improvement.

Disclosures

Dr. Pearson is the Spine Associate Web Editor and serves on the Spine Associate Editorial Board. Dr. McEntarfer and Dr. Klare have no disclosures to report.

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