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The SPINE JOURNAL

The Spine Journal 000 (2023) 1–12

Clinical Study

Would you do it again? Discrepancies between patient and surgeon perceptions following adult spine deformity surgery

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FDA device/drug status: Not applicable.

Author disclosures: ***SB***: Grant: depuy synthes (F, Paid directly to institution), nuvasive (F, Paid directly to institution), k2m stryker (F, Paid directly to institution), issgf (E, Paid directly to institution); Royalties: k2m stryker (F), nuvasive (C); Consulting: stryker (C), mirus (B), atec (D); Speaking and/or Teaching Arrangements: stryker (B), atec (B); Grant: Medtronic (F, Paid directly to institution), depuy synthes (F, Paid directly to institution), nuvasive (F, Paid directly to institution), globus (E, Paid directly to institution), Carlsmed (E, Paid directly to institution), sea spine (E, Paid directly to institution), stryker (F, Paid directly to institution). ***BL***: Consulting: Internation Spine Study Group Foundation (D), ***CA***: Nothing to disclose. ***DB***: Royalties: DePuy Spine (B), Globus, Blue Ocean; Stock Ownership: Progenerative Medical (B), Consulting: Blue Ocean Spine (none to date), DePuy Spine (A), Globus (B); Board of Directors: Scoliosis Research Society, International Spine Study Group; Reserch Support (Investigator Salary, Staff/Materials): DePuy Spine (E, Paid directly to institution), Pfizer (B, Paid directly to institution), Bioventus (B, Paid directly to institution). ***GM***: Royalties: Nuvasive (E), Seaspine, Stryker (C); Stock Ownership, Seaspine (B), Consulting: Nuvasive (F), Seaspine (D), Viseon (B), SI BONE (C), Board of Directors: Globus spine outreach, San Diego Spine Foundation; Scientific Advisory Board/Other Office: Seaspine (C), Nuvasive (C); Fellowship Support: Nuvasive (E), Seaspine (E). ***RE***: Royalties: Globus (B), SI BONE (B), Seaspine (C), Nuvasive (D); Stock Ownership: Carevature (A); Private Investments: Alphatec (Unknown number of options, <1% ownership), Seaspine (Unknown number of options, <1% ownership), SI BONE (Unknown number of options, <1% ownership), Nuvasive (Unknown number of options, <1% ownership); Consulting: Nuvasive (E), Seaspine (C), SI BONE (D), Medtronic (B), Carevature (B), Johnson/Johnson (B), Spine Elements (B), Neo Spine, Silony; Speaking and/or Teaching Arrangements: Radius (A); Board of Directors: San Diego Spine Foundation, Matrisys, Nocimed; Reserch Support (Investigator Salary, Staff/Materials): Medtronic (D, Paid directly to institution), Nuvasive (D, Paid directly to institution), Seaspine (D, Paid directly to institution); Fellowship Support: Nuvasive (F, Paid directly to institution), Seaspine (E, Paid directly to institution), AO, (E, Paid directly to institution). ***RH***: Royalties: DePuy (E), Globus, Seaspine; Consulting: DePuy, Globus (C), Medtronic (C), Allosource (A), Seaspine (C), PropioVision (B), Orthofix; Speaking and/or Teaching Arrangements: DePuy, Globus; Reserch Support (Investigator Salary, Staff/Materials): DePuy, Misonix; ***MG***: Innomed (C), DePuy (G); Stock Ownership: J&J (100 Share); Consulting: Medtronic (C), DePuy (E), Globus (B); Speaking and/or Teaching Arrangements: LSU Grand Round (B), Wright State (A), AO Spine (B); Trips/Travels: Scoliosis Research Society (co-chair course), DePuy (chair course), AO Spine (chair course); Board of Directors: Scoliosis Research Society (non-financial); Fellowship Support: AO Spine;Omega (varies year to year). ***EK***: Consulting: DePuy Synthes (F), Stryker (F), Medicrea Medtronic (C), Speaking and/or Teaching Arrangements: AO Spine (B); Board of Directors: AO Spine Incoming Chair, Also Fellow Chair; Fellowship Support: Fellowship Grant. ***HK***: Grant: ISSGF (Variable); Royalties: Zimmerbiomet (F), K2M Stryker (E), Acuity Surgical (B); Consulting: Nuvasive (B); Scientific Advisory Board/Other Office, Vivex Biology (A), Aspen Medical (B); Fellowship Support: AO Spine (E). ***RH***: Nothing to disclose. ***KK***: Nothing to disclose. ***VL***: Royalties: Nuvasive (C); Stock Ownership: Nemaris Inc (20%), VFT Solution LLC (50%), See spine LLC (33%); Consulting: Globus Medical (B); Alphatec (C); Speaking and/or Teaching Arrangements: Implanet (B), J&J (B), Stryker (C); Scientific Advisory Board/Other Office: ISSG; ***RL***: Nothing to disclose. ***FS***: Royalties: Medtronic (F), Zimmer Biomet (F), Medicrea (B), Stock Ownership: See spine (not compensated), VFT Solutions (not compensated); Consulting: Medtronic (B), Main Stray (C), Grants: DePuy, MDS, Sl Bone, K2M, Stryker (grants paid through ISSGF). ***CS***: ISSG Foundation (D), Royalties: NuVasive (E), Medtronic (D), Sl Bone (C); Stock Ownership: NuVasive (E); Consulting: Medtronic (C), NuVasive (B); Board of Directors: SRS; Scientific Advisory Board/Other Office: Proprio; Grants: NuVasive (B); Fellowship Support: NuVasive (E, Paid directly to institution), Globus (E, Paid directly to institution). ***JSS***: Nothing to disclose. ***ISSG***: Grant: NuVasive (G, Paid directly to institution), K2M/Stryker (F, Paid directly to institution), NuVasive (H, Paid directly to institution), Medtronic, (G, Paid directly to institution), Globus (F, Paid directly to institution), Sl Bone, (E, Paid directly to institution), Stryker (F, Paid directly to institution), DePuy Synthes Spine (G, Paid directly to institution).

Level of evidence: I-IV: Level III; prognostic.

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https://doi.org/10.1016/j.spinee.2023.04.018

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Received 11 October 2022; revised 3 April 2023; accepted 27 April 2023

Abstract

BACKGROUND: Adult spinal deformity (ASD) surgery can improve patient pain and physical function but is associated with high complication rates and long postoperative recovery. Accordingly, if given a choice, patients may indicate they would not undergo ASD surgery again.
PURPOSE: Evaluate surgically treated ASD patients to assess if given the option (1) would surgically treated ASD patients choose to undergo the same ASD surgery again, (2) would the treating surgeon perform the same ASD surgery again and if not why, (3) evaluate for consensus and/or discrepancies between patient and surgeon opinions for willingness to perform/receive the same surgery, and (4) evaluate for associations with willingness to undergo or not undergo the same surgery again and patient demographics, patient reported outcomes, and postoperative complications.
STUDY DESIGN: Retrospective review of a prospective ASD study.
PATIENT SAMPLE: Surgically treated ASD patients enrolled into a multicenter prospective study.
OUTCOME MEASURES: Scoliosis Research Society-22r questionnaire (SRS-22r), Short Form-36v2 questionnaire (SF-36) physical component summary (PCS) and mental component summary (MCS), Oswestry Disability Index (ODI), numeric pain rating for back pain (NRS back) and leg pain (NRS leg), minimal clinically important difference (MCID) for SRS-22r domains and ODI, intraoperative and postoperative complications, surgeon and patient satisfaction with surgery.
METHODS: Surgically treated ASD patients prospectively enrolled into a multicenter study were asked at minimum 2 year postoperative, if, based upon their hospital and surgical experiences and surgical recovery experiences, would the patient undergo the same surgery again. Treating surgeons were then matched to their corresponding patients, blinded to the patients' preoperative and postoperative patient reported outcome measures, and interviewed and asked if (1) the surgeon believed that the corresponding patient would undergo the surgery again, (2) if the surgeon believed the corresponding patient was improved by the surgery and (3) if the surgeon would perform the same surgery on the corresponding patient again, and if not why. ASD patients were divided into those indicating they would (YES), would not (NO) or were unsure (UNSURE) if they would have same surgery again. Agreement between patient and surgeon willingness to receive/perform the same surgery was assessed and correlations between patient willingness for same surgery, postoperative complications, spine deformity correction, patient reported outcomes (PROs).
RESULTS: A total of 580 of 961 ASD patients eligible for study were evaluated. YES (n=472) had similar surgical procedures performed, similar duration of hospital and ICU stay, similar spine deformity correction and similar postoperative spinal alignment as NO (n=29; $p>.05$). UNSURE (n=79) had greater preoperative depression and opioid use rates, UNSURE and NO had more postoperative complications requiring surgery, and UNSURE and NO had fewer percentages of patients reaching postoperative MCID for SRS-22r domains and MCID for ODI than YES ($p<.05$). Comparison of patient willingness to receive the same surgery versus surgeon perceptions on patient's willingness to receive the same surgery demonstrated surgeons accurately identified YES (91.1%) but poorly identified NO (13.8%; $p<.05$).
CONCLUSIONS: If given a choice, 18.6% of surgically treated ASD patients indicated they were unsure or would not undergo the surgery again. ASD patients indicating they were unsure or would not undergo ASD surgery again had greater preoperative depression, greater preoperative opioid use, worse postoperative PROs, fewer patients reaching MCID, more complications requiring surgery, and greater postoperative opioid use. Additionally, patients that indicated they would not have the same surgery again were poorly identified by their treating surgeons compared to patients indicating they would be willing to receive the same surgery again. More research is needed to understand patient expectations and improve patient experiences following ASD surgery.

Keywords: Adult spinal deformity; Complications; Patient perception; Patient reported outcomes; Satisfaction; Surgery

Introduction

Symptomatic adult spine deformity (ASD) is associated with severe disability that can be improved with surgical treatment [1−3]. However, ASD surgery is also associated with high complication rates and protracted postoperative recovery durations [4−7]. Consequently, surgically treated ASD patients may express regret regarding their decision for surgical treatment, especially if they incur postoperative complications. Additionally, patients may report that their postoperative pain, physical function, and self-image did not improve to the degree they had hoped compared to their preoperative condition, which can also generate decision regret following surgery [3,5−8]. Discrepancies in opinion have been demonstrated between patients and treating surgeons regarding the anticipated outcomes following spine surgery, consequently there is little consensus regarding the criteria that constitute a "successful" surgery [9]. Little data exists to assist ASD surgeons in counseling patients when patients ask "are your patients happy they had this surgery," and "do your patients indicate they would have the surgery again?" The purpose of this study was to evaluate a cohort of surgically treated ASD patients with minimum 2 year follow-up and (1) ask the ASD patients if based upon their preoperative condition and their surgical and recovery experience, if given a choice, would he/she undergo the same surgical treatment again, (2) match the ASD patients to their corresponding treating surgeons, interview the treating surgeons regarding the patients' treatment and postoperative outcomes, and ask the surgeon if (a) he/she believes the ASD patient's condition was improved by the surgery, (b) ask if the treating surgeon believes their corresponding ASD patient would undergo the same surgery again, and (c) if the treating surgeon would perform the same surgery on the ASD patient, and if not why.

Materials and methods

Data for this study was obtained from a multicenter, prospective, observational study of operatively and nonoperatively treated ASD patients (study registered at ClinicalTrials.gov Identifier: NCT00738439). Inclusion criteria for the prospective study is patient ≥18 years of age, and minimum of one of the following spine deformity parameters; maximal scoliosis ≥20°, sagittal vertical axis ≥5 cm, pelvic tilt ≥25°, and/or thoracic kyphosis ≥60°). Exclusion criteria for the prospective study are spinal deformities associated with autoimmune, acute traumatic, neoplastic, neuromuscular, syndromic, and/or infectious disorders. All patients were enrolled at one of 11 participating sites in the United States. All sites received IRB approval prior to enrolling patients into the prospective study. Surgically treated ASD patients with minimum 2 year follow-up were identified, and patients were asked "Would you have the same management again if you had the same condition?" Patients were divided into those that indicated they would (YES), were unsure (UNSURE or would not (NO) have same management again. The treating surgeons were then matched to their corresponding ASD patients and were blinded to their patients' response to the question "Would you have the same management again if you had the same condition?" and the surgeons were asked the three following questions about their corresponding patients: (1) do you believe your patient's condition was improved by the surgery that you performed, and if no why, (2) if your patient was given a choice, do you believe that your patient would choose to have the same spine surgery that you performed again, and if no why, and (3) knowing your patient's preoperative disability and your patient's postoperative recovery would you perform the same surgery on your patient, and if no why.

Surgically treated ASD patients eligible for this study were assessed for preoperative demographics, medical history, opiate use, and spine deformity magnitude, details of ASD surgery performed, duration of postoperative intensive care unit (ICU) and hospital stay, and minimum 2 year postoperative spinal alignment and postoperative complications. Preoperative and minimum 2 year postoperative patient reported outcomes (PROs) including Scoliosis Research Society-22r questionnaire (SRS-22r), Short Form-36v2 questionnaire (SF-36) physical component summary (PCS) and mental component summary (MCS), Oswestry Disability Index (ODI), and numeric pain rating for back (NRS back) and leg (NRS leg) pain were evaluated and the percentages of patients reaching postoperative improvements that achieved minimal clinically important difference (MCID) for SRS-22r domains and ODI were calculated for YES versus UNSURE and NO, as previously reported [10−12]. Agreements between patient and surgeon willingness receive/perform the same surgery were evaluated, reasons why surgeons believed patients reported they would not receive the same surgery again were evaluated.

All radiographic analyses were performed at a single measurement center utilizing 36-inch cassette or full body antero-posterior (AP) and lateral radiographs that visualized from the skull base to the pelvis. Coronal and sagittal spinal/spinopelvic alignment parameters were assessed using Spineview (Laboratory of Biomechanics, Paris, France), as previously described [13,14].

Skewness of data was evaluated using the Shapiro-Wilk test. Student's *t* test, Wilcoxon/Kruskal-Wallis tests, Chi square were used where appropriate. Statistics were performed using JMP version 15.0.0 (SAS Institute Inc., Cary, NC, USA).

Results

Dataset analysis identified 580 of 961 patients enrolled into the prospective study from 2009 to 2018 were eligible for this study. UNSURE (n=79) were younger (57.2 vs. 61.6 years) were more frail (ASD frailty scale 3.9 vs. 3.3), had a greater incidence of preoperative depression (35.4% vs. 23.6%) and greater percentage of patients using opioids

Table 1
Preoperative demographics, frailty, and radiographic parameters for YES, UNSURE, and NO

	YES N=472	UNSURE N=79	NO N=29	p value
Age (y)	61.6 (12.7)[1]	57.2(13.9)[1]	62.2 (12.6)	**.0135[1]**
Gender (% Female)	78.9[1]	78.5[2]	55.2[1,2]	**.0029[1], .0165[2]**
ASD frailty index	3.3 (1.5)[1]	3.9(1.5)[1]	3.9 (1.4)	**.0050[1]**
History of depression (%)	23.6[1]	35.4[1]	31.0	**.0246[1]**
Preop opioid use (%)	52.8[1]	68.0[1]	62.1	**.0129[1]**
Last opioid use (%)	26.4[1]	46.2[1]	39.3	**.0004[1]**
Preop max scoliosis (deg)	41.3 (20.4)	38.9 (20.1)	41.4 (24.8)	>.05
Last max scoliosis (deg)	19.6 (13.9)	17.5 (13.9)	23.1 (20.4)	>.05
ΔMax scoliosis (deg)	-21.9 (15.7)	-22.2 (15.2)	-18.2 (16.1)	>.05
Preop SVA (mm)	75.0 (73.3)	64.5 (69.7)	90.8 (68.9)	>.05
Last SVA (mm)	30.6 (53.6)	34.1 (54.8)	48.8 (55.9)	>.05
ΔSVA (mm)	-44.4 (68.8)	-30.4 (66.8)	-42.0 (74.9)	>.05
Preop PI-LL (deg)	19.8 (19.9)	17.7 (19.9)	19.1 (19.1)	>.05
Last PI-LL (deg)	4.0 (13.9)	4.3 (14.6)	2.2 (13.0)	>.05
ΔPI-LL (deg)	-15.8 (17.2)	-13.4 (16.3)	-16.9 (20.2)	>.05

ASD, Adult Spinal Deformity; Max Cobb, maximum scoliosis; SVA, Sagittal Vertical Axis; PI-LL, the difference between Pelvic Incidence and Lumbar Lordosis. YES, patients indicating they would have the same surgical treatment again; UNSURE, patients indicating they are unsure if they would have the same surgical treatment again; NO, patients indicating they would not have the same surgical treatment again.

Superscript numbers define what cohorts were compared for the corresponding *p* value.

Bold *p* values are significant and <.05.

preoperatively (68.0% vs. 52.8%) than YES, respectively (n=472; p<.05; Table 1). NO (n=29) demographics were similar to YES except for gender distribution (NO=55.2% vs. YES= 78.9% female; p<.05). Preoperative sagittal and coronal spinopelvic parameters were similar for NO, UNSURE, and YES (p>.05; Table 1). At the time of surgery, NO and UNSURE had similar total levels fused, had similar osteotomies performed and had similar duration of ICU and hospital stay as YES (p>.05). UNSURE had fewer fusions to the pelvis than YES and NO had a longer length of hospital stay than YES (p<.05; Table 2). At minimum 2 year postoperative follow-up sagittal and coronal spinopelvic parameters were similar for NO, UNSURE, and YES (p>.05; Table 1). Evaluation of complications demonstrated that NO and UNSURE patients had more intraoperative complications requiring return to surgery, had more complications at 90 days to 2 years postoperative that required surgery, and had more complications at >2 years postoperatively that required surgery. Additionally, NO patients had more proximal junctional failure and implant failure at >2 years postoperatively than the YES patients (p<.05, Table 3).

Preoperative SRS-22r self-image, SRS-22r activity, and SRS-22r mental health and MCS were worse for UNSURE versus YES, (p<.05; Fig. 1, Fig. 2, Fig. 3, Fig. 4). At minimum 2 year follow-up, NO and UNSURE had worse PRO scores for all PROs administered and had worse postoperative improvements for all PROs administered including SF-36 PCS (2.5 and 1.6 vs. 10.0), SRS-22r subscore domain (0.2 and 0.4 vs. 0.9), SRS-22r pain domain (0.4 and 0.6 vs. 1.2), SRS-22r activity domain (-0.01 and 0.2 vs.0.8), SRS-22r self-image domain (0.4 and 0.7 vs. 1.3), and ODI (3.2 and 3.9 vs. 18.9) than YES, respectively (p<.05, Fig. 1−Fig. 4). At minimum 2 year follow-up, NO and

Table 2
Surgical and hospital parameters and hospital course for YES, UNSURE and NO

	YES N=472	UNSURE N=79	NO N=29	p value
ASA	2.4	2.4	2.6 (0.6)	>.05
Levels	13.3 (3.5)	13.4 (3.5)	13.5 (3.9)	>.05
Fusion to the pelvis (%)	82.7[1]	78.5[1]	85.7	**.0153[1]**
3COs (%)	19.5	20.3	31.0	>.05
SICU (%)	73.9	70.9	62.1	>.05
SICU (h)	33.1 (38.2)	30.1 (32.9)	35.6 (49.2)	>.05
LOS (days)	8.1 (4.3)[2]	7.5 (3.1)[1]	11.0 (5.1)[1,2]	**.0004[1], .0013[2]**

ASA, American Society of Anesthesiologists physical status classification system; 3CO, three column osteotomies; SICU, Spine Intensive Care Unit; LOS, length of stay; YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

Superscript numbers define what cohorts were compared for the corresponding *p* value.

Bold *p* values are significant and <.05.

Table 3
Comparison of patient complications following surgical management of their spine condition, YES vs UNSURE and NO

N = 580	YES N=472 (81.4%)	UNSURE N=79 (13.6%)	NO N=29 (5.0%)	p value
Total intraoperative complications (%)	29.7	25.3	37.9	>.05
Major intraoperative complications (%)	11.4	6.3	17.2	>.05
Minor intraoperative complications (%)	14.0	11.4	13.8	>.05
Return to surgery intraoperative complications (%)	0.4[1,2]	2.5[1]	3.5[2]	**.04[1,2]**
Total complications <90 d (%)	40.3	43.0	44.8	>.05
Major complications <90 d (%)	12.3	16.5	17.2	>.05
Minor complications <90 d (%)	18.0	19.0	24.1	>.05
Return to surgery <90 d (%)	6.8	8.9	10.3	>.05
Implant failure <90 d (%)	0.6	2.5	0.0	>.05
Deep wound infection <90 d (%)	1.5	1.3	3.5	>.05
Proximal junctional failure <90 d (%)	4.9	5.1	3.5	>.05
Total complications 90 d - 2 y (%)	35.0	45.6	48.3	>.05
Major complications 90 d - 2 y (%)	10.0	5.1	10.3	>.05
Minor complications 90 d - 2 y (%)	9.3	13.9	3.5	>.05
Return to surgery 90 d- 2 y (%)	12.3[1]	20.3	34.5[1]	**.0007[1]**
Implant failure 90 d - 2 y (%)	14.0	11.4	17.2	>.05
Deep wound infection 90 d - 2 y (%)	0.8	1.3	0.0	>.05
Proximal junctional failure 90 d - 2 y (%)	7.6	13.9	6.9	>.05
Total complications >2 y (%)	11.2	17.7	20.7	>.05
Major complications >2 y (%)	3.8	6.3	0.0	>.05
Minor complications >2 y (%)	3.2[1]	3.8	10.3[1]	**.0441[1]**
Return to surgery >2 y (%)	0.4[1,2]	3.8[1]	6.9[2]	**.0034[1], .0001[2]**
Implant failure >2 y (%)	2.8[1]	7.6[1]	6.9	**.0291[1]**
Deep wound infection >2 y (%)	0.4[1]	0.0	3.5[1]	**.0404[1]**
Proximal junctional failure >2 y (%)	1.5[1]	2.5	6.9[1]	**.0331[1]**

YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

Superscript numbers define what cohorts were compared for the corresponding *p* value.

Bold *p* values are significant and <.05.

UNSURE had fewer percentages of patients reaching MCID for SRS-22r pain (55.2% and 45.6% vs. 75.3%), SRS-22r activity (24.1% and 29.1% vs. 62.6%), SRS-22r self-image (48.3% and 59.5% vs. 81.3%), SRS-22r subscore (37.9% and 48.1% vs. 76.4%), and ODI (37.9% and 30.4% vs. 66.5%), than YES, respectively (p<.05; Fig. 5). At minimum 2 year follow-up, UNSURE had greater percentage of patients using opioids than YES,

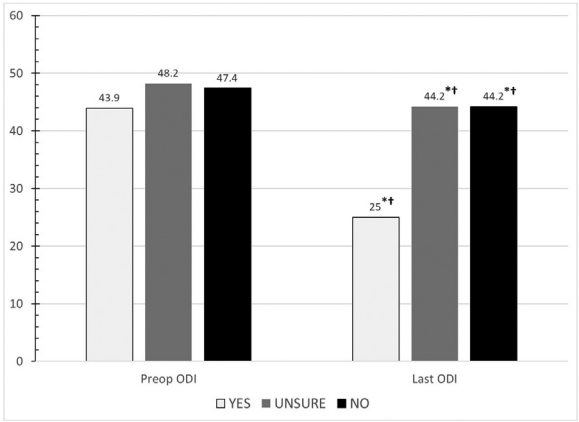

Fig. 1. Preoperative and Postoperative ODI for YES, UNSURE and NO. ODI=Oswestry disability index [15,16]; *=YES ODI value significantly lower than UNSURE or NO (p<.05); †=YES postoperative ODI improvement was significantly better than UNSURE or NO (p<.05). YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

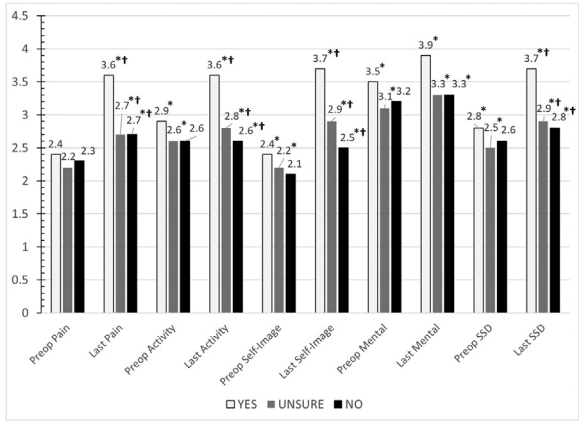

Fig. 2. Preoperative and Postoperative SRS-22r Domains for YES, UNSURE and NO. SRS-22r=Scoliosis Research Society 22 item questionnaire, revised; *=YES significantly greater than UNSURE or NO (p<.05); †=YES postoperative improvements were significantly greater than UNSURE or NO (p<.05). YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

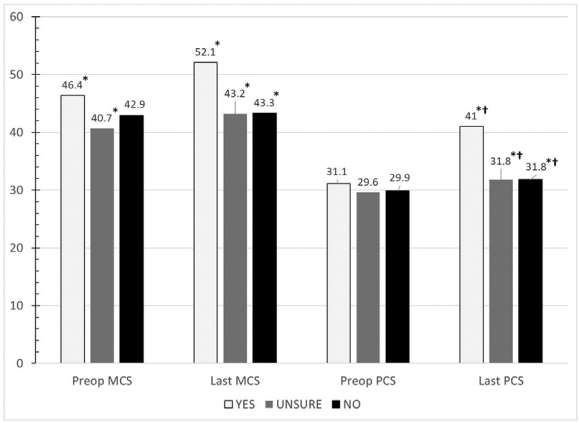

Fig. 3. Preoperative and Postoperative SF-36 MCS and PCS values for YES, UNSURE and NO. SF-36=Short form-36 version 2 [17,18]; PCS=physical component summary; MCS=mental component summary; *=YES significantly greater than UNSURE or NO (p<.05); †=YES postoperative improvements were significantly better than UNSURE or NO (p<.05). YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

based on SRS-22r question 11 (46.2% vs. 26.4%), respectively (p<.05; Table 1). Additionally, at minimum 2 year follow-up 93.0% of YES reported they were satisfied with the results of their back management on question 21 of the SRS-22r, compared 82.3% of UNSURE and 72.4% of NO (p<.05; Table 4).

Interviews with the treating surgeons regarding if they believed that their patients would indicate they would or would not have the surgery again demonstrated that the surgeons were able to identify the YES cohort with high accuracy (surgeons identified YES cohort with 91.1%

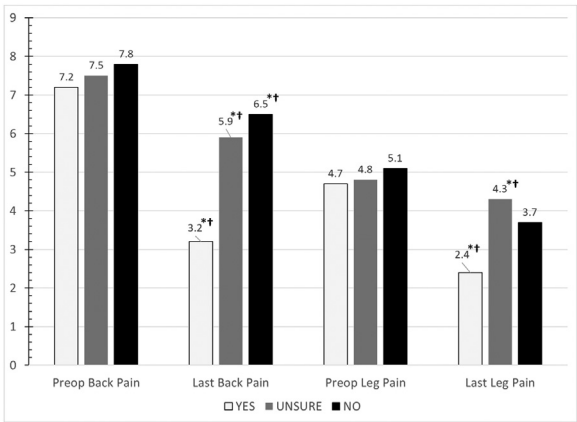

Fig. 4. Preoperative and Postoperative NRS Back and Leg Pain for YES and NO. NRS=Numeric Rating Scale; *=YES significantly less than UNSURE or NO (p<.05); †= YES postoperative improvements were significantly better than UNSURE or NO (p<.05). YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

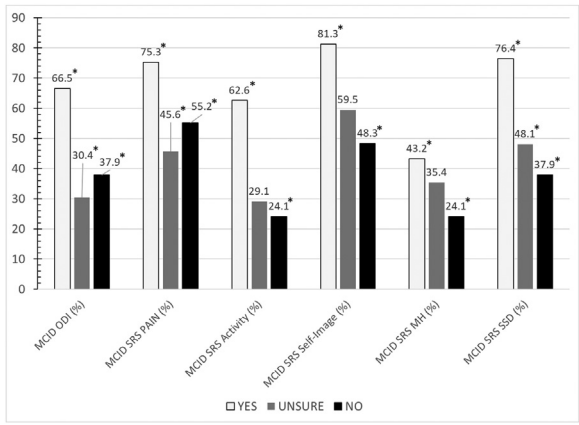

Fig. 5. Percent of Patients Reaching ODI and SRS-22 Domain MCID for YES, UNSURE and NO. *=YES significantly greater than UNSURE or NO (p<.05). YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

accuracy), however the surgeons poorly identified the NO cohort (surgeons identified the NO cohort with 13.8% accuracy; Fig. 6A–C). When surgeons were asked if they believed their patient was improved from his/her preoperative condition because of the spine surgery performed, surgeons indicated "yes" more often than they indicated "no" or "unsure" (90.5% vs. 3.8% and 5.7%, respectively; p<.05; Table 5). Of the patients that the treating surgeons believed were improved because of the surgery, 83.7% consisted of YES patients, while 16.0% of the patients that the surgeons believed were not improved by the surgery consisted of NO patients and 19.5% of the patients surgeons were uncertain whether the patient was better were UNSURE patients. The most common reasons why surgeons indicated that they were unsure or believed their respective patients were not improved by the surgery were (1) that the patient's postoperative pain relief did not meet patient expectations (30.3% and 45.5% respectively) and (2) the patient had postoperative complications requiring surgery (42.4% and 4.5% respectively; Table 5). Of the YES patients surgeons were unsure or did not believe patients were better due to (1) Pain relief not meeting patient expectation (40.0% and 38.5% respectively), and

Table 4
Comparison of treatment satisfaction at minimum 2 year follow-up for YES versus UNSURE and NO

	YES N = 472	UNSURE N = 79	NO N = 29	p value
Yes, satisfied (%)	93.0	82.3	72.4	.0002
Unsure if satisfied (%)	4.2	11.4	13.8	
No, not satisfied (%)	2.8	6.3	13.8	

YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

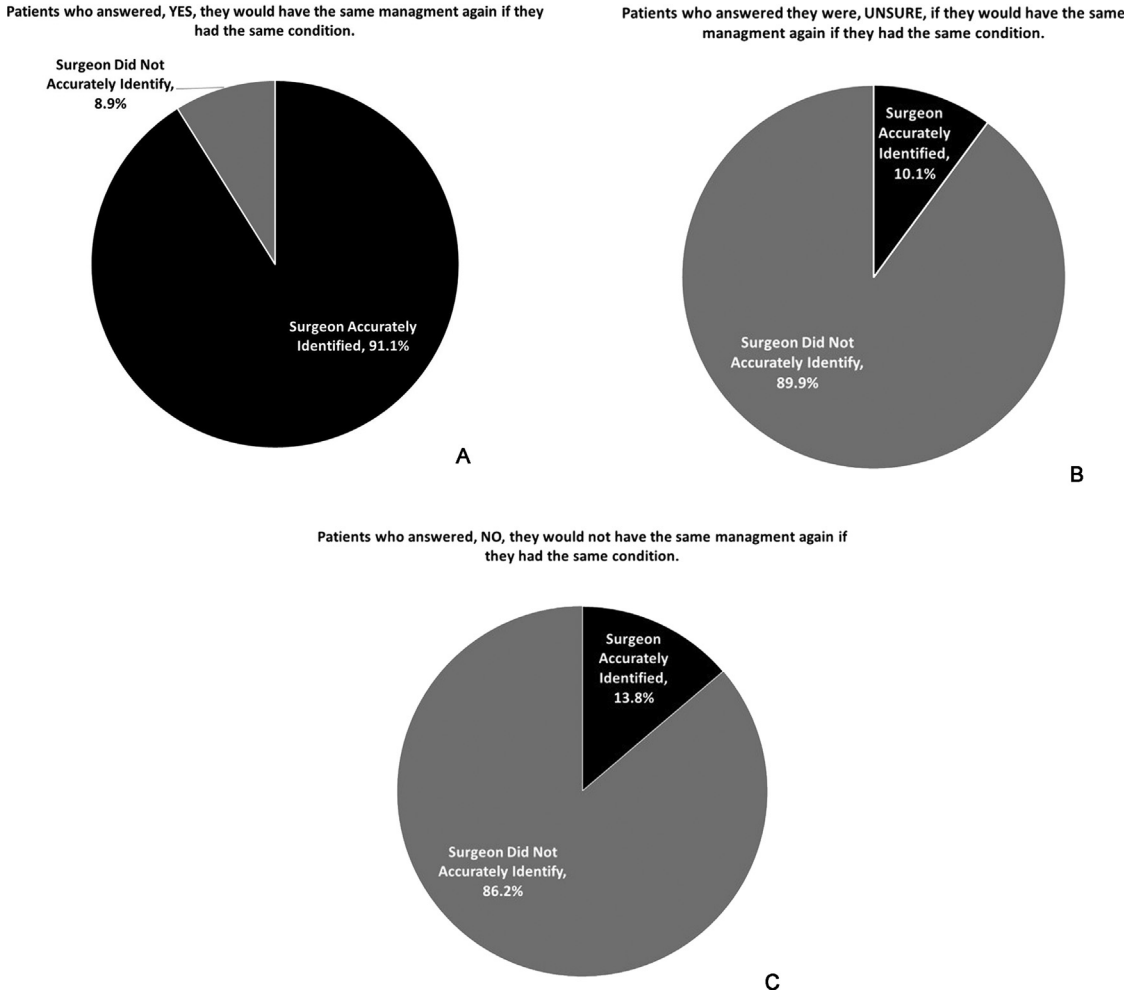

Fig. 6. A–C. Surgeon Ability to Accurately Identify YES, UNSURE, and NO patients. YES= patients indicating they would have the same surgical treatment again; UNSURE= patients indicating they are unsure if they would have the same surgical treatment again; NO= patients indicating they would not have the same surgical treatment again.

(2) patients requiring revision surgery (35.0% and 7.7% respectively; Table 6). When asked if they believed their respective patient would receive the same surgery again, surgeons more frequently indicated "yes" than "no" or "unsure" (88.6% vs. 4.3% and 7.1% respectively; $p<.05$; Table 5). The majority of patients that the surgeons believed would have the surgery again, also consisted of YES patients (83.7%), however of those patients that the surgeons believed would not choose to have surgery again, 56.0% consisted of YES patients, while 16.0% were NO patients and 28.0% UNSURE patients (Table 5). The most common reasons surgeons believed their patients were unsure or would not elect to undergo the surgery again was (1) that pain relief did not meet patient expectations (39.0% and 44.0% respectively) and (2) the patient incurred a postoperative complication requiring surgery (41.5% and 12.0% respectively; Table 5). Of the YES patients surgeons were unsure or believed patients would not elect to undergo the same surgery again because (1) pain relief did not meet patient expectations (42.9% and 50.0% respectively) and (2) patients incurred a postoperative complication requiring surgery (39.3% and 14.3% respectively; Table 6) When surgeons were asked if they would perform the same surgery on their respective patient, the surgeons responded "yes" more frequently than "no" or "unsure" (82.9% vs. 8.6% and 8.5%, respectively; $p<.05$; Table 5). Of the patients the surgeons indicated they would perform the same surgery again, 84.2% were YES patents, however, of the patients that the surgeons indicated that they would not perform the same surgery again 14.0% were NO or 30.0% UNSURE patients. The most common reasons surgeons indicated they were unsure or would not perform the same surgery again were (1) a postoperative complication requiring surgery (49.0% and 38.0% respectively), and (2) the surgeon believed the patient's postoperative pain relief did not meet patient expectations (32.6% and 20.0% respectively; Table 5). Of the YES patients surgeons were unsure or would not perform the same spine surgery again on patients because (1) patients had postoperative complications requiring surgery (46.2% and 42.9% respectively) and (2) pain relief did not

Table 5
Surgeon perspective of patient outcomes based upon patient willingness to have surgery again

Patient perspective	YES (n=472)	UNSURE (n=79)	NO (n=29)
Do you believe this patient is better now compared to his/her preoperative condition because of the spine surgery you performed?	525 (90.5%)	33 (5.7%)	22 (3.8%)
Reason for No/Unsure			
Pain relief did not meet patient expectations		10 (30.3%)	10 (45.5%)
New or worsened pain		3 (9.1%)	1 (4.5%)
New or worsened neurological deficit		2 (6.1%)	5 (22.7%)
Decreased range of motion or decreased function independent of pain or weakness		1 (3.0%)	0%
Physical functional improvement did not meet patient expectations		2 (6.1%)	2 (9.1%)
Revision surgery		14 (42.4%)	1 (4.5%)
Other complication		1 (3.0%)	3 (13.6%)
Death		0%	0%
If the patient was given a choice, do you believe this patient would choose to have the same spine surgery again that you performed?	514 (88.6%)	41 (7.1%)	25 (4.3%)
Reason for No/Unsure			
Pain relief did not meet patient expectations		16 (39.0%)	11 (44.0%)
New or worsened pain		2 (4.9%)	1 (4.0%)
New or worsened neurological deficit		1 (2.4%)	3 (12.0%)
Decreased range of motion or decreased function independent of pain or weakness		0%	1 (4.0%)
Physical functional improvement did not meet patient expectations		5 (12.2%)	3 (12.0%)
Revision surgery		17 (41.5%)	3 (12.0%)
Other complication		0%	3 (12.0%)
Death		0%	0%
If you were given a choice, would you perform the same spine surgery again on this patient that you performed?	481 (82.9%)	49 (8.5%)	50 (8.6%)
Reason for No/Unsure			
Pain relief did not meet patient expectations		16 (32.6%)	10 (20.0%)
New or worsened pain		4 (8.2%)	0%
New or worsened neurological deficit		1 (2.0%)	2 (4.0%)
Decreased range of motion or decreased function independent of pain or weakness		0%	0%
Physical functional improvement did not meet patient expectations		2 (4.1%)	1 (2.0%)
Revision surgery		24 (49.0%)	19 (38.0%)
Other complication		2 (4.1%)	14 (28.0%)
Death		0%	0%
Other		0%	4 (8.0%)

Yes= surgeons indicating they would perform the same surgical treatment again; Unsure= surgeons indicating they are unsure if they would perform the same surgical treatment again; No= surgeons indicating they would not perform the same surgical treatment again.

meet patient expectations (35.9% and 14.3% respectively; Table 6).

Discussion

Patient reported satisfaction following surgery is a multifactorial phenomenon that is dependent upon multiple variables including postoperative improvement in patient reported outcome measures, achievement of patient reported treatment goals, occurrence of postoperative complications, as well as psychosocial factors including patient-surgeon relationships, patient-office staff relationships, and patient experience at the treating hospital facilities [8,19−21]. In an attempt to reduce the number of confounding variables that impact the reporting of patient satisfaction, this study aimed to ask more specific questions, namely if given a choice (1) would ASD patients undergo the reconstructive spine surgery again, (2) did the treating surgeons believe the surgery that they performed improved the patient's condition and (3) would the surgeon perform the same surgery again. This study found that although the majority of ASD patients (81.4%) indicated that they would undergo the same surgery, nearly 1 in 5 ASD patients (18.6%) indicated they were unsure or would not have the surgery again. The patients that indicated they were unsure or would not be willing to undergo ASD surgery again had greater rates of preoperative depression and opioid use, greater incidence of postoperative complications requiring surgery, less improvement in postoperative PROs, and fewer patients achieving postoperative MCID for PROs than patients indicating they would have the surgery again, despite having similar spine deformity magnitude, similar surgical procedures performed, and similar spine deformity correction. Additionally, patients who indicated they would have surgery again reported they were more satisfied with treatment compared to those who were unsure if they would have surgery again and compared to those that indicated they would not have surgery again. The treating surgeons were frequently able to identify patients that indicated they would have the surgery again (91.1% of patients), however,

Table 6
Unsure and No choices and reason by surgeons for patients who said, YES, they would have the same surgery again

YES patients (n = 472)	Unsure	No
Do you believe this patient is better now compared to his/her preoperative condition because of the spine surgery you performed?	20 (4.2%)	13 (2.8%)
Reason for No/Unsure		
Pain relief did not meet patient expectations	8 (40.0%)	5 (38.5%)
New or worsened pain	2 (10.0%)	1 (7.7%)
New or worsened neurological deficit	1 (5.0%)	3 (23.1%)
Decreased range of motion or decreased function independent of pain or weakness	0%	0%
Physical functional improvement did not meet patient expectations	1 (5.0%)	1 (7.7%)
Revision surgery	7 (35.0%)	1 (7.7%)
Other complication	1 (5.0%)	2 (15.4%)
Death	0%	0%
If the patient was given a choice, do you believe this patient would choose to have the same spine surgery again that you performed?	28 (5.9%)	14 (3.0%)
Reason for No/Unsure		
Pain relief did not meet patient expectations	12 (42.9%)	7 (50.0%)
New or worsened pain	2 (7.1%)	0%
New or worsened neurological deficit	0%	1 (7.1%)
Decreased range of motion or decreased function independent of pain or weakness	0%	0%
Physical functional improvement did not meet patient expectations	3 (10.7%)	2 (14.3%)
Revision surgery	11 (39.3%)	2 (14.3%)
Other complication	0%	2 (14.3%)
Death	0%	0%
If you were given a choice, would you perform the same spine surgery again on this patient that you performed?	39 (8.3%)	28 (5.9%)
Reason for No/Unsure		
Pain relief did not meet patient expectations	14 (35.9%)	4 (14.3%)
New or worsened pain	3 (7.7%)	0%
New or worsened neurological deficit	0%	1 (3.6%)
Decreased range of motion or decreased function independent of pain or weakness	0%	0%
Physical functional improvement did not meet patient expectations	2 (5.1%)	0%
Revision surgery	18 (46.2%)	12 (42.9%)
Other complication	2 (5.1%)	9 (32.1%)
Death	0%	0%
Other	0%	2 (7.1%)

YES= patients indicating they would have the same surgical treatment again; Unsure= surgeons indicating they are unsure if they would perform the same surgical treatment again; No= surgeons indicating they would not perform the same surgical treatment again.

surgeons were only able to identify 13.8 % of their patients that indicated they would not have the surgery again.

Assessment of patient treatment goals is critically important when counseling for surgery. Scheer et al [8] found that administration of the patient generated index (PGI), which allows for patients to generate individualized outcome goals, correlated strongly with legacy PROs including ODI, SF-36 domains, and SRS-22r scores. Additionally, the authors reported that the PGI helped provide insight to individual patient treatment goals and outcome desires that might not be captured by the currently used standardized outcome measures. In an attempt to provide counseling guidelines for ASD patients considering surgery, Line et al used the SF-36 and SRS-22r to quantify the anticipated postoperative improvements in standardized health domains. The authors reported that ASD patients, on average, demonstrate a 45% reduction in bodily pain, a 27% improvement in physical function, and a 62% improvement in self-image. These data demonstrate the feasibility to (1) identify patient goals for surgery and (2) provide useful surgical counseling information for ASD patients. However, these data do not assist in discerning if the patient will be satisfied with the anticipated clinical improvements and if the patient will believe that their outcome justified their surgery. Findings from the current study demonstrated that the NO, UNSURE, and YES cohorts had improvement in PRO domains administered, however the NO and UNSURE cohorts (1) improved less and (2) had fewer percentages of patients reaching MCID than the YES cohort. Consequently, it is possible that, although the patients in the NO cohort improved, these patients did not improve as much as they had hoped. Consistent with these findings, the most common reason surgeons in this study indicated that they believed the patient was not improved by the surgery and why the patients would not undergo the surgery again, was the surgeons believed that the amount of pain relief reported by their patients did not meet patient expectations.

Important discrepancies also exist between patient and surgeon perceptions for anticipated outcomes following spine surgery. Mancuso et al [9] evaluated a cohort of patients undergoing lumbar spine surgery and found that patients were expecting complete relief of spine related

disability following lumbar spine surgery, whereas the treating surgeons expectations were much more tempered regarding anticipated patient pain relief, ranging from "a little to a lot of disability improvement," however surgeons did not anticipate patients would have complete relief of their spine related disability. Similarly, Aoude et al [4] evaluated patients in the Canadian Spine Outcomes and Research Network for discrepancies in patient versus surgeon reported expectations for outcomes following spine surgery, finding that patients anticipated more improvement in neck or back pain than the surgeons anticipated, and the discrepancies in anticipated improvements between patients and surgeons widened for older patient populations. Consistent with these results, this study demonstrated that patients in the NO and UNSURE cohorts had less pain and physical function improvement than patients in the YES cohort, and fewer NO and UNSURE patients reached MCID versus the YES cohort. Carreon et al [22] reported that patients with better preoperative MCS scores and worse preoperative ODI scores were more likely to improve after lumbar fusion. We also found that patients in the NO and UNSURE cohorts had worse preoperative MCS and SRS-22r mental health scores, however our study found that the preoperative ODI scores were similar in the NO and UNSURE cohorts compared to the YES cohort and the NO and UNSURE cohorts demonstrated less postoperative ODI improvement and had a lower greater percentage of patients reaching MCID for ODI than the YES cohort. These findings may indicate that while patients in the NO cohort had greater preoperative disability and greater potential to improve the ODI scores compared to the YES cohort, the potential for improvement was not achieved by the NO cohort leading to disappointment in the surgical outcomes.

An important question is why did patients in the NO and UNSURE cohorts have worse clinical outcomes than the YES cohort, despite having similar surgery performed, similar preoperative spine deformity, and similar postoperative spine deformity correction as YES. Depression and poor mental health have been documented by numerous studies to have a negative impact on clinical outcomes following spine surgery. Lafage et al [23] reported that ASD patients with low SF-36 MCS were less likely to improve clinically following ASD surgery, were less likely to reach MCID, and were less likely to be satisfied postoperatively. Sivaganesan et al [7] found that patients with baseline psychological distress were more likely to report dissatisfaction following spine surgery despite clinical improvement in disability and pain. Preoperative opioid use has also been recognized as a risk factor for poor surgical outcomes [24–27]. In this study, patients in the UNSURE cohort had greater preoperative depression rates, worse preoperative MCS scores, worse preoperative SRS-22r mental health scores, and greater preoperative and postoperative opioid use than the YES cohort. These findings reinforce the established literature that patients with poor mental health and using opioids preoperatively are at greater risk for poor treatment outcomes and treatment dissatisfaction. Another likely reason the NO cohort indicated they would not have the surgery again is the greater incidence of postoperative complications requiring surgery compared to the YES cohort. Smith et al reported a 52% complication rate and 28% incidence of revision surgery following ASD surgery for a large cohort of ASD patients [28]. Smith et al [29] also reported that serious adverse events (SAE) had a significantly negative impact on outcomes following surgery for adult symptomatic lumbar scoliosis, as patients that incurred a postoperative SAE demonstrated less improvement in SRS-22r and ODI at 2 and 4 years postoperative than patients that did not incur an SAE. The incidence of total and major complications in this study were similar between the NO and the YES cohorts, however, the NO and UNSURE cohorts had greater rates of complications requiring surgery, likely demonstrating the substantial negative impact that revision surgery can have not only on clinical outcomes but also on patient perceptions of treatment efficacy and treatment satisfaction. This is also reflected in that at minimum 2 year follow-up satisfaction rates with surgical treatment rates were greater for YES (93.0%) compared to UNSURE (82.3% satisfied with surgery treatment) and NO (72.4% satisfied with surgical treatment ($p<.05$).

There are several limitations to this study, most importantly, we did not ask patients why they indicated they would or would not have the surgery again, and we did not assess or quantify the patient and surgeon expectations for the surgery. Prospective outcome tools that capture patient goals for treatment, including the PGI, and then post-treatment inventory of goal achievement is an important next step to build upon the findings for this study. Discussions that are interactive with patients assessing what was and was not achieved via treatment will help educate patients and bridge the gap between the discrepancies in patient and surgeon anticipated outcomes. Additionally, it is critically important to establish reasonable patient expectations for surgical outcomes during the discussion process. Active patient involvement in deciding the most effective treatment plan via assimilation of patient desires, goals and fears is an important next step as is the development and use of patient assessment tools that can quantify the amount of patient treatment goal achievement will help improve research in this domain. Another limitation to this study is that a standardized preoperative counseling methodology to assess treatment expectations was not used. We absolutely acknowledge the value of standardized preoperative patient counseling and believe use of standardized preoperative counseling warrants clinical investigation.

In conclusion, nearly one-fifth of patients from a large cohort of surgically treated ASD patients indicated, if given a choice, they were uncertain or would not have ASD surgery again. Patients indicating they were unsure or would not have the surgery again had greater rates of preoperative depression and opioid use, had less postoperative improvements in patient reported outcomes, fewer patients reaching

MCID for PROs, had greater incidence of postoperative complication rates requiring surgery, and lower treatment satisfaction rates at minimum 2 year follow-up than patients indicating they would have the surgery again. Surgeons were poorly able to identify the patients indicating they would not have the surgery again, however, when the surgeons were able to accurately identify patients in the NO cohort, the surgeons identified the potential reasons patients would not undergo surgery again including postoperative complications requiring surgery and/or the patients not achieving the anticipated amount of postoperative pain relief. These results demonstrate opportunities to improve patient counseling for realistic expectations following ASD surgery and align patient and surgeon expectations for clinical outcomes following surgery to improve patient counseling and reduce patient regret. These findings also demonstrate the negative impact that poor preoperative mental health, preoperative opioid use, and postoperative complications can have upon outcomes following ASD surgery and the critical need to improve these potentially modifiable risk factors to improve patient outcomes.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Depuy Synthes Spine, Stryker Spine, and Nuvasive provided research support in part for this study via the International Spine Study Group Foundation including financial support for study patient enrollment and data analysis.

Appendix. List of questions posed to surgeons and patients

Question 1. Do you believe this patient is better now compared to his/her preoperative condition because of the spine surgery you performed?

Definitely yes =5
Probably yes =4
Not sure =3
Probably no =2
Definitely no =1

Why do you believe that the patient is not better?

1= Pain relief did not meet patient expectations
2= New or worsened pain
3= New or worsened neurological deficit
4= Decreased range of motion or decreased function independent of pain or weakness
5= Physical functional improvement did not meet patient expectations
6= Revision surgery
7= Other complication
8= Death

Question 2. If the patient was given a choice, do you believe this patient would choose to have the same spine surgery again that you performed?

Definitely yes =5
Probably yes =4
Not sure =3
Probably no =2
Definitely no =1

Why do you believe if given the choice the patient would not have surgery again?

1= Pain relief did not meet patient expectations
2= New or worsened pain
3= New or worsened neurological deficit
4= Decreased range of motion or decreased function independent of pain or weakness
5= Physical functional improvement did not meet patient expectations
6= Revision surgery
7= Other complication
8= Death

Question 3. If you were given a choice, would you perform the same spine surgery again on this patient that you performed?

Definitely yes =5
Probably yes =4
Not sure =3
Probably no =2
Definitely no =1

If given the choice why would you not do the surgery again?

1= Pain relief did not meet patient expectations
2= New or worsened pain
3= New or worsened neurological deficit
4= Decreased range of motion or decreased function independent of pain or weakness
5= Physical functional improvement did not meet patient expectations
6= Revision surgery
7= Other complication
8= Death

SRS-22r Question 22. Would you have the same management again if you had the same condition?

Definitely yes =5
Probably yes =4
Not sure =3
Probably no =2
Definitely no =1

5s and 4s were combined for the “Yes” category and 1–3 were combined for the “No” category.

References

[1] Bess S, Line B, Fu KM, et al. The health impact of symptomatic adult spinal deformity: comparison of deformity types to United States population norms and chronic diseases. Spine (Phila Pa 1976) 2016;41(3):224–33.

[2] Kelly MP, Lurie JD, Yanik EL, et al. Operative versus nonoperative treatment for adult symptomatic lumbar scoliosis. J Bone Joint Surg Am 2019;101(4):338–52.
[3] Line B, Bess S, Lafage V, et al. Counseling guidelines for anticipated postsurgical improvements in pain, function, mental health, and self-image for different types of adult spinal deformity. Spine (Phila Pa 1976) 2020;45(16):1118–27.
[4] Aoude A, Litowski M, Aldebeyan S, et al. A comparison of patient and surgeon expectations of spine surgical outcomes. Global Spine J 2021;11(3):331–7.
[5] Hayashi K, Boissière L, Larrieu D, et al. Prediction of satisfaction after correction surgery for adult spinal deformity: differences between younger and older patients. Eur Spine J 2020;29(12):3051–62.
[6] Lonner B, Castillo A, Jain A, et al. The patient generated index and decision regret in adolescent idiopathic scoliosis. Spine Deform 2020;8(6):1231–8.
[7] Sivaganesan A, Khan I, Pennings JS, et al. Why are patients dissatisfied after spine surgery when improvements in disability and pain are clinically meaningful? Spine J 2020;20(10):1535–43.
[8] Scheer JK, Keefe M, Lafage V, et al. Importance of patient-reported individualized goals when assessing outcomes for adult spinal deformity (ASD): initial experience with a patient generated index (PGI). Spine J 2017;17(10):1397–405.
[9] Mancuso CA, Duculan R, Cammisa FP, et al. Concordance between patients' and surgeons' expectations of lumbar surgery. Spine (Phila Pa 1976) 2021;46(4):249–58.
[10] Carreon LY, Kelly MP, Crawford 3rd CH, et al. SRS-22R minimum clinically important difference and substantial clinical benefit after adult lumbar scoliosis surgery. Spine Deform 2018;6(1):79–83.
[11] Carreon LY, Sanders JO, Diab M, Sucato DJ, Sturm PF, Glassman SD. The minimum clinically important difference in Scoliosis Research Society-22 Appearance, Activity, And Pain domains after surgical correction of adolescent idiopathic scoliosis. Spine 2010;35(23):2079–83.
[12] Copay AG, Glassman SD, Subach BR, Berven S, Schuler TC, Carreon LY. Minimum clinically important difference in lumbar spine surgery patients: a choice of methods using the Oswestry Disability Index, Medical Outcomes Study questionnaire Short Form 36, and pain scales. Spine J 2008;8(6):968–74.
[13] Rillardon L, Levassor N, Guigui P, et al. [Validation of a tool to measure pelvic and spinal parameters of sagittal balance]. Revue de chirurgie orthopedique et reparatrice de l'appareil moteur 2003;89(3):218–27.
[14] El Fegoun AB, Schwab F, Gamez L, Champain N, Skalli W, Farcy JP. Center of gravity and radiographic posture analysis: a preliminary review of adult volunteers and adult patients affected by scoliosis. Spine (Phila Pa 1976) 2005;30(13):1535–40.
[15] Fritz JM, Irrgang JJ. A comparison of a modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. Phys Ther 2001;81(2):776–88.
[16] Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. Physiotherapy 1980;66(8):271–3.
[17] Ware JE, Kosinski M, Bjorner J, Turner-Bowker DM, Gandek B, Maruish ME. User's manual for the SF-36v2 health survey. 2nd ed.. London: QualityMetric Incorporated; 2007.
[18] Ware Jr. JE. SF-36 health survey update. Spine 2000;25(24):3130–9.
[19] Macki M, Alvi MA, Kerezoudis P, et al. Predictors of patient dissatisfaction at 1 and 2 years after lumbar surgery. J Neurosurg Spine 2019;32(3):1–10.
[20] Rehman Y, Syed M, Wiercioch W, et al. Discrepancies between patient and surgeon expectations of surgery for sciatica: a challenge for informed decision making? Spine (Phila Pa 1976) 2019;44(10):740–6.
[21] Schoenfelder T, Klewer J, Kugler J. Factors associated with patient satisfaction in surgery: the role of patients' perceptions of received care, visit characteristics, and demographic variables. J Surg Res 2010;164(1):e53–9.
[22] Carreon LY, Glassman SD, Djurasovic M, et al. Are preoperative health-related quality of life scores predictive of clinical outcomes after lumbar fusion? Spine 2009;34(7):725–30.
[23] Lafage R, Ang B, Schwab F, et al. Depression symptoms are associated with poor functional status among operative spinal deformity patients. Spine (Phila Pa 1976) 2021;46(7):447–56.
[24] Bonner BE, Castillo TN, Fitz DW, Zhao JZ, Klemt C, Kwon YM. Preoperative opioid use negatively affects patient-reported outcomes after primary total hip arthroplasty. J Am Acad Orthop Surg 2019;27(22):e1016–e20.
[25] Cron DC, Englesbe MJ, Bolton CJ, et al. Preoperative opioid use is independently associated with increased costs and worse outcomes after major abdominal surgery. Ann Surg 2017;265(4):695–701.
[26] Goplen CM, Verbeek W, Kang SH, et al. Preoperative opioid use is associated with worse patient outcomes after Total joint arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord 2019;20(1):234.
[27] Jain N, Phillips FM, Weaver T, Khan SN. Preoperative chronic opioid therapy: a risk factor for complications, readmission, continued opioid use and increased costs after one- and two-level posterior lumbar fusion. Spine (Phila Pa 1976) 2018;43(19):1331–8.
[28] Smith JS, Klineberg E, Lafage V, et al. Prospective multicenter assessment of perioperative and minimum 2-year postoperative complication rates associated with adult spinal deformity surgery. J Neurosurg Spine 2016;25(1):1–14.
[29] Smith JS, Shaffrey CI, Kelly MP, et al. Effect of serious adverse events on health-related quality of life measures following surgery for adult symptomatic lumbar scoliosis. Spine (Phila Pa 1976) 2019;44(17):1211–9.