Original Clinical Article

JOURNAL OF CHILDREN'S ORTHOPAEDICS

Predictors of persistent postoperative pain after surgery for idiopathic scoliosis

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Abstract

Purpose To identify factors contributing to persistent postoperative pain in patients treated surgically for idiopathic scoliosis.

Methods In total, 280 patients aged ten through 25 years at surgery, were identified in the Swedish Spine registry; all having preoperative and postoperative visual analogue scale (VAS) for back pain scores. The patients were divided into a high and low postoperative pain group based on the reported postoperative VAS for back pain scores (by using 45 mm on the 0 mm to 100 mm VAS scale as a cut-off). The patient-reported questionnaire included VAS for back pain, the 3-level version of EuroQol 5-dimensional (EQ-5D-3L) instrument, the EuroQol VAS (EQ-VAS) and the Scoliosis Research Society 22r instrument (SRS-22r). Predictors of postoperative back pain were searched in the preoperative data.

Results The 67 (24%) patients that reported high postoperative VAS back pain (> 45 mm) also reported lower postoperative EQ-5D-3L, EQ-VAS and SRS-22r than patients with low postoperative VAS back pain (all $p < 0.001$). Two preoperative variables were independently associated with postoperative pain; each millimetre increase in preoperative VAS back pain (on the 0 mm to 100 mm scale) was associated with a higher risk of being in the high postoperative back pain group (odds ratio (OR) 1.03; 95% confidence interval (CI) 1.02 to 1.05) and each 1 point decrease on the preoperative SRS-22r mental health (scale from 1 to 5) was associated with a higher risk of being in the high postoperative back pain group (OR 1.68; 95% CI 1.03 to 2.73).

Conclusion High preoperative back pain and low preoperative mental health are independent predictors of back pain after surgery for idiopathic scoliosis.

Level of Evidence: III

Cite this article: Charalampidis A, Rundberg L, Möller H, Gerdhem P. Predictors of persistent postoperative pain after surgery for idiopathic scoliosis. *J Child Orthop* 2021;15:458-463. DOI: 10.1302/1863-2548.15.210090

Keywords: idiopathic scoliosis; predictors of postoperative pain; quality of life; patient reported outcome measures

Introduction

Idiopathic scoliosis is the most common type of spinal deformity with an estimated prevalence of 3%.[1,2] The majority of the patients with idiopathic scoliosis are treated conservatively.[3] Nevertheless, around 10% will require fusion surgery and correction[2] in order to prevent long-term health problems such as respiratory dysfunction and back pain.[4]

Traditionally, the outcome of surgical treatment for idiopathic scoliosis has been mainly evaluated by radiographic changes, such as the change in the magnitude and correction of the curve, but these parameters have failed to correlate with persistent pain after the surgery[5] and have been shown to be weak predictors of patient satisfaction.[6] Only in the past several years have the incorporation of standardized, disease-specific patient-reported outcome questionnaires shown that, although deformity correction and spinal fusion may improve quality of life in patients with idiopathic scoliosis,[7-11] it can result in persistent back pain and dissatisfaction.[10,12] Thus, identifying possible predictors of poor clinical outcome in patients treated surgically for idiopathic scoliosis could have important clinical implications. Additionally, demographic parameters, such as sex, age and body mass index (BMI), which could influence the course of postoperative satisfaction and quality of life, are still unexplored.

The aim of this study was to identify specific preoperative characteristics in patients reporting high postoperative pain.

Materials and methods

We hypothesized that patients with high postoperative pain would report high preoperative pain as compared with patients with no or minor postoperative pain. The

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identification of these characteristics could pave the way to further improve scoliosis surgery outcome. To our knowledge, this is the first nationwide study searching for factors of importance for poor clinical outcome in patients treated surgically for idiopathic scoliosis.

This is a retrospective analysis of prospectively collected data from the deformity part of the Swedish spine registry (Swespine).[13] Swespine contains information on surgeries for spinal deformity since October 1st 2006, and include preoperative, one-, two-, five- and ten-year patient-reported questionnaire data and surgeon reported data at time of surgery, and has more than 97% diagnostic accuracy.[14,15] We identified patients treated surgically with posterior fusion for idiopathic scoliosis until 20 June 2017, aged between ten and 25 years at surgery, having both preoperative and a minimum of two-year follow-up patient-reported outcome data for visual analogue scale (VAS) back pain. A total of 280 patients met the inclusion criteria for the study (Fig. 1); 183 patients had two-year follow-up data and 97 patients in the cohort had five-year follow-up data, giving a mean follow-up of three years. We used 45 mm on the VAS scale as a cut off in order to define the 'high pain group' as it has been shown by previous investigators that scores equal to or above 45 mm on the VAS scale may be considered moderate and severe pain.[16]

Patient demographics and surgeon-reported data

Patient demographics including age, sex and BMI were collected from Swespine. Surgical data were reported by the surgeon at the time of discharge. Data included preoperative Cobb angle of the primary curve, operating time, type of surgery, blood loss, operated vertebrae, complications and length of stay at the hospital. Information about any revision surgeries recorded until 20 June 2017, was searched in the Swespine registry.

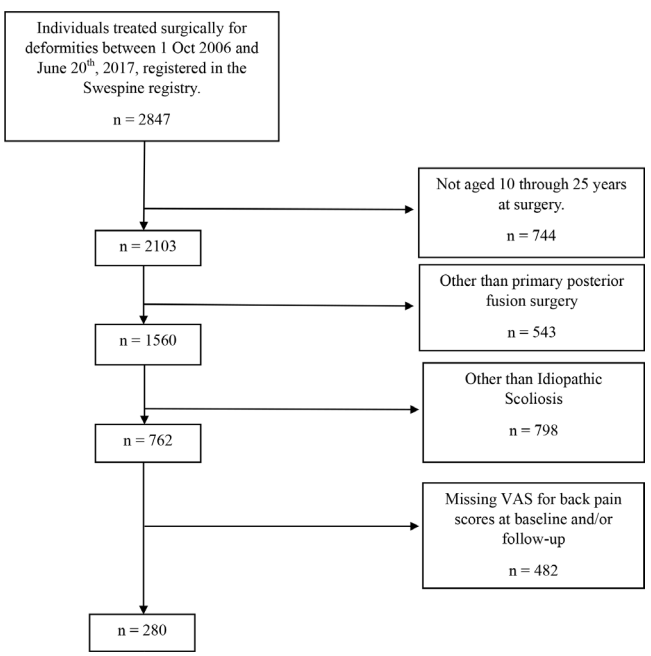

Fig. 1 Flow chart for the inclusion of patients in the study (VAS, visual analogue scale).

Patient-reported questionnaire

The patient-reported questionnaire included VAS for back pain,[17] the EuroQol 5-dimensional quality of life questionnaire, 3 level (EQ-5D-3L) instrument,[18] the EuroQol VAS (EQ-VAS)[18] and after February 2008 also the Scoliosis Research Society 22r instrument (SRS-22r).[19]

VAS for back pain is a measure of pain intensity; it ranges from 0 (no pain) to 100 (worst possible pain).[17]

The EQ-5D-3L is a non-disease-specific instrument used for describing and valuing health-related quality of life. The UK-tariff was used. It ranges from -0.59 (worst) to 1.00 (best). The EQ-VAS ranges from 0 (worst imaginable health state) to 100 (best imaginable health state).[18]

The SRS-22r questionnaire contains five domains; function, pain, self-image, mental health and satisfaction. These domains are then used to calculate the subscore (excluding the satisfaction domain) and the total score (including all domains). Domains, subscore and total score range from 1 (worst) to 5 (best).[19]

Statistical analysis

Descriptive data are presented as mean (range or SD) or number (%). Analysis of variance, the Pearson chi-squared test, paired samples t-test, the Fisher exact test or binomial logistic regression were used for statistical analysis. In the case of missing data, exclusions have been made analysis by analysis. Statistical significance was set at $p < 0.05$. IBM SPSS statistical software version 23 was used for statistical analyses (IBM SPSS Statistics for Windows; Armonk, New York).

Results

Overall, 67 (24%) out of the 280 patients reported high VAS for back pain scores (≥ 45 mm) at the mean three-year follow-up. There was a higher proportion of female patients in the high postoperative pain group ($p = 0.028$) but no significant differences in baseline age, BMI, radiographic or surgical parameters compared with the group with low postoperative pain (all $p \geq 0.05$) (Table 1). At baseline, patients in the high postoperative pain group reported significantly higher VAS for back pain scores, lower EQ-VAS scores and significantly lower SRS-22r domain scores and subscores compared with the low postoperative pain group (all $p \leq 0.039$) (data not shown; results summarized in this paragraph).

At follow-up, patients in the high postoperative pain group reported significantly lower EQ-5D-3L, EQ-VAS and SRS-22r (including domains, subscores and total scores) compared with the low postoperative pain group (all $p < 0.001$) (Table 1).

Patients in the high postoperative pain group demonstrated a significant postoperative deterioration with increased VAS back pain and decreased EQ-5D-3L, EQ-VAS and SRS-22r pain compared with preoperatively (all $p \leq 0.037$) (Table 2). In contrast, patients in the low postoperative pain group demonstrated a significant postoperative improvement in all scores (all $p < 0.001$), with the exception of SRS-22r mental health score ($p = 0.3$) (Table 3).

Regression analysis

Logistic regression analyses were performed to ascertain predictors of high postoperative back pain. Variables that were found to differ significantly at baseline (sex, VAS back pain, EQ-VAS, SRS-22r function, SRS-22r pain, SRS-22r self-image, SRS-22r mental health) were identified as risk factors correlating with postoperative back pain (Table 4). The same variables were entered in a forward stepwise selection in a multiple logistic regression model.

Table 1 Comparison of baseline characteristics and postoperative scores between patients in the high and low postoperative pain group

	High postoperative VAS back pain group (n = 67)	Low postoperative VAS back pain group (n = 213)	p-value
Baseline data			
Female patients, n (%)	59 (*88*)	163 (*76*)	**0.028**┬
Mean age, yrs (SD)	16.9 (2.7)	16.3 (2.4)	0.09±
Mean BMI, m/kg² (SD)	21.6 (3.7)	20.5 (3.7)	0.05±
Mean preoperative Cobb angle, ° (SD)	53 (9)	55 (10)	0.14±
Number of fused vertebrae (%)	11 (*2*)	11 (*2*)	0.3±
Mean duration of surgery, mins (SD)	227 (76)	257 (151)	0.1±
Mean blood loss, ml (SD)	1098 (720)	1176 (860)	0.5±
Mean length of stay, days (SD)	7 (2)	7 (2)	0.5±
Postoperative scores			
Mean VAS back pain, score (SD)	61 (12)	13 (12)	< **0.001**±
Mean EQ-5D-3L, score (SD)	0.61 (0.26)	0.86 (0.14)	< **0.001**±
Mean EQ-VAS, score (SD)	65 (20)	84 (15)	< **0.001**±
Mean SRS-22r function, score (SD)	3.8 (0.8)	4.6 (0.4)	< **0.001**±
Mean SRS-22r pain, score (SD)	3.0 (0.9)	4.3 (0.6)	< **0.001**±
Mean SRS-22r self-image, score (SD)	3.1 (0.8)	4.1 (0.7)	< **0.001**±
Mean SRS-22r mental health, score (SD)	3.5 (0.9)	4.0 (0.8)	< **0.001**±
Mean SRS-22r satisfaction, score (SD)	3.3 (1)	4.3 (0.8)	< **0.001**±
Mean SRS-22r subscore (SD)	3.4 (0.7)	4.3 (0.5)	< **0.001**±
Mean SRS-22r total score (SD)	3.4 (0.6)	4.3 (0.5)	< **0.001**±

VAS, visual analogue scale; BMI, body mass index; EQ-5D-3L, EuroQol 5-dimensional quality of life questionnaire, 3 level; EQ-VAS, EuroQol VAS; SRS-22r, Scoliosis Research Society questionnaire 22r instrument. Bold values indicate statistical significance ($p < 0.05$)
┬ chi-squared test
± UNIANOVA

Table 2 Changes from preoperative to postoperative in the high postoperative visual analogue scale (VAS) back pain group (n = 67)

	Preoperative	Postoperative	p-value
Mean VAS back pain, score (SD)	43 (23)	61 (12)	< **0.001**†
Mean EQ-5D-3L, score (SD)	0.72 (0.17)	0.61 (0.26)	**0.004**†
Mean EQ-VAS, score (SD)	71 (19)	65 (20)	**0.037**†
Mean SRS-22r function, score (SD)	4.0 (0.7)	3.8 (0.8)	0.05†
Mean SRS-22r pain, score (SD)	3.4 (0.9)	3.0 (0.9)	**0.005**†
Mean SRS-22r self-image, score (SD)	2.8 (0.8)	3.1 (0.8)	0.1†
Mean SRS-22r mental health, score (SD)	3.5 (0.8)	3.5 (0.9)	0.8†
Mean SRS-22r subscore (SD)	3.4 (0.6)	3.4 (0.7)	0.3†

EQ-5D-3L, EuroQol 5-dimensional quality of life questionnaire, 3 level; EQ-VAS, EuroQol VAS; SRS-22r, Scoliosis Research Society questionnaire 22r instrument. Bold values indicate statistical significance ($p < 0.05$)
† Paired samples t-test

Table 3 Changes from preoperative to postoperative in the low postoperative visual analogue scale (VAS) back pain group (n = 213)

	Preoperative	Postoperative	p-value
Mean VAS back pain, score (SD)	24 (23)	13 (12)	< **0.001**†
Mean EQ-5D-3L, score (SD)	0.77 (0.18)	0.86 (0.14)	< **0.001**†
Mean EQ-VAS, score (SD)	77 (21)	84 (15)	< **0.001**†
Mean SRS-22r function, score (SD)	4.4 (0.6)	4.6 (0.4)	< **0.001**†
Mean SRS-22r pain, score (SD)	4.0 (0.7)	4.3 (0.6)	< **0.001**†
Mean SRS-22r self-image, score (SD)	3.1 (0.8)	4.1 (0.7)	< **0.001**†
Mean SRS-22r mental health, score (SD)	3.9 (0.7)	4.0 (0.8)	0.3†
Mean SRS-22r subscore (SD)	3.9 (0.5)	4.3 (0.5)	< **0.001**†

EQ-5D-3L, EuroQol 5-dimensional quality of life questionnaire, 3 level; EQ-VAS, EuroQol VAS; SRS-22r, Scoliosis Research Society questionnaire 22r instrument. Bold values indicate statistical significance ($p < 0.05$)
† Paired samples t-test

The model explained 19% (Nagelkerke R^2) of the variance and correctly classified 80% of the cases. An increase in the preoperative VAS back pain was independently associated with a higher risk of being in the high postoperative back pain group (odds ratio (OR) 1.03; 95% confidence interval (CI) 1.02 to 1.05 per mm increase) (Fig. 2). A decrease in the preoperative SRS-22r mental health was independently associated with a higher risk of being in the high postoperative back pain group (OR 1.68; 95% CI 1.03 to 2.73 per point decrease) (Fig. 3).

Revision rate

Overall, 20 (7%) patients required revision surgery at a mean of 2.7 years (0.3 to 9.2) after the index surgery; 11 for an infection, four to remove an implant, one for pseudarthrosis and four for other reasons not specified by the surgeon. There were more revision cases reported in the high (nine out of 67 cases) than in the low postoperative pain group (11 out of 213 cases) ($p = 0.030$, Fisher's exact test). At follow-up, patients who underwent revision surgery reported significantly higher VAS for back pain scores, lower

Table 4 Results from the logistic regression showing the risk of being in the group with the highest postoperative back pain (≥ 45 mm on the visual analogue scale (VAS) back pain 0 mm to 100 mm scale) for sex (female *versus* male) and preoperative variables (continuous) that differed at baseline between the high and the low postoperative back pain group

Variable	Odds ratio	95% confidence interval	p-value
Sex (female *versus* male)	2.26	1.01 to 5.05	**0.046‡**
Preoperative variables			
VAS back pain (per mm increase)	1.03	1.02 to 1.04	< **0.001‡**
EQ-VAS (per point decrease)	1.01	1.00 to 1.02	**0.042‡**
SRS-22r function (per point decrease)	2.79	1.68 to 4.60	< **0.001‡**
SRS-22r pain (per point decrease)	2.70	1.78 to 4.09	< **0.001‡**
SRS-22r self-image (per point decrease)	1.58	1.05 to 2.38	**0.027‡**
SRS-22r mental health (per point decrease)	2.09	1.37 to 3.19	**0.001‡**

EQ-VAS, EuroQol VAS; SRS-22r, Scoliosis Research Society questionnaire 22r instrument. Bold values indicate statistical significance (p< 0.05)
‡ Binomial logistic regression

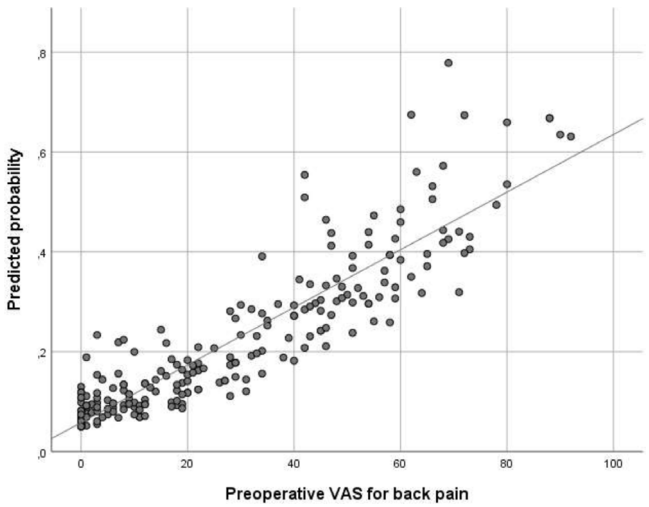

Fig. 2 This figure demonstrates the results of the multiple logistic regression analysis. Each millimetre increase in preoperative visual analogue scale (VAS) back pain (on the 0 mm to 100 mm scale) was independently associated with a higher risk of being in the high postoperative back pain group (odds ratio 1.03; 95% confidence interval 1.02 to 1.05).

EQ-5D-3L and significantly lower SRS-22r satisfaction scores, subscores and SRS-22r total scores compared with patients who did not undergo revision surgery (all p ≤ 0.042) (data not shown; results summarized in this paragraph).

Discussion

In this nationwide study with data from Swespine we found high preoperative pain and low patient-reported outcome measures to be independent predictors of pain after surgery for idiopathic scoliosis.

We demonstrated that persistent postoperative pain is prevalent among patients treated with fusion surgery

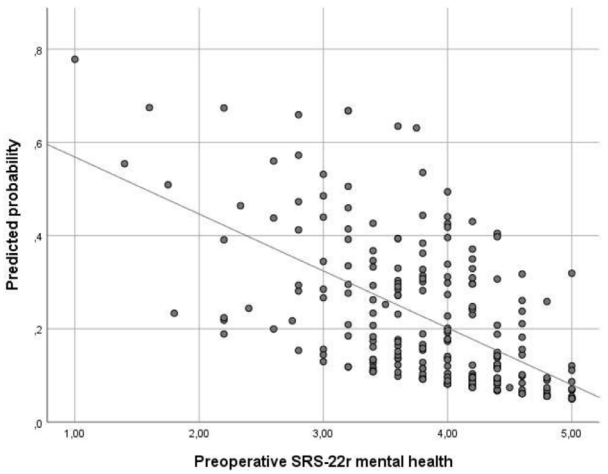

Fig. 3 This figure demonstrates the results of the multiple logistic regression analysis. Each point decrease on the preoperative Scoliosis Research Society (SRS) 22r mental health instrument (scale from 1 to 5) was associated with a higher risk of being in the high postoperative back pain group (odds ratio 1.68; 95% confidence interval 1.03 to 2.73).

for idiopathic scoliosis, with a considerable 24% of them reporting high VAS for back pain scores at the mean three-year follow-up. These patients were found to have significantly higher preoperative VAS for back pain and lower scores in all SRS-22r domains compared with the low postoperative back pain group.

Interestingly, patients with persistent pain after surgery did not demonstrate any significant improvement in the SRS-22r self-image scores. In contrast, the greatest improvement in patients with low postoperative pain was noticed in the self-image domain of the SRS-22r questionnaire. In line with our results, in a retrospective analysis of 1433 patients with adolescent idiopathic scoliosis, Landman et al[10] found a higher Spinal Appearance Questionnaire (SAQ) score – indicating a higher perception of deformity – to be associated with greater preoperative pain and less postoperative pain reduction. It seems that patients' perception of deformity is an important variable associated with pain reduction and satisfaction after scoliosis surgery. In fact, patients in the high postoperative pain group reported significantly lower (worse) SRS-22r satisfaction scores. This finding may also be attributed to a correlation between the SRS-22r self-image and the satisfaction domain. Correlations between the SRS-22r domains and satisfaction scores have been reported in the literature; Asher et al,[20] found strong correlations between the satisfaction and self-image domains and between the satisfaction and the SRS subscore, reporting correlation coefficients of 0.66 and 0.67, respectively. This can be expected given the fact that, in these otherwise healthy patients, appearance is the most evident result of surgery. Although not a subject of investigation in this study,

our results support previous findings on the relationship between self-image and satisfaction following spinal fusion for idiopathic scoliosis.

Beyond self-image, mental health may be influencing pain experience in patients with idiopathic scoliosis. In the current study, patients in the high postoperative pain group reported significantly lower (worse) mental health scores compared with the low postoperative pain group, and low mental health also independently predicted high postoperative pain. Previous investigators reported on the association between mental health scores and high levels of preoperative pain.[21] Hwang et al[21] in a retrospective analysis of 2585 patients treated surgically for idiopathic scoliosis, found lower mental health scores in the SRS-22r questionnaire to be associated with greater preoperative pain. Our results support and expand these findings; we found preoperative back pain and mental health to be independent predictors of postoperative pain; thus, we demonstrated that patients with high levels of preoperative pain and low mental health scores may not experience a beneficial effect of scoliosis surgery in terms of pain reduction.

The reoperation rate of 7% observed in this study was similar to rates reported in the literature.[22,23] Not unexpected, a higher reoperation rate was observed in the high postoperative pain group; patients that were revised after index scoliosis surgery reported higher postoperative pain scores, worse quality of life and lower (worse) SRS-22r scores than the others. Our results, consistent with previous reports in the literature,[24] suggest that reoperation in scoliosis surgery is associated with a negative impact on clinical outcome and quality of life.

There are certainly some limitations to this study. It is retrospective in nature and, therefore, prone to selection bias. However, this limitation is compensated for by the large and nationwide sample size giving the data high external validity. Opioid use in relation to pain was not investigated either in the immediate postoperative period nor at follow-up. The adjusted R^2 value in our regression model was moderate to low, indicating that other variables of importance, not included in our analysis, may have an impact on the scores. In addition, anxiety sensitivity as well as pain catastrophizing that have been shown to be predictors of postoperative pain[25] were not assessed in this study since such variables are not registered in Swespine. Cultural and ethnic background that may influence how individuals perceive pain was not investigated.[26,27] Postoperative radiographic analyses were not carried out since postoperative radiographic data are not collected in Swespine, which has an emphasis on patient-reported outcome measures. However, in the current study there were no differences in preoperative curve severity and earlier studies have shown no correlation between postoperative curve size, implant density, amount of correction and patient reported outcome scores in patients treated with spinal fusion for idiopathic scoliosis.[4,6,14]

Conclusion

The results of this study suggest that high levels of preoperative pain and low patient-reported outcome measures may be factors associated with high levels of postoperative pain in patients treated surgically for idiopathic scoliosis. Future studies should focus on preventive strategies and preoperative patient education in a systematic and multidisciplinary fashion in order to reduce the incidence of persistent pain in this population.

Received 29 April 2021, accepted after revision 11 July 2021

COMPLIANCE WITH ETHICAL STANDARDS

FUNDING STATEMENT

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

ETHICAL STATEMENT

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Regional Ethical Review Board in Stockholm approved the study (Dnr: 2012/172-31/4).

Informed consent: As in the majority of the Swedish quality registries, patient participation in the registry Swespine is made using the opt-out method. This means that surgical information may be registered without consent, but the collected information is deleted if the patient contacts the registry. Answering the patient-reported outcome questionnaire is voluntary.

ICMJE CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflict of interest.

This study was financially supported by funds from CIMED, Karolinska Institutet, Karolinska Institutet funds, Region Stockholm (ALF project) and the Swedish Research Council grants number 2012-01771, 2012-02275, 2017-01639. The senior author of this study was supported by Region Stockholm in a clinical research appointment.

AUTHOR CONTRIBUTIONS

AC: Study design, Data collection, Data analysis, Preparation of the manuscript, Revision of manuscript, Approval of the final version of the manuscript.

LR: Study design, Data collection, Data analysis, Preparation of the manuscript, Revision of manuscript, Approval of the final version of the manuscript.

HM: Study design, Data collection, Data analysis, Preparation of the manuscript, Revision of manuscript, Approval of the final version of the manuscript.

PG: Study design, Data collection, Data analysis, Preparation of the manuscript, Revision of manuscript, Approval of the final version of the manuscript.

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