Do Preoperative Depression and Anxiety Predict Outcomes of Lumbar Spinal Surgery?

ABSTRACT:

Study design:

Retrospective study with prospectively collected data.

Purpose:

To identify the prevalence of anxiety and depressive symptoms and disability pre-operatively, and post-operatively at least 6 months following Lumbar spinal surgery, and recognise their influence on surgical outcomes.

Methods:

Data was extracted from a prospective outpatient PROMS (Patient Reported Outcome Measures) database containing over 2000 patients. Eighty-five patients were identified, who received Lumbar Spine Surgery (LSS) from a single Consultant Spinal Surgeon under the Cardiff and Vale Health board between 2012 to 2016. PROMs were combined with clinic letters to analyse the prevalence of anxiety and depression before and after LSS, and examined for their relationship with overall outcome. Anxiety and depression scores were measured using GAD-7 and PHQ-9 psychometric scores respectively. Pain scores were measured using a Visual Analogue Scale (VAS) and disability using the ODI score.

Results:

Pre-operatively, 29.4% of patients were classified as having severe depression and 35.3% with severe anxiety. The mean score for VAS back, VAS leg, PHQ-9, GAD-7 and ODI reduced post-operatively by 38.9%, 45.8%, 27.1%, 27.1% and 24.0% respectively. The overall outcome measured on average at 1-year post-surgery was not related to pre-operative PHQ-9 and GAD-7 scores. An association was found between patients with a higher pre-operative GAD-7 score and those receiving injections post-surgery.

Conclusions:

Overall, pre-operative PHQ-9 and GAD-7 was not predictive of post-surgical outcomes. The prevalence of depressive and anxiety symptoms decreased after surgery, and the majority of patients, despite psychological factors agreed the operation was helpful.

INTRODUCTION:

Chronic lower back pain (CLBP) signifies a major public health burden that consumes vast amounts of health resources globally (1). With the median point prevalence of CLBP at 15% globally and the life time prevalence at 84%, this common condition represents a considerable economic burden (2).

Following Lumbar Spinal Surgery (LSS), satisfactory clinical outcomes range between 16-95%, with several differences in biological factors contributing to the variation in outcome (3). In particular, depressive symptoms in patients correlate with poor surgical recovery (3), and pre-operative anxiety scores predict post-operative physical complaints (4). It is difficult to decipher whether psychosocial influences pre-dispose to CLBP, or whether they are result of the CLBP itself. According to Polatin et al (5), of those patients with CLBP, 59% had concurrent depression, 55% had depression prior, and 45% became depressed after the CLBP onset. In support of this, previous studies showed a deterioration of patient

depression and anxiety scores after the onset of back pain, with changes in mental state associated with declines in physical health as well in immunity, mood and well being (6). There is no definite accepted method for assessing the outcome of spinal surgery (7). Nevertheless, it is well established that psychological factors affect the success of post-operative results (8).

The question remains as to whether patients intended for spinal surgery should be routinely screened pre-operatively for psychological risk factors to identify those that may require adjuvant treatment in order to improve their outcome (9).

Aims:

Depression and anxiety have been considered as the most common psychological conditions associated with CLBP (10). However, in comparison with depression, far fewer studies have examined the clinical influences of anxiety in spinal surgery (11). The aim of the current study was to identify the prevalence of depressive and anxiety symptoms and disability pre-operatively and post-operatively following LSS and examine their influence on post-surgical outcomes.

METHODS:

Patients:

The present retrospective study used data taken from a PROMS questionnaire database collected prospectively by a single Consultant Spinal Surgeon at University Hospital of Wales and University Hospital Llandough. Data was collected as part of routine clinics both on admission and as part of post-operative follow up. The database currently contains data for over 2000 patients.

Patients were extracted from the database over a period of 4 years. They were excluded from this study if they did not have LSS or had previous back surgery, or were in those diagnostic groups of tumours, infections, fractures, and Cauda Equina Syndrome. Out of a potential 356 patients, 85 met these criteria. All of these patients had completed scores both pre-operatively and post-operatively past 6 months.

Anxiety and depression*:*

Anxiety was measured using the Generalised Anxiety Disorder 7 (GAD-7) scoring system. The system uses a 7 item anxiety scale with a strong criterion validity for identifying Generalised Anxiety Disorder (sensitivity 89%, specificity 82%) (11). It also has a high sensitivity and good specificity for detecting Panic Disorder, Social Anxiety Disorder and Post Traumatic Stress Disorder (12). The GAD-7 scoring system has been developed based upon DSM-IV criteria for diagnosing GAD (13). Scores on this scale below cut off points of 5, 10, and 15 correspond to mild, moderate and severe anxiety, respectively. Higher scores are strongly associated with more functional impairment (11,13).

Depressive symptoms were identified using Patient Health Questionnaire 9 (PHQ-9) score which is a more commonly used self administered version of the Primary Care Evaluation of Mental Disorders (PRIME-MD) diagnostic tool for mental disorders (14). It contains 9 items each corresponding to one of the 9 criteria of the DSM-IV used to diagnose depressive disorders. Each of the 9 items are scored from 0, "not at all" to 3, "nearly every day" giving a maximum score of 27. Cut off points for mild, moderate, moderate severe and severe are 5, 10, 15, and 20 respectively. A score of >10 gives a positive likelihood ratio for Major Depression of 7.1 (sensitivity 88%, specificity 88%) (15).

Pain and disability:

To analyse pain, patients were asked to rate their pain on a Visual Analog Scale known as the VAS score, in this case specifically back and leg pain. To measure disability pre-operatively and post-operatively, the Oswestry Disability Index v2 (ODI) was utilised. The ODI encompasses a questionnaire with 10 sections, each with 6 statements scored on a 5-point scale, with higher scores indicating greater disability. This score is a lower back condition-specific measure used commonly in management of spinal disorders (16). We also identified changes in walking distance capabilities both pre-operatively and post-operatively.

Overall outcome:

Following their LSS, patients were asked if they found the operation helpful, whether they would have the operative again, whether they were satisfied and whether it met their expectations. These were scored in a binary (yes/no) format.

Statistical analysis:

The results are summarised for the cohort by means, standard deviation (SD) and 95 % Confidence Intervals for continuous variables, or by proportions of the total number of cases for categorical variables. Statistical analyses were performed using SPSS Software (version 23) and involved use of Students' t, Chi squared and Fisher's Exact tests.

RESULTS:

Patient Demographics:

Table 1 summarises the demographic data of the 85 patients included in the study. There were 50 females (59%) and 35 males (41%) of mean age 49 years (range from 16-75). Only 23/85 (27%) patients were found to be a smoker during their first consultation. 27/85 (32%) claimed Disability Benefits at the time of their consultation. Prior to surgery, some patients had tried Nerve Root Blocks or Spinal injections or both but these had given only short term relief (n=39, 45.9%).

Surgery included: Transforaminal Lumbar Interbody fusion (28%); Posterior Lumbar Decompression and Instrumental fusion (19%); Anterior Lumbar Interbody Fusion (8%); Lumbar Decompression (13%); Lumbar Disectomy (25%); and other (7%).

Concerns and expectations at initial outpatient consultation were recorded and are summarised in **Tables 2 and 3.** The common concerns were organised into 5 groups, the largest group (52.9%) did not express any major concerns, 25.9% stated that 'Impact on day to day life' was their most prevalent concern, and involved worries regarding family life, finances and occupation. The next most common concerns were 'Risks of Surgery' (10.6%), then 'Losing walking ability' (7.1%) followed by 'Paralysis/Cauda Equina Syndrome risk' (3.5%). The main expectations at initial outpatient consultation were 'Pain relief' (45.9%) followed by 'None' (38.8%), 'Improve quality of life' (9.4%), 'Cure' (4.7%) and 'Stop need for analgesics' (1.2%).

	Mean	**n**
Age/ years (95%CI)	49.3 (46.3-52.3)	85
Sex (male: female) (% male)	35:50 (41.2%)	85
Smoker (yes: no) (%yes)	23:62 (27.1%)	23
Disability Benefits (yes: no) (% yes)	27:58 (31.8%)	27
Prior Nerve Root Block (yes: no) (%yes)	39:46 (45.9%)	39

Table 1. Patient demographics

Pre-operative concerns	**N**
Risks of Surgery	9
Losing walking ability	6
Paralysis/ CES risk	3
Impact on day to day life	22
None	45

Table 2. Patient Pre-operative concerns

Pre-operative expectations	**N**
Pain relief	39
Improve Quality of Life	8
Stop need for analgesics	1
Cure	4
None	33

Table 3. Patient pre-operative expectations

<u>Overall outcomes:</u>

Out of the 85 patients that were included in this study, 70/83 (84%) subjectively agreed that their operation was 'Helpful', with 52/56 (93%) patients confirming they were satisfied with the overall care and 58/64 (91%) said they would have the operation again. We also measured whether the spine operation met the patient's expectations, with 2 = All (n=26) 1

= some (n=32), and 0 = None (n=5), the mean score being 1.3 (n=63), concluding that the majority of patients had between some and all of their expectations met as discussed above.

PROMS Data:

The average follow-up time was 11.5 months' post surgery (range 6 – 24 months). We compared post-operative scores collected at this time to pre-operative scores **(Table 4).** Of the 85 patients, 29.4% (n = 25) had a pre-operative PHQ-9 score representing severe depression (>20), and 35.3% (n = 30) had a GAD-7 score representing severe anxiety (>15).

At follow-up, we saw a reduction of mean score for VAS Back, VAS leg, PHQ-9, GAD-7, and ODI by 38.9%, 45.8%, 27.1%, 27.1% and 24.0% respectively. These average reductions are also shown in **Figures 1 to 5.** Walking distance was improved by 163% on average at follow up.

SCORES:	PRE OPERATIVE SCORES		POST OPERATIVE SCORES			% Change
	Mean	95% CI	Mean	95% CI	P value	
VAS Back	7.2	6.7-7.8	4.4	3.8-5.1	<0.001	38.9
VAS leg	7.2	6.6-7.8	3.9	3.2-4.5	<0.001	45.8
PHQ-9	14.4	12.8-16.1	10.5	8.6-12.3	<0.001	27.1
GAD-7	10.7	9.2-12.2	7.8	6.3-9.3	<0.001	27.1
ODI	53.8	50.1-57.5	40.9	35.6-46.2	<0.001	24.0
Walking distance (m)	360.7		749.3			163

Table 4. Comparison of pre- and post-operative VAS back, VAS leg, PHQ-9, GAD-7, ODI score, Walking distance (m) averages and percentage change.

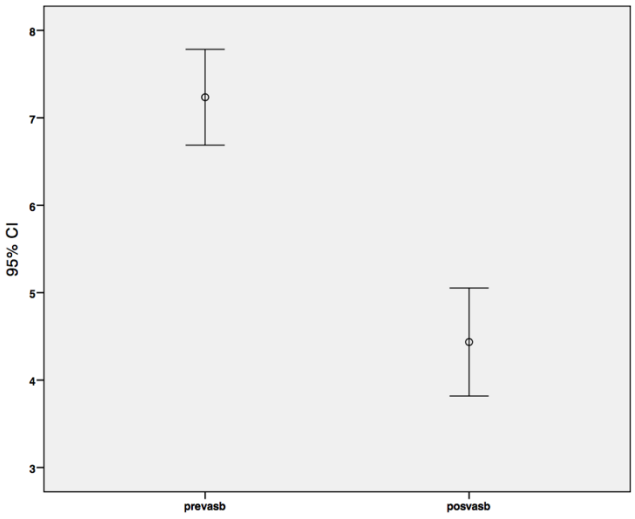

Figure 1. Pre- and post-operative comparison of VAS back score

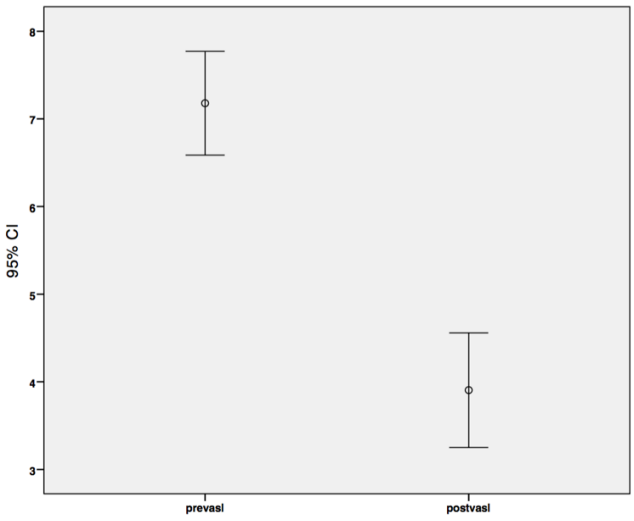

Figure 2. Pre- and post-operative comparison of VAS leg score

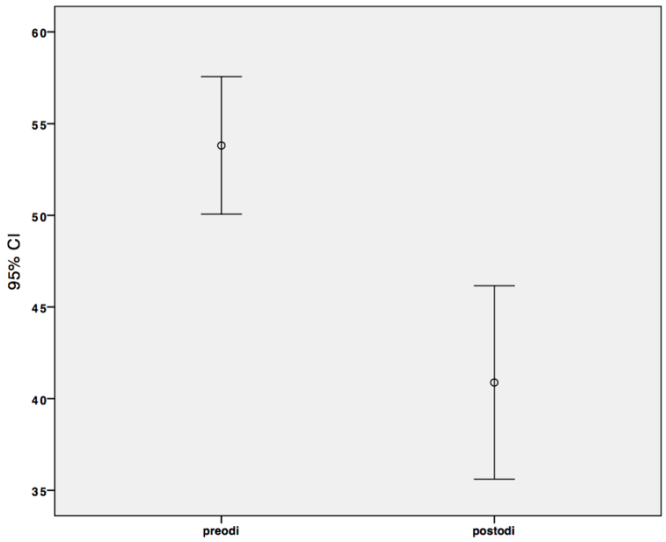

Figure 3. Pre- and post-operative comparison of ODI score

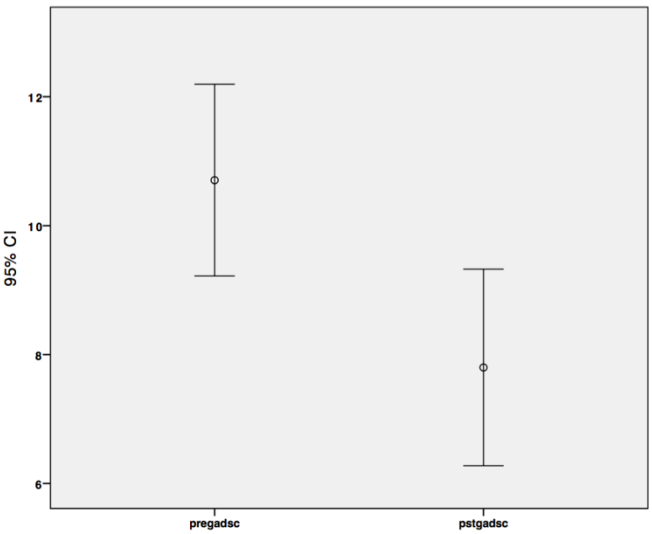

Figure 4. Pre- and post-operative comparison of GAD-7 score

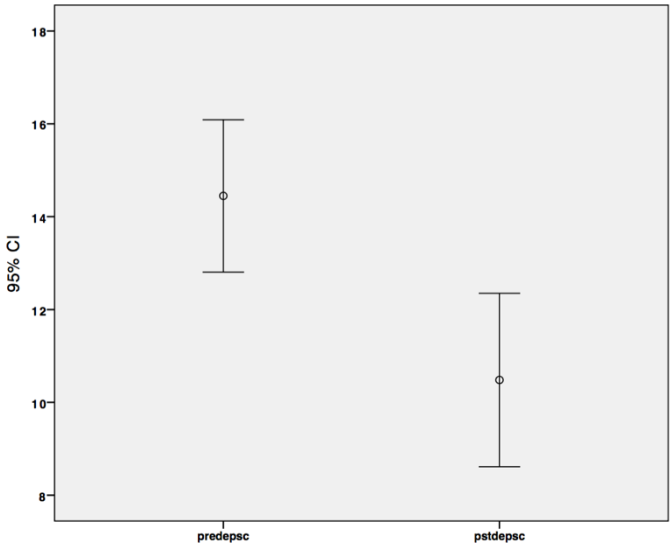

Figure 5. Pre- and post-operative comparison of PHQ-9 score

The difference in average pre-operative and post-operative scores were calculated for VAS back, VAS leg, ODI, PHQ-9 and GAD-7 and compared to their respective Minimum Clinically Important Difference (MCID). A difference of 2, 10 (17), and 5 (18) was considered clinically significant for the VAS, ODI and PHQ-9 scores respectively. The GAD-7 score does not currently have a recognised MCID. The average changes can be seen in **Table 5.** This shows that of the 85 patients, 72.9% of patients had a clinically significant change in their VAS scores for both back and leg, with 61.2% showing a clinically significant change in ODI score and despite the average score for PHQ-9 not being >5 and therefore not clinically significant, 56.5% of patients demonstrated a significant change in their score.

	VAS Back	**VAS Leg**	**ODI**	**PHQ-9**	**GAD-7**
Average Difference between pre/post op	-3	-3	-13	-4	-3
Number of clinically significant changes (%)	62	62	52	48	N/A

Table 5. Average difference between pre- and post-operative scores and percentage of patients with clinically significant changes in scores. - = reduction in score, + = increase in score.

Pre-operative PHQ-9 and GAD-7 score associations:

Patients who smoked and claimed disability benefits were more likely to score highly on the PHQ-9 and GAD-7 ($p<0.05$) indicating that these individuals experienced more depression and anxiety.

A strong positive correlation was seen between pre-operative GAD-7 and PHQ-9 scores (Figure 6, $r = 0.86$, $p<0.001$). Given that the questionnaires are different, this would indicate that anxiety and depression are linked.

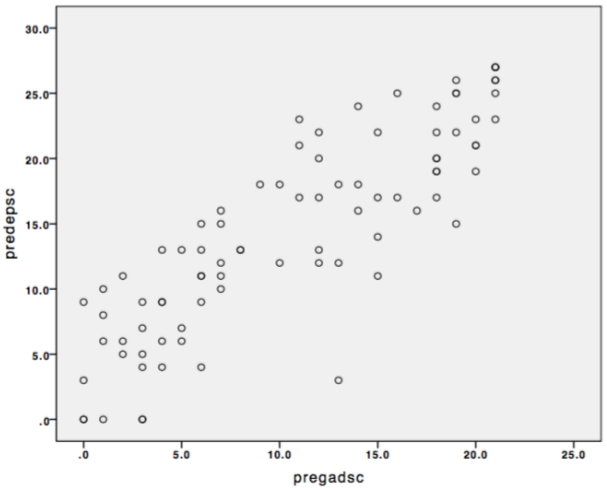

Figure 6. Scatter plot showing correlation between pre operative GAD-7 scores and pre-operative PHQ-9 scores.

Strong positive correlations were also seen between pre-operative PHQ-9 score and post-operative GAD-7 ($r = 0.52$, $p=0.001$), ODI ($r=0.52$, $p=0.001$) and PHQ-9 scores ($r= 0.52$, $p<0.001$). Those patients with higher PHQ-9 scores pre-operatively, were commonly found to have higher post-operative PHQ-9, GAD-7 and ODI scores. A weaker but statistically significant positive relationship was seen also between pre-operative PHQ-9 score and post VAS leg score ($r= 0.28$, $p=0.01$) but pre-operative depression did not predict post operative VAS back score and therefore was not associated with the level of back pain felt by the patient following surgery.

In terms of pre-operative GAD-7 scores, anxiety before surgery was seen to correlate positively with post-operative anxiety ($r=0.67$, $p<0.001$), depression ($r=0.58$, $p<0.001$), ODI ($r=0.58$, $p=0.001$), VAS back pain ($r=0.25$, $p=0.001$) and VAS leg pain ($r=0.43$, $p=0.05$). This indicates that those with high anxiety prior to surgery were more likely to still be experiencing back pain post-operatively in comparison to those with depression.

Association with overall outcome:

Despite correlating with the psychometric, pain and disability scores post-operatively, no association was found between pre-operative psychometric scoring and our measures of overall outcome, such as whether the patient would have the operation again, whether it helped them and whether they were satisfied. Student's t test and the graphical representations in **Figures 7 and 8** show no significant differences in the pre-operative PHQ-9 and GAD-7 scores between groups of people based on whether the operation helped or not. All three outcomes measured are summarised in **Table 6**.

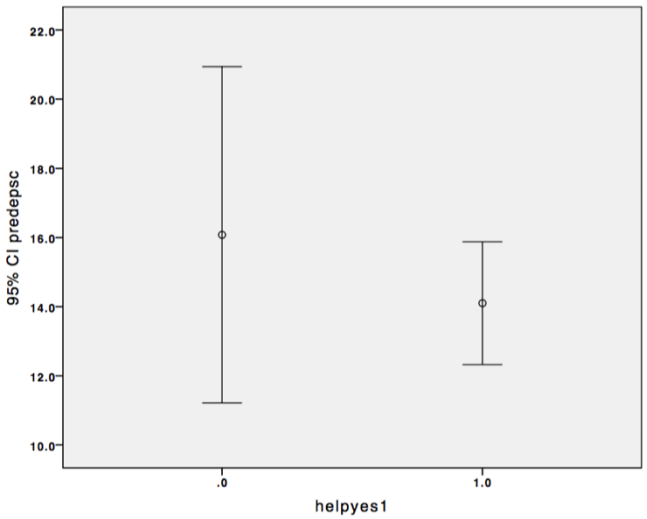

Figure 7. Error line graph showing the influence of pre-operative PHQ-9 score on whether the operation 'Helped'.

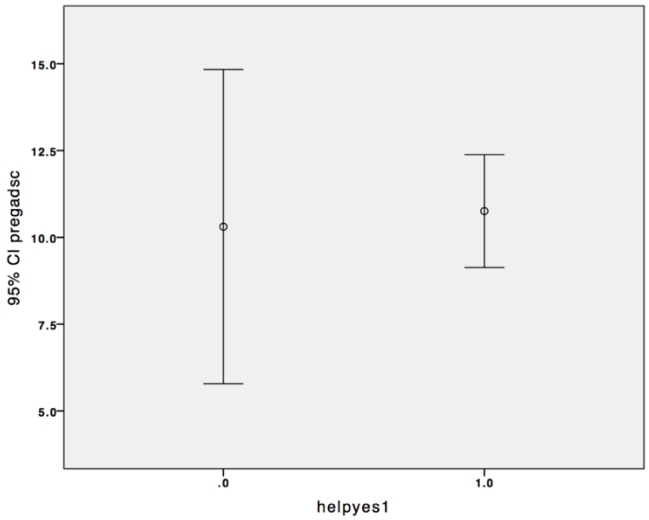

Figure 8. Error line graph showing the influence of pre-operative GAD-7 score on whether the operation 'Helped'.

		N	Mean diff	t	p value
Pre PHQ-9	**Helped**	83	1.98	0.87	0.39
	Op. again	64	-1.12	-0.36	0.72
	Satisfied	56	-1.25	-0.35	0.77
Pre GAD-7	**Helped**	83	-0.45	-0.22	0.83
	Op. again	64	-3.25	-1.11	0.27
	Satisfied	56	-2.77	-1.60	0.16

Table 6. Student's t test looking at the significance of pre-operative PHQ-9 and GAD-7 scores on post-operative outcome. Pre PHQ-9 = pre operative PHQ-9 score, Pre GAD-7 = pre-operative GAD-7 score, N= Number of proms results. 'Helped' = How many patients said the operative helped, 'Op. again' = How many patients would have the operative again, 'Satisfied' = How many patients said they were satisfied.

Interestingly, of those patients who were reported to have severe depression (n=24, 29.4%), 83% (20/24) claimed their operation helped them. A similar pattern was seen for those with severe anxiety (n=29, 35.3%), with 83% (24/29) also reporting that the operation helped (**Table 7 and 8)**. It is worth noting that the high correlation between depression and anxiety pre-operatively, would suggest that some of these individuals are the same (i.e. they have both severe depression and severe anxiety). Nevertheless, it is notable that the large majority of such severely affected individuals were positive about the outcome of their surgery.

		Severe Depression	
		No	**Yes**
Operation Helped	**No**	9	4
	Yes	50	20

		Severe Anxiety	
		No	**Yes**
Operation Helped	**No**	8	5
	Yes	46	24

Table 7 and 8. Comparison of number of patients with severe anxiety and depression who found the operative helped or didn't help.

The only factor that was statistically associated with whether the operation 'Helped' or not, was the post-operative ODI score, where the group that stated the operation 'Helped' was seen to have the biggest drop in ODI score and therefore level of self perceived disability ($p<0.001$, **Figure 9).**

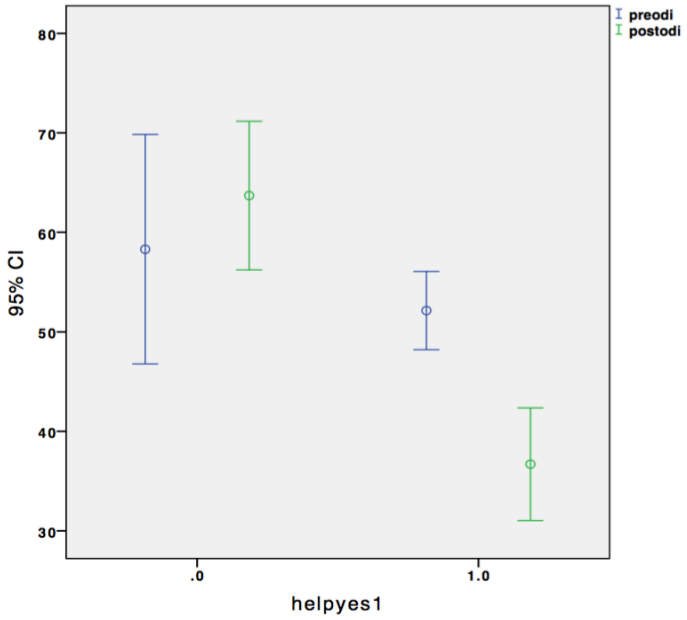

Figure 9. Comparison between pre- and post-operative ODI score and its associated with whether the operation 'Helped'

The group of patients who underwent decompression surgery, which is primarily required for cases of Spinal Stenosis (19) showed the highest percentage of patients who required a further operation following their first surgical intervention (19%) **(Table 9).** It is positive to see that the majority of patients under going any of the three surgeries in **Table 9** saw a clinically significant positive change in their VAS back, VAS leg and ODI score, suggesting a strong overall improvement in these post-operative PROMS scores for physical symptoms. Transforaminal Lumbar Interbody Fusion (TLIF) procedure had the best result based on a measure of overall outcome, with 100% of patients being 'Satisfied' with their operation and claiming they would have the 'Operation again'

Mean follow up time 1 year				
	Overall no. %	**TLIF %**	**Post LDF %**	**Decom/ Disc %**
CSI VAS back	73	71	63	75
CSI VAS leg	73	79	56	72
CSI ODI	61	58	63	63
Helped	84	92	75	83
Satisfied	93	100	90	95
Op. again	91	100	92	88
Further op	8	8	6	19
Further Inj.	17	16	18	34

Table 9. The post-operative outcomes compared among the three most common operations. Numbers indicate the percentage of patients for each of the outcome measures. Overall no. = number of patient results overall, TLIF = Transforaminal Lumbar Interbody fusion, Post LDF = Posterior Lumbar Decompression and Instrumental fusion, Decom/Disc = Decompression and Discectomy's, CSI = Clinically significant change

Further treatments:

Out of the 85 patients, following their primary operation, 11 went on to have a further operation. This outcome was not found to be related to either pre-operative GAD-7 or PHQ-9 score ($p>0.05$). A similar result was found when looking at those patients who had to have further Nerve Root Block injections following their surgery due to on going symptoms (n=20) and pre-operative PHQ-9 scores ($p>0.05$). However, a small association was identified between future injections and pre-operative GAD-7 score ($p<0.05$) suggesting those with a higher GAD-7 score were more likely to have a further injection post-operation.

DISCUSSION:

The main objective of this study was to identify the relationship between pre-operative measured of depression and anxiety (PHQ-9 and GAD-7 scores, respectively) and post-operative outcome in a large group of patients who underwent lumbar spine surgery. No association was found between these two scores and our measures of overall outcome. However, if we extend our definition of outcome to include post-operative psychometric, disability and physical scoring, we could see a correlation between pre-operative PHQ-9 scores and post-operative ODI, GAD-7, VAS leg and PHQ-9 scores. These findings suggest that those with a higher level of depression before surgery may experience more pain, disability and psychological problems after their surgery, in comparison with those who have a lower PHQ-9 score. Despite this, the overall PHQ-9 average score reduced after surgery. This was seen in the study by Wahlman et al (20) identifying the reduction in prevalence of depressive symptoms post-operatively.

It is interesting to find, as well as mirroring the correlation between PHQ-9 scores and post-operative scores, GAD-7 was individually associated with post-operative VAS back scores. Those with higher levels of anxiety expressed a higher level of back pain post-surgically in

comparison to those with a lower anxiety score. This has been previously reported by Groot et al (4), whereby these patients report higher levels of physical complaints after their surgery. This may explain why a relationship was seen between pre-operative GAD-7 score and future post-surgical injections: those with anxiety, even after their surgery, may still be experiencing physical symptoms in need of further intervention. It therefore may help in predicting whether a patient with anxiety will need further interventions following their spinal surgery.

Of those 20 patients who had further injections, the two most common operations were Discectomy (35%) and TLIF (25%). This gave a mixed pictures of prior operations suggesting these were not the causative factor as to why these patients required a future injection, and it is more likely it is due to the GAD-7 score. It was further noted that 75% of these patients were female (n=15) with 80% claiming following their operation their Walking Distance did not improve.

Also, the fact that Decompression surgery and further operations were associated is reflected in a study by Shipman et al (21) which shows Spinal Stenosis to be the most common diagnostic reason (21.5%) for Failed Spinal Surgery Syndrome, which is a generalised term used to describe those patients who have experienced pain after unsuccessful spinal surgery (22).

The main pre-operative expectation was 'Pain relief', and alongside the fact that the majority of expectations were met, we saw a large reduction in average VAS leg and back pain score following surgery. Overall, 84% of patients agreed their operation helped them, suggesting that there is no need to exclude patients from surgery based on their psychometric scores. Walking distance improved by 163% on average after 1 year follow up, indicating a positive outcome given that 'losing walking ability' was one of the identified 5 top pre-operative concerns.

It was reassuring to see that the majority of those with scores representing Severe depression and Severe anxiety said they found their operation helpful. This is encouraging, as it suggests that despite a patient qualifying for severe anxiety or depression, which may have a large psychological influence on their perception of surgery success and any pain that they may experience (23), the majority of the operations nonetheless was perceived by these patients as helpful, which essentially is our most important outcome.

<u>Limitations:</u>

There are some limitations to this study, alongside the small sample size and mixed operation types. In terms of the psychometric scoring systems, though quick, cheap and easy methods for analysing a patient's psychological state pre- and post-operatively, they do involve a self rating system rather than a formal clinical diagnosis. Therefore, they may only be a rough indication of a patient's psychological profile. However, both tests as previously mentioned have a high specificity and sensitivity for their conditions (11,15) and so it is assumed that the scoring systems are suitable for research such as this. Of note, the surgeon did not use the pre-operative PROMs or psychometric scores to determine whether a patient was suitable for surgery.

It is difficult to assume that the CLBP as felt by the patient is the only contributing factor, and the surgery the only alleviating factor, of psychological distress. Consequently, any improvements of patient's psychological profile cannot be explained just by the variables seen in this study (23).

In terms of data collection, there was bias as the Surgeon often discharged discectomy / decompression patients after 3 months, whereas other patients had longer follow-ups. These patients are not followed up further unless they had complications or ongoing problems.

CONCLUSION:

Overall, pre-operative PHQ-9 and GAD-7 were not associated with the patients' perception of surgical success. Depression, disability, anxiety and pain scores on average showed a reduction following surgery, and most patients, including those with severe depression and anxiety claimed the operation 'Helped'. Those with higher pre-operative GAD-7 scores were more likely to require an injection after their operation, and were found to experience higher levels of back pain. Therefore, though screening for anxiety and depressive disorders may help identify those patients who need further interventions and pain management post-surgery, they should not be used as a single predictor of post-surgical outcome.

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