How the Straight Leg Raise (SLR) and Crossed Straight Leg Raise (XSLR) Sign influence Patient Reported Outcome Measures (PROMs) in Patients with a Lumbar Disc Herniation

Alexandra Stanley
1703575

Abstract:

Study Design: A retrospective review of prospectively collected data.

Aim: To assess the significance of the straight leg raise (SLR) and crossed straight leg raise (XSLR) sign on patient reported outcome measures (PROMs) in patients with an MRI confirmed lumbar disc herniation.

Background: Low back pain (LBP) is a very common and often disabling condition. A common variation is LBP with associated lumbar radiculopathy, most frequently caused by a herniated lumbar disc. This can be clinically assessed using the SLR test. However, the SLR test lacks diagnostic accuracy and so in addition the XSLR test, a more specific test, can be used. LBP is considered a biopsychosocial issue with multiple contributary factors. Such factors can be assessed using PROMs scores. Although there is significant evidence supporting the links between LBP and various psychosocial issues, there is little looking at the psychosocial elements in relation to the outcomes of clinical tests, such as the SLR and XSLR test.

Methods: A single spinal surgeon's database was used to find all private patients that presented with LBP and radiating leg pain and were treated for an MRI confirmed lumbar disc herniation. Data was collected using clinic letters and MRI reports to assess variables including each patient's PROMs scores. Data was then analysed using SPSS to assess the significance of each variable with regard to the SLR and XSLR test.

Results: Patients with a positive clinical test on examination had 'worse' reported PROMs scores, with a positive XSLR sign being associated with the 'worst' PROMs scores. For each of the PROMs variables, *t*-test analysis reported a significant difference between the NSLR and SLR groups and NSLR and XSLR groups.

Conclusion: Patients with PROMs scores indicating a lower health-related quality of life, higher pain severity, increased levels of disability, anxiety and depression and greater expectations are associated with a positive SLR test or XSLR test when compared to patients without (NSLR).

Introduction

Low back pain (LBP) is incredibly common with a global prevalence of around 31% (1). Patients find it to be a disabling condition, with LBP being a major cause of absence from work (2), subsequently causing huge financial burden on individuals, families and society as a whole (3). There are many potential causes for LBP, including pathology in muscle, joints, intervertebral discs and abdominal organs (4).

The most common variation of LBP is LBP associated with pain radiating from the buttock down the leg (sciatica) (5). The literature reports variable prevalence estimates, ranging from 1.2% to 43% (6), whilst it is considered the most prevalent type of neuropathic pain (7). It is most commonly due to a lumbar disc herniation (4, 8), which is defined as the displacement of disc material, either nucleus pulposus or annulus fibrosis, beyond the intervertebral disc space (9). Such displacement can irritate nerve roots causing lumbar radiculopathy, which gives symptoms of leg pain, paraesthesia and neurological impairment (10). It is important to distinguish patients who experience only LBP from those who have LBP with lumbar radiculopathy, as this allows early and targeted treatment, thus improving outcomes and reducing disability (11).

A diagnosis of lumbar disc herniation is most commonly confirmed using Magnetic Resonance Imaging (MRI), which provides high quality images without exposing the patient to potentially harmful ionising radiation (12). MRI scans have been shown to have excellent sensitivity (13) and are capable of giving clear visualisation of soft tissue (12). However, it has been found that imaging findings are only weakly related to symptoms (4) and a cross-sectional study of asymptomatic patients found that 36% had a herniated disc on MRI (14). Clinically it is therefore important to consider the intercorrelations between both the MRI report and findings from clinical tests (15).

The most commonly used clinical test in assessing patients who present with LBP and lumbar radiculopathy is the straight leg raise (SLR) test (15), also known as Lasègue's test. The SLR test is performed with the patient lying supine on the examining couch and the examiner slowly raising the patient's leg, keeping their knee in full extension. The examiner continues to raise the leg until maximum hip flexion is reached or the patient reports pain in the lifted leg (13). There are varying definitions of what is regarded as a positive test (16), with studies showing generally poor interpretation of positive tests and the understanding of the underlying pathological mechanism (17). However, it is still considered a useful test (17), with moderate accuracy in detecting lumbar radicular pain (15). Due to the potential for alternative causes of a positive test, such as lumbar facet joint hypertrophy (18), the SLR test has a high sensitivity, but overall low specificity (19).

Individual clinical tests used independently lack the diagnostic accuracy to detect MRI confirmed disc herniations (20), and given the significance of an accurate diagnosis in the effective management of patients (21), it is therefore important to use multiple clinical tests simultaneously alongside the patient's history to significantly improve diagnostic accuracy (21, 22). An additional sign that could be considered in the assessment of such patients is the crossed straight leg raise (XSLR). This test is conducted in a similar manner to the SLR

test, with a positive test reported if the patient experiences pain in the affected limb when the unaffected limb is flexed at the hip (23). The XSLR has a higher specificity (16) and a positive test considered 'highly suggestive of a disc herniation' (23).

The literature agrees that there is a significant psychosocial component in the development of LBP (1, 4) and there is evidence to demonstrate that conditions such as depression and anxiety can have a key role in the transition of acute LBP to chronic (24, 25). Such conditions and the patient's own perception of their health can be assessed using Patient Reported Outcome Measures (PROMs) in the form of questionnaires (26). PROMs can be generic health status measures, such as the EQ5DVAS score (27), or can focus on more specific aspects of health, for example the GAD-7 score screens for generalised anxiety (28). PROMs have been deemed a 'useful clinical tool' (26) and should be used in conjunction with other aspects of the clinical assessment of patients in order to decide on the correct management plan.

Aim

The primary aim of this study was to assess the significance of the SLR and XSLR sign on PROMs scores, such as the EQ5DVAS, ODI, PHQ-9 and GAD-7 score, in patients with an MRI confirmed lumbar disc herniation. The null hypothesis is that there is no relationship between the outcome of the SLR or XSLR test and PROMs scores in patients with a herniated lumbar disc.

Method

A retrospective review of prospectively collected data was carried out for all patients fitting the inclusion criteria that were treated privately by a single spinal surgeon for a herniated lumbar intervertebral disc.

The surgeon's database of all treated patients from April 2012 to August 2019 was used. The inclusion criteria was; any patient presenting with leg pain, that radiated from the buttock, with an MRI confirmed central or posterolateral disc herniation within the spinal canal. Patients presenting with isolated LBP and those with foraminal or extraforaminal herniations were excluded.

A total of 3,402 sets of patient data were manually filtered. Duplicate entries and follow up treatment for the same disc herniation were collated under one entry. A total of 217 patients met the defined parameters for inclusion in this study.

Data was collected using the surgeon's clinic letters and the patient's MRI report. Collected variables included; the presence, side and degree of SLR, presence of the XSLR sign, history of spinal surgery, duration of symptoms, level and side of disc prolapse, any interventions and PROMs scores.

The PROMs used in this study were Visual Analogue Scales for interpretation of back and leg pain intensity (VAS back/leg), Oswestry Disability Index (ODI) (29), EuroQol 5D (EQ5DVAS)

(30), Patient Health Questionnaire 9 (PHQ-9) for self-reported depression (31), Generalised Anxiety Disorder score (GAD-7) (28) and expectations survey for lumbar spine surgery (32).

The collected data was then analysed using IBM SPSS Software Version 25. We used either Chi-squared test, independent *t*-test or Pearson correlation analysis to determine the significance of each variable with regard to the SLR and XSLR test.

Results

There were a total of 217 patients included in this study, which consisted of 89 (41%) females and 128 (59%) males. The mean age was 50.4 years (SD 15.4, range 15-85). There were 102 (47.0%) patients with a negative SLR test (NSLR), 94 (43.3%) patients with a positive SLR test (SLR) and 20 (9.2%) patients with both a positive SLR test and positive XSLR test (XSLR). There was one (0.5%) patient who did not have this information recorded.

The mean age for NSLR was 53.7 years (CI 50.4-57.0), 49.2 years (CI 46.5-51.9) for SLR and 39.3 years (CI 33.3-45.3) for XSLR. *t*-test analysis revealed significant differences between all three mean values (NSLR vs SLR $P = .04$, NSLR vs XSLR $P < .0001$, SLR vs XSLR $P = .003$).

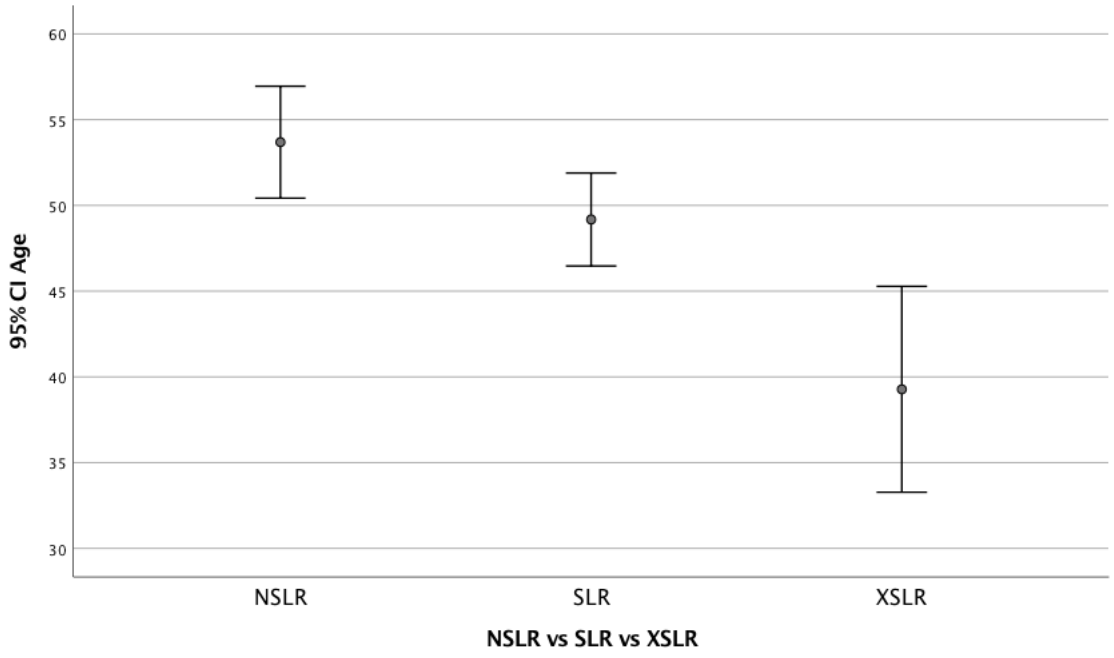

Figure 1. Mean age for each outcome of SLR test (NSLR vs SLR vs XSLR)

A total of 24 (11.1%) participants underwent operative treatment for their disc herniation, whilst the remaining 158 (72.8%) of patients received either conservative treatment or a nerve root block injection. 73 (33.6%) patients opted for conservative management, such as physio, analgesia and advice to manage their symptoms, whilst 85 (39.2%) patients received an injection. Treatment information was missing for 35 (16.1%) patients. There was a significant association between outcome of the SLR and XSLR test and the treatment a

patient received (x^2 (4) = 29.2, *P* < .001). Cramer's V value was significant (Cramer's V = 0.283, *P* < .001) indicating a weak association.

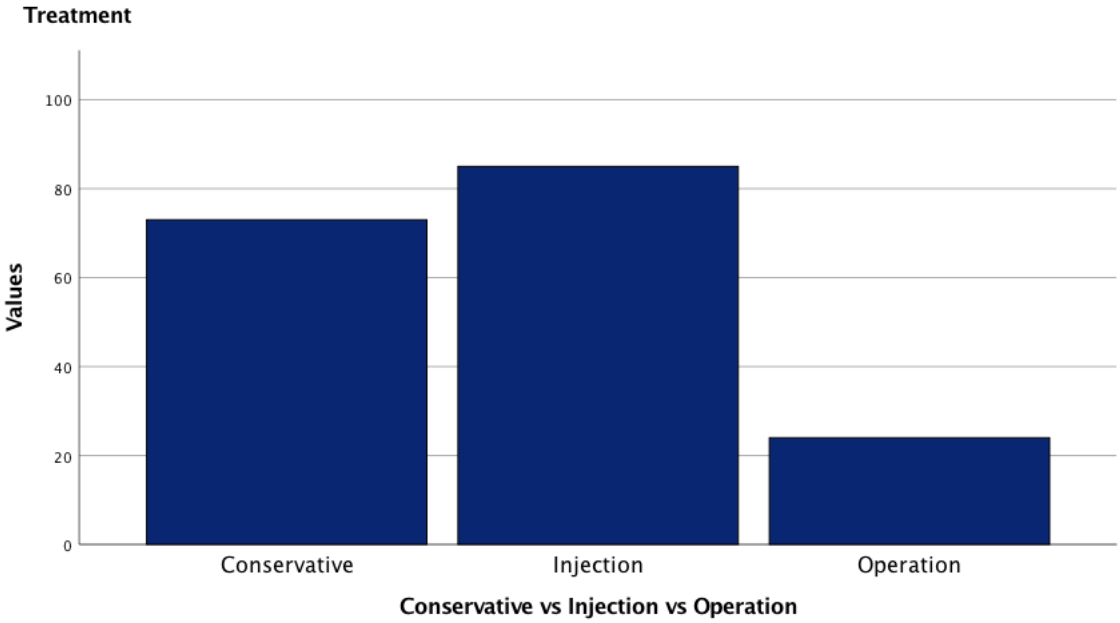

Figure 2. Number of patients for each treatment group

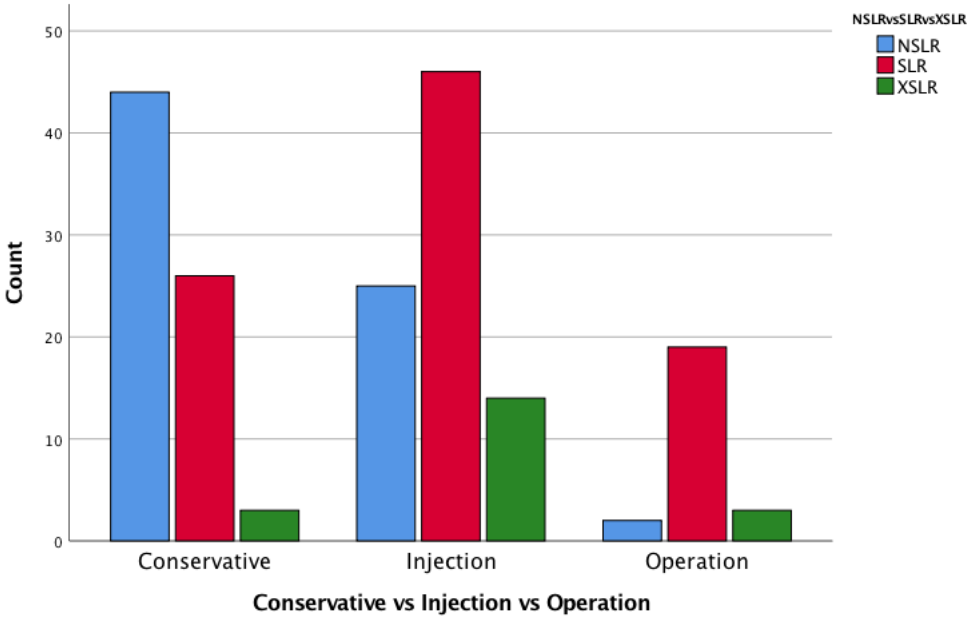

Figure 3. Number of patients for each treatment group depending on each outcome of SLR test (NSLR vs SLR vs XSLR)

VAS leg

The lowest VAS leg scores were reported for patients with NSLR (mean 6.3, CI 5.7-6.9) whilst scores were higher for patients with a positive SLR (mean 7.5, CI 7.0-8.0) and highest for

patients with a positive XSLR (mean 8.5, CI 7.4-9.6). The difference was statistically significant between NSLR and SLR ($t(194) = -3.1$, $P = .003$) and between NSLR and XSLR ($t(121) = -3.1$, $P = .003$), but not between SLR and XSLR ($P = .1$).

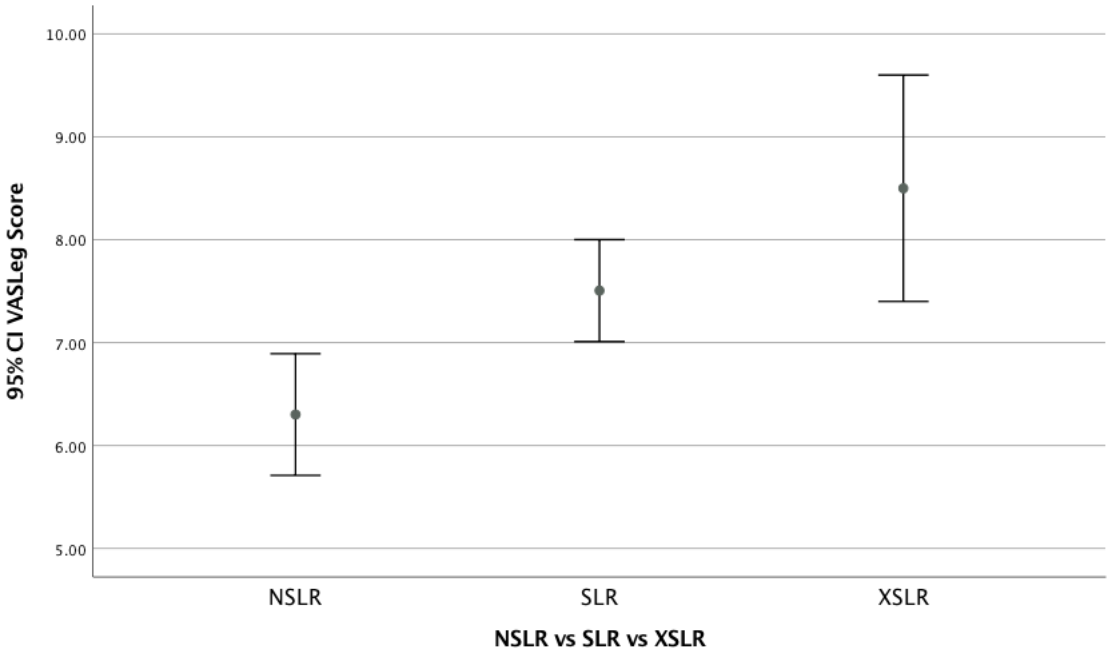

Figure 4. Mean VAS leg score for each outcome of SLR test (NSLR vs SLR vs XSLR)

EQ5DVAS

Patients with a positive XSLR reported the lowest EQ5DVAS scores for health-related quality of life (mean 42.6, CI 28.3-56.9) compared to that of patients with only a positive SLR (mean 47.1, CI 42.5-51.7) and patients with NSLR (mean 59.6, CI 54.2-65.0). Again, *t*-test analysis revealed the difference between NSLR and SLR ($t(160) = 3.5$, $P = .001$) and NSLR and XSLR ($t(96)=2.5$, $P = .01$) was significant, whilst that between SLR and XSLR was not ($P = .4$).

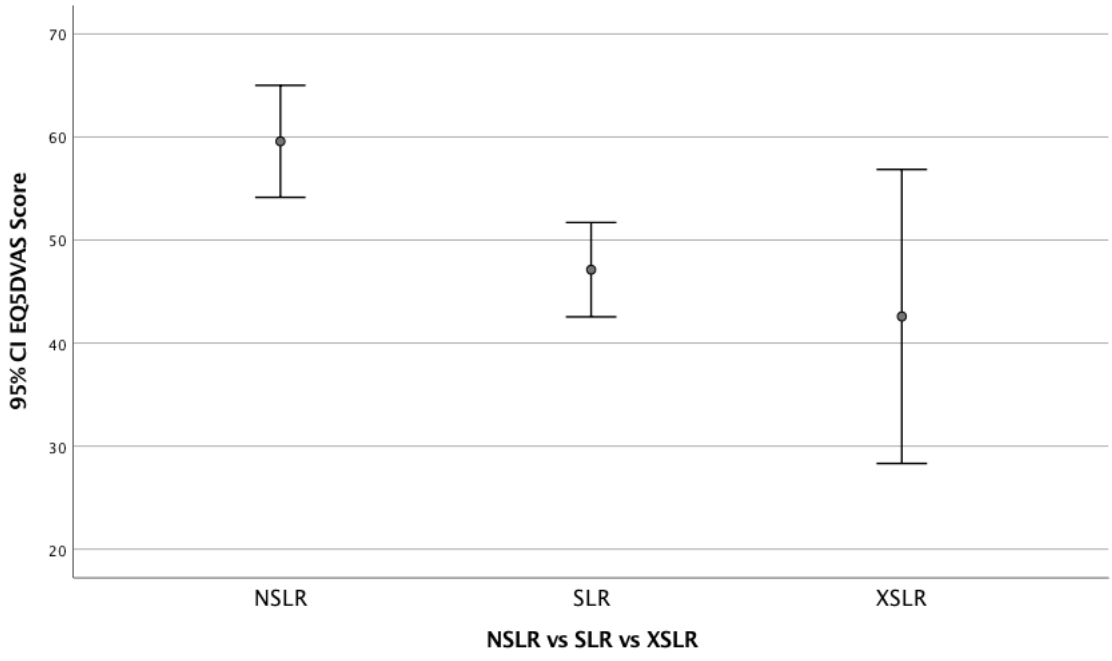

Figure 5. Mean EQ5DVAS score for each outcome of SLR test (NSLR vs SLR vs XSLR)

ODI

ODI scores were highest in patients with a positive XSLR (mean 52.0, CI 43.4-60.6) compared to those with solely a positive SLR (mean 46.3, CI 42.5-50.1) and those with NSLR (mean 38.7, CI 34.9-42.5). *t*-test analysis showed this difference was not significant between SLR and XSLR (*P* = 2.17). However, the difference did reach significance between NSLR and SLR (*t*(182) = -2.8, *P* = .005) and NSLR and XSLR (*t*(111) = -2.8, *P* = .006).

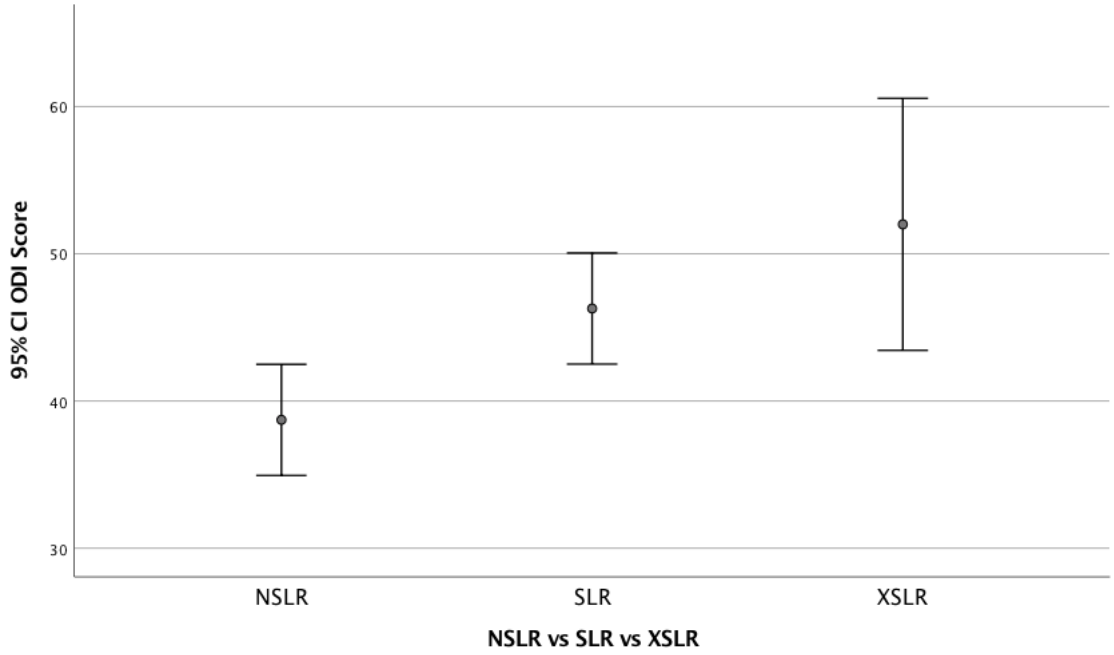

Figure 6. Mean ODI score for each outcome of SLR test (NSLR vs SLR vs XSLR)

PHQ-9 & GAD-7

Patients with NSLR were reported to be the least depressed with the lowest PHQ-9 scores (mean 7.6, CI 6.1-9.1) and the least anxious with similarly low GAD-7 scores (mean 4.5, CI 3.0-6.1) compared to patients with a positive SLR (PHQ-9; mean 10.5, CI 8.5-12.6, GAD-7; mean 7.1, CI 5.2-9.0) and patients with a positive XSLR (PHQ-9; mean 13.9, CI 8.4-19.4, GAD-7; mean 11.1, CI 6.4-15.8). In the case of both the PHQ-9 scores and GAD-7 scores, *t*-test analysis reported a significant difference between NSLR and SLR (PHQ-9; *t*(93) = -2.3, *P* = .02, GAD-7; *t*(93) = -2.1, *P* = .04) and NSLR and XSLR (PHQ-9; *t*(59) = -3.0, *P* = .004, GAD-7; *t*(59) = -3.2, *P* = .002), but not between SLR and XSLR (PHQ-9; *P* = 0.2, GAD-7; *P* = .08).

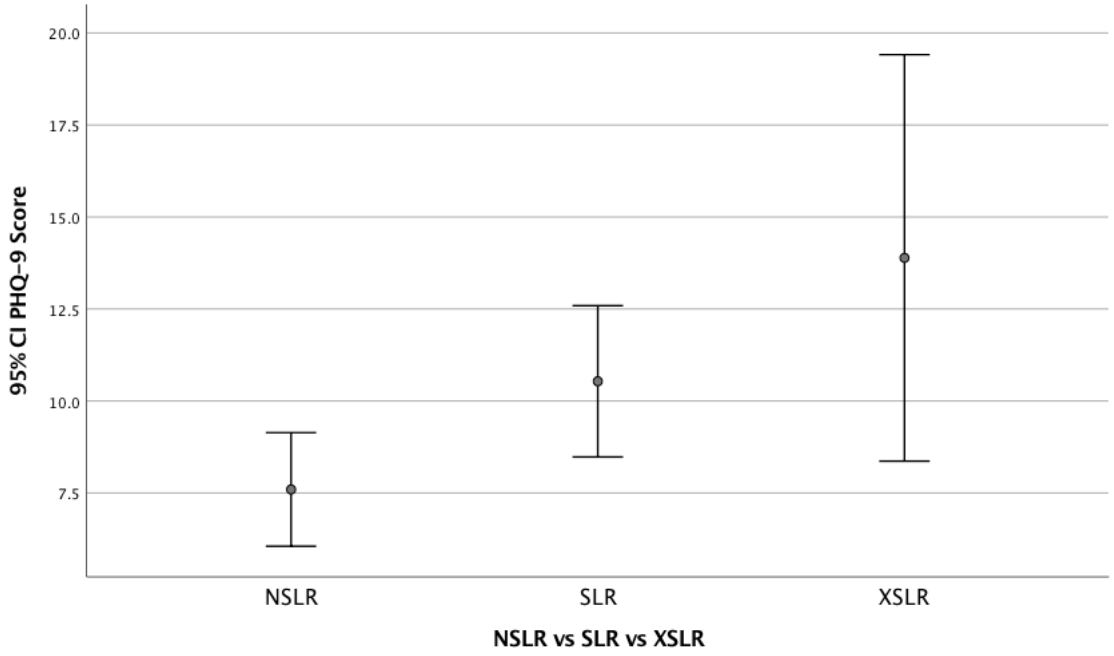

Figure 7. Mean PHQ-9 score for each outcome of SLR test (NSLR vs SLR vs XSLR)

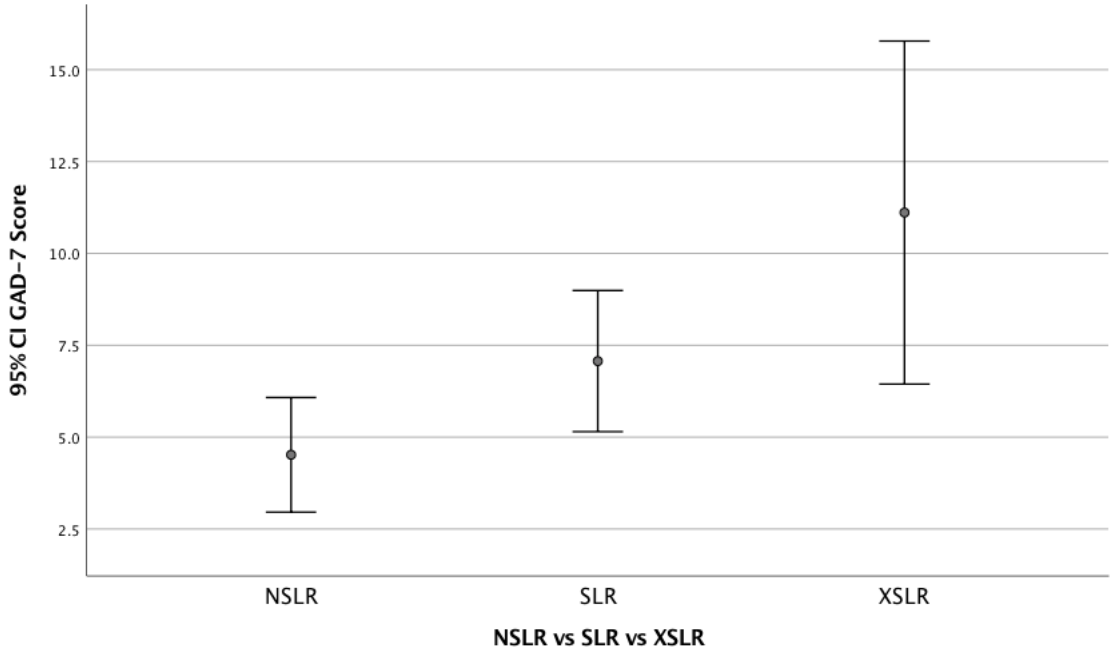

Figure 8. Mean GAD-7 score for each outcome of SLR test (NSLR vs SLR vs XSLR)

Expectations

Patients with NSLR had lower expectation scores (mean 48.4, CI 41.5-55.2) compared to patients with a positive SLR (mean 61.2, CI 55.9-66.5). Patients with a positive XSLR test had the highest expectation scores (mean 70.3, CI 57.9-82.7). Analysis using a *t*-test revealed the

difference to be significant between NSLR and SLR ($t(71) = -3.0$, $P = .004$) and NSLR and XSLR ($t(42) = -2.7$, $P = .01$), but once more not between SLR and XSLR ($P = .2$).

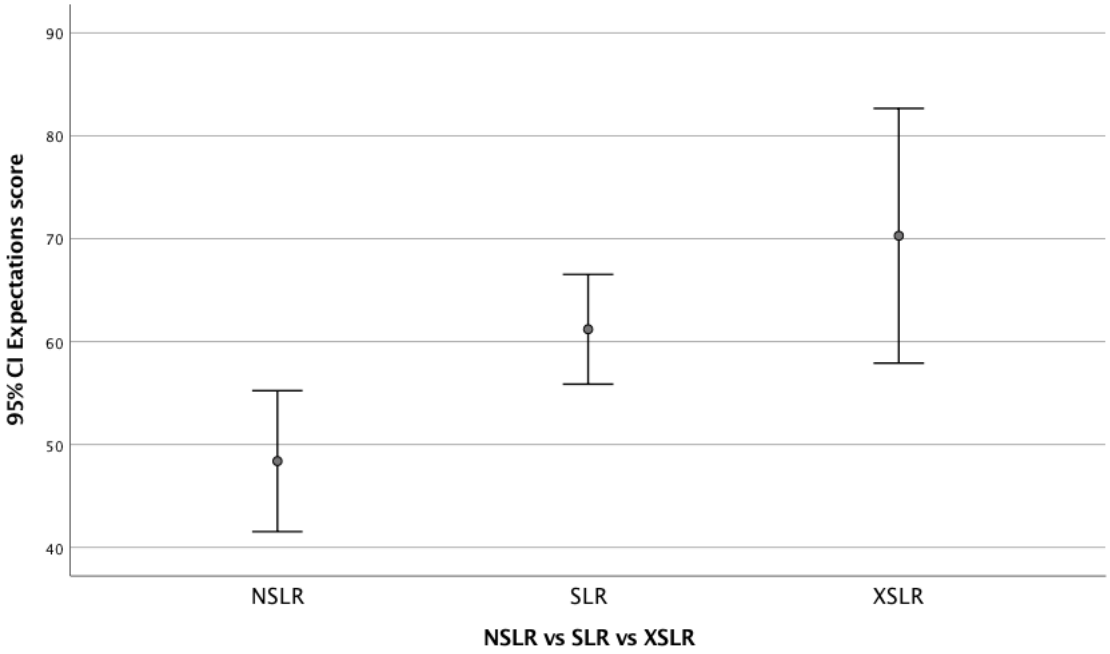

Figure 9. Mean Expectations score for each outcome of SLR test (NSLR vs SLR vs XSLR)

Additional findings

There was significant association found between a history of spinal surgery and whether a patient had NSLR, a positive SLR or positive XSLR test ($x^2(2) = 8.00$, $P = .018$). Cramer's V value was significant (Cramer's V = 0.192, $P = .018$), but only indicated a weak association.

Fisher's exact test demonstrated a significant association between chronic LBP and disc herniation at multiple levels (p=0.004). Cramer's V value was significant (Cramer's V = 0.251, $P = .001$) indicating a moderate association. This is a known fact.

Results of PROMs scores analysis are summarised in Figures 10 and 11.

		n	mean	SD	95% CI Upper Bound	95% CI Lower Bound
VAS leg	NSLR	103	6.3	3.0	5.7	6.9
	SLR	93	7.5	2.4	7.0	8.0
	XSLR	20	8.5	2.4	7.4	9.6
EQ5DVAS	NSLR	81	59.6	24.6	54.2	65.0
	SLR	81	47.1	20.7	42.5	51.7
	XSLR	17	42.6	27.8	28.3	56.9
ODI	NSLR	95	38.7	18.5	34.9	42.5
	SLR	89	46.3	17.9	42.5	50.1
	XSLR	18	52.0	17.2	43.4	60.6
PHQ-9	NSLR	52	7.6	5.6	6.1	9.1
	SLR	43	10.5	6.7	8.5	12.6
	XSLR	9	13.9	7.2	8.4	19.4
GAD-7	NSLR	52	4.5	5.6	3.0	6.1
	SLR	43	7.1	6.2	5.2	9.0
	XSLR	9	11.1	6.1	6.4	15.8
Expectations of lumbar spine surgery	NSLR	37	48.4	20.5	41.5	55.2
	SLR	36	61.2	15.8	55.9	66.5
	XSLR	7	70.3	13.4	57.9	82.7

Figure 10. Summary of the mean, SD and CIs for each PROMs score compared to the outcome of the SLR/XSLR

		t	df	Sig. (2-tailed)
VAS leg	NSLR vs SLR	-3.1	194	.003
	NSLR vs XSLR	-3.1	121	.003
	SLR vs XSLR	-1.7	111	.095
EQ5DVAS	NSLR vs SLR	3.5	160	.001
	NSLR vs XSLR	2.5	96	.013
	SLR vs XSLR	.8	96	.442
ODI	NSLR vs SLR	-2.8	182	.005
	NSLR vs XSLR	-2.8	111	.006
	SLR vs XSLR	-1.2	105	.217
PHQ-9	NSLR vs SLR	-2.3	93	.021
	NSLR vs XSLR	-3.0	59	.004
	SLR vs XSLR	-1.4	50	.182
GAD-7	NSLR vs SLR	-2.1	93	.039
	NSLR vs XSLR	-3.2	59	.002
	SLR vs XSLR	-1.8	50	.082
Expectations of lumbar spine surgery	NSLR vs SLR	-3.0	71	.004
	NSLR vs XSLR	-2.7	42	.010
	SLR vs XSLR	-1.4	41	.162

Figure 11. Summary of the *t*-test analysis for each PROMs score compared to the outcome of the SLR/XSLR test

Discussion

It is common knowledge that there are both physical and psychological components to LBP, with it being largely considered a biopsychosocial issue (33). Whilst the SLR and XSLR test act as important clinical tests for judging the physical aspects of LBP and lumbar radiculopathy, the psychosocial elements can be well assessed using PROMs scores. The purpose of this study was to assess whether the SLR and XSLR sign have any significance on the PROMs scores in patients with an MRI confirmed lumbar disc herniation.

The general findings from this study have shown that patients with a positive clinical test on examination had 'worse' reported PROMs scores, with a positive XSLR sign being associated with the 'worst' PROMs scores.

All patients that were included in our study presented with low back pain and radiating leg pain *AND* had an MRI scan confirming a lumbar disc herniation. We were therefore unable to calculate both sensitivity and specificity of the SLR and XSLR tests as we had no control group. However, the literature is in agreement that the SLR test has a high sensitivity and low specificity, with Devillé et al. (19) reporting a sensitivity of 0.91 and a specificity of 0.26. Conversely, the XSLR test had a reported sensitivity of 0.29 and a specificity of 0.88 (19),

indicating a low sensitivity and high specificity (16). The low specificity of the SLR limits its diagnostic accuracy in detecting lumbar disc herniations (19), whilst the XSLR test is more specific, with a positive test indicating a high likelihood of lumbar disc herniation (19, 23).

VAS leg

Pain is the common presenting symptom in many musculoskeletal pathologies (34) and acts as an important determinate for decision making in spinal surgery (35). VAS assessment is considered the simplest and most commonly accepted method of assessing pain severity (35). In this study, patients that reported the highest severity of leg pain had a positive XSLR test, whilst those with the lowest pain scores had NSLR. This is unsurprising. The significance of self-reported leg pain, as assessed by the VAS leg score, was highlighted by Hill et al. (36) and it has been associated with a much worse clinical course.

EQ5DVAS

Health-related quality of life is considered one of the core outcome domains for trials around spinal surgery (37). Analysis results from this study are consistent with the findings of Selim et al. (38) which concluded that in a study of patients with LBP, those with pain below the knee *AND* a positive SLR test had a decreased health-related quality of life, compared to those patients with LBP alone. This highlights the potential significance of severe sciatica symptoms capable of eliciting a positive SLR/XSLR test on an individual's health related quality of life, and the EQ5DVAS' ability to indicate important factors and changes in patients with LBP (39).

ODI

In clinical trials regarding LBP, physical functioning is considered one of the most important outcome measures (37). Such physical functioning is commonly assessed using the ODI score (29). This study showed a significant difference between the ODI scores for patients with a positive SLR or positive XSLR compared to those with NSLR, with patients with a positive clinical test reporting greater levels of disability. This is consistent with a study by Tonosu et al. (40), which showed that the ODI scores of patients with sciatica were significantly higher than those without. It is suggested that such patients, with high ODI scores, true sciatica and subsequently a positive SLR/XSLR have worse clinical presentation (36).

PHQ-9 & GAD-7

Not only is there a significant relationship between poor mental health and the development of LBP (41), but the correlation between the comorbidity of anxiety and depressive disorders and depressive and anxiety measures is commonly known (28). Spitzer et al. (2006) have also commented on the correlation between anxiety and bodily pain. This was evident looking at our data, as there was a significant difference between both the GAD-7 anxiety and PHQ-9 depression scores in patients with a positive SLR or XSLR compared to those without.

Expectations of lumbar spine surgery

Assessing patient's expectations is acknowledged as a key part of their overall assessment, especially in the case of spinal surgery (32). Preliminary evidence has been found to suggest that the expectations survey for lumbar spine surgery has potential 'discriminative validity by distinguishing between patients with a primary diagnosis of radiculopathy versus myelopathy' (32). This could be due to patients with a primary diagnosis of radiculopathy having higher scores for pain, disability and anxiety compared to those with a diagnosis of myelopathy, therefore leading them to develop a greater desire to be 'fixed' and subsequently greater expectations for a successful treatment. The results of our study are consistent with this suggestion, as patients with a higher expectation score, and therefore greater expectations, had a positive SLR test and/or XSLR test, indicating a diagnosis of lumbar radiculopathy.

Additional findings

Tabesh et al. (42) found that age has a significant effect on the outcome of the SLR test, with a SLR test being positive in only a minority of elderly patients. This supports our study's finding that the average age for NSLR was higher than that of the SLR group and XSLR group. There is implication in this, as the result of the SLR test is often key in the decision to perform an MRI of the spine to confirm the diagnosis of a disc herniation (19). It is therefore important to not let a NSLR test result in elderly patients deviate clinicians from a potential diagnosis of lumbar disc herniation (42).

Our study has shown a significant, but weak, association between the presence of a positive SLR or XSLR sign and the final treatment that the patient receives. Awad et al. (43) highlighted the importance of tailoring a patient's treatment to their spinal pathology, socioeconomic status and behavioural environment. Thus reinforcing the concept that multiple pieces of information and clinical tests should be used to give the best outcome for each patient.

Data analysis in this study revealed a weak association between having a history of spinal surgery and a positive SLR or XSLR test. However, it is felt that this result could be due to the study's relatively small sample size for patients with a positive XSLR test. Therefore further testing, with a larger sample population and subsequently a greater number of patients with a positive XSLR sign, is necessary.

Additionally, the analysis showed that there was a moderate correlation between chronic LBP and having disc herniations at multiple levels. This is consistent with findings by Cheung et al. (44), which state that there is a significant correlation between increasing severity of lumbar disc degeneration, and thus disc herniation, and increasing chronic LBP. This subsequently aids in confirming the validity of this study's sample.

Strengths and Limitations

A key strength of this study is the inclusion of only a single surgeon's data. This eliminated the potential issue with regard to the lack of consensus on interpretation of the SLR/XSLR

test and what constitutes a positive result, therefore improving the consistency of the collected data and quality of analysis.

Furthermore, the use of questionnaires to assess PROMs scores ensured that the questions were presented to each patient in exactly the same manner each time, therefore ensuring consistency. However, certain elements of the use of such questionnaires did act as limitations to this study. For example, the potential for unconscious bias and the responses to each question being very subjective. There was also an element of 'survey fatigue', with many participants completing the first questionnaires, but fewer completing the whole set.

The main limitation for this study was its retrospective study design and relatively small sample size for patients with a positive XSLR sign. Notably, the small sample size for positive XSLR sign may have affected some of the statistical analysis. A prospective study with a larger sample size would therefore be required to further validate the results of this study.

Conclusion

This study has shown that there is a significant relationship between the outcome of the SLR test and XSLR test and PROMs scores in individuals with a lumbar disc herniation. Patients with PROMs scores indicating a lower health-related quality of life, higher pain severity, increased levels of disability, anxiety and depression and greater expectations are associated with a positive SLR test or XSLR test when compared to patients without (NSLR).

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