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Concordance Between Clinical Examination and MRI Findings, and Its Effect on Surgical Outcome in Patients with Lumbosacral Radiculopathy

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Abstract

Background: Lumbosacral radiculopathy is a common cause of pain and disability. Surgical intervention improves pain and quality of life in patients who do not respond to conservative treatment. A proportion of patients experience their symptoms in a different dermatomal distribution to what might be expected from abnormalities seen on MRI. Previous investigators have concluded that clinical examination and dermatomal maps are inaccurate in this group, and that anatomical variability exists. This study investigates clinical outcome following surgical treatment of this patient cohort.

Materials and Methods: Surgical outcome data from 137 spinal surgery patients at a teaching hospital over 6 years were analy-sed retrospectively. Patients were divided into two groups - those whose examination findings were concordant with their MRI findings, and those whose findings were non-concordant. Improvements in validated surgical outcome measures were compared between the two groups.

Results: The concordant group (n = 100) improved significantly ($P < 0.05$) across 9 out of 10 measures. The non-concordant group (n = 37) improved significantly across 8 out of 10 measures. The difference in improvement between the two groups was not significant.

Conclusion: The non-concordant group appeared to have surgical outcomes as good as the concordant group. This suggests that the pathology seen on MRI is the source of the patient's symptoms, and is in keeping with previous research suggesting that dermatomal innervation is variable, and clinical examination using dermatome maps can be inaccurate. The study is limited by its size and its retrospective nature. A larger, prospective study could confirm these results.

	:	Magnetic Resonance Imaging
CT	:	Computed Tomography
ESP	:	Extended Scope Practitioner
LBOS	:	Low-Back Outcome Score
ODI	:	Oswestry Disability Index
MSPQ	:	Modified Somatic Perception Questionnaire
VAS	:	Visual Analogue Scale
ADL	:	Activities of Daily Living
SD	:	Standard Deviation
MRC	:	Medical Research Council

Introduction

Lumbosacral radiculopathy, or sciatica, is a common cause of pain and disability in adults, with a reported prevalence of between

1.6% and 43% depending on definition and study population [1]. The prognosis of lumbosacral radiculopathy, especially when secondary to disc herniation, is good, and some patients will improve with conservative treatment [2,3]. In patients whose symptoms are refractory to 6 weeks of conservative treatment, surgical intervention can lead to the rapid resolution of symptoms, and provides better short-term relief than the continuation of conservative measures [4]. When radiculopathy is due to disc herniation, the benefit of surgery over conservative management in these patients has been demonstrated for as long as 8 years post-operatively [5]. In patients who present with symptoms and signs of radiculopathy history, clinical examination and Magnetic Resonance Imaging (MRI) are useful in establishing a diagnosis. Clinical examination varies in sensitivity and specificity for detecting spinal pathologies depending on what tests are used [6,7]. Pain location is the most accurate single test when trying to identify the level of lumbar disc herniation; however, no single test is highly accurate in isolation. Even in combination, standard tests have been shown to have low sensitivity and specificity for determining the spinal level at which pathology exists [7].

This may be due to the variability in the dermatomal patterns, which exist between patients, as a result of anatomical variance of nerve roots and the lumbosacral plexus. These anatomical variants include conjoined nerve roots and the Furcal nerve. Selective nerve root blocks have been used to demonstrate that predictable L4, L5 and S1 dermatomes only exist in around 80% of individuals [8]. Variability also exists in dermatome maps used by clinicians - 14 different maps are currently in wide use [9], with differences not only between texts, but also between different editions of the same text [10]. The same clinical information might be mapped to dermatomes up to two spinal levels apart, depending on which dermatome map is used [11]. MRI is used in patients with suspected spinal pathology to detect the level at which there is nerve root impingement, spinal stenosis or a prolapsed intervertebral disc, amongst other abnormalities. It has the advantage over Computed Tomography (CT) of higher contrast [12], and of not exposing the patient to radiation. However, it is known that some abnormalities detected on MRI can be asymptomatic, with studies showing that 30% of people who have never had spinal symptoms will have an abnormal MRI of the lumbar spine [13,14].

When a patient presents with signs and symptoms of lumbosacral radiculopathy, but the pathology seen on MRI is at a different spinal level to what would be expected from the history and examination, it raises the question of whether or not that pathology is the cause of the patient's symptoms. Previous investigators have tried to explain the discrepancy in these patients by suggesting, on the basis of MRI, that clinical examination could be inaccurate [6,7], or alternatively that the pathology seen could be an incidental finding [13,14]. Others have used selective nerve root blocks to suggest that there may be variability between individuals in the innervation of the lower limb [8]. To the best of our knowledge, our study is the first to attempt to investigate this discrepancy pragmatically using independently assessed, validated outcome measures following surgical decompression.

The purpose of the study was to establish the relationship between clinical findings, MRI findings and surgical outcomes in patients presenting with lumbosacral radiculopathy. Our aim was to identify two cohorts of patients - those with a concordant clinical picture to their MRI and those non-concordant and assess whether this played any bearing on their validated outcome measures following spinal surgery. This information would provide further aid in deciding who would have a favourable outcome from surgical intervention.

Material and Methods

Study Population

The study population was taken from a database of validated, surgeon-independent outcome measures collected for all patients undergoing spinal surgery at Royal Preston Hospital from October 2006 to March 2012. Patients were included in the study if they had been given a diagnosis of lumbosacral radiculopathy, disc prolapse or lateral recess stenosis, after giving a convincing history and having positive clinical examination findings. All patients included in the study also had to have a record in the electronic notes of pre-operative clinical examination findings, pre-operative MRI findings, pre-operative baseline outcome measures, and outcome measures at either 6-months, 1 year or 2 years post-operatively. Patients were excluded if they had been given any other diagnosis or their diagnosis was unclear, if they were having a revision procedure, if they had not had an MRI, or if any of the above information was missing from the electronic notes.

Ethical Approval

Advice was sought on ethical approval. It was not deemed necessary as the study used retrospective, anonymised data.

Pre-Operative Clinical Examination and MRI Findings

Electronic notes were used to determine the patients' pre-operative examination findings, including the suspected level of spinal pathology. All patients had been originally examined by a consultant, a registrar, an Extended Scope Practitioner (ESP) physiotherapist or a specialist nurse. Radiologists' MRI reports were used to determine the radiological level of pathology. Patients were split into two groups - those whose radiological findings were concordant with their physical examination, and those whose findings were non-concordant.

Outcome Measures

At the time of outcome data collection, those collecting and recording outcome scores were blind with respect to cohort, for the purposes of this study. The outcome measures used to assess the patients were Low-Back Outcome Score (LBOS), Oswestry Disability Index (ODI), Modified Zung Index, Modified Somatic Perception Questionnaire (MSPQ) and Visual Analogue Scales (VAS) for pain intensity (now and average over a week), level of distress caused by pain (now and average over a week) and degree to which pain interferes with Activities of Daily Living (ADL). LBOS [15] measures change in functional status. The final score reflects the patient's level of pain, the effect their pain is having on their work life, social life, sex life and domestic tasks, and their need for rest, analgesia and treatment or consultation. The composite nature of the score aims to reduce the confounding effects of any single area of a patient's life (e.g. social or economic effects on work life). The scores range from 0 to 75, with higher scores indicating better functional status; the scoring system is designed to reflect small changes in a patient's ability as well as measuring gross disability.

ODI [16] is a measure of disability. It covers similar areas to the LBOS, but unlike LBOS it is a measure of the patient's level of disability now, rather than a measure of change. The scores range from 0 to 100, with higher scores indicating a higher level of disability. The Modified Zung Index [17] is a depression score which, includes both positive (e.g. "I feel hopeful about the future") and negative statements (e.g. "I feel downhearted and sad") regarding the patient's psychological status. Scores range from 0 to 69, with higher scores indicating more severe psychological symptoms. MSPQ [18] is a measure of somatisation, which includes symptoms such as feeling hot all over, and having pain or an ache in the stomach. Scores range from 0 to 39, with higher scores indicating more marked somatic symptoms. The Modified Zung Index and MSPQ are used together in the Distress and Risk Assessment Method (DRAM) [15], which is a pre-operative psychological assessment linked to surgical outcome. All of the visual analogue scales are 11-point index scales ranging from 0 to
10. The measures above have all been validated for used in patients with spinal pathologies [16-19]. Patients completed questionnaires at their pre-operative assessments, and subsequent questionnaires by post at 6 months, 1 year and 2 years post-operatively. Patients also received a follow-up telephone call at 6 weeks post-operatively.
Post-operative questionnaires also included the percentage to which, subjectively (subjective determination of symptomatic improvement), patients felt their symptoms had improved.

Analysis Open office Calc

The baseline pre-operative results for the two groups were compared using an unpaired T-test. Post-operative data were compared to pre-operative data for both groups to determine if surgery had made a significant improvement to outcome scores, using a paired T-test. The difference between post- and pre-operative data for each score was then compared between the two groups, using an unpaired T-test. 95% confidence intervals were calculated. Statistical significance was taken as $P < 0.05$

Results

Of 1128 patients on the database, 162 met all the inclusion criteria. Of those 162, 25 further patients were excluded due to inadequate recording of clinical examination findings. 137 patients were included in the final study. Clinical examination findings for these patients were compared to MRI reports to see if the examination had identified the same spinal level as the MRI. In 100 patients, the findings were concordant, and in 37 patients the findings were non-concordant. The characteristics of patients included in the study are summarised in (Table 1).

Characteristic		Group	
		Concordant	Non-concordant
Gender	Male	53	16
	Female	47	21
Available postoperative data	6 months	42	13
	12 months	50	20
	24 months	8	4
Diagnosis	Prolapse	63	28
	Stenosis	37	9
Age n (SD)		55.96 (15.42)	52.41 (14.79)

Table 1: Characteristics of patients included in the study.

The data sets had some omissions, which were taken into account during analysis. The outcome measure most frequently omitted was LBOS; the data available is summarised in (Table 2).

Group (n)	Measure	Data available (n)
Concordant (100)	LBOS	34
	ODI	98
	Modified Zung	94
	MSPQ	97
	Pain now (VAS)	92
	Average pain over week (VAS)	90
	Distress now (VAS)	90
	Average distress over week (VAS)	90
	Effect on ADL (VAS)	92
	Improvement (%)	87

Non-concordant (37)	LBOS	9
	ODI	34
	Modified Zung	30
	MSPQ	35
	Pain now (VAS)	33
	Average pain over week (VAS)	33
	Distress now (VAS)	31
	Average distress over week (VAS)	31
	Effect on ADL (VAS)	32
	Improvement (%)	30

Table 2: Availability of individual outcome measure data for the concordant and non-concordant groups.

The mean baseline scores for both groups are shown in (Table 3).

	Group		
Measure	**Concordant**	**Non-concordant**	**P**
LBOS	20.94	21.09	0.9466
ODI	51.11	52.66	0.6463
Modified Zung	25.83	29.35	0.1795
MSPQ	7.37	6	0.1117
Pain now (VAS)	6.78	6.26	0.2823
Average pain over week (VAS)	7.01	6.65	0.4873
Distress now (VAS)	6.66	6.38	0.5977
Average distress over week (VAS)	6.95	6.74	0.7124
Effect on ADL (VAS)	7.8	7.35	0.4232

Table 3: Mean pre-operative outcome measure scores for concordant and non-concordant groups. The difference between the groups is not significant ($P > 0.05$) for all measures.

There was no significant difference between the two groups pre-operatively for any of the outcome measures. The change from pre-operative to post-operative scores is shown in (Table 4) and (Figure 1-6).

	Concordant		**Non-concordant**	
Measure	**Change from pre-operative score**	**P**	**Change from pre-operative score**	**P**
LBOS	11.03	*0.0004*	7.89	*0.0295*
	(5.23 – 16.78)		(1.01 – 14.77)	
ODI	-7.52	*0.0021*	-10.68	*0.0185*
	(-12.24 – -2.80)		(-19.45 – -1.91)	
Modified Zung	-3.53	*0.0079*	-3.7	*0.1446*
	(-6.11 – -0.95)		(-8.73 – 1.34)	
MSPQ	-0.95	*0.0872*	1.71	*0.1598*
	(-2.04 – 0.14)		(-0.71 – 4.14)	
Pain now (VAS)	-2.11	*<0.0001*	-1.55	*0.0311*
	(-2.17 – -1.43)		(-2.94 – -0.15)	
Average pain over week (VAS)	-1.94	*<0.0001*	-2	*0.0052*
	(-2.52 – -1.37)		(-3.36 – -0.64)	
Distress now (VAS)	-2.09	*<0.0001*	-2.13	*0.0093*
	(-2.86 – -1.32)		(-3.69 – -0.56)	
Average distress over week (VAS)	-2.23	*<0.0001*	-2.48	*0.0028*
	(-2.94 – -1.53)		(-4.04 – -0.93)	
Effect on ADL (VAS)	-2.8	*<0.0001*	-2.06	*0.0108*
	(-3.48 – -2.13)		(-3.61 – -0.51)	

Table 4: Mean change from pre-operative to post-operative scores for concordant and non-concordant groups. Significant values ($P < 0.05$) shown in italics.

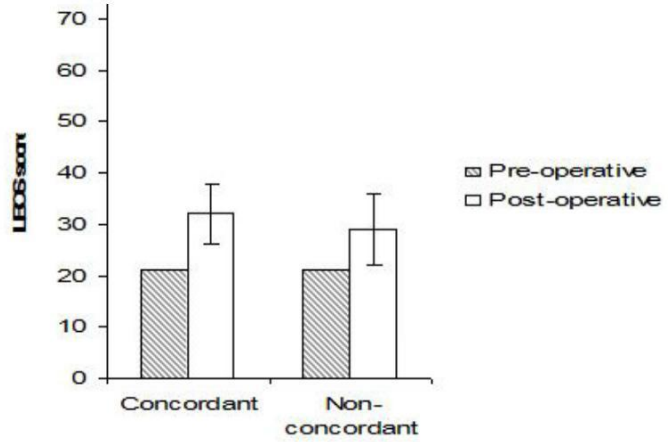

Figure 1: Change in LBOS score from pre-operative to post-operative. An increase in score represents improvement in symptoms. Changes for both groups are significant ($P < 0.05$). Error bars show 95% Confidence Interval (CI). Values are shown in (Table 4).

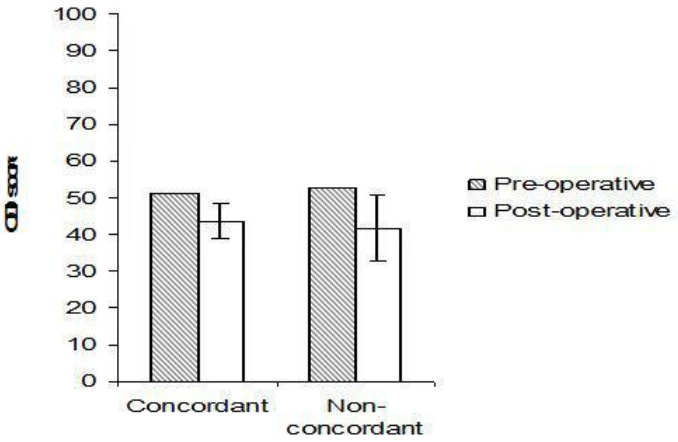

Figure 2: Change in ODI score from pre-operative to post-operative. A decrease in score represents improvement in symptoms. Changes for both groups are significant ($P < 0.05$). Error bars show 95% CI. Values are shown in (Table 4).

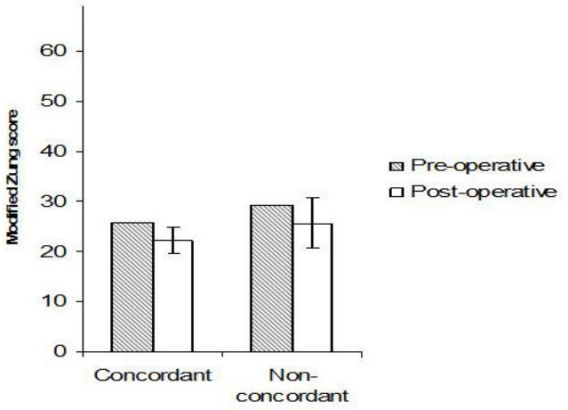

Figure 3: Change in Modified Zung Index score from pre-operative to post-operative. A decrease in score represents improvement in symptoms. The change in the concordant group is significant ($P < 0.05$) but the change for the non-concordant group is not. Error bars show 95% CI. Values are shown in (Table 4).

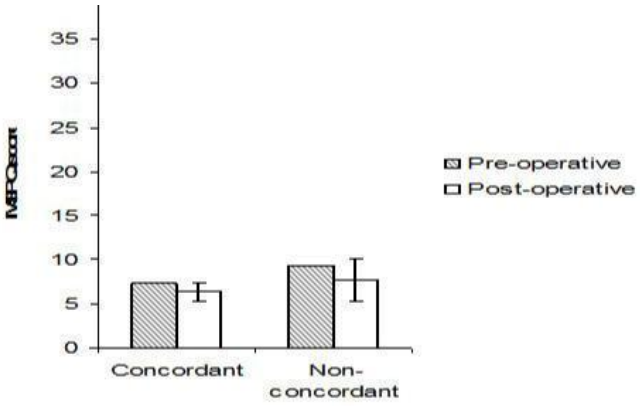

Figure 4: Change in MSPQ score from pre-operative to post-operative. A decrease in score represents improvement in symptoms. The concordant group shows a non-significant ($P > 0.05$) decrease. The non-concordant group shows a non-significant increase. Error bars show 95% CI. Values are shown in (Table 4).

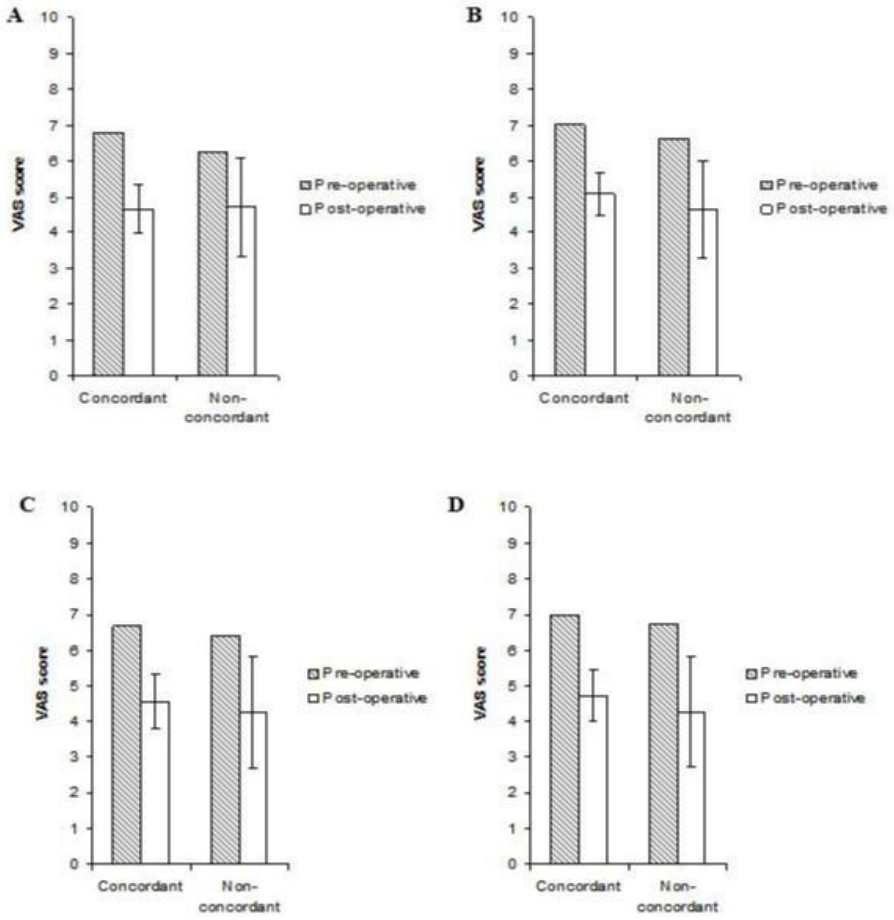

Figure 5: Change from pre-operative to post-operative VAS scores. **A.** Pain now. **B.** Average pain over last week**. C.** Distress now. **D.** Distress over last week. A decrease in score represents improvement in symptoms. Both groups made a significant improvement (P <0.05) in every measure. Error bars show 95% CI. The difference in improvement between the two groups was not significant for any of the VAS measures. Values are shown in (Table 4).

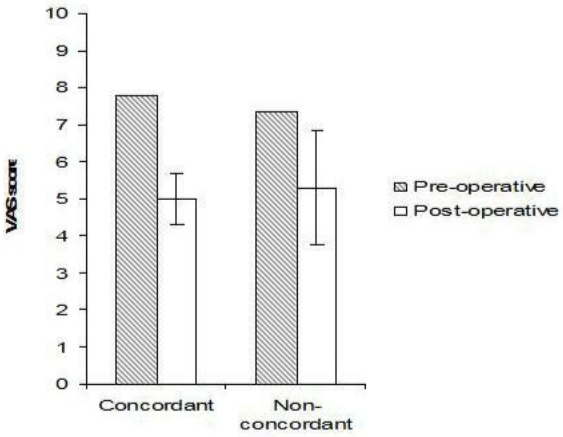

Figure 6: Change from pre-operative to post-operative VAS scores – effect on ADL. Both groups made a significant improvement (P <0.05). Error bars show 95% CI. The difference in improvement between the two groups was not significant. Values are shown in (Table 4).

The concordant group showed a significant improvement in 9 out of 10 measures. The non-concordant group showed an improve-ment in 9 measures, which was significant in 8 measures. The difference in improvement between the two groups was not significant for any measure, except for MSPQ shown in (Table 5).

Improvement from pre-operative scores				
Measure	**Concordant**	**Non-concordant**	**Difference**	**P**
LBOS	11.03	7.89	3.14 (-8.45 – 14.72)	0.5871
ODI	-7.52	-10.68	3.16 (-6.28 – 12.59)	0.5093
Modified Zung	-3.53	-3.7	0.17 (-5.06 – 5.39)	0.9502
MSPQ	-0.95	1.71	2.66 (0.07 – 5.26)	*0.048*
Pain now (VAS)	-2.11	-1.55	0.56 (-0.83 – 1.95)	0.4244
Average pain over week (VAS)	-1.94	-2	0.06 (-1.18 – 1.29)	0.9242
Distress now (VAS)	-2.09	-2.13	0.04 (-1.54 – 1.62)	0.96
Average distress over week (VAS	-2.23	-2.48	0.25 (-1.23 – 1.73)	0.7386
Effect on ADL (VAS)	-2.8	-2.06	0.74 (0.91 – 2.39)	0.2059
Percentage improvement	44.43	30.7	13.73 (-1.51 – 28.96)	0.0771

Table 5: The difference in improvement between the two groups. Significant values ($P < 0.05$) are shown in italics.

The difference in MSPQ needs to be interpreted with caution as neither group had a significant change in this score from baseline.

Discussion

In this study, patients showed a significant improvement in validated outcome measures following spinal surgery, regardless of whether or not their pre-operative clinical examination findings were concordant with their MRI findings. Our results appear to challenge the assumption that symptoms felt in a different dermatomal distribution to the pathology seen on MRI will not be improved by surgery. Pain being felt at a different anatomical site to its source is not unique to spinal pathology. Contributions to the innervation of the hip by the obturator, femoral and sciatic nerves mean that hip pain can be felt in the thigh, groin, buttock or knee [20], and even distally in the leg [21]. Pain felt in the knee, but with a normal knee examination and positive hip examination findings, would be an indication for treatment of the hip, rather than the knee. In a similar way, pain felt in the dermatomal distribution of one spinal nerve root may sometimes warrant surgical intervention at another. The high incidence of asymptomatic lumbar spine lesions in the normal population [13,14] raises the concern that patients will have unnecessary surgery on abnormalities which are not responsible for their symptoms. Likewise, this is comparable to knee pathology, as x-ray changes consistent with osteoarthritis of the knee have been reported in the asymptomatic population [22], and imaging alone is not enough to make a diagnosis in patients complaining of knee symptoms. Not all patients complaining of low back pain with leg symptoms will be suffering from lumbosacral radiculopathy, and history, examination and imaging are all important in making a diagnosis. Back pain is multifactorial, with nociceptors within degenerate discs [23], altered truncal motor control [24], neuropathic pain [25] and psychosocial factors [26] all contributing to the patient's symptoms. Leg symptoms too can be caused by many different pathological processes, originating from the knee or hip as well as from the spine.

When the history and examination are suggestive of lumbosacral radiculopathy, but the dermatomal pattern found clinically is not concordant with abnormalities seen on MRI, it is not unreasonable to question whether the symptoms have a different underlying pathology. Previously there has been no evidence available to support or refute the benefit of surgical intervention in these patients. However, in our study, all patients improved with surgery, raising the question of how decompressing one nerve root can alleviate

symptoms in a dermatome served by another. Differences in clinical examination technique and dermatome maps will certainly go some way towards explaining the improvement shown in these patients - if the dermatome recorded after examination of the patient is inaccurate, it is unlikely to correlate with subsequent imaging. The patients in our study were examined by different clinicians using a range of techniques based on Medical Research Council (MRC) data, and the specificity of some of the examinations performed is likely to be low [7].

However, variability between individuals may also be a contributing factor. In their review of the current understanding of dermatomes [10] argue that due to the dynamic nature of innervation, inter-individual variation and extensive overlap between adjacent dermatomes, a dogmatic approach to dermatome mapping should not be used in clinical practice. It is difficult to say that a patient has pathology at the wrong spinal level, when we do not have strict definition for what is right, and when what is right may vary between individuals. The current evidence suggests that around 80% of individuals will have normal dermatomal innervation [8]; we found that 73% of our patients had concordant examination and MRI findings. The lower proportion in our study may be due to methodological differences or differences in sample size. It is interesting that MSPQ (somatic symptoms) showed no significant improvement in either group, and Modified Zung Index (depressive symptoms) only improved significantly in the concordant group. This suggests that, in our study, the physical elements of the patients' symptoms were more amenable to surgery than the psychological elements. Other studies which have used these measures have used them either only pre-operatively [27] or only post-operatively [28] so it is difficult to compare our results in these measures to those of other authors [29].

Our study is limited by being retrospective, and by using data not collected specifically for this purpose, meaning there was little control over sample size. The smaller size of the non-concordant group makes the results for this group less reliable; we did not achieve power of >0.8 for most of the calculations involving this group. However, non-concordant patients were in the minority, in keeping with findings from previous studies [7,8] making it impossible to create the groups of equal size. LBOS unfortunately had particularly low numbers with available data, which makes it difficult to comment on the significance of our findings in this measure. There is potential for bias in our results. The clinical examination was performed prior to the MRI in only 59% of patients in the concordant group and 68% of patients in the non-concordant group; the remaining patients had already undergone their MRI by the time they were examined. Patients who were examined in the context of a pre-existing MRI report may artificially have been placed in the concordant group, as clinicians may have been biased towards agreeing with pre-existing information. There is also a bias towards patients who were willing to fill in questionnaires; the willingness to participate might be a surrogate marker for disease severity or socioeconomic status, both of which could affect the results.

Conclusion

Overall this study found that when patients gave a convincing history of lumbosacral radiculopathy, they improve with surgery even if their spinal pathology appears to be at a different level to where they experience their symptoms. The fact that surgical outcome is good in patients with non-concordant findings adds to, and supports, the current evidence which suggests that the specificity of clinical examination is low, and that there are variations in dermatomal innervation between individuals. Measures of physical symptoms and functional status appear show a greater improvement after surgery than psychological or somatic symptoms. This was a small, retrospective study, and there is a paucity of research to confirm or refute our findings. More research is needed to properly determine the benefit of surgery in patients with non-concordant examination and MRI findings.

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