Validity of pain drawings for predicting psychological status outcome in patients with recurrent or chronic low back pain

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Objectives: To investigate the association between baseline pain drawings and future psychological status, and estimate the prognostic value of pain drawing assessment for predicting somatization, distress, and depression at one-year follow-up, in patients with recurrent or chronic low back pain (RCLBP).

Methods: This was a multi-center prospective cohort study of 138 patients with RCLBP. Participating patients completed at baseline and one-year follow-up: a blank pain drawing; the Modified Somatic Perceptions Questionnaire; modified Zung Depression Scale; and Distress and Risk Assessment Method. Pain drawings were analyzed quantitatively using the Pain Sites Score (PSS) and Simple Body Region (SBR) method. The association between baseline pain drawing assessment and one-year psychological status was estimated using correlation and Relative Risk (RR) statistics.

Results: We obtained complete data from 81 patients (59%). Psychological status and pain drawings did not differ significantly between completers and non-completers. Pain drawing area at baseline was associated with depression and somatization at one-year follow-up (Spearman's Rho 0.25, $P=0.022$; 0.31 $P=0.006$, respectively). Stronger associations resulted from analyses using the PSS, compared with the SBR. Patients with abnormal PSS pain drawings at baseline had significantly greater RR of depression (RR 6.1, 95% CI 1.1, 33.5), somatization (RR 4.1, 95% CI 1.7, 9.9) and distress (RR 6.8, 95% CI 1.9, 25.3) at one-year follow-up.

Discussion: These results provide the first evidence that abnormal baseline pain drawings predict greater risk of abnormal psychological states or poor psychological outcome at one-year follow-up, in patients with RCLBP.

Keywords: Patient examination, Prognosis, Pain drawing, Low back pain, Psychological state

Introduction

Low back pain (LBP), especially when recurrent or chronic, is a common disorder that has a significant individual and societal impact.^{1,2} The role of psychological factors in the development and perpetuation of LBP are well documented.³ Psychological factors, such as depression and emotional distress, are associated with poor outcome after intervention in LBP,³⁻⁵ and it is thought that better outcomes may be achieved by accurate identification of these factors, helping ensure that appropriate cognitive and behavioral intervention is provided.

Psychological state can be clinically assessed using a variety of instruments, such as questionnaires.⁶ The

pain drawing, commonly used in clinical practice to assess distribution of symptoms, has also been considered for use in screening the psychological state of patients with LBP.⁷ First introduced by New Zealand physician Harold Palmer in 1949⁸ as a means of differentiating between organic and non-organic pain, the pain drawing (Fig. 1) has enjoyed diverse application in clinical practice.⁹ Debate continues regarding whether the pain drawing provides information about the presence of disc pathology or nerve involvement in radiating spinal pain.¹⁰⁻¹³ A report by Ransford *et al.*, in 1976,¹⁴ reporting a significant association between an abnormal pain drawing and certain personality characteristics in people with chronic LBP, led to another surge of interest in the pain drawing.¹⁵ Despite reports indicating that pain drawing scores are not significantly associated with psychological factors,^{16,17} their popularity continued,

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Figure 1 The Pain Drawing form. Instructions to the patient were, 'Carefully shade or mark in the areas where you feel any pain on the pain drawing below.'

with some reports indicating significant relationships between pain drawing assessment and psychological factors.^{15,18} While the pain drawing scores demonstrated some correlation with measures of psychological distress,^{12,19-21} it now appears conclusive that

the pain drawing has insufficient concurrent validity with adverse psychological states for it to be useful as an accurate screening tool.^{15-17,21} However, there is an absence of research investigating the prognostic usefulness of pain drawings for predicting future

psychological status or outcome over time. Predictive validity would assist clinicians in making patient management decisions, alerting the clinician that the patient's condition may be more complicated, management may require more resources, and a referral may be necessary. This information may also be useful to researchers in identifying and controlling for potential confounding variables.

This research investigates whether pain drawings at baseline predict psychological status or outcome over a 1 year period in patients with recurrent or chronic low back pain (RCLBP). The aims of the study were:

1. to investigate whether the area of pain reported at an initial clinical examination is associated with psychological variables at baseline or one-year follow-up RCLBP; and
2. to compare the predictive validity of two quantitative pain drawing methods for estimating psychological distress or outcome over a one-year period in a cohort of patients presenting with RCLBP.

Methods

Design

This was a multi-center prospective cohort study. Consecutive eligible patients presenting with a new episode of RCLBP were recruited by 17 clinics located in three urban centers in Otago and Canterbury, New Zealand.²² Patients were included if they had presented with a new episode of LBP and had experienced similar LBP before, the first episode of which was at least 3 months before the date of recruitment, or were experiencing persistent LBP of at least 3 months duration. Patients were excluded if they: had received spinal surgery within the previous 6 months; had a history of traumatic fracture of the spine which resulted in permanent neurological deficit; had a history of serious neurological or psychiatric disease; were under 20 years of age; or were pregnant.

This research was approved by the Otago and Canterbury Regional Ethics Committees (reference # 01/05/030 & 01/10/095) of the New Zealand Ministry of Health.

At the baseline assessment all patients completed a blank front- and back-view pain drawing,^{14,20} the modified Zung Self-rated Depression Scale (mZDS),^{23–25} and the Modified Somatic Perceptions Questionnaire (MSPQ).²⁴ The Distress and Risk Assessment Method (DRAM) was calculated from the mZDS and MSPQ.²⁶ At 12-month follow-up, all patients were mailed the same forms, with a postage-paid return envelope.

Method of analysis

We analyzed the pain drawings using two quantitative methods, the Simple Body Region (SBR) method,¹² derived from Margolis *et al.*,¹⁹ and the Pain Sites Score (PSS).²¹ Both the SBR and PSS methods have been found to possess high inter-rater

and test-retest reliability and to be correlated with measures of psychological distress.^{12,19–21} The SBR, PSS, mZDS, MSPQ, and DRAM were scored as described in the literature.^{12,21,24,26,27}

Missing data

Data were excluded case-wise if incomplete at baseline or follow-up in any of the following fields: mZDS, MSPQ, DRAM, SBR, or PSS.

Subjects lost to follow-up and missing data

As loss to follow-up can lead to bias or confounding in the results of cohort studies, we assessed whether patients lost to follow-up differed in key characteristics to patients retained and with complete follow-up data.

Statistical analysis

As the PSS is an ordinal scale, correlations between PSS and psychological questionnaires were calculated using the Spearman's Rho test. As SBR is an ordered polytomous data form, point biserial correlations between SBR and psychological questionnaires were calculated, using an online calculator,²⁸ after SBR was dichotomized (as described below).

In order to calculate Relative Risk (RR), the outcome variables (MSPQ, mZDS, and DRAM) were dichotomized into categories as described in previous research.²⁶ The MSPQ was divided into negative somatization (<12), and positive somatization (≥ 12).²⁶ Two cut-off values were used for the mZDS; moderate risk (>17) and high risk (>33).²⁶ The DRAM was categorized as described by Main *et al.*²⁶ into normal (DRAM-N), at risk (DRAM-R), distressed depressive (DRAM-DD), and distressed somatic (DRAM-DS). These were further dichotomized into 'not distressed' (DRAM-N+DRAM-R) and 'distressed' (DRAM-DD+DRAM-DS).

For the purposes of this study, therefore, somatization is defined as a score of ≥ 12 on the MSPQ, representing elevated levels in the domains of autonomic symptoms and somatic anxiety.²⁴ Distress is defined as psychological difficulties associated with the domains of inappropriate illness behavior and emotional affect, resulting in DRAM categorization as Distressed.²⁶ Depression is defined as persistent low affect (mood) that interferes with well-being and life functions, resulting in a score surpassing the above-stated cut-off scores on the mZDS.^{23,25,29}

The predictor variables were also divided at previously described cut-off values.^{14,21,30} The SBR scores were collapsed from the original six nominal categories (0–5) into two categories: pain above the knee excluding anterior thigh (≤ 2), and pain below the knee as well as anterior thigh (≥ 3).²⁰ This division was used because pain below the knee and over the anterior thigh is typically outside the normal

distribution for simple organic LBP.^{14,21,30} The PSS was divided into three groups: normal (0–4), abnormal (>4), and highly abnormal (≥ 8).²¹ To independently verify these previously described cut-off values, we calculated the optimal cut-off value for PSS using receiver operating characteristics (ROC) curve methodology, described elsewhere.^{31,32} The above analyses were conducted using the SPSS computer program (SPSS Inc., Chicago, IL, USA).

Contingency tables were used to calculate RR. The predictor variables (SBR and PSS) were assessed against the outcome variables (MSPQ, mZDS, and DRAM) using an on-line computer program (<http://www.cebm.utoronto.ca/practise/ca/statscal/>) to calculate RR and 95% confidence intervals. Statistical significance was set at $P < 0.05$.

Results

A total of 138 patients were recruited. Of these, 48 (35%) patients were lost to follow-up, and complete pain drawing and psychological questionnaire data were available for 81 (59%). These 81 patients are described in Table 1.

Subjects lost to follow-up and missing data

Retained patients were older (mean age 42 years vs. 36 years, Table 1), and a lesser proportion of LBP reported was chronic (i.e. a higher proportion had recurrent LBP); these differences were statistically significant. However there were no significant differences in psychological state or pain drawings between the retained/complete and lost/incomplete groups (Table 2).

Correlation analysis

Spearman's Rho test was used to analyze correlations between baseline and follow-up variables (Table 3). There were moderately strong, significant Spearman correlations between the mZDS and the MSPQ at both baseline and 12-month follow-up, and between PSS and MSPQ at 12-month follow-up. The Spearman correlation between PSS and MSPQ at baseline was weak but significant. The point biserial correlations between the dichotomized SBR at baseline and MSPQ at 12 months, and dichotomized SBR and mZDS at 12 months, were weak but significant.

Defining cut-off values

Receiver operating characteristics curve analysis resulted in an optimal PSS cut-off value of >4 for both mZDS and MSPQ, which was consistent with previous literature.²¹

Relative risk analysis

Analysis of RR was performed using 2×2 contingency tables, to estimate the ability of pain drawings to predict depression (Table 4), somatization (Table 5), and psychological distress (Table 6) at 12 months. A significant relationship was found between baseline pain drawing PSS >4 and depression at 12-month follow-up (RR 6.1; 95%CI 1.1, 33.5). Significant relationships were found between baseline pain drawing scores $\text{SBR} \geq 3$ and PSS >4 and somatization at 12-month follow-up, with estimated RR (95%CI) of 2.7 (1.1, 6.8) and 4.1 (1.7, 9.9), respectively. A significant relationship was found between baseline pain drawing PSS ≥ 8 and psychological distress at 12-month follow-up (RR 6.8; 95%CI 1.9, 25.3).

Table 1 Baseline and 12-month follow-up measurements of patients ($n=81$)

		Baseline mean (sd) or number (%)	12-month follow-up Mean (sd) or number (%)
Sex (% female)		47.0	47.0
Age		41.9 (10.9)	43.1 (11.2)
Chronic		16 (19.8%)	—
Recurrent		65 (80.2%)	—
Psychological questionnaire scores			
mZDS		17.0 (9.7)	16.3 (10.4)
MSPQ		6.2 (5.2)	7.0 (6.2)
DRAM	Normal	45 (56%)	51 (63%)
	At Risk	26 (32%)	22 (27%)
	Distressed depressive	5 (6%)	0 (0%)
	Distressed somatic	5 (6%)	8 (10%)
Pain drawings			
SBR	0	3 (4%)	0 (0%)
	1	48 (59%)	51 (63%)
	2	8 (10%)	5 (6%)
	3	3 (4%)	7 (9%)
	4	7 (9%)	5 (6%)
	5	12 (15%)	13 (16%)
PSS	Mean	3.6	4
	Median	2	2
	Range	0, 24	1, 14

sd=Standard Deviation; mZDS=Modified Zung Depression Scale; MSPQ=Modified Somatic Perceptions Questionnaire; DRAM=Distress and Risk Assessment Method; SBR=Pain drawing: Simple Body Region; PSS=Pain drawing: Pain Sites Score.

Table 2 Comparison of baseline data between subjects lost to follow-up and subjects with complete data

		Retained and complete data at one-year	Lost to follow-up or incomplete data	P-value
		Mean (sd) or number (%)	Mean (sd) or number (%)	
Total in group		81	44	–
Sex (% female)		47.0	45.5	0.87
Age		41.9 (10.9)	35.5 (11.0)	<0.01*
Chronic		16 (19.8%)	16 (36.4%)	0.04*
Recurrent		65 (80.2%)	27 (61.4%)	0.02*
Missing		0 (0.0%)	1 (2.3%)	–
Psychological state				
mZDS		17.0 (9.7)	18.9 (9.5)	0.29
MSPQ		6.2 (5.2)	6.3 (4.9)	0.92
DRAM (N)	Normal	45 (56%)	19 (43%)	0.16
	At Risk	26 (32%)	19 (43%)	0.22
	Distressed Depressive	5 (6%)	2 (5%)	0.82
	Distressed Somatic	5 (6%)	4 (9%)	0.53
Pain drawings				
SBR (N)	0	3 (4%)	1 (2%)	0.55
	1	48 (59%)	32 (73%)	0.12
	2	8 (10%)	4 (9%)	0.86
	3	3 (4%)	2 (5%)	0.79
	4	7 (9%)	1 (2%)	0.13
	5	12 (15%)	4 (9%)	0.34
PSS	Mean	3.6	3.5	
	Median	2	2	
	Range	0, 24	0, 20	

sd=Standard Deviation; mZDS=Modified Zung Depression Scale, MSPQ=Modified Somatic Perceptions Questionnaire; DRAM=Distress and Risk Assessment Method; SBR=Pain drawing: Simple Body Region; PSS=Pain drawing: Pain Sites Score.

Note: significance for age, mZDS and MSPQ were calculated with *t*-test or difference of proportion for frequencies.

*Significant difference at *P*<0.05.

Discussion

Our findings suggest a predictive relationship between baseline pain drawing scores and the psychological state of patients with RCLBP at one-year follow-up. Significant RR for somatization (as indicated by MSPQ) at one-year were found for abnormal baseline pain drawing score, whether scored with the SBR or PSS methods. Patients with an abnormal PSS score were at 4.1 times greater risk of being affected by positive somatization at 12 months, while those with abnormal SBR score were at 2.7 times greater risk.

Relative risk of suffering depression or psychological distress was also significantly greater in patients with abnormal baseline pain drawings (see Tables 4 and 6), however, as the frequencies in some categories were less than five, the test statistics may not be chi-square distributed, therefore, these results should be treated with caution. Nonetheless, the results are consistent across the three psychological outcome variables (MSPQ, mZDS, and DRAM). As the PSS method of scoring pain drawings has larger RR values than the SBR, it may be a better predictor of abnormal psychological state. A possible reason for

Table 3 Spearman Rho and point biserial correlation table of baseline variables

		mZDSb	MSPQb	d-SBRb ^T	PSSb	mZDS12	MSPQ12	d-SBR12 ^T	PSS12
mZDSb	r	–	0.56*	0.11	0.19	–	–	0.25	–
	p		<0.01	0.31	0.10			0.03*	
MSPQb	r	–	–	0.08	0.28**	–	–	0.13	–
	p			0.48	0.01			0.25	
mZDS12	r	–	–	0.10	0.25**	–	0.537*	0.21	0.26**
	p			0.20	0.02		0.000	0.06	0.02
MSPQ12	r	–	–	0.23	0.31*		–	0.19	0.44*
	p			0.04*	<0.01			0.09	<0.01

All correlation coefficients are Spearman Rho except^T are point biserial;

*Correlation is significant at the 0.05 level (two-tailed);

**Correlation is significant at the 0.01 level (two-tailed);

mZDSb=modified Zung Depression Scale at baseline; mZDS12=modified Zung Depression Scale at 12 months; MSPQb=Modified Somatic Perceptions Questionnaire at baseline; MSPQ12=Modified Somatic Perceptions Questionnaire at 12 months; d-SBRb=dichotomized Simple Body Region score at baseline; d-SBR12=dichotomized Simple Body Region score at 12 months; PSSb=Pain drawing: Pain Sites Score at baseline; PSS12=Pain drawing: Pain Sites Score at 12 months.

Table 4 Predicting depression at 12 months

Method for scoring pain drawing	Depression measure	Relative risk	95% Confidence interval
SBR (≥ 3) ^{12,20}	mZDS (≥ 17)	1.55	0.89, 2.71
PSS (>4) ²¹		1.24	0.65, 2.36
PSS (≥ 8) ²¹		0.65 ^a	0.19, 2.24 ^a
SBR (≥ 3) ^{12,20}	mZDS (>33)	1.79 ^a	0.32, 9.99 ^a
PSS (>4) ²¹		6.09 ^a	1.11, 33.48 ^a
PSS (≥ 8) ²¹		2.28 ^a	0.29, 18.01 ^a

* Significant association at $P < 0.05$

^a The relative risk test may not be chi-square distributed as the frequency in a category is less than five; mZDS (≥ 17)=modified Zung Depression Scale score greater than or equal to 17; mZDS (>33)=modified Zung Depression Scale score greater than 33;

SBR (≥ 3)=Pain drawing: Simple Body Region score greater than or equal to three;

PSS (>4)=Pain drawing: Pain Sites Score greater than four;

PSS (≥ 8)=Pain drawing: Pain Sites Score greater than or equal to eight.

this may be due to the larger, ordinal scoring scale of the PSS, providing richer data than the nominal SBR scoring system. We confirmed PSS cut-off scores for both mZDS and MSPQ reported in previous research.²¹

These RR results are consistent with the correlation found between PSS at baseline and MSPQ or mZDS at follow-up which also indicate a weak but significant association. The significant correlation between the PSS at baseline and both the MSPQ and mZDS at 12 months, and the MSPQ at baseline (see Table 2), suggests that the PSS is associated with psychological state to some extent. The correlations also suggest that the PSS may be more strongly associated with somatization ($r=0.305$ $P < 0.01$) than depression ($r=0.254$ $P < 0.05$), however, the strong

correlation between the MSPQ and mZDS, both at baseline and follow-up, suggests that these variables are not entirely independent. This is consistent with other literatures,^{3,4,24} and is to be expected, as they are both psychological measures, although with differing purposes (somatization vs. depression).

Some strengths of this study include that it was a prospective cohort study of 138 consecutive patients recruited at a defined stage of their LBP condition, spread over 17 physiotherapy clinics in three urban centers, and involving 27 different physiotherapists. This allowed a wide range of data collection, reducing potential selection bias and increasing generalizability of the results. Most of the populations studied in previous research have been selected from tertiary level care institutions or are on surgical waiting lists.

Table 5 Predicting somatization at 12 months

Method of pain drawing	Somatization measure	Relative risk	95% Confidence interval
SBR (≥ 3)	MSPQ (≥ 12)	2.68	1.06, 6.77*
PSS (>4)		4.06	1.66, 9.93*
PSS (≥ 8)		2.49 ^a	0.87, 7.09 ^a

* Significant association at $P < 0.05$

^a The relative risk test may not be chi-square distributed as the frequency in a category is less than five;

MSPQ (≥ 12)=Modified Somatic Perceptions Questionnaire score greater than or equal to 12;

SBR (≥ 3)=Pain drawing: Simple Body Region score greater than or equal to three;

PSS (>4)=Pain drawing: Pain Sites Score greater than four;

PSS (≥ 8)=Pain drawing: Pain Sites Score greater than or equal to eight.

Table 6 Predicting psychological distress at 12 months

Method of pain drawing	Distress measure	Relative risk	95% Confidence interval
SBR (≥ 3)	DRAM D-S or D-D	2.01 ^a	0.50, 8.28 ^a
PSS (>4)		3.05 ^a	0.76, 12.28 ^a
PSS (≥ 8)		6.84 ^a	1.85, 25.29*, ^a

* Significant association at $P < 0.05$

^a The relative risk test may not be chi-square distributed as the frequency in a category is less than five;

DRAM=Distress and Risk Assessment Method; D-S=Distressed Somatic; D-D=Distressed Depressive; SBR=Pain drawing: Simple Body Region; PSS=Pain drawing: Pain Sites Score.

High loss to follow-up and/or incomplete data was a potential limitation; case-wise deletion of all cases with incomplete questionnaires or pain drawings reduced complete data to only 81 patients (59%). This poses risk of confounding or bias. In order to assess potential risk of bias, comparisons of descriptive baseline data were done between patients with complete data and those lost to follow-up (Table 2). Although the age and LBP type of retained patients differed by a statistically significant extent, the differences were arguably not clinically significant. As there was no significant difference in psychological status or pain drawings between completers and non-completers, the authors' view is that risk of bias is minimal. The diminished sample size has also led to wide confidence intervals for some results, which may represent type 2 error (i.e. failing to find a statistically significant association due to insufficient sample size, when in truth an association exists). Similarly, low prevalence of serious psychological distress led to fewer than five subjects within several categories, which caused statistical difficulties with RR calculations, and resulted in only two RR calculations out of a possible 12 being both statistically significant and assured valid (i.e. all categories containing five or more cases). However, our results are consistent across different outcome variables giving some indication that they are robust to these limitations. As our study presents unique analyses, further studies with larger samples are required to independently validate the results.

The stability of pain drawings must also be considered, as the study was carried out over a 12-month period, however, pain drawings have been found to possess a test-retest repeatability of 93.3% over a period averaging 244 days.²⁰

Clinical relevance

Although previous studies have investigated the concurrent association between pain drawings of patients with LBP and psychological status,¹⁵ there is an absence of literature which specifically investigates the ability of pain drawings to predict psychological state over 1 year. Some authors have speculated that pain drawings would likely fail tests of predictive validity. Although Parker *et al.*²¹ found a concurrent relationship between pain drawings and psychological scores, they concluded that the accuracy of pain drawings in identifying distressed or normal patients was insufficient, and therefore hypothesized that they would not be a valid predictive tool.²¹ Our findings provide data that dispute that hypothesis.

Our results indicate that pain drawings may have useful predictive validity, with the PSS method a more accurate predictor of abnormal psychological state at 12 months follow-up than the SBR method,

in the given population. This suggests that extent of pain is a more accurate predictor of somatization than area of pain, and that the SBR scoring method may be too general to reflect psychological disorders in this population.

Recommendations for future research

As this is the first study to investigate the usefulness of pain drawings to predict psychological distress at a future time point, further studies with a larger sample size are required to support the results of this investigation. As relationships have been found between qualitatively analyzed pain drawings and psychological state,^{14,18,33} it may be valuable to also consider qualitative analysis of pain drawings as well as quantitative.

Conclusions

The results of this study indicate that pain drawings may be useful to predict the likelihood of a RCLBP patient presenting with an abnormal psychological state at 12-month follow-up. The Pain Sites Score system²¹ appears to be better at predicting psychological state at 12 months than the SBR method¹² in patients with RCLBP in primary care. This information may assist the clinician in managing patients who are identified as being at greater risk of developing an abnormal psychological state by alerting the clinician that the patient's condition may be more complicated than average, that management may require more resources, or that a referral may be necessary.

Low numbers of data in the high psychological risk categories resulted in weak associations and wide confidence intervals in some of our results. A larger study is required to independently validate these findings. Although there appears to be a risk association between pain drawings at baseline and psychological state at 12 months, the pain drawing should not replace such validated questionnaires as a tool for screening or diagnosis of psychological risk, and further investigation is needed to validate the usefulness of the potential predictive capabilities of the pain drawing.

Conflict of Interest

The authors declare they have no conflicts of interest.

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