ELSEVIER

The Spine Journal 6 (2006) 370–379

THE SPINE JOURNAL

Clinical predictors of screening lumbar zygapophyseal joint blocks: development of clinical prediction rules

Mark Laslett, PT, PhD[a,*], Barry McDonald, PhD[b], Charles N. Aprill, MD[c], Hans Tropp, MD, PhD[d], Birgitta Őberg, PhD[e]

[a]*PhysioSouth, Moorhouse Medical Centre, 3 Pilgrim Place, Christchurch, 8002, New Zealand*
[b]*Massey University, Institute of Information and Mathematical Sciences, Albany Campus, Auckland, New Zealand*
[c]*Magnolia Diagnostics, 2718 Cadiz St., New Orleans, LA 70115, USA*
[d]*Department of Orthopedics, Linköping University, Linköping, Sweden 5-581 83*
[e]*Department for Health and Society, Physiotherapy, Linköping University, Linköping, Sweden 5-581 83*

Received 10 December 2004; accepted 14 January 2006

Abstract

BACKGROUND: Only controlled intra-articular zygapophyseal joint (ZJ) injections or medial branch blocks can diagnose ZJ-mediated low back pain. The low prevalence of ZJ pain implies that identification of clinical predictors of a positive response to a screening block is needed.

PURPOSE: To estimate the predictive power of clinical findings in relation to pain reduction after screening ZJ blocks.

STUDY DESIGN: As part of a wider prospective blinded study investigating diagnostic accuracy of clinical variables, a secondary analysis was carried out to seek evidence of variables potentially valuable as predictors of screening ZJ block outcomes.

PATIENT SAMPLE: Chronic low back pain patients received screening ZJ blocks (n=151) with 120 patients included in the analysis after exclusions.

OUTCOME MEASURES: Pain intensity was measured using a 100-mm visual analog scale, and responses were categorized according to 75% through 95% or more pain reduction in 5% increments.

METHODS: Patients completed pain drawings, questionnaires, and a clinical examination before screening lumbar ZJ blocks. History, demographic and clinical variables were evaluated in cross tabulation and regression analyses with diagnostic accuracy values calculated for variables and variable clusters in relation to different pain reduction standards.

RESULTS: At the 75% pain reduction standard, 24.5% responded to screening ZJ blocks and 10.8% responded at the 95% standard. The centralization phenomenon is not associated with pain reduction using any standard. No variables were useful predictors of post–ZJ block pain reduction of less than 90%. Seven clinical findings were associated with 95% pain reduction after blocks. Five useful clinical prediction rules (CPRs) were found for ruling out a 95% pain reduction (100% sensitivity), and one CPR had a likelihood ratio of 9.7, producing a fivefold improvement in posttest probability.

CONCLUSIONS: A negative extension rotation test, the centralization phenomenon, and four CPRs effectively rule out pain ablation after screening ZJ block. One CPR generates a fivefold improvement in posttest probability of a negative or positive response to ZJ block.

Keywords: Chronic low back pain; Zygapophyseal joint blocks; Diagnosis; Diagnostic accuracy; Clinical examination; Clinical prediction rules

FDA device/drug status: not applicable.

Supported by the International Spinal Injection Society, a New Zealand Society of Physiotherapists scholarship, and the New Zealand Manipulative Physiotherapists Education Trust Fund. Nothing of value received from a commercial entity related to this manuscript.

* Corresponding author. PhysioSouth @ Moorhouse Medical Centre, 3 Pilgrim Place, Christchurch, 8002, New Zealand. Tel.: +64-3-377-0162; fax: +64-3-377-0614.

E-mail address: mark.laslett@xtra.co.nz (M. Laslett)

1529-9430/06/$ – see front matter
doi:10.1016/j.spinee.2006.01.004

Introduction

It is estimated that 15–40% of chronic low back pain patients have pain arising from the lumbar zygapophyseal joints (ZJ) with increasing prevalence in older age groups [1,2]. Based on complete relief of pain from controlled diagnostic blocks, the prevalence of isolated ZJ-mediated back pain is estimated to be as low as 4% [3]. Near-total pain ablation after controlled injections into the joints or at their nerve supply is a widely accepted reference standard technique for diagnosis of ZJ pain [4,5]. Both techniques are believed to produce equivalent diagnostic results [6], although recent opinion favors medial branch blocks [4,7]. Earlier studies have used 50% reduction in pain [8] after intra-articular injections in a placebo-controlled design, 75% reduction [9] after single intra-articular blocks, 75% [10] using double medial branch blocks [10], 80% reduction [11] using double medial branch blocks, verbal numeric scale [12] using single intra-articular blocks, a Likert scale of pain relief [13] using single intra-articular blocks, or a Likert scale for the screening block and 50% or more reduction in pain after confirmatory block [14] using either intra-articular or medial branch blocks. Single uncontrolled blocks carry a high false positive rate between 25% [15] and 38% [1], and can only be used as an initial screening procedure to rule out patients with non-ZJ sources of pain. Previous studies have indicated that history and physical examination findings cannot predict results from diagnostic ZJ blocks [3,10,16,17], but these studies have used less stringent pain reduction standards as references standards than is currently recommended [3,10,17,18]. The question remains ''Can clinical variables predict the outcome of ZJ blocks when complete or near-complete ablation of pain is used as the reference standard?''

The low prevalence of isolated ZJ-mediated back pain implies the need for clinical rules to identify patients unlikely to respond to an initial screening ZJ block. Patients with a low probability of a positive anesthetic response need not be subjected to the screening block, and the tissue origin of pain should be sought elsewhere.

Patients with ZJ pain confirmed by controlled blocks do not experience pain in the spinal midline [3]. The extension rotation (ER) test has been found to have 100% sensitivity and 12% specificity in relation to double ZJ blocks [14], but paradoxically, Revel et al. reported that ''no pain with the ER test'' was associated with a positive response to a screening ZJ block [9]. These authors found that two clinical strategies using five of seven clinical variables may be valuable as a screening test for ZJ blocks [9] and had sensitivities of 92–100% and specificities of 66–80%. These rules and midline pain have been recommended for inclusion in an algorithmic approach to the diagnosis of chronic low back pain [7]. The results of Revel et al. were not replicated in a recent study recording 11% sensitivity and 91% specificity [19], or in a study using double ZJ blocks as the reference standard [10]. These studies did not evaluate the predictive power of clinical variables against the stringent reference standard of immediate total or near-total reduction of pain.

A recent study found that ''No pain rising from sitting'' was associated with an 80% or more reduction in pain intensity after ZJ blocks ($p=.008$) and no patients experiencing centralization or the opposite pain behavior, peripheralization, responded to single ZJ blocks [20]. Centralization (CP) is the progressive reduction and eventual abolition of referred pain or movement of referred pain towards the spinal midline during a specific examination of standardized repeated movement testing (the McKenzie evaluation) [21,22]. CP has been found to be highly specific to positive pain provocation during discography, but not very sensitive [23].

The aim of this analysis was to evaluate potentially valuable predictor variables against the different reference standards, including near-total pain ablation, to see if there were any clinical prediction rules that may assist clinicians in selecting patients for ZJ block procedures.

Methods

Design

As part of a wider study of the diagnostic accuracy of clinical examination variables in relation to available reference standard diagnoses [24,25] in chronic low back pain, a subset of patients received a screening local anesthetic injection into the ZJ joint or medial branch targets. The results of clinical tests were compared with reduction in pain after the screening ZJ blocks. Pain intensity was measured on 100-mm pain visual analogue scales (VAS). A positive response was based on 75–95% pain reduction in increments of 5% and was used in separate analyses.

Patients

Patients with low back pain with or without lower extremity symptoms referred to a private radiology practice in a private clinic specializing in the diagnosis of spinal pain were invited to participate in the study. Patients were either referred specifically for ZJ blocks, or had the procedure included in their radiology examination based on pre-injection clinical evaluation by the injectionist. This examination included consideration of imaging studies, history, and a brief physical examination that included range of motion evaluation, routine neurological screening, and palpation for paraspinal tenderness. All patients had undergone imaging studies before referral and were referred by a variety of medical and paramedical practitioners with some self-referrals. The study was approved by the Louisiana State Institutional Review Board. Between May 2001 and October 2002, physical therapists attended the clinic

in blocks that ranged from 4 to 8 weeks and examined patients. Normal scheduling was not affected by the presence of the visiting therapists, so patients were consecutive during these periods.

Patients were excluded from the study if they were too frail to tolerate a physical examination, or were deemed unable to comprehend study procedure by any member of the clinic team. Before the physical therapy clinical examination, clinic staff recorded basic demographic characteristics and the following data:

Pain: 100 mm VASs for current, best, and worst pain since onset. A current pain VAS was repeated after the clinical examination and following ZJ blocks. The Roland-Morris Disability Questionnaire [26,27] evaluated disability, and the Zung Depression Index [28], Modified Somatic Perception Questionnaire (MSPQ) [29], and the Distress Risk Assessment Method (DRAM) [30] evaluated psychosocial distress.

The physical therapy examination

History taking and structured physical examinations were carried out by a physical therapist with 30 years of clinical experience as a manipulative therapist. Some patients were examined by a physical therapist with 24 years experience. Both therapists hold credentials in the McKenzie method of examination and treatment. The examination occupied 30 to 60 minutes and was carried out before ZJ blocks and on the same day in the majority of cases. Inconclusive findings or incomplete examinations were documented. The physical examination included a visual assessment of range of motion, recording of anatomical location of dominant pain, and testing of nerve tension, key muscle strength, tendon reflexes, and light touch sensitivity. Seven provocation sacroiliac joint tests [31,32] and the items of history and physical examination previously used to identify symptomatic zygapophyseal joint pathology were also included [9,20,33,34].

The physical examination included a McKenzie styled assessment [22]. It utilizes, but is not limited to: assessment of the lumbar lordosis, inspection for a visible lateral shift, and highly standardized single and repeated end range movements and specific postures. These test movements were repeated in sets of 5 or 10 and the effect on pain, if any, was documented. A complete examination was attempted in all cases, but when limited by patient tolerance or time constraints, this was recorded.

Centralization [22] of pain was recorded if the pain in the region furthermost from the midline of the lumbar spine was abolished or substantially reduced during the repeated movements evaluation. Peripheralization was recorded as present if pain was caused to move further from the spinal midline towards the foot, or if the most peripheral symptoms were substantially worsened and could not be reduced or centralized again. If a clear symptomatic response to repeated movements revealed centralization or peripheralization, the repeated movement evaluation was terminated.

Radiology examination

Before ZJ blocks, the radiologist reviewed case notes and imaging studies, and conducted a physical examination that guided the type of diagnostic procedure to be employed and the target structures. Selection of specific ZJs was based on results of imaging, pain location, and palpation for local tenderness. Intra-articular ZJ joint injection or medial branch block using standard technique [18] was carried out by an interventional radiologist with 25 years of experience, or by an injectionist under guidance. Pain responses to injections were recorded as 0.5 cc of lidocaine 2% was injected into the target joint or at medial branch targets. Pain intensity 100-mm VASs were recorded before and 30 to 45 minutes after the procedure. Positive responders were rescheduled for confirmatory blocks using bupivacaine 0.75%. A positive response was defined as reduction or abolition of pain at the confirmatory block lasting the known duration of the anesthetic, approximately 1½ hours for lidocaine and over 4 hours for bupivacaine. Some patients received ZJ blocks and sacroiliac joint injections during the same session. If the combined block was positive, the patient was scheduled to return for confirmatory blocks to identify which structure was responsible for the effect. If the response was negative, the ZJ was not considered the sole source of back pain.

Blinding

Physical therapists conducting the clinical examination were blinded to the results of previous imaging studies and diagnostic injections, the Roland, Zung, and MSPQ questionnaires. The injectionist was blinded to the results of the physical therapy examination and diagnostic conclusions.

Data analysis

Demographic, history, and clinical examination variables (Appendix) were tested for association with responses to screening ZJ blocks in contingency table and regression analyses. Basic statistical values for variables were calculated using statistics software (Minitab version 14.12; Minitab Inc., 2003). Differences between patients receiving or not receiving ZJ blocks were evaluated with two sided Student *t*, chi-square, and Kruskal-Wallis tests where appropriate. Significance for differences was set at $p<.05$. Sensitivity, specificity, and likelihood ratios with 95% confidence intervals were calculated using Confidence Interval Analysis software [35]. The significance of clinical signs in combination with others was

established using logistic regression. Receiver operator characteristic (ROC) curves for potentially valuable clinical prediction rules were constructed and the areas under the curves (AUC) calculated using SPSS for Windows version 11.0 (SPSS, Inc. 2001).

Using pre- and postprocedure pain VASs, separate variables for pain reduction above 75%, 80%, 85%, 90%, and 95% cutoff points were constructed for use as separate reference standards. Percent change in pain intensity was calculated [(postinjection VAS–preinjection VAS)/ preinjection VAS]*100.

Results

Physical examinations and screening ZJ blocks were carried out on 151 chronic low back pain patients. Thirty-one were excluded from the main analysis as they received another intervention in the same procedure session and did not return for differentiating and confirmatory blocks or received blocks at another facility before examination in the current study. Table 1 contains demographic and other descriptive characteristics with comparisons between included and excluded patients. Included patients reported higher ''best'' and ''worst'' pain intensity scores ($p<.05$). Otherwise the two groups had similar characteristics. Table 2 presents proportions of patients responding to the different pain reduction standards.

A general pattern of diminishing diagnostic accuracy was observed for predictor variables with lower pain reduction standards. Only against the 90% and 95% pain reduction standards did variables achieve useful levels of diagnostic accuracy, with variables consistently showing best accuracy against the 95% standard. An example typifying this pattern is illustrated using the ER test (Table 3).

Data on centralization exist for 92 included patients with 26 (28.3%) reporting the phenomenon. One centralizing patient reported 90% pain relief, but no centralizers reported 95% reduction in pain. ''No pain on rising from sitting'' was not associated with a positive ZJ block using any pain reduction standard (Fisher exact test $p>.1$). Maximum sensitivity was 27%, and maximum specificity 83% was obtained at the 85% pain reduction standard. Satisfaction of Revel's criteria [9] was not associated with any pain reduction standard either ($p>.7$).

Using the 95% pain reduction standard, none of the 13 responders stated that their dominant pain was located ''across the low back'' or in the groin, thigh, calf, or foot. All these patients stated that the pain at onset was located at the low back, but never included the groin, thigh, calf, or foot. Five reported that the location of dominant pain included the spinal midline, of whom three reported that the dominant location was confined to the spinal midline.

Increasing age was associated with a positive response to ZJ blocks only at the 95% pain reduction standard (odds ratio 1.05, 95% confidence interval [CI] 1.0, 1.1, $p=.03$). Age ≥ 50 was the cutoff point with the highest odds ratio of 3.55 (95% CI 1.03, 12.25), $p=.06$.

Seven variables were found to possess characteristics suitable for consideration in creating clinical prediction rules (CPRs):

1. Age 50 or more;
2. Pain is best when walking;
3. Pain is best when sitting;

Table 1
Basic demographic data results for chronic low back pain patients receiving screening zygapophyseal blocks

	All patients (n=151)			Excluded patients (n=31)			Included patients (n=120)			
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	p Value*
Age (years)	44	13	43	48	14	48	43	13	42	0.17
Duration (weeks)	147	170	95	105	96	74	158	184	104	0.12
Time off work (weeks)	90	82	74	66	40	69	95	90	78	0.37
VAS (today)	56	25	61	48	28	51	56	23	63	0.07
VAS (at best)	30	23	27	23	21	15	32	23	30	0.042
VAS (at worst)	86	13	89	78			88	11	90	0.008
Roland-Morris Questionnaire	18	5	20	19	4	19	18	5	20	0.59
Zung Depression Index	30	12	29	27	12	27	30	11	30	0.12
MSPQ Questionnaire	10	7	9	10	7	10	10	7	9	0.82
% Male	53.0			48.4			54.2			0.57
% Smoker	34.4			35.5			34.2			0.89
% Off work	50.0			45.2			51.3			0.55
% Previous spinal surgery	25.8			16.1			28.3			0.15
%Traumatic onset	69.5			74.2			68.3			0.52
%Distressed†	48.0			38.7			50.4			0.24
%Severe disability‡	54.0			51.6			54.6			0.77

MSPQ=Modified Somatic Perception Questionnaire; VAS=visual analogue scale.

* Comparisons between included and excluded patients.

† Distressed=categories ''distressed depressed'' or ''distressed somatic'' according to the Distress Risk Assessment Method [30].

‡ Severe disability=Roland-Morris≥19/23.

Table 2
Percent of patients responding to different standards of pain reduction after screening blocks (n=120)

	Reduction in pain after screening zygapophyseal block				
	75%	80%	85%	90%	95%
Number	29	25	22	17	13
Proportion (%)	24.2	20.8	18.3	14.2	10.8

4. Onset of pain was paraspinal;
5. MSPQ score exceeding 13 (suggesting a somatization disorder);
6. ER test;
7. Absence of centralization during repeated movement testing.

Table 4 presents the diagnostic accuracy results for these clinical signs treated individually against the 95% pain reduction standard. Prediction variables were then created by counting the number of clinical signs present for each patient and were evaluated using logistic regression and an ROC curve analysis and its summary measure, the AUC.

Four different combinations of these variables were superior at predicting the outcome of a single ZJ block at the 95% standard:

1. Using all seven signs AUC 0.97 (95% CI 0.94, 1.0), SE 0.018;
2. Using six signs (non-CP excluded). AUC 0.97 (95% CI 0.93, 1.0), SE 0.019;
3. Using five of six signs (ER test and non-CP excluded). AUC 0.95 (95% CI 0.90, 1.0), SE 0.027;
4. Using five of six signs (MSPQ>13 and non-CP excluded). AUC 0.94 (95% CI 0.87, 1.0), SE 0.034.

One or more signs present, two or more present, and so forth in each combination were evaluated with sensitivity, specificity, likelihood ratios, and AUC analyses to establish the optimal points for creation of CPRs. Optimal CPRs and associated diagnostic accuracy statistics are presented Table 5.

In the absence of any CPR, the probability (prevalence) of a 95% pain reduction after ZJ block was 0.11 (13 of 120), which means that 89% of patients will report less than 95% pain reduction. The posttest probability of a positive block is 0.55 when CPR5 is satisfied and 0.02 when not satisfied.

Discussion

Our results for the ER test replicate those in an earlier study [14], but are in contrast to the results of Revel et al. [9]. The low specificity means that the test has no diagnostic value for ZJ-mediated back pain. However, the high sensitivity (100%) allows the clinician to rule out (SnNout) [36] a 95% pain reduction after a screening block if the right and left ER tests are negative. The ER test is typically considered positive when pain is provoked by extension combined with rotation towards the painful side—presumably causing joint compression. Our results indicate lower sensitivity and higher specificity for this application of the test, but the likelihood ratio approaches 1.0. The test has similar properties when applied contrary to usual practice, ie, pain being provoked during rotation away from the side of dominant pain—presumably causing capsular stretching. This application of the test offers even less predictive power than the other applications of the test.

In this study, dominance of pain in the spinal midline was not associated with a positive response to screening ZJ blocks. This does not contradict previous findings, because those authors reported absence of midline pain in patients confirmed as having ZJ-mediated pain [3], not just a positive response to a screening block. We did not

Table 3
Counts and diagnostic accuracy statistics for the extension rotation test (missing=5)

	Counts				Diagnostic accuracy statistics							
	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	$p\chi^2$	Logistic regression OR (95% CI)
% Pain reduction standard												
75	24	19	68	4	85.7	21.8	26.1	82.6	1.1	0.65	0.39	1.68 (0.52, 5.43)
80	21	20	71	3	87.5	22.0	22.8	87.0	1.1	0.57	0.30	1.97 (0.53, 7.29)
85	19	21	73	2	90.5	22.3	20.7	91.3	1.2	0.43	0.18	2.73 (0.59, 12.69)
90	15	22	77	1	93.8	22.2	16.3	95.7	1.2	0.28	0.14	4.29 (0.54, 34.27)
95	12	23	80	0	100.0	22.3	13.0	100.0	1.3	0.0	0.07	* (0.0.*)

TP=true positives; TN=true negatives; FP=false positivies; FN=false negatives; PPV=positive predictive value; NPV=negative predictive value; +LR=positive likelihood ratio; LR=negative likelihood ration; 95% CI=95% confidence intervals; OR=odds ratio derived from univariate logistic regression; $p\chi^2$=p value based on chi-square.

Total counts of less than 120 from missing data in some variables.

* Estimates in logistic regression are unreliable.

Table 4
Counts and diagnostic accuracy statistics for variables achieving significance in relation to screening zygapophyseal blocks at the 95% pain reduction standard

Age 50 or more											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
8	82	25	5	61.5	76.6	24.2	94.2	2.6	0.50	0.006	5.25 (1.57, 17.49)
Best activity is walking											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
4	97	9	9	30.8	91.5	30.8	91.5	3.6	0.76	0.015	4.79 (1.23, 18.69)
Best activity is sitting											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
4	94	11	8	33.3	89.5	26.7	92.2	3.2	0.74	0.03	4.27 (1.1, 16.53)
Onset pain is paraspinal											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
9	75	29	3	75.0	72.1	23.7	96.2	2.69	0.35	0.001	7.76 (1.96, 30.69)
MSPQ>13 (somatization)											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
6	73	32	7	46.2	69.5	15.8	91.3	1.51	0.77	0.35	1.96 (0.64, 6.28)
Extension/Rotation (ER) Test											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
12	23	80	0	100.0	22.3	13.0	100.0	1.3	0.0	0.07	* (0.0,*)
Absence of the centralization phenomenon											
Counts				Diagnostic accuracy statistics							
TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	+LR	−LR	p χ^2	Log. regr OR (95% CI)
11	14	67	0	100.0	14.1	17.3	100.0	1.2	0.0	0.1	*

Total counts of less than 120 from missing data in some variables. TP=true positives; TN=true negatives; FP=false positives; FN=false negatives; PPV=positive predictive value; NPV=negative predictive value; +LR=positive likelihood ratio; −LR=negative likelihood ratio; MSPQ=Modified Somatic Perception Questionnaire; 95% CI=95% confidence intervals; OR=odds ratio derived from univariate logistic regression; Log. Regr.=logistic regression; pχ^2=p value based on chi square.

* Estimates in logistic regression are unreliable.

† Incalculable.

confirm earlier findings [20] that increased pain rising from sitting is associated with a positive ZJ block.

The variables ER test, ''age 50 or more'', ''best walking'', ''best sitting'', onset pain is paraspinal, MSPQ>13, and CP are associated with a positive response to ZJ block at the 90% and 95% pain reduction standards, but not at standards less stringent. This is consistent with previous studies where standards of less than a 90% pain reduction were used. ''Best walking'' is most interesting. Conditions such as peripheral vascular disease and spinal stenosis are characterized by claudicant pain, and like ZJ pain, are associated with older age. If a 95% pain reduction response to ZJ block is associated with reduced or absent pain while walking and older age, perhaps this clinical finding is potentially valuable in characterizing those with ZJ-mediated pain versus those with other pathologies more common in the elderly? This merits further exploration in future studies.

The CPRs identified in this analysis as potentially valuable may be divided into two types of clinical utility. CPRs 1 through 4 all have 100% sensitivity. If any of these rules are not satisfied, the probability of a 95% pain reduction after ZJ block is very low. CPR5 has a likelihood ratio of 9.7 and if satisfied, posttest probability of a positive ZJ block increases from the pretest probability of 0.11 to a posttest probability of 0.55. If not satisfied, posttest probability falls to 0.02, a fivefold improvement either way. Further research is needed to validate these rules in a different sample using single screening blocks and controlled blocks. If the CPRs are validated against controlled ZJ blocks, the existence of a clinical ''lumbar facet joint syndrome'' may be proposed.

ROC analyses of the CPRs in relation to a 90% pain reduction standard revealed AUCs approximately 5–8 percentage points below those achieved in the 95% standard

Table 5
Table of counts, diagnostic accuracy statistics, and Area under the Curve results with 95% confidence intervals for optimal clinical prediction rules (CPR) created from selected variables

	Counts						Dignostic accuracy statistics					
	TP	TN	FP	FN	Senstivity	Specificity	PPV	NPV	+LR	−LR	AUC	SE AUC
CPR1	9	66	10	0	100 (70, 100)	87 (77, 93)	47 (27, 68)	100 (95, 100)	7.6 (4.5, 13.7)	0.0 (0.0, 0.35)	0.93 (0.88, 0.99)	0.027
CPR2	12	37	67	0	100 (76, 100)	36 (27, 45)	15 (9, 25)	100 (91, 100)	1.6 (1.5, 1.8)	0.0 (0.0, 69)	0.68 (0.55, 0.80)	0.063
CPR3	12	28	79	0	100 (76, 100)	26 (19, 35)	13 (8, 22)	100 (88, 100)	1.4 (1.3, 1.5)	0.0 (0.0, 95)	0.63 (0.49, 0.77)	0.070
CPR4	12	52	51	0	100 (76, 100)	50 (41, 60)	19 (11, 30)	100 (93, 100)	2.0 (1.8, 2.5)	0.0 (0.0, 0.49)	0.75 (0.65, 0.86)	0.053
CPR5	11	94	9	2	85 (58, 96)	91 (84, 95)	55 (34, 74)	98 (93, 99)	9.7 (5.0, 18.8)	0.17 (0.05, 0.60)	0.88 (0.76, 1.0)	0.060

Total counts of less than 120 from missing data insome variables.

CPR=clinical prediction rule; TP=true positives; TN=true negatives; FP=false positives; FN=false negatives; PPV=positive predictive value; NPV=negative predictive value; +LR=positive likelihood ratio; −LR=negative likelihood ratio; MSPQ=Modified Somatic Perception Questionnaire; 95% confidence intervals; AUC=area under the receiver operating characteristic curve; SE AUC=standard error of AUC; p values (asymptotic) for AUC are <0.001 for all CPRs.

CPR1: Four or more of seven clinical signs: Age≥50, symptoms best walking, symptoms best sitting, onset pain is paraspinal, MSPQ >13, positive extension/rotation test, and absence of centralization.

CPR2: Two or more of six signs: Age≥50, symptoms best walking, symptoms best sitting, onset pain is paraspinal, MSPQ >13, and positive extension/rotation test.

CPR3: One or more or five signs: Age≥50, symptoms best walking, symptoms best sitting, onset pain is paraspinal, and MSPQ >13.

CPR4: Two or more of five clinical signs: Age≥50, symptoms best walking, symptoms best sitting, onset pain is paraspinal, and positive extension/rotation test.

CPR5: Three or more five clinical signs: Age≥50, symptoms best walking, symptoms best sitting, onset pain is paraspinal, and positive extension/rotation test.

analyses. We conclude that clinical findings can only predict ZJ blocks that treat a 95% pain reduction standard as a positive block.

Study limitations

The pragmatic nature of this study has resulted in several significant weaknesses:

The high exclusion rate was caused by the confounding influences of other procedures such as sacroiliac joint blocks conducted in the same session as the screening ZJ block. In most cases, the combined blocks were not expected to result in a substantial reduction in pain, as the source of nociception was considered to be elsewhere, eg, the intervertebral disc. We were wrong in this expectation. Surprisingly, of the 19 patients confounded by such factors, 10 reported a 95% or more reduction in pain. In these cases, it was expected that in the event of a positive response to the combined block, the patient would return for isolated and selective blocks to differentiate between the possible sources of pain. Indeed these patients were scheduled, but failed to show usually because the patients had received the test for which referral was initiated (discography) and presumably further tests were not considered necessary by the referring clinician. As a consequence, some patients with true positive responses to ZJ blocks may have been excluded from analysis, which is unfortunate given the low numbers of responders to the screening block.

Selection bias: It is possible that patients referred specifically for ZJ blocks were selected on the basis of results of commonly used tests such as the ER test. If this were the case, then sensitivity for such tests will be overestimated and specificity underestimated. We believe that this tendency was small, however.

Study size: A larger study without such confounding influences may be able to identify weaker predictors of the initial screening block not identified in the current analysis.

Prevalence of ZJ-mediated low back pain cannot be estimated from the current data because the lack of confirmatory blocks precludes the diagnosis. However, the prevalence cannot be higher than 10.8%, and could be as low as 6% if a false positive rate of 38% pertained. This estimate is compatible with an earlier estimate based on complete relief of pain after confirmatory blocks [3].

Of patients included in the analysis, 10.8% reported a positive response at the 95% or more reduction of pain level, 14.2% at the 90% level, and 20.8% at the 80% level. These results are less than the 64% reported by Manchikanti et al. [10], the 47% response rate obtained by Schwarzer et al. [1], and 58% reported by Carette et al. [8]. A 95% standard will necessarily generate false negatives when another structure besides the ZJ is a significant additional source of pain. However, the combination of putative

Appendix

Variables evaluated for diagnostic accuracy

Variable	Description
Demography and history	
Age	
Gender	
Handedness	Left, right, ambidextrous
Smoking	Smoking or not
Cause of pain	Traumatic or not
Duration of symptoms	Measuredin weeks
Work status	Working or not
Time off work	If off work, how many weeks
Sleep status	Is sleep distributed?
Average sleeping hours	Number of hours per day
Sleeping position	Supine, prone, side
Pain intensity	Current, Best, Worst
Pain distribution	Midline, paraspinal, buttock, thigh, groin, calf, foot
Location of dominant pain location	Midline, paraspinal, buttock, thigh, groin, calf, foot
Location of pain at onset	Midline, paraspinal, buttock, thigh, groin, calf, foot
Constant versus intermittent pain	Ine each area: midline, paraspinal, buttock, thigh, groin, calf, foot
Effect of movements and position on pain	Walking, standing, sitting, rising from sitting or lying, lying (supine, side, prone),bending, rising from bending, time of day, lifting
Effect of coughing, sneezing, straining	Provoke back or leg pain
Number of past pregnancies	
Previous lumbar surgeries	
General health self-report	Good, fair, poor
Self-reported bladder function	Normal/abnormal
Changes in body weight in last 12 months	Increased/decrease/no change
Report of allergies or drug reactions	
Illnesses: Heart disease, diabetes seizures, asthma, stomach ulcer, etc.	
Roland-Morris Disability Questionnaire	
Zung Depression Index	
Zung Depression Index	
Modified Somatic Perception Questionnaire	
Distress Risk Assessment Method	Derived from Zung and MSPQ
Ransford classification of pain drawings	Carried outby blinded, independent colleague
Currently taking medication groups	Opiates, antidepressants, NSAIDs, muscle relaxants, etc.
Physical examination	
Sitting posture	Poor, fair, good
Lateral shift	Right, left, nil
Scoliosis	Present/absent
Range of flexion, extension, lateral flexion	Visual estimation – normal, minimal loss, moderate loss, major loss. Each dichotomized 0 = normal or minimal loss, 1 = moderate or major loss
Effects of standardized repeated movements examination	Centralization, peripheralization, directional preference
Sacro-iliac joint tests	Pain provocation tests Distraction Compression Thigh thrust (right and left) Gaenslen's test Midline sacral thrust Belt test Active SLR test
Hip joint examination	Passive movements and isometric resisted tests. Provoke the pain or not. Faber test
Basic nuerological examination	SLR, femoral nerve test, slump test, key muscle strength, patellar and ankle tendon reflexes, light touch sensitivity
Spring tests to each lumbar spinous process	Provokes pain or not
Extension rotation test	Right and left rotation
Signs and symptoms of instability	
Past history of frequent episodes	
History of persistent pain between acute episodes	

(*Continued*)

Appendix

Continued

Variable	Description
Feelings of ''vulnerability'' in the ''neutral zone''	
Patient supports back through the ''neutral zone''	
Patient drops through ''neutrol zone'' during flexion	
Patient avoids ''neutral zone'' on return from flexion	
Symptoms and signs of inappropriate pain behavior	
Symptoms and dysfunction through out a body region	
Pain on the tip of the coccyx	
Whole leg numbness	
Whole leg pain	
Report of the whole leg giving way	
No time during episode with minimal pain	
Emergency room attendance for back pain	
All treatments have made the pain worse	
Superficial tenderness over wide area of low back	
Pain provocation with axial compression	
Simulated SLR does not provoke pain but SLR does	
Pain with simulated trunk rotation	
Overreaction to tests	
Use of catastrophic language	
''Cogwheel''/ jerky response to key muscle tests	
Revel's criteria—signs and symptoms	
Predictive of 75% reduction in pain after facet joint block	
Age over 65	
Good relief lying down	
No pain with flexion	
No pain returning from flexion	
No pain with extension	
No pain with extension/rotation test	
No pain with cough or sneeze	
Symptoms associated with spinal stenosis	
Pain is wortst with walking or standing	
Pain is best sitting	
Walking distance improved when lumber spine flexed	
Claudication pain pattern—intermittent? A repeatable pattern of pain produced after a specific distance or time, which is relieved by sitting or standing for a specified (short) time.	

MSPQ=Modified Somatic Perception Questionnare; NSAID=nonsteroidal anti-inflammatory drugs; SLR=straight leg raise test

discogenic pain (positive discography) and ZJ pain has been shown to be as low as 3% [37].

Conclusions

Diagnosis of symptomatic ZJ joint by noninvasive means remains elusive. Clinical findings have predictive power only for ZJ blocks using a stringent pain reduction or ablation standard. This study has mainly negative value in that clinicians may rule out a positive response to a screening ZJ block when the ER test or one of four clinical prediction rules are negative, or in the presence of pain centralization. One clinical prediction rule (CPR5) shows a fivefold advantage in selecting patients to receive ZJ blocks.

References

[1] Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N. The false-positive rate of uncontrolled diagnostic blocks of the lumbar zygapophysial joints. Pain 1994;58:195–200.

[2] Manchikanti L, Pampati VS, Pakanati RR, et al. Prevalence of patients' facet joint pain in chronic low back pain. Pain Physician 1999;2:59–64.

[3] Schwarzer AC, Aprill C, Derby R, Fortin JD, Kine G, Bogduk N. Clinical features of patients with pain stemming from the lumbar zygapophysial joints. Is the lumbar facet syndrome a clinical entity? Spine 1994;19:1132–7.

[4] Dreyfuss PH, Dreyer SJ, Vaccaro A. Lumbar zygapophysial (facet) joint injections. Spine J 2003;3:50–9.

[5] Merskey H, Bogduk N. Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms. 2nd ed. Seattle: IASP Press, 1994.

[6] Marks RC, Houston T, Thulbourne T. Facet joint injection and facet nerve block: a randomised comparison in 86 patients with chronic low back pain. Pain 1992;49:325–8.

[7] Bogduk N, McGuirk B. Medical management of acute and chronic low back pain. Amsterdam: Elsevier Science BV, 2002. 173–4.

[8] Carette S, Marcoux S, Truchon R, Grondin C, Gagnon J, Allard Y, Latuppie M. A controlled trial of corticosteroid injections into facet joints for chronic low back pain. N Engl J Med 1991;325:1002–7.

[9] Revel M, Poiraudeau S, Auleley GR, et al. Capacity of the clinical picture to characterize low back pain relieved by facet joint anesthesia. Proposed criteria to identify patients with painful facet joints. Spine 1998;23:1972–7.

[10] Manchikanti L, Pampati V, Fellows B, Baha GA. The inability of the clinical picture to characterize pain from facet joints. Pain Physician 2000;3:158–66.
[11] Dreyfuss P, Halbrook B, Pauza K, Joshi A, McLarty J, Bogduk N. Efficacy and validity of radiofrequency neurotomy for chronic lumbar zygapophysial joint pain. Spine 2000;25:1270–7.
[12] Jackson RP, Jacobs RR, Montesano PX. 1988 Volvo award in clinical sciences. Facet joint injection in low-back pain. A prospective statistical study. Spine 1988;13:966–71.
[13] Moran R, O'Connell D, Walsh MG. The diagnostic value of facet joint injections. Spine 1988;13:1407–10.
[14] Schwarzer AC, Derby R, Aprill CN, Fortin J, Kine G, Bogduk N. Pain from the lumbar zygapophysial joints: a test of two models. J Spinal Disord 1994;7:331–6.
[15] Manchikanti L, Pampati V, Fellows B, Bakhit CE. The diagnostic validity and therapeutic value of lumbar facet joint nerve blocks with or without adjuvant agents. Curr Rev Pain 2000;4:337–44.
[16] Jackson RP. The facet syndrome: myth or reality? Spine 1992;279: 110–21.
[17] Schwarzer AC, Wang S-C, O'Driscoll D, Harrington T, Bogduk N, Laurent R. The ability of computed tomography to identify a painful zygapophysial joint in patients with chronic low back pain. Spine 1995;20:907–12.
[18] Dreyfuss PH, Dreyer SJ, Herring SA. Contemporary concepts in spine care: lumbar zygapophysial (facet) joint injections. Spine 1995;20:2040–7.
[19] Laslett M, Oberg B, Aprill CN, McDonald B. Zygapophysial joint blocks in chronic low back pain: a test of Revel's model as a screening test. BMC Musculoskel Disord 2004;5:43.
[20] Young SB, Aprill CN, Laslett M. Correlation of clinical examination characteristics with three sources of chronic low back pain. Spine J 2003;3:460–5.
[21] McKenzie RA. The lumbar spine: mechanical diagnosis and therapy. Waikanae: Spinal Publications Ltd, 1981. 22.
[22] McKenzie RA, May S. The lumbar spine; Mechanical diagnosis and therapy. 2nd ed. Waikanae, New Zealand: Spinal Publication New Zealand Ltd, 2003. 167–9, 404–26.
[23] Laslett M, Oberg B, Aprill CN, McDonald B. Centralization as a predictor of provocation discography results in chronic low back pain, and the influence of disability and distress on diagnostic power. Spine J 2005;5:370–80.
[24] Laslett M. The diagnostic accuracy of the clinical examination compared to available reference standards in chronic low back pain patients. Faculty of Health Sciences, Linköpings Universitet 2005.
[25] Laslett M, McDonald B, Tropp H, Aprill CN, Oberg B. Agreement between diagnoses reached by clinical examination and available reference standards: a prospective study of 216 patients with lumbopelvic pain. BMC Musculoskelet Disord 2005;6:28.
[26] Roland M, Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. Spine 1983;8:141–50.
[27] Patrick DL, Deyo RA, Atlas SJ, Singer DE, Chapin A, Keller RB. Assessing health-related quality of life in patients with sciatica. Spine 1995;20:1899–909.
[28] Zung WWK. A self-rating depression scale. Arch Gen Psych 1965;12:63–70.
[29] Main CJ. The Modified Somatic Perception Questionnaire (MSPQ). J Psychosom Res 1983;27:503–14.
[30] Main CJ, Wood PL, Hollis S, Spanswick CC, Waddell G. The distress and risk assessment method: a simple patient classification to identify distress and evaluate the risk of poor outcome. Spine 1992;17:42–52.
[31] Laslett M, Williams M. The reliability of selected pain provocation tests for sacroiliac joint pathology. Spine 1994;19:1243–9.
[32] Laslett M, Young SB, Aprill CN, McDonald B. Diagnosing painful sacroiliac joints: a validity study of a McKenzie evaluation and sacroiliac joint provocation tests. Aust J Physiother 2003;49:89–97.
[33] Helbig T, Lee CK. The lumbar facet syndrome. Spine 1988;13:61–4.
[34] Young S, Aprill C. Characteristics of a mechanical assessment for chronic lumbar facet joint pain. J Manual Manipulat Ther 2000;8: 78–84.
[35] Bryant TN. Confidence intervals analysis. Bristol: BMJ Books, 2000:208–13.
[36] Sackett DL, Haynes RB, Guyatt GH, Tugwell P. Clinical epidemiology: a basic science for clinical medicine. 2nd ed. Boston: Little Brown, 1991:77–85.
[37] Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N. The relative contributions of the disc and zygapophyseal joint in chronic low back pain. Spine 1994;19:801–6.