Derivation of a clinical decision guide in the diagnosis of cervical facet joint pain

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PII: S0003-9993(14)00208-1
DOI: 10.1016/j.apmr.2014.02.026
Reference: YAPMR 55771

To appear in: ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION

Received Date: 16 February 2014
Accepted Date: 27 February 2014


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Clinical decision guide – facet pain

Sources of support: Canadian Institutes of Health Research, LifeMark Health, Calgary Orthopaedic Research and Education Fund, Alberta Spine Foundation

Acknowledgements: The authors wish to thank Mr. Scott Sherman (PT), Ms. Heather Scherer (BSc), and Ms. JoAnna Herring (BSc) for their assistance in the organization and evaluation of study subjects.
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Abstract

Objective: To derive a clinical decision guide (CDG) to identify patients best suited for cervical diagnostic facet joint blocks.

Design: Prospective cohort study.

Setting: Interventional pain management centre.

Participants: Consecutive patients with neck pain, referred to an interventional pain management centre were approached to participate. One hundred twenty-five patients participated.

Interventions: Subjects underwent a standardized testing protocol, performed by a physiotherapist, prior to receiving diagnostic facet joint blocks. All subjects received the reference standard diagnostic facet joint block protocol, namely controlled medial branch blocks (MBB). The physicians performing the MBB were blinded to the local anaesthetic used and the findings of the clinical tests.

Main Outcome Measure(s): Multivariate regression analyses were performed in the derivation of the CDG’s. Sensitivity, specificity, positive and negative likelihood ratios, and 95% confidence intervals were calculated for the index tests and CDG’s.

Results: A CDG involving the findings of the manual spinal examination (MSE), palpation for segmental tenderness (PST), and extension-rotation test (ER) demonstrated a specificity of 84% (95% CI: 77 - 90) and positive likelihood ratio of 4.94 (95% CI: 2.80 – 8.20). Sensitivity of the PST and MSE were 94% (95%
CI: 90 – 98) and 92% (95% CI: 88 – 97) respectively. Negative findings on the PST were associated with a negative likelihood ratio of 0.08 (95% CI: 0.03 – 0.24).

Conclusions: The MSE, PST, and ER may be useful tests in identifying patients suitable for diagnostic facet joint blocks. Further research is needed to validate the CDGs prior to their routine use in clinical practice.

Key words: clinical decision rule, neck pain, facet joint, cervical spine, physical examination, sensitivity, specificity

Abbreviations:
NPRS - Numeric Pain Rating Scale
ROM – Range of motion
NDI – Neck Disability Index
PCS – Pain Catastrophizing Scale
GHQ-28 – General Health Questionnaire 28
S-LANSS - self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs pain scale
ERT – Extension-rotation test
MSE – Manual spinal examination
PST – Palpation for segmental tenderness
CI – Confidence interval
LR+ - Positive likelihood ratio
LR- - Negative likelihood ratio
It is estimated that the facet joint is a source of nociception in 36%-67% of individuals with persistent neck pain.\textsuperscript{1-3} Patients, with persistently high levels of neck pain/disability for at least three months, who fail to respond to conservative pharmacological or rehabilitation interventions may undergo facet joint interventions.\textsuperscript{4} In the United States, between 1997 and 2006, facet joint interventions increased in clinical use by 624%,\textsuperscript{5} which is notable, because they are invasive procedures, associated with significant costs, and carry a small risk of adverse events to the patient.

In many jurisdictions, where resources are limited, there are lengthy wait-times for facet joint interventions. Diagnostic facet joint blocks are used to determine an individual’s suitability for an intervention. However those who fail to positively respond to the diagnostic blocks, magnify delays for those who are appropriate candidates. Determining candidacy for diagnostic facet joint blocks is typically clinician-driven. At present there is little evidence to suggest stand-alone patient history or clinical examination can predict the outcome of these procedures.\textsuperscript{6} Although controversial, clinical tests such as range of motion (ROM), segmental palpation (PST), the extension-rotation test (ERT), and manual spinal examination (MSE) are used as tools to assist clinicians assessing patients who may be suffering from cervical facet joint mediated pain.\textsuperscript{7-9} As with most clinical decision-making, no single test can reliably identify the facet joint as the source of pain. The derivation of a clinical decision guide (which pools findings from a cluster of clinical tests), may improve the accuracy of determining candidacy for diagnostic facet joint blocks.\textsuperscript{9}
This study aimed to derive a clinical decision guide (CDG) from physical tests to identify which patients are best suited for diagnostic facet joint blocks. Since psychological factors may also have an influence on outcomes, potential moderating variables were also examined.

Methods

Study Design

A prospective cohort study conducted in a tertiary interventional pain management centre in Calgary, Alberta, Canada. Ethical approval was obtained from the Conjoint Health Research Ethics Board at the University of Calgary.

Participants

Data collection occurred between October 2011 and December 2012. Consecutive subjects with persistent neck pain, referred for diagnostic facet joint blocks were approached to participate. Subjects between the ages of 18-65 years with reported neck pain intensity of $\geq 3/10$ on a Numeric Pain Rating Scale (NPRS) for a minimum of 3 months were included. The value of $\geq 3/10$ was selected to exceed the reported measurement error of the NPRS. Exclusion criteria were: cervical radiculopathy, upper motor neuron disease; neck pain related to systemic disease, infection, neoplasm, or fracture; a medically diagnosed psychological disorder; uncontrolled diabetes; uncontrolled clotting disorder; pregnancy; workers compensation claim or ongoing litigation.
Upon enrollment, subjects completed a demographic questionnaire and four standardized self-report measures. The Neck Disability Index (NDI), Pain Catastrophizing Scale (PCS), General Health Questionnaire–28 (GHQ-28), and the self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs pain scale (S-LANSS) are reliable/valid measures for spine-related pain. Two distinct clinician groups participated in the study. Physiotherapists performed the clinical examinations and an interventional radiologist, physiatrist, and radiology technician were responsible for the diagnostic facet joint blocks. Both groups were blinded to each other’s test results.

**Clinical examination**

One of four experienced physiotherapists with 10-25 years of clinical experience assessed subjects prior to the diagnostic blocks. To standardize the examinations, all physiotherapists received a training manual outlining the operational definitions of the clinical tests and a one-hour training session.

The examination included cervical ROM testing, the ERT, MSE, and PST. Measurements of ROM into flexion, extension and side-flexion were made with an inclinometer. Rotation was measured using a dual-armed goniometer. Thoracic movement was consciously minimized and subjects were asked to move their head and neck as far as possible. ROM was measured and subjects reported any pain on an NPRS, which was subsequently categorized as
‘increased’, ‘decreased’ or ‘no change’ in familiar pain. For the ERT, subjects were seated and asked to extend fully their head, followed by rotation to both sides. Subjects reported any pain at the end of motion. A positive test was defined as the provocation of familiar cervical spine pain intensity ($\geq 3/10$).

MSE$^{7,25}$ was performed to detect the presence or absence of cervical facet joint dysfunction.$^{7,23}$ The subject was positioned prone with their cervical spine in a neutral position. The assessor applied a posterior-anterior directed force over the articular pillars from C2-3 to C6-7 on each side (diagnostic facet joint blocks were not performed for the C0-1 and C1-2 joints). Any perceived resistance to motion was categorized as ‘normal’, ‘slight’, ‘moderate’, or ‘marked’.$^{23}$ The subject also reported any pain provocation on a NPRS; with a positive test defined as a report of familiar local or referred pain of $\geq 3/10$ when the assessor rated ‘moderate’ or ‘marked’ resistance to motion.$^{23}$

PST was performed with the subject prone. The assessor palpated the segmental muscles overlying the facet joints, C2-3 to C6-7 bilaterally. These muscles have the same nerve supply as the painful joint and react with tenderness and spasm.$^{24,25}$ The test was considered positive if the patient reported an increase in familiar pain, either local or referred, at an intensity of $\geq 3/10$.

All tests have demonstrated moderate to excellent intra-rater and inter-rater reliability in patients with axial neck pain referred for diagnostic facet joint blocks.$^{26}$ Each testing session lasted approximately 15 minutes.
Reference standard diagnostic facet joint blocks:

Comparative medial branch blocks (MBB) were performed as the reference standard for the diagnosis of facet joint pain for all subjects, which is the most widely internationally accepted approach. For this approach, the MBB is performed on two occasions with two different anaesthetics to reduce the high false positive rate associated with single block procedures. This procedure involved the injection of 0.5 ml of either Bupivacaine 0.5% or Lidocaine 2% under fluoroscopic guidance onto the sensory nerves (medial branch of the dorsal ramus and/or the third occipital nerve) of the target facet joint. Contrast material (0.25 ml of Omnipaque 300) was injected at each spinal level to ensure target specificity of the facet blocks. The anaesthetics were delivered in a random order to minimize measurement bias associated with the order of delivery of the anaesthetics. The subjects and the interventional radiologist or physiatrist performing the block was blinded to the anaesthetic used. The interventional radiologist, physiatrist, and radiology technician were blinded to any study related pre-injection outcomes measures or clinical examination findings. The physicians performing the MBBs had 5-15 years of experience in these procedures.

All subjects underwent an initial MBB. A radiology technician recorded subjects’ neck pain intensity on an 11-point NPRS before and after the block. A positive response was defined as a $\geq 80\%$ decrease in familiar neck pain intensity for at least the duration of the anaesthetic used ($\geq 1$ hour for Lidocaine and $\geq 3$ hours for Bupivacaine). Positive responders underwent a second MBB one
week following their initial block. A subject was deemed to have facet joint pain if they experienced a positive response to both MBB’s. For negative responders, if the physician performing the injection or the referring physician felt that another facet joint was the likely source of neck pain, the subject underwent another facet joint block at a neighboring spinal level.

Data Analysis

The sample size was determined a priori based on the reported prevalence (36%-67%) of facet joint pain in the cervical spine.\textsuperscript{1-3} With conservative use of this data, we estimated the prevalence of facet joint pain in our sample to be 40%. In deriving a CDG from multivariable regression analyses, at least 10 outcome events (diagnosis of facet joint pain) should occur for each predictor variable.\textsuperscript{33,34} A priori, we determined that a CDG with more than five predictor variables may not be efficient for clinicians utilizing the guide in practice. From this, our study would require at least 50 positive outcome events (subjects diagnosed with facet joint pain). Given an anticipated prevalence of facet joint pain in our sample of 40% and the use of up to five predictor variables in the CDG, the number of subjects needed in our study was 125 (50/n = .40).

Descriptive statistics were used to summarize subjects’ baseline demographic data. Clinical measures were analyzed for their association with the outcome of diagnostic facet blocks via univariate and multivariate logistic regression. Clinical tests with acceptable levels of intra-rater and inter-rater reliability (kappa statistic $\geq 0.60$ or intraclass correlation coefficient $\geq 0.80$) were
considered in the development of the CDG.\textsuperscript{35} The outcome data from the clinical tests and diagnostic facet joint blocks were entered into contingency tables to calculate sensitivity, specificity, and likelihood ratios (LR+ and LR-) and subsequent confidence intervals associated with the CDG’s. Interpretation of the magnitude of the likelihood ratios followed the guide reported by Guyatt and colleagues.\textsuperscript{36}

The presence of effect modification by age, gender, catastrophization, and psychological distress was evaluated in multivariate logistic regression analyses. Confounding by age, gender, baseline neck pain and disability, catastrophization, and psychological distress was controlled for in the analyses. Receiver operating characteristic (ROC) curves for the statistically- and clinically-significant prediction models were constructed, along with their respective areas under curve (AUC). All statistical analyses were performed using STATA 11 (StataCorp LP, College Station, Texas, USA).

**Results**

Of the 177 individuals approached to participate in the study, 38 were excluded based on the inclusion/exclusion criteria, 14 declined participation, and 125 consented to participate (Figure 1). There were no clinically relevant differences in age, gender, neck pain intensity, and duration of neck pain between participants (Table 1) and non-participants. The C5-6, C6-7, and C2-3 facet joints were the most frequent joints to undergo diagnostic facet joint blocks, with a prevalence of 36%, 33%, and 23% respectively. Of the 125 subjects, 52
(42% pre-test probability/prevalence) had positive responses to the blocks. Of the positive responders, 14 were positive at C2-3; 12 were positive at C3-4; four were positive at C4-5; 21 were positive at C5-6; and 11 were positive at C6-7, and 10 were positive at two levels (i.e., C2-3 and C3-4). There were no adverse events associated with the index tests or reference standard.

From the statistically significant univariate logistic regression analyses, the most robust odds ratios were found with PST, followed by MSE and the ERT (Table 2). In all three analyses 95% confidence intervals were wide. Table 3 outlines the contingency tables comparing the clinical test findings with the outcome of the diagnostic facet joint blocks. In all circumstances, a higher percentage of true positives and true negatives occurred with each single or combinations of test findings. If a subject tested positive on all three clinical tests, the LR+ was 4.94 (95%CI: 2.80–8.20) and the post-test probability of a diagnosis of facet joint pain increased from 42% to 78%. Conversely, if a subject tested negative on PST, the LR- was 0.08 (95%CI: 0.03–0.24) and the post-test probability of a diagnosis of facet joint pain decreased to 5% (Table 4).

In analyzing the results of the multivariate logistic regression analysis, because of high agreement between MSE and PST, collinearity was evident in the model (Table 5). As a result, multivariate logistic regression analyses were performed for two separate models with one containing the predictor variable PST, and the other containing the MSE. The multivariate model, controlling for age, gender, catastrophization, baseline neck pain and disability, and psychological distress, examining the association between PST and the ERT and
the outcome of the diagnostic facet joint blocks revealed no evidence of effect modification or confounding. For this model, ROC analysis resulted in an AUC of 0.90 and a sensitivity and specificity of 89% and 84% respectively. There was also no evidence of effect modification or confounding for the regression model that included MSE and the ERT. For this model, the AUC determined from ROC analysis was 0.89 and the sensitivity and specificity was 87% and 82% respectively.

Discussion

This study is the first to derive a CDG, incorporating the findings from a cluster of clinical tests, with utility to predict a diagnosis of cervical facet joint mediated pain. Our findings indicate that a positive stand-alone finding on the extension-rotation test lacks the diagnostic accuracy to rule-in facet joint mediated pain, and suggests a similar conclusion for MSE and PST when used in isolation. In contrast, our results showed that the MSE and PST exhibit high sensitivity and low LR-, used as a stand-alone finding or in combination, which supports their use as potential screening tests prior to referring a patient for facet joint blocks. Our data indicated that the lowest LR- was associated with the PST test (CDG 2). Subsequently, if a patient tests negative on the PST test, this provides clinicians with a large and notable shift in probability that the patient does not have facet joint mediated pain.\textsuperscript{36,38}

These CDGs require validation, as the clinical implications of our findings may have a positive influence on practice. In a large sample of Medicare
patients, Manchikanti et al.\textsuperscript{39} reported that 317, 220 cervical/thoracic facet joint blocks were performed in 2011 (a 359\% increase from the year 2000). Thus, the use of effective screening procedures to determine candidacy for facet joint blocks could eliminate a substantial number of inappropriate procedures with significant cost savings. When a patient tests positive on the MSE, PST, and ERT, or combination of either MSE/ERT or PST/ERT (CDGs 5-7) the magnitude of the LR+ associated with the CDGs provides clinicians with a small/moderate shift in probability that the patient has facet joint mediated pain.\textsuperscript{36,38} If our findings are transferable to clinical practice, a positive cluster of MSE, PST and ERT would improve the likelihood of targeting facet joint blocks to the proper candidates.

In clinical practice, multiple factors often influence decision-making and outcomes. Thus, we performed a multivariate analysis, with control for covariates, to reflect these outside contributions. Two models (one consisting of the MSE and the ERT and the other involving PST and the ERT) possessed good diagnostic accuracy, whether adjusted or unadjusted, and discriminative validity (as reflected by the AUC from the ROC analysis). However, the use of multivariate modeling that address covariates which potentially influence outcomes for clinical decision-making is a complex venture; with most clinicians lacking statistical knowledge, technology, and ability to run analyses for informed management of their patients with neck pain. Sensible CDGs must be uncomplicated to use and should have the capacity to change clinician
The MSE and PST tests are both relatively simple to use, clinically relevant, and the standardized testing protocol is efficient. The assessment process used in this study requires explicitly applied movements to the joints and muscular tissue of the neck and has been historically used to assess patients with suspicion of cervical facet joint pain. Tests such as the MSE and PST, aim to identify specific dysfunctional spinal motion segments, either through identification of resistance, or reproduction of pain at a given segment. It has been hypothesized that pain thresholds and tonic guarding associated with muscular stiffness are notably altered in those with cervical facet joint pain. The cervical facet joint capsules possess free (nociceptive) nerve endings, mechanoreceptors, A-delta and C-fibres. The cervical facet joints and the deep segmental muscles are innervated by the medial branch of the dorsal rami. As a result, the tensile forces applied to the facet joint (capsule) and surrounding muscular tissue may explain the possible relationship that exists between results of the manually-oriented physical examination and the results of diagnostic facet joint blocks. Recent evidence suggests that cervical facet joint blocks have a short-term anaesthetic effect and a hypoalgesic benefit to mechanical stimuli at surrounding cervical muscular tissue. At best we can only speculate the potential overlap of response mechanisms as, to our knowledge, no study has evaluated the physiological effects of the manually-oriented physical examination and facet joint blocks in a single trial.
Two prior studies have used a similar MSE methodology and have reported contradictory results. A landmark study by Jull et al.\(^7\) examined the ability of an experienced physiotherapist to identify symptomatic facet joints in 20 patients with neck pain undergoing a single facet joint block. Remarkably, the manual spinal examination used in their study was 100% sensitive and 100% specific in deciphering those with and without facet joint pain. In our study, we incorporated a similar MSE procedure, but we compared our index test findings against those of the currently accepted reference standard, comparative, controlled MBBs, for the diagnosis of facet joint pain.\(^27\) Single diagnostic blocks provide high false positive rates ranging from 27% to 63%.\(^{29,30}\) This finding challenges the magnitude of the sensitivity and specificity noted by Jull et al.\(^7\), and may explain some of the discrepancies between our findings. King et al. questioned the value of the MSE. Using comparative, controlled MBBs as the reference standard, King et al.\(^6\) reported a sensitivity of 89% (95%CI: 82%-96%), specificity of 47% (95%CI: 37%-57%), and a LR+ of 1.7 (95%CI: 1.2–2.5). In their study, only patients with positive results on the MSE underwent the criterion standard facet joint blocks. As a result, measurement bias (verification bias) may explain the differences between our study results.\(^36\) This form of bias may have lead to an underestimate of the specificity of the MSE noted in their study.\(^47\)

Using electronic pressure algometry for the assessment of muscular pain sensitivity over the facet joints in a small number of patients with neck pain, Seigenthaler et al.\(^48\) challenged the diagnostic accuracy of the PST due to the
low sensitivity (13%) found in their study. Although their assessment methods
were sophisticated, one needs to be cautious when interpreting their findings, as
their study sample was small and not powered to determine diagnostic accuracy
statistics.

Study Limitations

Our assessors were experienced physiotherapists, thus the findings may
not necessarily be generalizable to all clinicians. The subjects had diagnostic
facet joint blocks to the putatively painful joints based on their pain pattern and
response to the previous facet joint blocks, and did not receive facet blocks at
every spinal level in the neck. Nonetheless, by having every subject undergo the
reference standard, we believe that we minimized diagnostic work-up bias. The
subjects duration of symptoms was highly variable, which may have influenced
our results. Importantly, our study sample is representative of patients referred
for diagnostics facet joint injections, facilitating the clinical utility of our findings.

We chose clinical tests that have either been studied previously for their
diagnostic accuracy for cervical facet joint pain or have been widely used by
clinicians based on the assumption of the test’s ability to provoke facet joint pain.
There may be other potentially useful clinical tests. For example, a lateral gliding
technique and MSE have been validated against dynamic radiographic
examination to detect cervical joint hypomobility (rather than necessarily the
symptomatic segment). These clinical tests are similar to those used in our
study and it may be of interest to evaluate their utility in future studies validating
our CDG. Our study involved the derivation of a potentially useful CDG. Validation studies and impact analyses are needed prior to the routine use of our CDG in clinical practice.

Conclusions

This study identified derived CDGs that have clinical sensibility, are easy to implement in clinical practice, and once validated, may augment decision-making when contemplating referral for facet joint blocks. Our initial findings suggest that negative findings on the MSE and/or PST may inform clinicians that facet joint blocks may not be an optimal procedure for their patients with persistent neck pain.
Clinical Decision Guide Facet Pain

References


Supplier

a. StataCorp LP, 4905 Lakeway Dr, College Station, TX 77845.

Figure Legend:

Figure 1: Flow diagram of subject recruitment and participation
<table>
<thead>
<tr>
<th></th>
<th>Median (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>49 (21 - 65)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>84 females, 41 males</td>
</tr>
<tr>
<td><strong>Baseline neck pain intensity (NPRS 0-10)</strong></td>
<td>6 (3 - 9)</td>
</tr>
<tr>
<td><strong>Subjects (%) with baseline neck pain intensity ≥ 5/10</strong></td>
<td>82</td>
</tr>
<tr>
<td><strong>Onset of pain (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Traumatic</td>
<td>47</td>
</tr>
<tr>
<td>Gradual</td>
<td>46</td>
</tr>
<tr>
<td>Sudden</td>
<td>7</td>
</tr>
<tr>
<td><strong>Motor vehicle collision (%) (n=53)</strong></td>
<td></td>
</tr>
<tr>
<td>Frontal impact</td>
<td>15</td>
</tr>
<tr>
<td>Side impact</td>
<td>26</td>
</tr>
<tr>
<td>Rear impact</td>
<td>59</td>
</tr>
<tr>
<td><strong>Smoker (%)</strong></td>
<td>22</td>
</tr>
<tr>
<td><strong>Employed (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Currently employed</td>
<td>63</td>
</tr>
<tr>
<td>On leave due to neck problem</td>
<td>10</td>
</tr>
<tr>
<td>Unemployed</td>
<td>11</td>
</tr>
<tr>
<td>Retired</td>
<td>11</td>
</tr>
<tr>
<td>Student</td>
<td>5</td>
</tr>
<tr>
<td><strong>Duration of neck pain (months)</strong></td>
<td>18 (3 - 216)</td>
</tr>
<tr>
<td><strong>Neck Disability Index (0-50)</strong></td>
<td>20 (3 - 38)</td>
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<tr>
<td><strong>Subjects (%) with Neck Disability Index scores ≥ 15/50 (self-reported moderate-severe neck pain and disability)</strong></td>
<td>74</td>
</tr>
<tr>
<td><strong>Pain Catastrophizing Scale (0-52)</strong></td>
<td>13 (0 - 44)</td>
</tr>
<tr>
<td><strong>General Health Questionnaire – 28 (0-84)</strong></td>
<td>22 (8 - 65)</td>
</tr>
<tr>
<td><strong>S-LANSS (0-24)</strong></td>
<td>8 (0 - 19)</td>
</tr>
</tbody>
</table>

**Abbreviations:** S-LANSS = self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs pain scale
Table 2: Odds Ratios of the clinical variables in univariate logistic regression for predicting cervical facet joint pain

<table>
<thead>
<tr>
<th>Clinical Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension-rotation test</td>
<td>1.92</td>
<td>0.44</td>
<td>6.85 (2.91 – 16.13)</td>
</tr>
<tr>
<td>Manual spinal examination</td>
<td>3.39</td>
<td>0.58</td>
<td>29.71 (9.51 – 92.81)</td>
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<tr>
<td>Palpation for segmental tenderness</td>
<td>3.77</td>
<td>0.65</td>
<td>43.28 (12.11 – 154.77)</td>
</tr>
</tbody>
</table>

Abbreviations: CI = confidence interval
Table 3: Contingency tables comparing the clinical test findings with the outcome of the diagnostic facet joint blocks

<table>
<thead>
<tr>
<th>Diagnostic facet joint block</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>48</td>
<td>21</td>
<td>69</td>
</tr>
<tr>
<td>Negative</td>
<td>4</td>
<td>52</td>
<td>56</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
</tr>
<tr>
<td>PST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>49</td>
<td>20</td>
<td>69</td>
</tr>
<tr>
<td>Negative</td>
<td>3</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
</tr>
<tr>
<td>ERT</td>
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<td></td>
<td></td>
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<tr>
<td>Positive</td>
<td>43</td>
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<tr>
<td>Negative</td>
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<td>43</td>
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</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
</tr>
<tr>
<td>MSE and PST</td>
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<td></td>
<td></td>
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<tr>
<td>Positive</td>
<td>48</td>
<td>18</td>
<td>66</td>
</tr>
<tr>
<td>Negative</td>
<td>4</td>
<td>55</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
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<tr>
<td>MSE and ERT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>41</td>
<td>14</td>
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<td>Negative</td>
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<td>Total</td>
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</tr>
<tr>
<td>PST and ERT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>41</td>
<td>13</td>
<td>54</td>
</tr>
<tr>
<td>Negative</td>
<td>11</td>
<td>60</td>
<td>71</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
</tr>
<tr>
<td>MSE/PST/ERT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>41</td>
<td>12</td>
<td>53</td>
</tr>
<tr>
<td>Negative</td>
<td>11</td>
<td>61</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>73</td>
<td>125</td>
</tr>
</tbody>
</table>

Abbreviations: MSE = manual spinal examination, PST = palpation for segmental tenderness, ERT = extension-rotation test
Table 4: Accuracy statistics with 95% confidence intervals for the clinical decision guides

<table>
<thead>
<tr>
<th>Clinical Decision Guide</th>
<th>Sensitivity* (95% CI)</th>
<th>Specificity* (95% CI)</th>
<th>Positive Likelihood Ratio (95% CI)</th>
<th>Negative Likelihood Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDG 1: MSE</td>
<td>92 (88 – 97)</td>
<td>71 (63 – 79)</td>
<td>3.17 (2.22 – 4.64)</td>
<td>0.11 (0.04 – 0.28)</td>
</tr>
<tr>
<td>CDG 2: PST</td>
<td>94 (90 – 98)</td>
<td>73 (65 – 80)</td>
<td>3.48 (2.35 – 5.03)</td>
<td>0.08 (0.03 – 0.24)</td>
</tr>
<tr>
<td>CDG 3: ERT</td>
<td>83 (76 – 89)</td>
<td>59 (50 – 68)</td>
<td>2.02 (1.49 – 2.72)</td>
<td>0.29 (0.16 – 0.54)</td>
</tr>
<tr>
<td>CDG 4: MSE and PST</td>
<td>92 (88 – 97)</td>
<td>75 (68 – 83)</td>
<td>3.74 (2.49 – 5.63)</td>
<td>0.10 (0.04 – 0.26)</td>
</tr>
<tr>
<td>CDG 5: MSE and ERT</td>
<td>75 (67 – 82)</td>
<td>84 (78 – 91)</td>
<td>4.69 (2.51 – 6.72)</td>
<td>0.30 (0.15 – 0.45)</td>
</tr>
<tr>
<td>CDG 6: PST and ERT</td>
<td>76 (68 – 83)</td>
<td>84 (78 – 91)</td>
<td>4.75 (2.65 – 7.39)</td>
<td>0.29 (0.15 – 0.44)</td>
</tr>
<tr>
<td>CDG 7: MSE, PST, and ERT</td>
<td>79 (72 – 86)</td>
<td>84 (77 – 90)</td>
<td>4.94 (2.80 – 8.20)</td>
<td>0.25 (0.15 – 0.43)</td>
</tr>
</tbody>
</table>

Abbreviations: CDG = clinical decision guide, MSE = manual spinal examination, PST = palpation for segmental tenderness, ERT = extension-rotation test, CI = confidence interval
* = proportions are stated as a percentage (%)
Table 5: Contingency table of frequency of test findings for the manual spinal examination and palpation for segmental tenderness

<table>
<thead>
<tr>
<th>MSE</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>66*</td>
<td>3</td>
<td>69</td>
</tr>
<tr>
<td>Negative</td>
<td>3</td>
<td>53*</td>
<td>56</td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>56</td>
<td>125</td>
</tr>
</tbody>
</table>

Abbreviations: MSE = manual spinal examination, PST = palpation for segmental tenderness, * = high levels of agreement between the two clinical tests
Figure 1: Flow diagram of subject recruitment and participation

Eligible patients n = 177

Excluded patients n = 38
- > 65 years (n = 19)
- Language barrier (n = 4)
- Already had injection (n = 4)
- Radiculopathy (n = 2)
- Could not cease anticoagulant therapy (n = 2)
- Pain intensity < 3 (n = 6)
- Did not have transportation (n = 1)

Declined to participate n = 14

Consented to participate n = 125

Participated in all index tests n = 125

Received reference standard comparative medial branch blocks n = 125

Positive outcome n = 52

Negative outcome n = 73