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Inter-therapist agreement in classifying patients with cervical radiculopathy and patients with non-specific neck-arm pain

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ABSTRACT

Identification of differences in clinical presentation and underlying pain mechanisms may assist the classification of patients with neck-arm pain which is important for the provision of targeted best evidence based management. The aim of this study was to: (i) assess the inter-examiner agreement in using specific systems to classify patients with cervical radiculopathy and patients with non-specific neck-arm pain associated with heightened nerve mechanosensitivity (NSNAP); (ii) assess the agreement between two clinical examiners and two clinical experts in classifying these patients, and (iii) assess the diagnostic accuracy of the two clinical examiners. Forty patients with unilateral neck-arm pain were examined by two clinicians and classified into (i) cervical radiculopathy, (ii) NSNAP, (iii) other. The classifications were compared to those made independently by two experts, based on a review of patients' clinical assessment notes. The experts' opinion was used as the reference criterion to assess the diagnostic accuracy of the clinical examiners in classifying each patient group. There was an 80% agreement between clinical examiners, and between experts and 70% to 80% between clinical examiners and experts in classifying patients with cervical radiculopathy (kappa between 0.41 and 0.61). Agreement was 72.5%–80% in classifying patients with NSNAP (kappa between 0.43 and 0.52). Clinical examiners' diagnostic accuracy was high (radiculopathy: sensitivity 79%–84%; specificity 76%-81%; NSNAP: sensitivity 78%–100%; specificity 71%-81%). Compared to expert opinion, clinicians were able to identify patients with cervical radiculopathy and patients with NSNAP in 80% of cases, our data supporting the reliability of these classification systems.

INTRODUCTION

The diversity of patients with nerve-related neck-arm pain is reflected in the different clinical presentations and underlying pain types (nociceptive/neuropathic) and related pain mechanisms. A conceptual model is proposed with one end of the spectrum comprising pain conditions due to a nerve lesion as seen in cervical radiculopathy, the other end containing clinical presentations with vague signs of a nerve disorder, characterised by non-specific neck-arm pain associated with heightened nerve mechanosensitivity (NSNAP) (Allison et al., 2002; Elvey 1997; van der Heide et al., 2006).

Heightened nerve mechanosensitivity is a feature of nerve trunk pain (Dilley et al., 2005) which is regarded as a nociceptive pain (Marchettini et al., 2006) or inflammatory pain (Bennett 2006). It is characterised clinically by local tenderness on palpation over accessible nerve trunks (Bennett 2006; Elvey 1997; Quintner and Bove 2001) and pain in response to limb movements that cause nerve elongation (Elvey 1997; Quintner and Bove 2001). The condition can be present in isolation without any signs of nerve damage (Bennett 2006; Bove et al., 2003; Dilley et al., 2005; Eliav et al., 2001; Marchettini et al., 2006), but can also coexist with a nerve lesion (Bennett 2006; Marchettini et al., 2006), as documented in patients with cervical radiculopathies (Chien et al., 2008; Wainner et al., 2003;) and in patients with nerve-related low back and leg pain (Schäfer et al., 2009). In the latter study, 10% out of 40 patients demonstrated features of heightened nerve mechanosensitivity as a discrete disorder without any clinically established neurological deficits, and in 57% heightened nerve

mechanosensitivity coexisted with clinical signs of nerve root damage such as sensory and strength/reflex deficits (Schäfer et al., 2009).

The two syndromes (heightened nerve mechanosensitivity and radiculopathy) could be viewed as disorders on a clinical continuum. Pathological conditions attacking the nerve from the outside might initially cause nociceptive nerve trunk pain and subsequently also cause nerve damage and may be associated with neuropathic pain (Marchettini et al., 2006). Neuropathic pain being defined as "pain caused by a lesion or disease of the somatosensory nervous system" (Jensen et al., 2011). However, based on clinical characteristics such as pain with or without negative and/or positive sensory signs, no assumption can be made on the underlying pain type (nerve trunk pain/radicular pain; nociceptive/neuropathic) and pathology. The mix of nociceptive and neuropathic pain components may vary between patients with nerve-related neck-arm pain. Identification of such differences and the appropriate classification of patients with these neck-arm pain conditions is important for the provision of appropriate best evidence management.

Due to a lack of diagnostic gold standards the classification of these patient groups is largely based on the findings of a comprehensive clinical examination (Butler 2000; Coppieters and Butler 2001; Elvey 1997; Kuijper et al., 2009; Wainner and Gill 2000) incorporating the medical history, an assessment of both musculoskeletal and related neural tissues, a neurological bedside examination of somatosensory and motor function (Cruccu et al., 2010; Hansson 2002; Jepsen et al., 2006; Wainner et al., 2003) and clinical nerve provocation tests (NPT) in the upper limb (Butler 2000; Elvey 1997; Rubinstein et al., 2007). Upper limb NPTs are analogous to the straight leg raise test

which is used for the assessment of nerve mechanosensitivity in the lower limb (Devillé et al., 2000; Freynhagen et al., 2008). The underlying concept for these NPTs is that sensitised nerve tissue may become non compliant to limb movements that cause nerve elongation (Elvey 1997) and that pain responses are provoked in response to these limb movements, resulting in movement restriction. In addition, mechanical pressure over sensitised nerve tissue such as in palpation over nerve trunks may provoke a hyperalgesic response (Elvey 1997; Hall and Quintner 1996; Quintner and Bove 2001). Results of medical investigations (e.g. imaging, electrodiagnostic tests) can also aid in the diagnostic work-up of neck-arm pain (Kuijper et al., 2009; Treede et al., 2008). Whilst moderate to substantial inter-examiner reliability (Landis and Koch 1977) has been documented for clinical tests of nerve function (sensory testing, reflexes and manual muscle testing) (Jepsen et al., 2004; Jepsen et al., 2006; Schmid et al., 2009) and for NPTs in the upper limb (Jepsen et al., 2006; Schmid et al., 2009; Vanti et al., 2010; Wainner et al., 2003), no study has investigated the reliability of the overall decision as to whether the primary clinical presentation is a cervical radiculopathy or demonstrates characteristics of heightened nerve mechanosensitivity. For the diagnosis of painful radiculopathy, the opinion and consensus of experienced clinicians/experts has been used for validation of patient classifications (Freynhagen et al., 2008), and this approach was applied in the current study.

Radhakrishnan et al (1994) proposed sets of diagnostic criteria for the presence of definite radiculopathy which incorporate physical examination findings with diagnostic tests or surgical verification (Table 1).

**Table 1**

The classification criteria used in this study to detect definite painful cervical radiculopathy (Radhakrishnan et al., 1994) in patients with neck-arm pain are outlined below. Category I, or II or III had to be met for the classification of definite painful cervical radiculopathy.

| Category | Criteria |
|---|---|
| **I** | a) Electromyographic evidence of acute denervation in cervical paraspinal muscles and/or in a myotome |
| | **or** |
| | b) Identification of an affected cervical root at surgery |
| **II** | a) Sensory changes in a dermatomal distribution |
| | **and** |
| | b) Weakness, atrophy or fasciculation in a myotomal distribution |
| | **and** |
| | c) Unilateral diminished deep tendon reflexes |
| **III** | a) Demonstrable abnormality on myelography, computer-assisted myelography, or magnetic resonance imaging correlating with cervical radiculopathy |
| | **or** |
| | b) Demonstrable abnormality on computed tomography scan at the clinically relevant level correlating with cervical radiculopathy[a] |
| | **with** |
| | c) Neck pain, arm pain or combined neck and arm pain |
| | **and** |
| | d) Paraesthesia, hyperaesthesia, or dysaesthesia in a nerve root distribution |
| | **or** |
| | e) Muscle weakness |
| | **and** |
| | f) Any of category II[a] |

[a]Criterion added to existing criteria. Computed tomography scans are deemed as valid confirmatory tests for nerve root compression (Treede et al., 2008; Bono et al., 2011), therefore Criterion IIIb was added. Signs of nerve root compression on imaging plus the presence of neck-arm pain with paraesthesia or muscle weakness do not necessarily implicate the presence of a cervical radiculopathy. Therefore Criterion IIIf was added.

Although this classification system is 16 years old, in the ongoing absence of consensus for appropriate reference standards for the diagnosis of cervical radiculopathy, this system was advocated as a clinically-reasoned approach (Rubinstein et al., 2007), however the reliability has never been assessed. For the clinical presentation of heightened nerve mechanosensitivity, a set of classification criteria has also been established (Elvey 1997) (Table 2), but the reliability of these criteria has not yet been evaluated in patients with neck-arm pain nor has the content validity of this classification system yet been investigated.

**Table 2**

The classification criteria used in this study to detect the clinical presentation of heightened nerve mechanosensitivity. The presence of Criteria I and II are essential for the classification of heightened nerve mechanosensitivity, Criterion III may or may not be present (+/-).

| **Criteria** | |
|---|---|
| **I** | Abnormal response to a nerve provocation test (reproduction of pain in the area of the patient's symptoms, plus reduced range of motion compared to the asymptomatic side, plus symptom response altered with addition of movements designed to elongate and add mechanical load on the peripheral nerves to be assessed (Elvey 1997) |
| **II** | A correlating active movement dysfunction (e.g. limitation of range of motion of shoulder abduction and/or pain on shoulder abduction, which increased with addition of cervical contralateral flexion and/or with wrist extension as loading manoeuvres) (Elvey 1997) |
| **III** | An abnormal response on clinically relevant upper limb nerve trunk palpation (hypersensitivity compared to the asymptomatic side) (Elvey 1997) |

The purpose of this study was threefold: to determine the inter-examiner agreement in classifying patients using these specific classification systems; secondly to assess the agreement in patient classification between two clinical examiners using the specific classification systems and two independent experts; and thirdly to determine the diagnostic accuracy of the clinical examiners using the opinion and consensus of the experts as a reference criterion.

## METHODS

### Study population

The study was conducted between February 2008 and May 2009. The patients with neck-arm pain were recruited from private physiotherapy, medical, and neurosurgery practices; physiotherapy, pain management, neurosurgery outpatient and triage clinics at five metropolitan hospitals; and via radio and newspaper advertising. The study protocols and the recruitment procedures were approved by the Ethics Committees of all participating institutions. The inclusion criterion was unilateral neck pain with upper limb pain and/or paraesthesia. Exclusion criteria were the presence of a central nervous system disease (except cervical spinal cord compromise) and an insufficient level of English. Patients were screened by phone or in the clinic to establish they satisfied these criteria. The protocol was explained to all patients and all patients consented in writing prior to entering the study.

### Clinical examination and classification

The two clinical examiners were experienced clinically active physiotherapists with a minimum of a postgraduate Masters qualification in musculoskeletal physiotherapy.

One examiner was a Specialist in Musculoskeletal Physiotherapy (Fellow of Australian College of Physiotherapists) with 28 years experience, the other had 17 years of experience as Musculoskeletal Physiotherapist. A Neurosurgeon (Fellowship-trained Spinal Neurosurgeon) and an additional Specialist in Musculoskeletal Physiotherapy were consulted as experts for further classification of patients.

The diagnostic criteria used to detect the presence of a painful cervical radiculopathy were based on the publication by Radhakrishnan et al (1994) and are listed in Table 1. If the patients met any one of the three categories for the classification of radiculopathy, they were assigned to this group.

The presence of heightened nerve mechanosensitivity was defined as evidence of increased peripheral nerve sensitivity to mechanical stimuli including NPTs and nerve palpation (Elvey 1997). The criteria for this classification are demonstrated in Table 2. The classification of NSNAP could relate to spinally mediated nerve sensitivity, as well as to clinically diagnosed distal/peripheral neuropathies (eg. carpal tunnel syndrome, ulnar nerve neuropathy). In patients where co-morbid condition(s) existed (e.g. frozen shoulder plus ulnar nerve neuropathy), patients were still classified as presenting with NSNAP, as long as the relevant classification criteria were met.

Patients were allocated to one of the two examiners. The order of testing by the two examiners varied, but for practical reasons, could not be randomised. A comprehensive clinical examination was performed by the first examiner and results of any medical investigations such as imaging and electrodiagnostic studies were reviewed. Within an interval of 26 days, the second examiner performed a similar full clinical examination

and nominated a classification. A hierarchical approach was used to classify patients into either: radiculopathy, or NSNAP or other. That is, if patients fulfilled the criteria for radiculopathy *and* they demonstrated clinical signs of heightened nerve mechanosensitivity, they were still classified as radiculopathy. Both examiners were blind to the other's classification and examined the patients entirely independently. Patients were asked not to provide the second examiner with any information that was given to the patient during the first examination. The assessment sheets together with the determined classification were placed in a sealed envelope and handed to an independent blinded person for data entry and analysis.

The two experts independently received a copy of each examiner's patient notes plus the results of any medical investigations, without any information on the classification criteria. The Neurosurgeon classified patients into either: radiculopathy or other. The Specialist Musculoskeletal Physiotherapist classified patients into radiculopathy, NSNAP or other. In addition, both experts were given a choice to use a fourth classification of 'undecided', if they were unable to make a classification based on the information provided to them. The experts' classifications were based on their clinical opinion. Clinical examination by the independent experts was not possible for logistic and ethical reasons. Assessment by four practitioners would have imposed a considerable burden on the patients. Moreover, repeated assessment could potentially cause a flare-up of the patient's pain condition raising ethical concerns.

Statistical analysis

A total sample size of 40 subjects (including patient groups) was needed to detect an 80% agreement between two raters, if the null kappa was 0.6 and the true kappa was 0.9 (Flack et al., 1988). A Kappa between 0.40 and 0.60 indicates moderate agreement, a Kappa between 0.61 and 0.80 indicates a substantial strength of agreement and a Kappa of 0.81 to 1.00 an almost perfect strength of agreement (Landis and Koch 1977). Statistical analyses were carried out with SPSS, Version 15.0. The Kappa coefficient, with prevalence and bias index (Sim and Wright 2005), and the percentage agreement were calculated to determine the proportion of agreement between:

1. The two examiners in classifying
    a) patients across all categories (‘radiculopathy, NSNAP, other)
    b) patients with radiculopathy
    c) patients with NSNAP
2. The two experts in classifying patients with radiculopathy
3. The two examiners and the two experts in classifying patients with radiculopathy
4. The two examiners and one expert in classifying patients with NSNAP

Due to differing numbers of classifications between raters (1 - 4), classifications had to be pooled to allow a pairwise comparison (Figure 1).

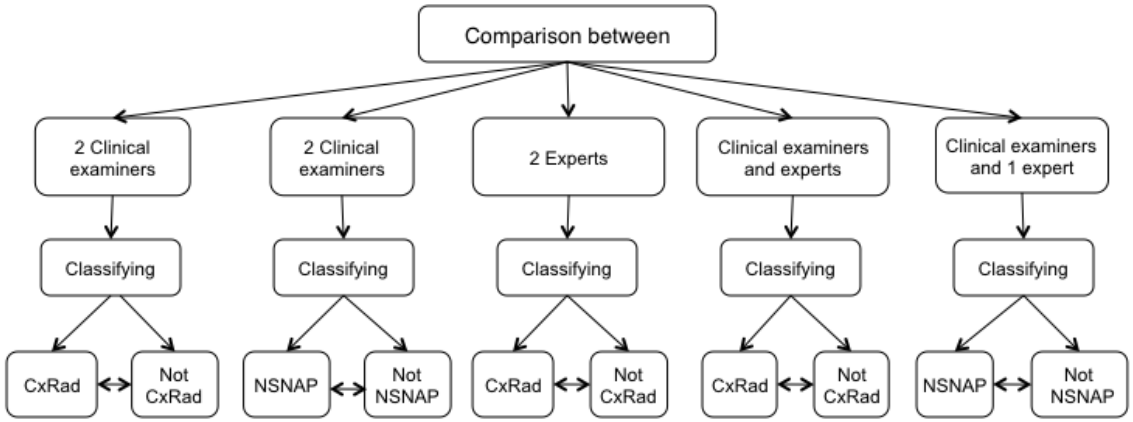


**Fig 1.** Pooling of classifications for pairwise comparison of classifications between clinical examiners and experts.

CxRAD = Cervical radiculopathy, NSNAP = Non-specific neck-arm pain associated with heightened nerve mechanosensitivity.

The consensus of experts in classifying patients with radiculopathy was used as the reference standard to determine the diagnostic accuracy (sensitivity, specificity) of both examiners. The opinion of one expert was used as the reference criterion to determine the diagnostic accuracy in classifying patients with heightened nerve mechanosensitivity. The receiver operating characteristic (ROC) curves were graphed and the areas under the curve (AUC) plus their 95% confidence intervals were measured. This value of AUC equals the probability of correctly classifying patients with and without the specific pain condition.

## RESULTS

Forty patients participated in the study (21 males; 19 female; mean ± SD age 47 ± 10.6 years; duration of symptoms 16.2 ± 27.4 months). Thirty of these patients had imaging of the cervical spine performed. Nine patients had imaging performed of the cervical spine, but no relevant abnormality was reported.

### Agreement between examiners

Examiners agreed in classifying 27 out of 40 patients (Kappa 0.46, 95% CI 0.24 to 0.68) (Table 3), yielding a 67.5% agreement. For the classification of patients with radiculopathy, the percentage agreement was 80% and the Kappa coefficient was 0.60 (95% CI 0.35 to 0.85) (Table 4). For the classification of patients with NSNAP, percentage agreement was 72.5% and the Kappa coefficient was 0.43 (95% CI 0.16 to 0.70). For the 13 patients classified differently by the clinical examiners, there were different findings recorded in the examiners' patient notes in 12 cases: 3 related to reflex testing, 3 to strength testing, 4 to neural tissue testing, and 2 to inconsistent

patient responses. In 5 of these cases the two experts agreed, in 2 cases the Specialist Musculoskeletal Physiotherapist classified the patient as NSNAP and the Neurosurgeon as other (i.e. they agreed the patient did not have a radiculopathy) and in the remaining 5 cases one expert chose the undecided option.

**Table 3**

The frequencies of patients (N = 40) classified by two Musculoskeletal Physiotherapists as having cervical radiculopathy, non-specific neck-arm pain associated with heightened nerve mechanosensitivity (NSNAP) or another pain condition, are shown below.

| | | **Examiner 2[b]** | | | |
|---|---|---|---|---|---|
| | | Radiculopathy | NSNAP | Other | Total |
| **Examiner 1[a]** | Radiculopathy | 16 | 3 | 0 | 19 |
| | NSNAP | 3 | 10 | 0 | 13 |
| | Other | 2 | 5 | 1 | 8 |
| | Total | 21 | 18 | 1 | 40 |

[a]Musculoskeletal Physiotherapist.
[b]Specialist Musculoskeletal Physiotherapist.

**Table 4**

The kappa coefficient, 95% Confidence Interval (CI) and % agreement, prevalence and bias index in classification of patients with cervical radiculopathy and patients with non-specific neck-arm pain associated with heightened nerve mechanosensitivity (NSNAP) are shown for two examiners.

| | Kappa | CI | % agreement | Prevalence Index | Bias Index |
|---|---|---|---|---|---|
| | | | **Cervical radiculopathy** | | |
| **Examiner 1 - Examiner 2[#]** | 0.60 | 0.35 - 0.85 | 80 | 0.00 | 0.05 |
| **Expert 1 - Expert 2*** | 0.61 | 0.39 - 0.83 | 80 | 0.15 | 0.20 |
| **Examiner 1 - Expert 1** | 0.41 | 0.16 - 0.66 | 70 | 0.15 | 0.20 |
| **Examiner 1 - Expert 2** | 0.60 | 0.35 - 0.85 | 80 | 0.05 | 0.00 |
| **Examiner 2 - Expert 1** | 0.59 | 0.36 - 0.82 | 80 | 0.20 | 0.15 |
| **Examiner 2 - Expert 2** | 0.60 | 0.35 - 0.85 | 80 | 0.00 | 0.05 |
| | | | **NSNAP** | | |
| **Examiner 1 - Examiner 2** | 0.43 | 0.16 - 0.70 | 72.5 | 0.22 | 0.12 |
| **Examiner 1 - Expert 2** | 0.50 | 0.21 - 0.79 | 77.5 | 0.45 | 0.10 |
| **Examiner 2 - Expert 2** | 0.52 | 0.29 - 0.75 | 80 | 0.32 | 0.22 |

[#]Examiner 1 = Musculoskeletal Physiotherapist, Examiner 2 = Specialist Musculoskeletal Physiotherapist.
*Expert 1 = Neurosurgeon, Expert 2 = Specialist Musculoskeletal Physiotherapist.

Agreement between experts

The frequencies of patients classified by the two experts as having cervical radiculopathy, NSNAP, or another pain condition or where no decision could be made is demonstrated in Table 5. For the classification of patients with radiculopathy, the

agreement was substantial at 80% with a Kappa of 0.61 (95% CI 0.39 to 0.83) (Table 4).

**Table 5**

The frequencies of patients (N = 40) classified by two experts as having cervical radiculopathy, non-specific neck-arm pain associated with heightened nerve mechanosensitivity (NSNAP), or another pain condition, or where no decision could be made, are shown.

| | | **Expert 1[a]** | | | |
|---|---|---|---|---|---|
| | | Radiculopathy | Other | No decision | Total |
| **Expert 2[b]** | Radiculopathy | 19 | 0 | 0 | 19 |
| | NSNAP | 1 | 8 | 0 | 9 |
| | Other | 2 | 3 | 0 | 5 |
| | No decision | 5 | 1 | 1 | 7 |
| | Total | 27 | 12 | 1 | 40 |

[a]Neurosurgeon.
[b]Specialist Musculoskeletal Physiotherapist.

Agreement between examiners and experts

There was 70% to 80% agreement between examiners and experts in classifying patients with cervical radiculopathy and patients with NSNAP. Kappa coefficients indicated moderate agreement (Table 4).

Diagnostic accuracy of both examiners

Using the consensus of the two experts as the reference standard, Examiners 1 and 2 demonstrated a sensitivity of 79% and 84% and a specificity of 81% and 76% respectively in classifying patients with cervical radiculopathy. For Examiner 1, the

AUC was 0.80 (95% CI .65 to .94) and for Examiner 2, the AUC was 0.80 (95% CI 0.66 to 0.95), indicating that both examiners chose the correct diagnosis 80% of the time. Using the opinion of Expert 2 as the reference criterion for the presentation of NSNAP, Examiner 1 demonstrated a sensitivity of 78% and specificity of 81% (AUC: .79; 95% CI 0.61 to 0.97), Examiner 2 a sensitivity of 100% and specificity of 71% (AUC: 0.85; 95% CI 0.74 to 0.97).

## DISCUSSION

To our knowledge, this is the first study to investigate the use of classification systems to assess the inter-examiner agreement in classifying patients with painful cervical radiculopathy and patients with NSNAP. There was high percentage agreement with moderate Kappa coefficients between raters in classifying both patient groups, supporting the reliability of the classification systems used. The discrepancy between Kappa and percentage agreement has been discussed in the literature (Sim and Wright 2005). Kappa takes into account the agreement occurring by chance. Where raters have based their classification on a thorough and methodical diagnostic work up, the probability that clinicians have resorted to simple guesswork is low. Consequently the Kappa coefficient can be a conservative estimate of agreement.

Both examiners demonstrated high sensitivity in classifying patients with cervical radiculopathy. Considering physiotherapists' expanding role in extended scope of practice (Kersten et al., 2007) such as triaging patients in emergency departments (Anaf and Sheppard 2007; Lau et al., 2008) or neurosurgery clinics, high diagnostic accuracy and the risk-benefit implications of making wrong decisions are important. This is of

particular significance for patients where alternative medical management is vital to managing their condition effectively, such as in patients with significant nerve root compromise or with dominantly neuropathic pain features.

There are ramifications with strictly applying classification systems without incorporating a component of clinical judgement. For example, a patient presented with C6 radicular pain and sensory dermatomal deficit, no motor impairment, heightened nerve mechanosensitivity and no clinically relevant abnormality on cervical imaging. The classification based on the opinion of both experts was that of a (sensory) radiculopathy. However, based on the applied classification system, this was not defined as radiculopathy as not all criteria of Category II were met. Therefore both examiners classified this patient as presenting with NSNAP. Furthermore, the criteria of Category II do not allow a differentiation between sensory and motor radiculopathy. Such differentiation is clinically important as each condition is indicative of a nerve root lesion and may need specific intervention. For example, a patient with a motor radiculopathy and no pain may not need any pharmaceutical intervention to target pain compared to a patient with a painful sensory radiculopathy.

The percentage agreement in classifying patients with NSNAP was between 70% and 80%, consistent with findings in patients with low back related leg pain (Schäfer et al., 2009). Sensitivity and specificity values for this classification were high in our study, however results have to be considered in light of the small number of patients classified by the expert (n = 9). The classification system for NSNAP was clinically feasible.

Future studies with a larger sample size are recommended to attest further to the reliability.

Limitations of the study

The main limitation of this study relates to the fact that the experts did not clinically assess the patients. However while the study design could be strengthened by the experts examining the patient, this would also add considerable responder burden for the patients. The clinical examiners differed in their recording of clinical examination findings and consequently in their classification of 12 patients which appears to have impeded the experts' decision making in 5 cases where one expert chose not to make a diagnosis. Nevertheless, despite this discordance the experts demonstrated agreement in classifying 7 out of these 12 patients. Considering the dynamic nature of a pain experience and possible changes in patient's signs on the day of examination, a 100% agreement would be unlikely. Furthermore, heightened nerve mechanosensitivity is not a disease process comparable to axonal damage seen in patients with radiculopathy. It is rather a clinical phenomenon, which can be transient and can fluctuate.

It can be argued that the time interval between patient examinations may create potential for disagreement between the examiners. Eight patients were not assessed on the same day, however the examiners' classification differed in only one of these patients.

The diversity of our patient cohort may be considered both a weakness as well as a strength of our study. While it may not allow generalisation to the patient population

seen in typical physiotherapy practice, the inclusion of patients from all referral sources is important considering the role of physiotherapists as extended scope practitioners. Both examiners were highly skilled and experienced. It is unclear if less experienced physiotherapists would have achieved similar outcomes. Although a sample size calculation was performed prior to the study, future studies with a larger sample size are recommended to further prove the reliability of the classification systems, in particular for the classification of patients with NSNAP.

One further limitation to the study lies in the hierarchical order of applying the classification systems. This approach treats the clinical pain presentations as being mutually exclusive, and this does not reflect the clinical presentation of our cohort of patients with neck-arm pain. For example, 7 out of 15 patients classified by all 4 raters with cervical radiculopathy also demonstrated clinical signs of heightened nerve mechanosensitivity. A further 5 patients out of these 15, demonstrated some signs of heightened nerve mechanosensitivity, but did not meet all criteria used for this specific classification.

Whilst the straight leg raise test is widely used in medicine to identify heightened nerve mechanosensitivity in lumbar/lower limb pain (Devillé et al., 2000; Freynhagen et al., 2008), this is not the case for the upper limb equivalent NPTs. These upper limb equivalents seem to be used predominantly by physiotherapists (Allison et al., 2002; Coppieters et al., 2003; Coppieters et al., 2006; Elvey 1997; Sterling et al., 2002; van der Heide et al., 2006; Wainner et al., 2003;) and their diagnostic value remains unclear (Rubinstein et al., 2007). While the NPT with bias to median nerve demonstrated 97%

sensitivity in identifying patients with cervical radiculopathy (Wainner et al., 2003), this NPT is not widely used by neurosurgeons. Thus, the Neurosurgeon in the current study was not asked to classify patients with NSNAP.

Two criteria were added to the classification system for radiculopathy that were deemed clinically relevant for the classification of radiculopathy. In addition, the Radhakrishnan et al (1994) classification system did not mention the presence of neck and/or arm pain for criteria I and II and this should be considered if the system is used for the classification of painful radiculopathies. The system was useful for identification of patients with radiculopathy demonstrating good sensitivity and specificity. However, sensitivity and specificity may yield even higher levels, if the criteria of category II of the classification system allowed for differentiation between the presence of sensory and motor radiculopathy.

In conclusion, this study demonstrated that the two examiners were able to distinguish between presentations of painful cervical radiculopathy and NSNAP in patients with neck-arm pain. Compared to the expert opinion, the examiners were able to identify 80% of cases with these specific clinical neck-arm pain presentations. As patients may demonstrate similar clinical characteristics for both presentations, such as radicular pain and paraesthesia, the identification of differences in clinical presentations is important for targeting best evidence management.

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