International consensus on the most useful physical examination tests used by physiotherapists for patients with headache: A Delphi study

Luedtke, K.[1]; Boissonnault, W.[2]; Caspersen, N.[3]; Castien, R. [4]; Chaibi, A. [5,6]; Falla, D. [7,8]; Fernández-de-las-Peñas, C.[9]; Hall, T. [10]; Hirsvang, J.R.[3]; Horre, T.[11]; Hurley, D.[12]; Jull, G.[13]; Krøll, L.S.[3]; Madsen, B.K. [3]; Mallwitz, J. [14].; Miller, C.[15]; Schäfer, B. [16]; Schöttker-Königer, T.[17]; Starke, W.[17]; von Piekartz, H.[18]; Watson , D.[19]; Westerhuis, P.[20]; May, A.[1].

Affiliations:
[1]Department of Systems Neuroscience, University Medical Centre Hamburg-Eppendorf, Martinistr. 52, 20246 Hamburg, Germany
[2]University of Wisconsin-Madison, Department of Orthopedics and Rehabilitation, Wisconsin, USA
[3]Danish Headache Centre, Department of Neurology, Glostrup Hospital, University of Copenhagen, DK-2600 Glostrup, Denmark
[4]Department of General Practice and Elderly Care Medicine, EMGO+Institute for Health Care Research, VU University Medical Center, Amsterdam, The Netherlands
[5]Head and Neck Research Group, Research Centre, Akershus University Hospital, 1478, Oslo, Norway
[6]Institute of Clinical Medicine, Akershus University Hospital and University of Oslo, 1474, Nordbyhagen, Norway
[7]Pain Clinic, Center for Anaesthesiology, Emergency and Intensive Care Medicine, University Hospital Göttingen, Göttingen, Germany
[8]Department of Neurorehabilitation Engineering, Bernstein Focus Neurotechnology, Bernstein Center for Computational Neuroscience, University Medical Center Göttingen, Georg-August University, Göttingen, Germany
[9]Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain
[10]School of Physiotherapy and Curtin Health Innovation Research, Curtin University, P.O. Box U1987, Perth, WA 6845, Australia
[11]Physiotherapy practice Jensen&Team, Nienstedtener Marktplatz 29, 22609 Hamburg, Germany
[12]Physiotherapy, Birmingham Community Healthcare NHS Trust, Birmingham, England
[13]Physiotherapy, School of Health and Rehabilitation Sciences, The University of Queensland, Australia
[14]Spine Center "Am Michel", Ludwig-Erhard-Str. 18, 20459 Hamburg, Germany
[15]Physiotherapy Department, University Hospital Birmingham Foundation Trust, Birmingham B15 2TH
[16]Migraine and Headache Clinic Königstein im Taunus, Ölmühlenweg 31, 61462 Königstein im Taunus, Germany
[17]Hochschule für angewandte Wissenschaft und Kunst Hildesheim / Holzminden / Göttingen, Fakultät Soziale Arbeit und Gesundheit, Studiengang Ergotherapie, Logopädie und Physiotherapie, Goschentor 1, 31134 Hildesheim; Germany
[18]University of Applied Sciences Osnabrueck, Fakultät Wirtschafts- und Sozialwissenschaften, Caprivistr. 30a, 49076 Osnabrück, Germany
[19]Watson Headache Institute, GPO Box 4714, Sydney, NSW 2001, Australia
[20]Heimlisbergstr. 47, 4513 Langendorf, Switzerland

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Corresponding author:

Kerstin Luedtke, PhD
Department of Systems Neuroscience
University Medical Centre Hamburg-Eppendorf
Martinistr. 52,
20246 Hamburg
Germany

Telephone: +49 40 741058943

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Abstract

Background

A wide range of physical tests have been published for use in the assessment of musculoskeletal dysfunctions in patients with headache. Which tests are used depends on a physiotherapist's clinical and scientific background as there is little guidance on the most clinically useful tests.

Objectives

To to identify which physical examination tests international experts in physiotherapy consider the most clinically useful for the assessment of patients with headache.

Design / Methods

Delphi survey with pre-specified procedures based on a systematic search of the literature for physical examination tests proposed for the assessment of musculoskeletal dysfunctions in patients with headache.

Results

Seventeen experts completed all three rounds of the survey. Fifteen tests were included in round one with eleven additional tests suggested by the experts. Finally eleven physical examination tests were considered clinically useful: manual joint palpation, the cranio-cervical flexion test, the cervical flexion-rotation test, active range of cervical movement, head forward position, trigger point palpation, muscle tests of the shoulder girdle, passive physiological intervertebral movements, reproduction and resolution of headache symptoms, screening of the thoracic spine, and combined movement tests.

Conclusions

Eleven tests are suggested as a minimum standard for the physical examination of musculoskeletal dysfunctions in patients with headache.

Key words: headache, migraine, Delphi, consensus, examination, physical therapy.

Introduction

The lifetime prevalence of any headache in the European population is more than 90% indicating the relevance and burden of headaches (Steiner et al. 2014). A recent study reported that tension-type headache (TTH) and migraine were also the most common recurrent headaches with prevalences of 20.77% and 14.7%, respectively (Vos et al. 2012). Headache compromises a person's quality of life and reduces their functional capability as well as their work capacity (D'Amico et al. 2013; Raggi et al. 2013). This results in high socioeconomic cost mainly due to days off work (Burton et al. 2002; Pradalier et al. 2004; Berg and Stovner 2005; Bloudek et al. 2012; Lanteri-Minet 2014).

There is ongoing scientific debate about the contribution of cervical neuromusculoskeletal dysfunction to headache. Although the results of a systematic review suggest that there is probably no influence of musculoskeletal dysfunctions in the pathogenesis of migraine (Robertson and Morris 2008), migraine patients have a high prevalence of neck pain (Ashina et al. 2015) and muscle or joint dysfunctions have been hypothesised to act as triggers for migraine attacks (Vincent 2011). In TTH patients, muscle tenderness and trigger points are consistent findings (Fernández-de-las-Peñas et al. 2007; Abboud et al. 2013), while the evidence for muscle tension is conflicting (Bendtsen and Fernández-de-la-Peñas 2011).

Cervicogenic headache (CGH) is the most likely sub-group of headache to present with musculoskeletal dysfunction in the neck (Sjaastad et al. 1998; Zito et al. 2006; Jull et al. 2007). The IHS classification version III beta details the clinical features of CGH under section 11.2.1 (Headache Classification Committee of the International Headache Society (IHS) 2013). However, the diagnosis CGH itself is most controversial: Some strongly argue for the neck as a potential headache generator (Bogduk 1992; Sjaastad et al. 1998; Antonaci et al. 2001; Bogduk and Govind 2009; Becker 2010) but others doubt the existence of CGH and propose that the reported prevalence, estimated e.g. as 4.1% in the general population (Sjaastad and Bakketeig 2008), is due to misdiagnosed migraine or TTH (Pöllmann et al. 1997; Leone et al. 1998).

Patients suffering from headache commonly use self-management strategies such as self-massage, posture correction, stretching and exercises to reduce symptoms (Haque et al. 2012) and seek to reduce medication intake by using additional non-pharmacological therapies, most commonly physiotherapy (Chaibi et al. 2011; Chaibi and Russell 2012, 2014; Kristoffersen et al. 2012). A physiotherapist will conduct a patient interview to record the headache history, its temporal pattern, symptom behaviour, the patient's medication intake and other relevant health history to ensure that the headache is benign and to classify the type of headache. In order to decide whether and which type of physiotherapy interventions (eg. manual therapy, exercise,

soft tissue techniques, or postural correction) are likely to influence the patient's complaints, the subsequent physical examination focuses on the assessment for the presence (or absence) of musculoskeletal dysfunction.

A wide range of physical examination tests have been published for the assessment of cervical musculoskeletal dysfunctions in patients with headache. These include measurement of head/neck posture (Fernández-de-Las-Peñas et al. 2006b), range of cervical motion (Zito et al. 2006; Jull et al. 2007) including the flexion-rotation test (Hall and Robinson 2004) manual examination to detect painful cervical joint dysfunction (Zito et al. 2006; Jull et al. 2007), tests of cervical muscle function (Zito et al. 2006; Jull et al. 2007), tests for temporo-mandibular dysfunction (Caspersen et al. 2013; Harry von Piekartz 2015), palpation for trigger points (Fernández-de-Las-Peñas et al. 2006b) and many others. Currently, there are no published guidelines to support the decision on the most important physical examination techniques. Individual studies have evaluated tests for only one specific headache type (TTH, migraine or CGH) (i.e. Kidd and Nelson 1993; Jensen and Rasmussen 1996; Ashina et al. 1999; Calandre et al. 2006; Fernández-de-las-Peñas et al. 2006; Fernández-de-Las-Peñas et al. 2006b, 2007; Couppé et al. 2007; Bevilaqua-Grossi et al. 2009), or within specific sub-populations (e.g. with associated facial or neck pain (this includes -by definition- all studies on CGH). While this serves as an indicator for clinical usefulness of specific tests in specific populations, it does not inform on the usefulness of tests in other headache patients.

This Delphi survey was conducted to identify physical examination tests that international experts in physiotherapy consider the most clinically useful when examining a patient with headache and to specify for which types of headache or in which clinical situation the tests would be useful.

Methods

Study design

A Delphi-Survey was designed and conducted following the recommendations of Hasson et al. (Hasson et al. 2000), and published examples of Delphi Surveys with similar research questions (Sinha et al. 2011; Chiarotto et al. 2014). The survey was guided by a systematic evaluation of the literature on physical examination tests proposed for the assessment of musculoskeletal dysfunctions in patients with headache. Ethical approval (No: PV5011) was granted by the local ethics authority (Aerztekammer Hamburg). The data collection was conducted between October 2014 and April 2015.

Selection of experts was based on personal contacts and a search for authors of peer-reviewed publications on physical examination tests in headache populations. There is no guideline to define who is an expert for a Delphi Survey or how many experts are required (Hsu and Sandford 2007). Twenty international experts (defined as physiotherapists with a special interest in headaches) from nine countries were identified and invited via email to participate. The letter of invitation included the researcher's details and information on the purpose of the survey. It further explained how the aquired data will be used to design subsequent survey rounds. Seventeen experts with backgrounds ranging from dominantly clinical to dominantly research-based, participated in the survey and completed all three rounds of the survey. Participants remained anonymous during all rounds of the survey with the aim that they can express opinions without influence of dominant characters (Murphy et al. 1998) . After the final survey round, all experts were invited to be a co-author of the publication and subsequently received a first draft of the survey report for revision and a final draft for approval prior to submission.

The survey procedures were pre-designed and included the following steps:

1.) Initially a list of physical examination tests was generated based on a systematic evaluation of the literature to identify any type of publication that focused on physical examination tests in headache populations conducted within a physiotherapy setting. PubMed, Cinahl, EMBASE and PEDro were searched for articles published prior to 01.10.2014 using the following search strategy:

((((((headache[Title/Abstract] OR migraine[Title/Abstract]))) AND ((assessment OR measurement OR examination OR test))) AND ((dysfunction OR impairment))) AND ((strength OR length OR endurance OR sensitivity OR control OR mobility OR motion OR tension OR posture))) AND adult Filters: Humans

The literature search returned 3 reviews (Jensen and Rasmussen 1996; Robertson and Morris 2008; Abboud et al. 2013) and 43 additional articles that reported a total of 15 physical

examination tests (Lous and Olesen 1982; Langemark and Olesen 1987; Bovim 1992; Hatch et al. 1992; Garrett et al. 1993; Jensen et al. 1993; Kidd and Nelson 1993; Watson and Trott 1993; Jensen 1996; Lipchik et al. 1996; Sand et al. 1997; Zwart 1997; Ashina et al. 1999; Jull et al. 1999, 2007; Neufeld et al. 2000; Dumas et al. 2001; Mørk et al. 2003; Giacomini et al. 2004; Fernández-de-las-Peñas et al. 2006; Fernández-de-Las-Peñas et al. 2006a, 2006b, 2007, 2008; Sandrini et al. 2006; Zito et al. 2006; Amiri et al. 2007; Glaros et al. 2007, 2007; Ogince et al. 2007; Fernández-de-las-Peñas et al. 2008; Hall et al. 2008, 2010, 2010; Bevilaqua-Grossi et al. 2009; Peddireddy et al. 2009; Uthaikhup et al. 2009; Sohn et al. 2010, 2013; Stuginski-Barbosa et al. 2010; Melo et al. 2012; Watson and Drummond 2012; Marchand et al. 2014; Tali et al. 2014).

2.) In the first Delphi round, experts were asked to rate the clinical usefulness of the 15 tests (manual joint palpation, cranio-cervical flexion test, flexion-rotation test, active range of cervical movement, head forward position, trigger point palpation, muscle tests of the shoulder girdle, pressure pain thresholds, cervical slump test, skin-roll-test, electromyography, temporo-mandibular screening, goal oriented movements, cervical muscle strength, and joint position error) on a 5-point Likert scale ("extremely useful", "useful", "don't know", "probably not useful", "definitely not useful") for TTH, migraine and CGH patients. References were provided for each physical examination test detailing test procedures. In addition, the experts were invited to provide additional physical examination tests they considered as clinically relevant. The questionnaire used for the rating procedure was sent as a word document via email after it had been tested amongst work group members for comprehensibility. If individual ratings were missing or questionnaires were not returned, reminder emails were sent to clarify responses and to inquire whether the expert was still willing to continue the study.

3.) For the second round the group responses were analyses and fed back to the experts (via email) including the newly suggested tests. These were again rated for clinical usefulness. Since experts were from various backgrounds with a range of special interests and in order to reflect this variety in the results, tests that were rated as clinically useful by >50% of the participants were automatically included in the subsequent rounds, while tests that were rated as clinically useful by ≤ 50% of participants during the first and second round were further investigated in subsequent rounds by inviting comments on special clinical situations for which this tests may be useful.

4.) A third round was conducted in the same manner as the second round to include all new information that emerged from round 2.

Data analysis

All tests rated as "definitely not useful" or "probably not useful" were excluded from subsequent Delphi rounds (based on the mode value across the experts). Tests that received an overall rating (mode value) of "don't know" or that were rated as clinically useful by ≤ 50% of participants during the first and second round required further investigation: experts were asked to indicate specific clinical situations in which they would use these tests. These responses were analysed in a qualitative manner and summarised in a pre-designed table.

RESULTS

Results from round 1:

The most common finding was that the majority of experts (>50%) used similar tests for patients with different headache diagnoses. Individual experts supported the decision not to distinguish between headache diagnoses, when deciding on physical examination tests, with the following statements: "Physical examination tests are conducted to identify musculoskeletal dysfunctions and to develop a treatment plan independent of the diagnosis"; "there is substantial overlap of musculoskeletal findings in different headache types"; "patients can have more than one type of headache". Figures 1a-c present the ratings of clinical usefulness for each suggested physical examination test for each headache type.

By calculating the mode value across headache types for each suggested physical examination test, manual joint palpation, the cranio-cervical flexion test, the flexion-rotation test, active range of cervical movement, head forward position, trigger point palpation, muscle tests of the shoulder girdle, pressure pain thresholds, and cervical slump test, were considered useful/extremely useful. Rated as "probably not useful" or "definitely not useful" were: skin-roll-test, electromyography, goal oriented movements, cervical muscle strength, and joint position error. Further evaluation during the subsequent round was required for temporo-mandibular screening because the overall rating was "don't know" (Figure 1d). Participants were also asked in the subsequent round to indicate specific clinical situations for the use of pressure pain thresholds and the cervical slump test since these tests were not considered clinically useful by the majority of participants.

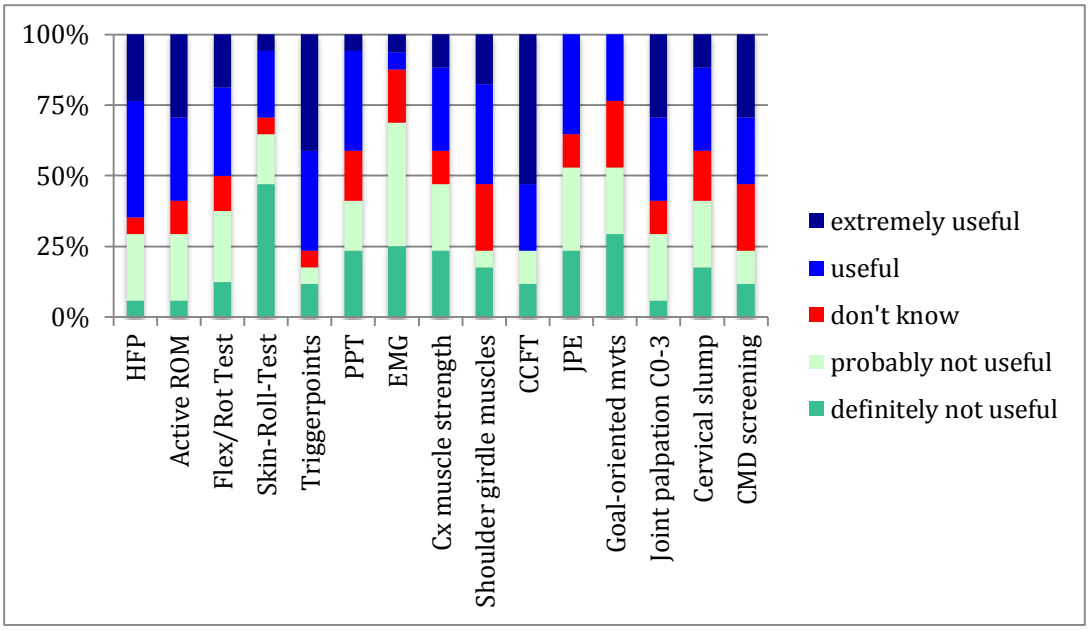

Fig 1a: Distribution of responses for tension-type headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

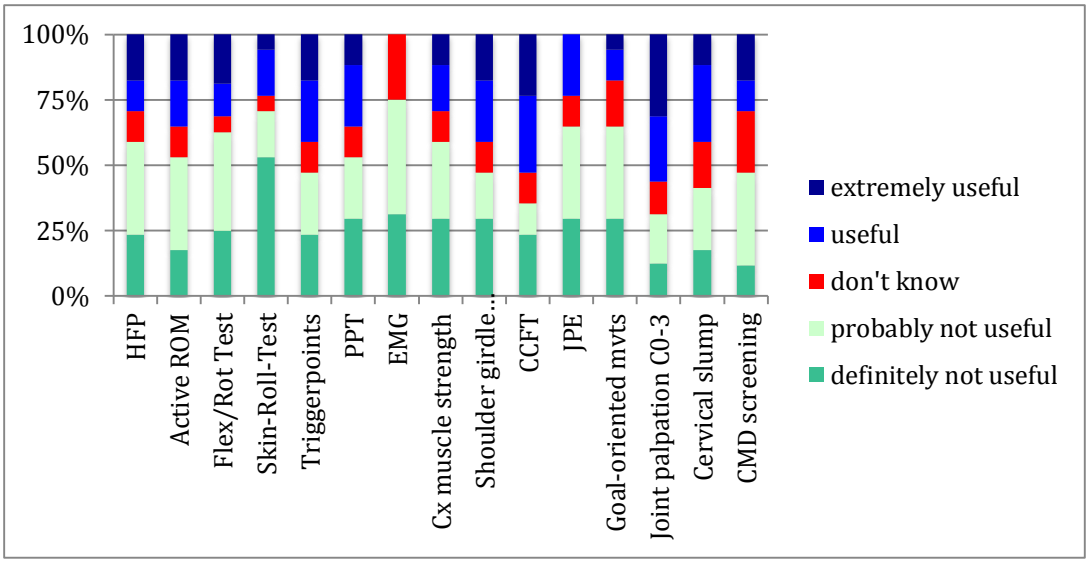

Fig 1b: Distribution of responses for migraine headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

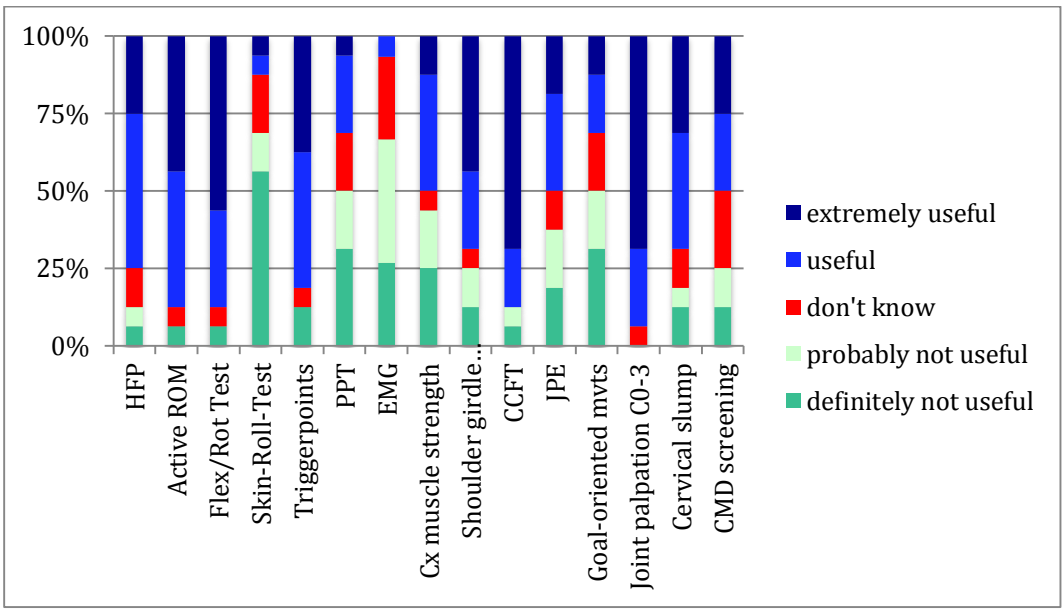

Fig 1c: Distribution of responses for cervicogenic headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

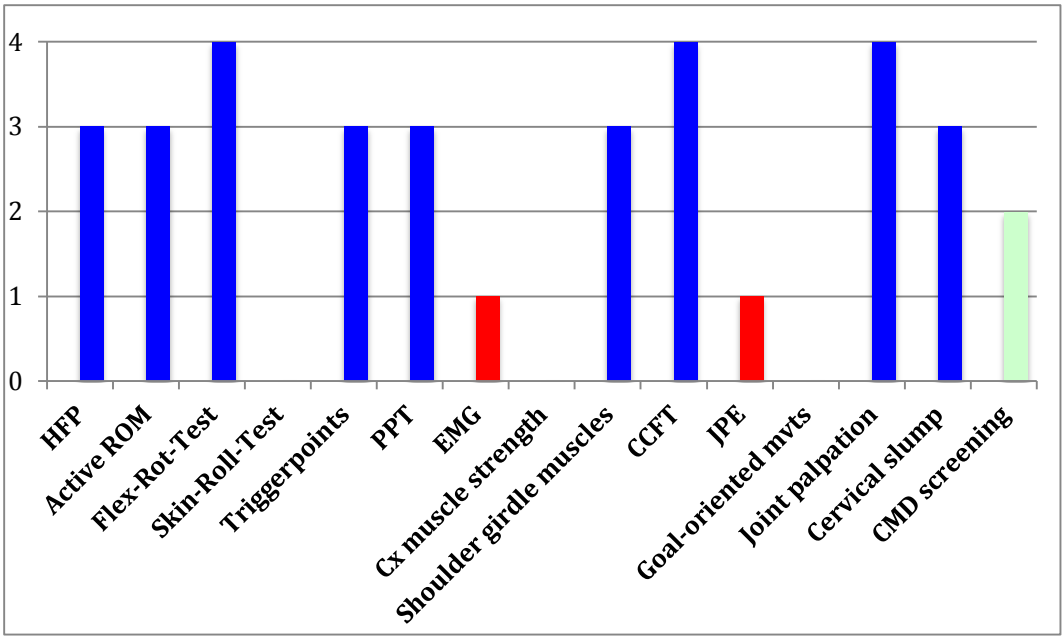

Figure 1d: Mode values across headache types for all participants
HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

The following new tests were suggested in round 1 and evaluated in round 2: passive physiological intervertebral movements, combined movements other than flexion-rotation, cranial nerve palpation, muscle lengths tests, thoracic spine screening, headache reproduction and resolution (to sustained palpation), left-right recognition, facial emotional recognition, and other neurodynamic tests.

Results from rounds 2 and 3:

There were no objections to the decision to rate the clinical usefulness of physical examination tests across all headache types rather than individually for specific headache diagnoses. Results indicated that muscle lengths tests were considered "probably not useful" and were thus excluded. Left-right-recognition, facial emotional recognition and other neurodynamic tests received a combined rating of "don't know" (Figures 2a and b). Table 1 summarises the qualitative responses to clarify clinical situations in which the use of tests was specified that were rated as either "don't know" or that were not perceived as clinically useful by the majority of participants. Two further tests were suggested: the total tenderness score and the McKenzie classification. The total tenderness score reached a summary score of "probably useful" but did not meet the >50% target of "extremely/probably useful" ratings. The McKenzie tests received an overall rating of "don't know" and qualitative responses for both tests were subsequently added to Table 1.

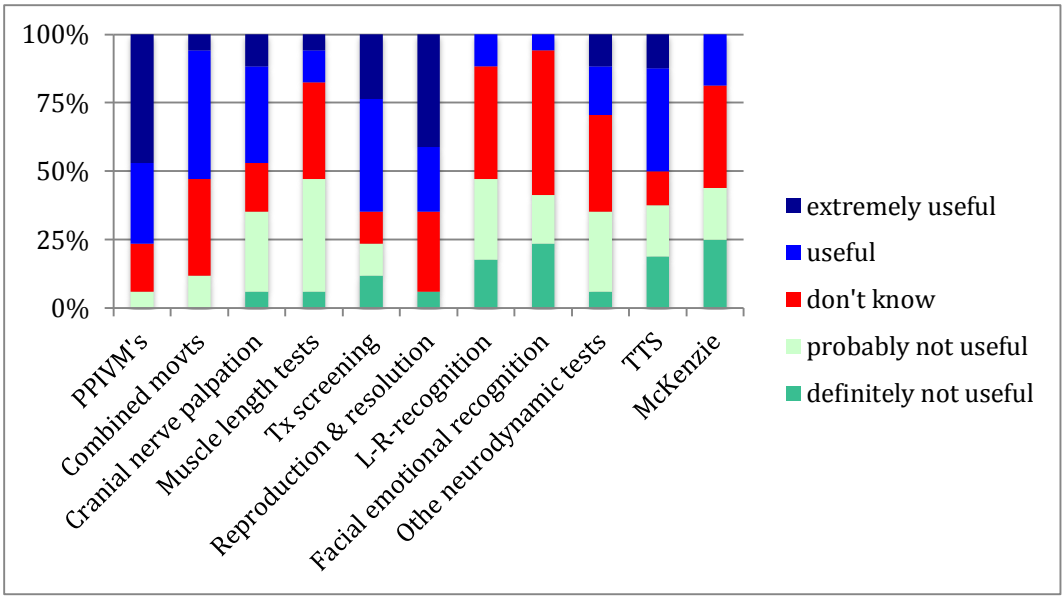

Figure 2a: Distribution of responses from rounds 2 and 3

PPIVMs= passive physiological intervertebral movements; Tx=thoracic; L-R=left-right; TTS= total tenderness score.

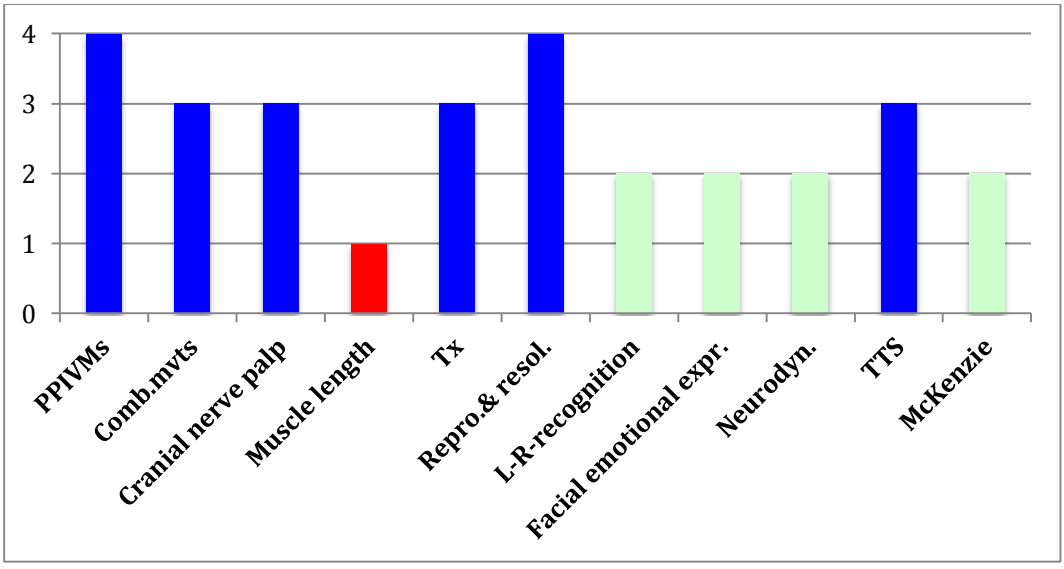

Figure 2b: Results from the second and third survey rounds. Values in the graph indicate the mode value across participants for each test.
PPIVMs= passive physiological intervertebral movements; Tx=thoracic; L-R=left-right; TTS= total tenderness score.

Table 1: Qualitative responses for clinical indications for tests that received a summary rating of "don't know" or were supported by <51% of the 17 participants. The number in brackets indicates the number of agreed responses on a statement.

Physical examination test	**Might be useful in these specific clinical situations:**
Temporo-mandibular screening	- orofacial pain or pain with mandibular movement (10) - cervical component suspected (3) - all other tests negative (2) - tension suspected as main pain mechanism (2) - insufficient improvement with the treatment of the cervical spine (2) - to exclude CMD (1)
Left-right-recognition	- CGH (1) - central sensitisation (1) - face or neck pain unilateral > 3 months (1)
Facial emotional recognition	- orofacial pain (2) - TTH (1)
Other Neurodynamic Tests e.g. upper cervical flexion with bilateral shoulder abduction	- to screen for neural tissue mechanosensitivity (3) - cervical spine flexion or retraction is restricted and painful (2) - CGH (2) - trigeminal neuralgia (1) - clinical pattern indicates neurodynamic component (1) - neuropathic pain pattern (1)
Pressure pain thresholds	- exclusively for research purposes (6) - to evaluate central sensitisation (6) - in chronic TTH as a re-assessment tool (2) - fibromyalgia suspected (1)
Cervical slump test	- CGH in cases where a neurodynamic component was suspected (9) - advanced test, if less aggressive test did not show conclusive response (2) - as a safety tests prior to cervical manipulation (1)
Cranial nerve palpation	- only if neuropathic component /cervical neural sensitisation suspected (5) - migraine (2) - no other findings (2) - to determine the cranial nerve sensitivity (2)
Total tenderness score	- suspected TMJ involvement (3) - TTH (3) - re-assessment (3) - all patients (1) - suspected central sensitisation (1) - to indicate musculoskeletal involvement (1) - myofascial pain syndrome (1) - if headaches symptoms were consistent with the referral pattern of the affected muscles (1) - to further investigate the relationship between arthrogenic and myogenic structure (1)
McKenzie tests	- no evidence (3) - maybe for CGH (2) - only if repeated movements change headache intensity/quality (2) - other tests more informative (1) - disc as a source of pain (1) - posture as a contributing factor (1) - to further identify segmental level (1)

TTH= tension-type headache; CGH= cervicogenic headache; TMJ= temporomandibular joint; CMD= craniomandibular dysfunction.

Discussion

Seventeen international experts in physiotherapy with expertise in headache treatment rated the following 11 tests as the most clinically useful for the evaluation of musculoskeletal dysfunctions in patients with headache: manual joint palpation, the cranio-cervical flexion test, the flexion-rotation test, active range of cervical movement, head forward position, trigger point palpation, muscle tests of the shoulder girdle, passive physiological intervertebral movements, reproduction and resolution of headache symptoms, screening of the thoracic spine, and combined movement tests.

Based on the patient interview and the physiotherapists' clinical reasoning, additional tests might be required or even prioritised. This is particularly so in specific clinical situations such as orofacial pain, or the presence of temporo-mandibular signs where the additional thorough examination of the temporo-mandibular joint and cranial nerve palpation is essential. Another example is the presence of dizziness or light-headedness, where tests discarded from the cluster of tests suggested in this article, such as proprioception tests, might become the most important assessment parameter.

There was a high participation rate (17/20) for all three rounds of the survey. Experts were from various clinical and scientific backgrounds. This strengthens the transferability of the suggested cluster of tests because experts rated the suggested tests for the assessment of musculoskeletal dysfunctions with a background in different patient populations: acute and chronic, patients referred by medical doctors or seen in a primary care setting, patients consulting an orthopaedic or a neurological clinic. Dominantly research-based physiotherapists pursued strong clinical aspect in their headache research and were therefore also well suited to comment on the clinical usefulness of physical examination tests.

The physical examination tests suggested for the first survey round were based on a systematic search of the literature, hence had been formally evaluated in a headache population in at least one publication. The additional tests suggested by the experts as clinically useful tools for the exmination of headache patients, that were subsequently included in the final cluster of test, were not all based on evidence from the literature. Reproduction and resolution had previously been shown to differentiate between migraine or TTH and control participants (Watson and Drummond 2012). However, PPIVMs, combined cervical movements and impairments of the thoracic spine have never been published to differentiate between headache populations and headache free participants. Additionally, test properties such as inter-/intra-rater reliability, have only been previously assessed for manual joint palpation (Watson and Trott 1993; Jull et al. 1997, 2007; Van Suijlekom et al. 2000; Zito et al. 2006; Hall et al. 2010), the cranio-cervical

flexion test, (Zito et al. 2006; Jull et al. 2007), the flexion-rotation test, (Ogince et al. 2007; Hall et al. 2008), active range of cervical movement (Van Suijlekom et al. 2000; Fernández-de-Las-Peñas et al. 2006b; Zito et al. 2006; Jull et al. 2007; Bevilaqua-Grossi et al. 2009), head forward position, (Watson and Trott 1993; Fernández-de-Las-Peñas et al. 2006b; Zito et al. 2006), reproduction and resolution of headache symptoms, (Watson and Trott 1993), and trigger point palpation (Fernández-de-Las-Peñas et al. 2006b). Information or data presented to evaluate the sensitivity and specificity of physical examination tests for headache populations is restricted to the flexion-rotation test (Ogince et al. 2007; Hall et al. 2008), manual joint palpation (Zito et al. 2006; Jull et al. 2007), range of cervical movement (Zito et al. 2006), and the craniocervical flexion test (Zito et al. 2006). Nevertheless, the results of this consensus paper are based on the expertise of participants who valued the suggested 11 tests as clinically useful even in the absence of sufficient evidence on test properties. There is a clear need for future research to close this gap between clinical beliefs and scientific evidence to promote a more evidence based approach in clinical physiotherapy.

Physical examination tests for the assessment of musculoskeletal dysfunctions were more frequently considered useful / extremely useful in CGH and least useful for migraine. However no test emerged as being regarded as especially useful for a specific headache type. Given the pathophysiological concepts one could discuss whether there should be a focus on muscle tests for TTH, a focus on the central nervous system in migraine, and a focus on joint dysfunctions for CGH. However, when reflecting on the clinical purpose of such tests, it is clear that one of the main purposes of the physical examination is to identify the presence or absence of cervical musculoskeletal findings and to specify which structures and systems are most affected and are hence the most promising treatment target.

It was the general consensus after round one to evaluate the clinical usefulness across headache types rather than for each headache type individually, even though the ratings for individual headache diagnoses during the first survey round indicated that the clinical usefulness of tests was perceived differently for different headache diagnoses. The majority of experts considered only two physical examination tests useful in the evaluation of musculoskeletal impairments in patients diagnosed with migraine: cranio-cervical flexion test and manual joint palpation. The same tests were identified by an earlier publication as the two tests (combined with restricted cervical movement) that distinguished best between CGH and TTH / migraine (Jull et al. 2007).
This is acknowledged by the IHS classification (Headache Classification Committee of the International Headache Society (IHS) 2013) that includes provocation manoeuvres and restriction of cervical movement as clinical signs of CGH. However, according to the IHS classification, the diagnosis CGH is only justified in the presence of a pathological finding in the

cervical spine. These restrictions are the reason why physiotherapists often refer to one of the two alternative classification systems that provide a more functional description of CGH (www.iasp.org; (Sjaastad et al. 1998). This is rather problematic, as studies which are scientifically sound and statistically well done are still not comparable to each other which is a major restriction in the field. For comparability reasons and to support intra- and interprofessional communication, studies evaluating the usefulness of physiotherapeutic interventions for headache should clearly state which classification was used. Moreover, for clinical routine but especially for research purposes it will be mandatory in the future to harmonise the divergence between these classification systems.

Limitations

The internationality of this study and the different clinical and scientific backgrounds of experts might have introduced variability in responses. During the survey process a discussion emerged on the question whether such tests are used to make a diagnosis or to develop a treatment plan. This was not specified during the survey because not all experts had a first contact status and were therefore responsible for making a diagnosis. The suggested cluster of tests can therefore be applied in both situations and used by physiotherapists independent of the first contact status.

Since some of the tests have not been evaluated for sensitivity and specificity as well as reliability and validity, the suggested tests should be used with caution and within a sound clinical reasoning framework.

Conclusion

This is the first international consensus study providing guidance on the most useful physical examination tests for the evaluation of cervical musculoskeletal impairments in patients with headaches. The cluster of tests was based on a comprehensive evaluation of the literature and on the opinion of international experts in physiotherapy. Eleven physical examination tests for the assessment of musculoskeletal dysfunctions were considered useful by the majority of experts for the evaluation of patients with headache. Independent of the diagnosis of migraine, TTH or CGH, we suggest the use of this cluster of tests as a minimum standard for the evaluation of musculoskeletal dysfunction in patients with headache. However, a consensus study, can only reflect the opinion of experts and results should stimulate future discussion and as well as scientific evaluation.

Of note, eight additional tests were considered useful for specific clinical situations. This consensus paves the way for future research to further evaluate the measurement properties in many of these tests and to compare the prevalence of positive findings in patients with different headache types.

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Figure Captions

Fig 1a: Distribution of responses for tension-type headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

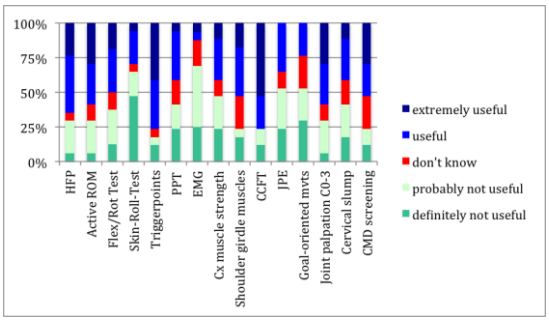

Fig 1b: Distribution of responses for migraine headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

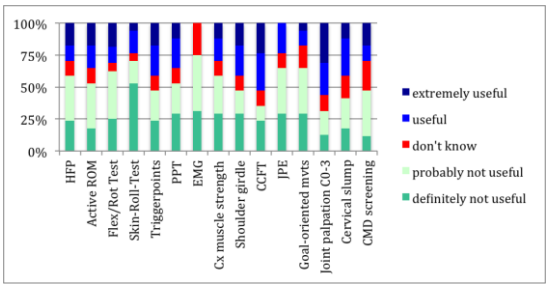

Fig 1c: Distribution of responses for cervicogenic headache

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

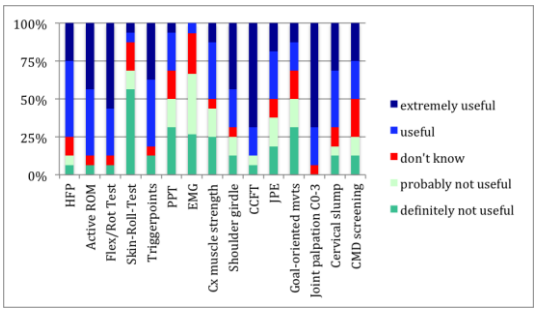

Figure 1d: Mode values across headache types for all participants

HFP=head forward posture; ROM=range of motion; PPT=pressure pain thresholds; Cx=cervical; CCFT=cranio-cervical flexion test; JPE=joint position error; mvts=movements; CMD=craniomandibular dysfunction.

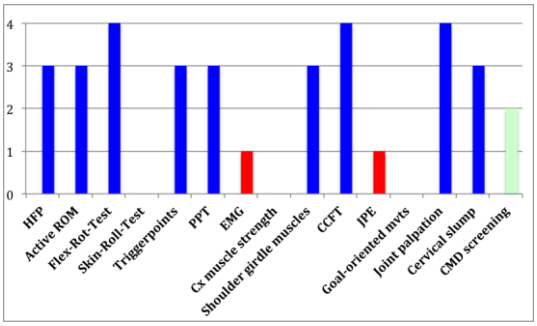

Figure 2a: Distribution of responses from rounds 2 and 3

PPIVMs= passive physiological intervertebral movements; Tx=thoracic; L-R=left-right; TTS= total tenderness score.

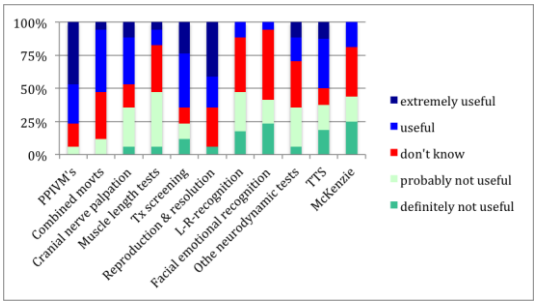

Figure 2b: Results from the second and third survey rounds. Values in the graph indicate the mode value across participants for each test.

PPIVMs= passive physiological intervertebral movements; Tx=thoracic; L-R=left-right; TTS= total tenderness score.