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O Uso de Feedback Extrínseco na Avaliação e Tratamento de Desordens Motoras

Porto Alegre
2020

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“Mucha gente pequeña, en lugares pequeños, haciendo cosas pequeñas, puedem cambiar el mundo” (Eduardo Galeano)

RESUMO

A dor cervical é uma das principais causas musculoesqueléticas de anos vividos com incapacidade em todo o mundo. Pacientes com dor cervical persistente apresentam desequilíbrios neuromusculares, como por exemplo, aumento da atividade dos flexores superficiais concomitantemente com redução da atividade dos flexores profundos. Para o tratamento destes pacientes que apresentam algum tipo de desequilíbrio neuromuscular, o exercício é consenso nas diferentes diretrizes de prática clínica. Apesar da literatura vigente demonstrar que exercícios realizados com o uso de *feedback* extrínseco promove efeitos superiores do que exercícios sem *feedback* extrínseco, os estudos falham em reportar adequadamente quais características de *feedback* foram utilizadas. Além disso, a literatura também suporta que algumas características promovem efeitos positivos, enquanto que outras características podem inclusive piorar o aprendizado motor. A ausência de clareza de informações sobre as características de *feedback* utilizadas pode ser um reflexo do desconhecimento dos fisioterapeutas sobre quais características são consideradas ideais e quais prejudiciais. Ademais, um dos possíveis testes frequentemente utilizados pelos fisioterapeutas para identificar algum desequilíbrio neuromuscular em pacientes com dor cervical crônica é o teste de flexão craniocervical (TFCC). Os mesmos procedimentos do teste também são utilizados como forma de treinamento com *feedback* extrínseco. Entretanto, a propriedades de medida do TFCC não foram adequadamente revisadas, com um instrumento indicado para avaliação do risco de viés dos estudos sobre este tema. Dessa forma, esta tese consiste em 3 estudos conduzidos para responder as atuais lacunas na literatura sobre: I) o conhecimento dos fisioterapeutas a respeito de características adequadas de *feedback* extrínseco; e II) as propriedades de medida do TFCC. Para identificar o conhecimento dos fisioterapeutas brasileiros sobre características de *feedback* extrínseco, foi realizado um estudo transversal com um questionário administrado on-line. Duzentos e quarenta e seis fisioterapeutas brasileiros participaram do estudo. Os resultados desta pesquisa indicam que os fisioterapeutas brasileiros não têm conhecimento suficiente sobre as diferentes características de *feedback* extrínseco, embora o consideram útil e o utilizem na maioria de seus pacientes. Os fisioterapeutas brasileiros adotam características de conteúdo adequadas. No entanto, existem inconsistências relacionadas ao seu conhecimento e as evidências atuais, principalmente em relação às características de tempo. Para verificar a qualidade das propriedades de medida do TFCC, foi realizado tanto um protocolo como uma revisão sistemática da literatura sobre o tema. Quatorze estudos foram incluídos. Existe um nível de evidência positivo e moderado para confiabilidade inter e intraexaminador e validade convergente. A classificação e o nível de evidência para validade discriminativa são conflitantes. O erro de medida é indeterminado, com nível de evidência desconhecido. A responsividade é negativa com nível de evidência limitado. O TFCC é um teste válido e confiável que pode ser usado na prática clínica como teste de avaliação. Devido às evidências conflitantes e de baixa qualidade, atualmente é aconselhável cautela ao usar o TFCC como teste discriminativo e como medida de desfecho. Futuros ensaios clínicos devem ser desenvolvidos para verificar se exercícios com características adequadas de *feedback* extrínseco produzem efeitos estatística e clinicamente superiores quando comparados a exercícios convencionais (como o exercício de flexão craniocervical) em pacientes com dor cervical.

Palavras-chave: *Feedback* extrínseco; Exercício terapêutico; Teste de flexão craniocervical; Propriedades de medida.

ABSTRACT

Neck pain is one of the main musculoskeletal causes of years of living with disability worldwide. Patients with persistent neck pain have neuromuscular imbalances, such as changes in coordination between muscles (for example, increased activity of superficial flexors concomitantly with reduced activity of deep flexors). For the treatment of these patients who present some type of neuromuscular imbalance, exercise is a consensus in the different clinical practice guidelines. Although the current literature demonstrates that exercises performed using extrinsic feedback promote superior effects than exercises without extrinsic feedback, studies fail to adequately report which feedback characteristics were used. In addition, the literature also supports that some characteristics promote positive effects, while other characteristics may even worsen motor learning. The lack of clear information about the feedback characteristics used can reflect the physical therapists lack of knowledge about which characteristics are considered ideal and which are harmful. In addition, one of the possible tests frequently used by physical therapists to identify any neuromuscular imbalance in patients with chronic neck pain is the craniocervical flexion test (CCFT). The same test procedures are also used as a form of training with extrinsic feedback. However, the measurement properties of the CCFT have not been adequately reviewed, with an instrument indicated for assessing the risk of bias in studies on this topic. Thus, this thesis consists of 3 studies conducted to answer the current gaps in the literature on: I) the knowledge of physical therapists regarding adequate feedback characteristics; and II) the measurement properties of the CCFT. To identify the knowledge of Brazilian physical therapists on extrinsic feedback characteristics, a cross-sectional study was conducted with a questionnaire administered online. Two hundred and forty-six Brazilian physical therapists participated in the study. The results of this research indicate that Brazilian physical therapists do not have sufficient knowledge about the different characteristics of extrinsic feedback, although they consider extrinsic feedback useful to use in most of their patients. Brazilian physical therapists adopt appropriate content characteristics. However, there are inconsistencies related to their knowledge and current evidence, especially in relation to timing characteristics. To verify the quality of the measurement properties of the CCFT, both a protocol and a systematic review of the literature were carried out. Fourteen studies were included. There is a positive and moderate level of evidence for inter- and intra-examiner reliability and convergent validity. The classification and level of evidence for discriminative validity are conflicting. The measurement error is indeterminate, with an unknown level of evidence. Responsiveness is negative with a limited level of evidence. CCFT is a valid and reliable test that can be used in clinical practice as an assessment test. Due to conflicting and low-quality evidence, caution is currently advised when using the CCFT as a discriminative test and as an outcome measure. Future clinical trials should be developed to verify whether exercises with adequate extrinsic feedback characteristics produce statistically and clinically superior effects when compared to conventional exercises (such as craniocervical flexion exercise) in patients with neck pain.

Key-words: Extrinsic feedback; Therapeutic exercise; Craniocervical flexion test; Measure properties.

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APRESENTAÇÃO

Este trabalho consiste na Tese de Doutorado intitulada "O Uso de *Feedback* Extrínseco na Avaliação e Tratamento de Desordens Motoras", a ser apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Universidade Federal de Ciências da Saúde de Porto Alegre, em vinte de março de 2020. Essa pesquisa foi avaliada e aprovada pelo Comitê de Ética em Pesquisa (CEP) da Universidade Federal de Ciências da Saúde de Porto Alegre, conforme parecer consubstanciado número 3.594.833.

A motivação deste trabalho se originou após o desenvolvimento de uma revisão sistemática intitulada "*Effectiveness of Physiotherapy interventions plus Extrinsic Feedback for neck disorders: A systematic review with meta-analysis*", publicada no periódico "*Musculoskeletal Science and Practice*" (Apêndice 6.1). Após a interpretação dos achados deste trabalho, vislumbramos uma lacuna científica e possibilidade de desenvolvimento de uma linha de pesquisa capaz de aprofundar os conhecimentos sobre a importância do emprego mais adequado das diferentes características de *feedback* extrínseco no tratamento de pacientes de variadas condições clínicas, especialmente de pacientes com dor cervical.

Essa tese é composta pelos seguintes itens: apresentação, revisão da literatura, justificativa, objetivos e três manuscritos científicos. O primeiro manuscrito intitulado "*Knowledge of extrinsic feedback characteristics: a survey of brazilian physical therapists"* foi submetido para apreciação do corpo editorial do periódico *"Brazilian Journal of Physical Therapy".* O segundo intitulado *"Measurement properties of the craniocervical flexion test: a systematic review protocol",* foi publicado no periódico *"BMJ Open".* O terceiro manuscrito, intitulado "*Measurement properties of the craniocervical flexion test: a systematic review"* foi aceito para a publicação no periódico "*Physical Therapy Journal"*.

1 REVISÃO DA LITERATURA

1.1 INTRODUÇÃO

A dor cervical é uma das principais causas musculoesqueléticas de anos vividos com incapacidade em todo o mundo (JAMES et al. 2018). Mais de 80% dos indivíduos experimentam dor cervical durante a vida, com 30-50% da população adulta em geral relatando esta queixa anualmente (HOGG-JOHNSON et al. 2009). Entre 50% e 75% das pessoas que sofreram um episódio de dor cervical ainda sofrerão algum sintoma de um a cinco anos após o episódio inicial (CARROLL et al. 2009). A prevalência aumenta com a idade e é mais comum em mulheres na quinta década de vida (CROFT et al. 2001). Esta alta prevalência é responsável por um grande impacto econômico e social (HOY et al. 2014).

A prevalência da dor cervical relatada em diferentes estudos é bastante variada (de 16.7%–75.1%, por exemplo) em parte devido à diferentes formas de classificação da dor cervical e metodologias empregadas na literatura epidemiológica sobre o tema (HOGG-JOHNSON et al. 2009; FEJER et al. 2006). Essa variação limita a capacidade de comparar ou combinar dados entre os estudos para chegar a um consenso. Apesar destas variações, geralmente os pacientes são classificados entre pacientes com dor cervical específica ou inespecífica. Essa diferenciação é parte crucial da avaliação fisioterapêutica, e reforçada por diferentes diretrizes de prática clínica, uma vez que a dor cervical específica pode ser oriunda de alguma lesão mais grave como fratura, infecção ou tumor, e, neste caso, o tratamento fisioterapêutico pode agravar a condição clínica do paciente (BIER et al. 2018; BLANPIED et al. 2017; CÔTÈ et al. 2016; BUSSIERES et al. 2016). Por outro lado, a dor cervical inespecífica não tem uma fonte de dor identificável com precisão e a elicitação nociceptiva pode ser de qualquer uma das principais estruturas inervadas na área cervical, incluindo articulações facetárias, ligamentos, músculos e discos intervertebrais (GUZMAN et al. 2009). O *Neck Pain Task Force* determina que, embora a causa seja inespecífica, dor cervical é uma experiência sensorial e emocional desagradável associada a dano tecidual real ou potencial na região do pescoço, entra a linha nucal superior e as espinhas das escápulas, com ou sem irradiação para cabeça, tronco e membros superiores (GUZMAN et al 2009).

O curso clínico da dor cervical é variável. Para a maior parte dos pacientes (entre 80 a 85%) a história natural é favorável e uma recuperação é esperada entre 6 e 12 semanas após o episódio inicial, especialmente para causas traumáticas (STERLING et al. 2010). Entretanto em muitos casos o prognóstico não é tão positivo, e a dor cervical pode apresentar uma característica de recorrência. Por exemplo, 23% dos indivíduos que se recuperam de um episódio de dor cervical sofrerão um episódio subsequente (CÔTÈ et al. 2004). É esse justamente o grupo de pacientes que necessita de mais atenção tanto no aprofundamento científico, como na avaliação e identificação precoce por parte dos clínicos. Para esses pacientes, frequentemente, a dor cervical é uma desordem biopsicossocial complexa com sintomas físicos e psicológicos associados. Neste cenário, a dor cervical está associada à diminuição da qualidade de vida relacionada à saúde, diminuição da produtividade no trabalho, limitações diárias das atividades e aumento da utilização da assistência médica (CÔTÈ et al. 2016)

Além dos fatores psicossociais que precisam ser investigados e bem endereçados, outros pacientes com dor cervical persistente apresentam desequilíbrios neuromusculares, como por exemplo diminuição da força muscular (MIRANDA et al., 2019; O'LEARY et al. 2007), diminuição da resistência muscular (OLIVEIRA et al. 2016; FALLA et al. 2007) atraso no início da ativação dos músculos cervicais (FALLA et al. 2004), e alterações na coordenação entre os músculos (por exemplo, aumento da atividade dos flexores superficiais concomitantemente com atividade reduzida dos flexores profundos cervicais) (JULL e FALLA, 2016). Alterações estruturais na morfologia dos músculos cervicais, como atrofia e infiltrado adiposo (ELLIOT et al. 2015), e inclusive alterações na representação no córtex motor primário dos músculos flexores cervicais superficiais e profundos (ELGUETA-CANCINO et al. 2019) também podem ocorrer em pacientes com dor cervical. Essas alterações podem contribuir para a perpetuação dos sintomas em pacientes com dor cervical crônica (LINDSTROM et al. 2011).

Devido à etiologia complexa e multifatorial, que inclui fatores psicossociais e musculoesqueléticos, diferentes propostas de subclassificação dos pacientes com dor cervical são apresentadas com o objetivo de agrupar pacientes com características mais homogêneas e, assim, ofertar um programa de tratamento mais bem direcionado para cada grupo. Dentre as quatro diretrizes de prática clínica mais recentes, três (BIER et al. 2018; CÔTÈ et al. 2016; BUSSIERES et al. 2016) adotam a classificação do *Neck Pain Task Force* (GUZMAN et al. 2009). Esta classificação divide os pacientes entre pacientes com dor cervical e desordens associadas ou pacientes com *whiplash* e desordens associadas, e, posteriormente, graduam os pacientes em I, II, III ou IV, de acordo com a severidade dos sintomas, envolvimento de patologias mais sérias e interferências nas atividades de vida diária. Sendo o grau I, pacientes com nenhum sinal ou sintoma sugestivo de patologia estrutural importante e nenhuma ou menor interferência nas atividades da vida diária, e o grau IV pacientes com sinais ou sintomas de patologia estrutural importante (como uma bandeira vermelha, por exemplo). Enquanto que apenas a diretriz produzida pela associação americana de fisioterapia adota a proposta do sistema de tratamento baseado em subclassificação (BLANPIED et al. 2017). Nesta classificação os pacientes não são separados entre *whiplash* ou não. A categorização dos pacientes também em ocorre em quatro grupos, mas não necessariamente baseado na severidade e sim em características das queixas relatadas e observadas durante a anamnese e exame físico (BLANPIED et al. 2017). Neste caso, os pacientes são divididos entre: 1) pacientes com dor cervical e problemas de mobilidade; 2) pacientes com dor cervical e problemas de coordenação (desordens associadas ao *whiplash*); 3) pacientes com dor cervical e cefaleia cervicogênica; e 4) pacientes com dor cervical com irradiação para o membro superior.

Apesar das diferentes classificações e das consequentes diferentes formas de manejo baseadas nas evidências atuais para cada uma, dentre as muitas abordagens de tratamento propostas para a dor cervical, o exercício se mostra uma alternativa eficaz para a redução da dor e melhora da incapacidade, especialmente para os pacientes com dor cervical crônica (BERTOZZI et al. 2013; GROSS et al. 2015). De fato, o exercício é consenso nas diferentes diretrizes de prática clínica e é recomendado para todos os subgrupos de classificação, com exceção do grupo IV da classificação do *Neck Pain Task Force* que apresenta bandeiras vermelhas (BLANPIED et al. 2017; CÔTÈ et al. 2016; BUSSIERES et al. 2016). Mesmo que o exercício seja consenso entre as diretrizes e indicado para todos os pacientes, parece que um grupo de pacientes pode ser mais beneficiado. Este grupo seria composto por pacientes que apresentam algum tipo de descoordenação/desequilíbrio muscular, correspondente ao grupo de dor cervical e problemas de coordenação da diretriz americana.

Para estes pacientes, diversos programas de fortalecimento específicos demonstraram ser eficazes na redução da dor e incapacidade cervical (GROSS et al. 2015; JULL et al. 2009; ANDERSEN et al. 2013). No entanto, existem evidências limitadas sobre qual programa é mais eficaz e, atualmente, não há consenso sobre qual tipo de exercícios de fortalecimento é superior (COX et al. 2019). Os programas variam desde exercícios mais globais, incluindo reforço de músculos escapulares (ANDERSEN et al. 2013), até programas mais específicos, direcionados aos músculos flexores cervicais profundos, como Longo do Pescoço e Longo da Cabeça, considerados músculos estabilizadores da região cervical (LLUCH et al. 2013; JULL et al. 2009).

Tendo em vista que os exercícios são considerados uma abordagem indispensável no tratamento de pacientes com dor cervical crônica que apresentem algum tipo de desequilíbrio muscular, e que a cronicidade é capaz de promover alterações neuromusculares inclusive a nível central (ELGUETA-CANCINO et al. 2019; PELLETIER et al. 2015), uma possível forma de incrementar os resultados dos exercícios seria a adição de algum tipo de *feedback* extrínseco, capaz de promover estímulos não apenas localmente no sistema musculoesquelético mas também no sistema nervoso central (OLIVO, 2018). De fato, uma recente revisão sistemática observou que a adição de *feedback* extrínseco a um programa de exercícios promoveu uma redução estatisticamente superior da dor quando comparados ao programa de exercícios isolados ou a um grupo controle (DE ARAUJO et al. 2017).

Entretanto, além da qualidade da evidência observada nesta revisão ter sido muito baixa em decorrência do alto risco de viés dos estudos incluídos, os estudos incluídos não reportaram quais características de *feedback* extrínseco foram utilizadas nos seus programas de tratamento. Dessa forma, não foi possível concluir se os estudos adotaram características mais ou menos adequadas, e, consequentemente, ainda existe uma lacuna na literatura sobre o efeito do uso adequado de *feedback* extrínseco como forma de tratamento de pacientes com dor cervical crônica.

1.2 CARACTERÍSTICAS DE *FEEDBACK* EXTRÍNSECO

Para o aprendizado de uma nova tarefa motora o corpo humano vale-se de informações sensoriais aferentes que podem ser provenientes de um sistema de *feedback* intrínseco ou extrínseco (SCHMIDT e WRISBERG, 2008; GENTILE, 1998). No *feedback* intrínseco a origem da informação se dá através do sistema somatosensorial, enquanto o *feedback* extrínseco se refere ao *feedback* externo ao fisiológico, que, através de elementos provenientes de uma fonte externa (aparelho de *biofeedback* de pressão, ou instruções e correções do fisioterapeuta, por exemplo), é usado para aumentar a cognição de um indivíduo sobre o que está ocorrendo fisiologicamente no corpo (SCHMIDT e WRISBERG, 2008; RIBEIRO et al. 2011). Ambos são importantes para informar o sistema motor sobre como ele está desempenhando ou corrigindo os movimentos (LAMETTI e WATKINS, 2016).

Embora ambas as formas de aprendizado ocorram concomitantemente, teoriza-se que o *feedback* extrínseco seja o principal componente num primeiro momento de obtenção de um novo comportamento motor. O fornecimento dessa informação geralmente é dado por terceiros ou por referências advindas do ambiente que cerca o paciente/praticante. À medida que o sujeito se torna mais proficiente, o desenvolvimento intrínseco se sobressai, torna-se mais automatizado, e o paciente necessita menos de informações externas ao corpo para aperfeiçoamento da tarefa (STEENBERGEN et al. 2010).

Pacientes com diferentes condições clínicas podem apresentar uma perda de funções neuromusculares (FALLA e FARINA, 2008; FALLA et al. 2004), levando ao comprometimento do uso das informações intrínsecas. Nesses casos o uso *feedback* extrínseco (ou aumentado) como ferramenta para melhora do desempenho, seja de atletas (SCHMIDT e WRISBERG, 2008) ou em um contexto de reabilitação (DE ARAUJO et al. 2017; RIBEIRO et al. 2011; RIBEIRO et al. 2011b) é prática corriqueira dos profissionais que lidam com movimento. Neste sentido, fisioterapeutas comumente utilizam alguma forma *feedback* extrínseco como parte do tratamento de pacientes com acometimentos no sistema musculoesquelético (DE ARAUJO et al. 2017; RIBEIRO et al. 2011; TSAO et al. 2010), neurológico (SUBRAMANIAN et al. 2010; VAN VLIET e WULF, 2006; MERIANS et al. 2002) e uroginecológico (PAINTER et al. 2007). O uso de *feedback* extrínseco pode ser realizado através de diferentes instrumentos como biofeedback eletromiográfico (PIETROSIMONE et al., 2015), ultrassom (ELLIS et al. 2018; POTTER et al. 2012), realidade virtual (MERIANS et al., 2002) e *biofeedback* de pressão (Jull et al., 2008).

Existem diversas características diferentes para a apresentação e fornecimento do *feedback* extrínseco, como por exemplo a quantidade de *feedback* (constante ou intermitente); o momento em que é fornecida a informação (durante a prática ou após finalizar a tentativa); o modo que essa instrução chega ao paciente (tátil, sonoro ou visual), entre outras (SCHMIDT e WRISBERG, 2008).

Primeiramente, o *feedback* extrínseco pode ser fornecido de duas formas, também definidas como a natureza do *feedback* extrínseco: conhecimento de resultados e conhecimento de desempenho (SCHMIDT e WRISBERG, 2008). O conhecimento de resultados informa sobre o resultado ou a consecução do objetivo / alvo de uma determinada tarefa (MAGILL, 2003). Por exemplo, um paciente pode ser informado de que foi capaz de transferir 40% do peso corporal para a perna hemiplégica, com balanças de banheiro sendo usadas para medir o resultado, ou que o número de milímetros de espessura de determinado músculo aumentou durante uma contração monitorada em tempo real por ultrassom. Enquanto que o *feedback* de conhecimento de desempenho informa sobre as características de um movimento ou tarefa realizada (MAGILL, 2003). Por exemplo, o fisioterapeuta pode dizer ao paciente que o joelho precisa ser mais estendido para suportar mais peso na perna hemiplégica, ou demonstrar um vídeo da imagem do ultrassom realizada durante a contração de um músculo profundo abdominal. Existe um debate a respeito de qual destas duas formas de fornecimento de *feedback* extrínseco seria mais adequada e não existe ainda um consenso sobre isso (HENRY e TEYHEN, 2007).

Além disso, as diversas formas de fornecer *feedback* extrínseco e as diferentes características podem ser posteriormente divididas em dois domínios principais: conteúdo e tempo (MAGILL, 2003). Características de conteúdo referem-se a atributos do foco de intervenção do *feedback* extrínseco, por exemplo *como* os resultados do *feedback* extrínseco são apresentados e o tipo de foco de atenção associado a ele. Enquanto que as características de tempo se referem a todos os atributos relacionados a <u>*quando*</u> o *feedback* é fornecido durante o treinamento motor (MAGILL, 2003) (Figura 1 e Tabela 1). O momento em que, e o modo no qual o *feedback* extrínseco é fornecido, bem como o estágio de aprendizagem em que o paciente se encontra, afetam o sucesso da aprendizagem motora (HENRY e TEYHEN, 2007).

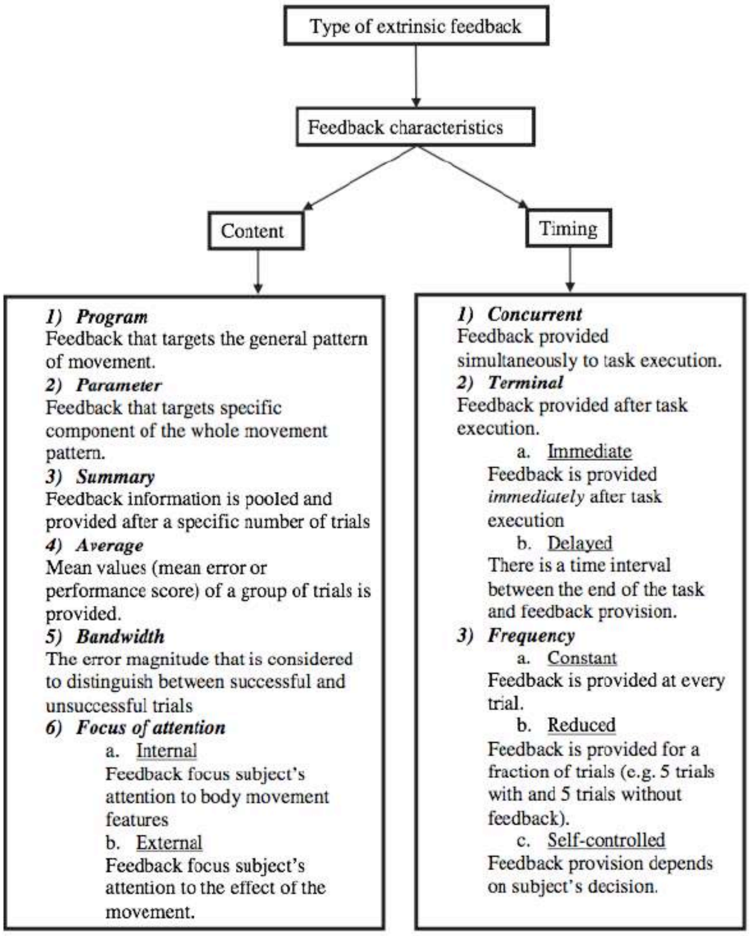

Figura 1. Características de *Feedback* Extrínseco

Fonte: RIBEIRO et al. 2011

Main term definitions for content and timing characteristics.

Content characteristics	
Program feedback	Feedback related to the general pattern of movement.
Parameter feedback	Feedback related to a specific component (part) of the whole movement pattern.
Summary feedback	Feedback is pooled and provided after a specific number of trials.
Average feedback	Feedback provided refers to mean values (mean error or performance score) of a group of trials.
Bandwidth (error magnitude)	The amount of error that is considered to distinguish between successful and unsuccessful trials.
Internal focus of attention	Feedback drives learner's attention to body movement characteristics.
External focus of attention	Feedback drives learner's attention to the effect of the movement.
Timing characteristics	
Concurrent feedback	Feedback is provided simultaneous to task execution.
Terminal feedback	Feedback is provided after task execution.
Immediate	Feedback is provided immediately after task execution;
Delayed	Feedback provision is delayed after the end of the task execution.
Frequency	
Constant	Feedback is provided at every trial.
Reduced	Feedback is provided for a fraction of trials (e.g. 30%).
Self controlled	Feedback provision depends on learner's decision.

Tabela 1. Definições das Características de *Feedback* Extrínseco

Fonte: RIBEIRO et al. 2011b

Entretanto, algumas evidências sugerem que estas características podem tanto melhorar como inclusive prejudicar a performance e o aprendizado motor (RIBEIRO et al. 2011). Ao considerar o uso de *feedback* extrínseco, as características do gesto ou tarefa em questão, assim como características do paciente, devem ser levadas em consideração. (HENRY e TEYHEN, 2007; RIBEIRO et al. 2011). Por esse motivo, antes de fornecer *feedback* extrínseco, as características de conteúdo e tempo devem ser cuidadosamente selecionadas (RIBEIRO et al. 2011b).

Diversas evidências apontam para as características mais adequadas para um melhor aprendizado motor e eficiência no uso do *feedback* extrínseco. Essas características consideradas ideais estão elencadas na Tabela 2. Por exemplo, dentre as diferentes características de conteúdo e de tempo, a literatura cientifica atual sugere que as características mais adequadas são:

1) *Feedback* resumido (*summary feedback*): no *feedback* resumido, ou *feedback* de média, várias execuções de um determinado exercício devem ser conduzidas sem *feedback*, seguidos pelo fornecimento de um feedback já resumido com informações mais efetivas comparadas aos desempenhos anteriores (RIBEIRO et al. 2011);

2) Foco de atenção externo: instruções que direcionam a atenção das pessoas para os efeitos de seus movimentos no ambiente, induzindo assim o chamado foco de atenção "externo", são mais eficazes para a aprendizagem do que instruções que direcionam atenção aos próprios movimentos ou indução de um foco 'interno' (VAN VLIET e WULF, 2006; WULF, 2013; WULF e LEWTHWAITE, 2016);

3) *Feedback* atrasado: apresentar *feedback* instantaneamente após a conclusão do movimento tende a criar uma forte dependência dele (VAN VLIET e WULF, 2006), além disso, ao fornecer *feedback* atrasado (por exemplo, instrução verbal ou *feedback* visual após alguns segundos de execução do movimento), os pacientes são encorajados a usar e organizar melhor as informações de *feedback* intrínseco (somatossensorial) (ANDERSON et al. 2005);

4) *Feedback* não simultâneo: embora o *feedback* simultâneo tenha efeitos muito fortes de melhoria de desempenho quando está presente durante a prática, normalmente resulta em decréscimos claros de desempenho quando é retirado em testes de retenção ou transferência, em relação ao *feedback* apresentado após o movimento (PARK et al. 2000; SCHMIDT e WULF, 1997);

5) *Feedback* intermitente, reduzido ou auto-selecionado (por exemplo, não fornecer um *feedback* a cada execução de uma série de exercícios): esta característica de tempo pode resultar em aprendizado mais eficaz do que apresentar *feedback* após cada execução (f*eedback* constante) (LAI e SHEA, 1998; WEEKS e KORDUS, 1998). Sugere-se que, escolhendo quando receber *feedback* (*feedback* auto-selecionado), os pacientes possam correlacionar melhor o *input* somatossensorial com as informações do *feedback* extrínseco e o desempenho motor (CHIVIACOWSKY e WULF, 2002).

Ideal content and timing characteristics for feedback provision.

Domain of feedback characteristics	Ideal characteristics
Content characteristics	Summary or averaged feedback Use of bandwidth External focus of attention
Timing characteristics	Delayed feedback Reduced frequency Self-controlled feedback (provided upon patient's request)

Tabela 2. Caraterísticas Ideais de Fornecimento de *Feedback* Extrínseco

Fonte: RIBEIRO et al. 2011

Apesar de existir um certo volume de evidência suportando os diferentes resultados obtidos a partir da seleção de diferentes características de *feedback* extrínseco, alguns estudos que utilizam do *feedback* extrínseco como parte de um tratamento, não reportam claramente quais características foram utilizadas, impedindo uma conclusão mais definitiva (RIBEIRO et al. 2011b; DE ARAUJO et al. 2017). Além disso, ao observarmos uma ausência na clareza dessas informações percebemos uma possível lacuna na literatura a respeito do conhecimento dos fisioterapeutas sobre as diferentes características de *feedback* extrínseco e a importância da seleção adequada destas características. Afinal, seria a ausência de entendimento sobre as diferentes formas de f*eedback* e suas influências na aquisição motora uma possível explicação para a baixa descrição das maneiras de entrega de *feedback* utilizadas nas intervenções?

1.3 TESTE E EXERCÍCIO DE FLEXÃO CRANIOCERVICAL

Como descrito anteriormente, pacientes com dor cervical crônica frequentemente apresentam diversas alterações neuromusculares, como por exemplo diminuição da força (O'LEARY et al. 2007; MIRANDA et al. 2019) e resistência musculares (OLIVEIRA et al. 2016; FALLA et al. 2007), que podem perpetuar a sua condição clínica. Para avaliar se o paciente com dor cervical possui uma destas tantas alterações - o desequilíbrio entre os músculos flexores cervicais superficiais e profundos - e, portanto, seria indicado para um tratamento com exercícios (com ou sem a adição de *feedback* extrínseco), os fisioterapeutas comumente realizam o teste de flexão craniocervical (TFCC).

O TFCC foi desenvolvido para avaliar a capacidade de um indivíduo de recrutar seletivamente os músculos flexores cervicais profundos (Longo do pescoço e Longo da cabeça, por exemplo), mantendo baixos níveis de atividade dos músculos flexores cervicais superficiais (por exemplo, Esternocleidomastóideo e Escaleno anterior) durante a realização do movimento ativo de flexão craniocervical. Para realizar o TFCC com uma unidade de *biofeedback* de pressão, o paciente é posicionado deitado em decúbito dorsal, com a coluna cervical em posição neutra. Em seguida, o paciente executa um movimento suave de assentimento ativo da cabeça. Durante esse movimento, o paciente tenta atingir cinco níveis diferentes de pressão, de 22 a 30 mmHg, evitando estratégias de compensação (JULL et al. 2008) (FIGURA 2).

Figura 2. Teste de Flexão Craniocervical

Fonte: JULL et al. 2008

A performance do paciente durante o TFCC é avaliada a partir da observação simultânea dos seguintes fatores: (1) a capacidade do paciente de executar a ação correta da flexão craniocervical sem estratégias de compensação; (2) a atividade excessiva dos flexores superficiais do pescoço em associação com a atividade reduzida nos flexores profundos do pescoço; (3) o nível de pressão alcançado com o correto ajuste craniocervical movimento de flexão, sem atividade excessiva dos flexores superficiais. Para realizar a avaliação eletromiográfica dos músculos flexores cervicais profundos, são necessários métodos invasivos (avaliação eletromiográfica através de eletrodos via nasofaringe) (FALLA et al. 2003) (Figura 3). Uma vez que já foi demonstrada uma relação inversa entre a atividade eletromiográfica dos músculos flexores superficiais e profundos cervicais (JULL e FALLA, 2016), tanto num ambiente clínico como em laboratório, frequentemente avaliam-se apenas os níveis de atividade dos músculos flexores superficiais.

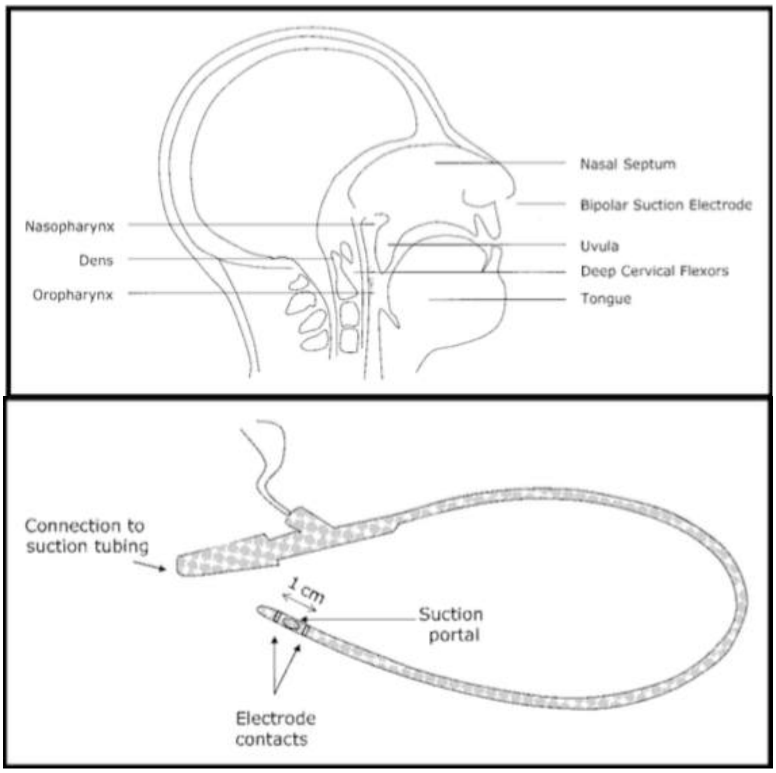

Figura 3. Demonstração do método de análise eletromiográfica via nasofaringe para a detecção da atividade dos músculos flexores cervicais profundos.

Fonte: FALLA et al. 2003

Os mesmos procedimentos realizados durante o TFCC podem ser utilizados como forma de exercício de fortalecimento endereçado aos músculos flexores cervicais profundos. Além disso, a unidade de *biofeedback* de pressão também pode ser usada como uma ferramenta de *feedback* extrínseco para facilitar o treinamento de controle motor nesses pacientes (JULL et al. 2009; DE ARAUJO et al. 2017). De fato, algumas evidências demonstram que o exercício de flexão craniocervical é capaz melhorar a performance no TFCC e inclusive reduzir níveis de dor e incapacidade de pacientes com dor cervical crônica (LLUCH et al. 2013; FALLA et al. 2013; O'LEARY et al. 2012; FALLA et al., 2012; JULL et al. 2009).

Entretanto, mesmo que evidências apontem uma melhora nos desfechos relacionados ao TFCC e mesmo aos desfechos clínicos, é importante ressaltar algumas limitações destes estudos. Primeiramente, a maior parte dos estudos sobre performance no TFCC foi realizado pelo mesmo grupo de autores, justamente o grupo que idealizou o teste. Dois estudos que observaram efeitos estatisticamente significativos na melhora da performance do TFCC e na redução da dor e incapacidade, tiveram apenas um grupo de intervenção, sem um grupo comparativo (LLUCH et al. 2013; FALLA et al., 2012). Um estudo incluiu um grupo comparativo, mas foi apenas um grupo controle e não um grupo comparando outro tipo de exercício ou abordagem terapêutica (FALLA et al. 2013). Apenas dois destes estudos incluiu um grupo comparativo ao tratamento a partir do exercício de flexão craniocervical, neste caso um grupo que realizou exercícios de reforço muscular com maior resistência, endereçado aos músculos flexores superficiais cervicais (JULL et al. 2009), ou grupos submetidos a exercícios tanto de resistência como de amplitude de movimento (O'LEARY et al. 2012). Ambos estudos observaram que o grupo que realizou o exercício de flexão craniocervical obteve de fato uma melhora estatisticamente significativa superior aos demais grupos na performance do TFCC, entretanto, não foi observada diferença estatisticamente significativa nos desfechos clínicos (dor e incapacidade) (O'LEARY et al. 2012; JULL et al. 2009).

Além de observarmos uma carência de estudos bem delineados, comparando diferentes formas de exercício para a melhora do controle motor, mas também da dor e incapacidade, essa ausência de benefícios clínicos mais claros pode ocorrer por dois motivos:

1) aparentemente o exercício como é proposto apresenta algumas características de *feedback* adequadas e outras não recomendadas pela literatura vigente sobre o tema. Por exemplo, o exercício é conduzido com um foco de atenção misto (nem totalmente interno nem totalmente externo, uma vez que as orientações podem se referir a movimentos do pescoço, mas ao mesmo tempo o paciente mantém os olhos no manômetro), com o paciente recebendo constantemente o *feedback* e recebendo imediatamente após cada execução. Estas características não são recomendadas

como ideais. Porém, na ausência de ensaios clínicos controlados e aleatorizados comparando essa forma tradicional do exercício com um grupo em que o exercício fosse realizado com um foco apenas externo, sem o *feedback* concomitante, com o paciente recebendo o *feedback* resumido após algumas execuções e com um tempo de atraso na entrega após uma série de execuções, não é possível afirmar se de fato os desfechos clínicos seriam diferentes.

2) é possível que as propriedades de medida do teste não sejam suficientemente capazes de detectar mudanças clinicamente importantes, e assim, os estudos apresentam mudanças no teste, mas estas mudanças observadas não refletem clinicamente nos pacientes.

1.3.1 PROPRIEDADES DE MEDIDA DO TESTE DE FLEXÃO CRANIOCERVICAL

Idealmente, as propriedades de medida (por exemplo, confiabilidade, validade e responsividade) de um teste, como o TFCC, devem ser determinadas antes de sua plena implementação na prática clínica (MOKKINK et al. 2010). A seleção de instrumentos com boas propriedades de medida é fundamental para uma prática clínica baseada em evidências e para conduzir ensaios clínicos bem delineados (MOKKINK et al. 2009).

Mesmo que o TFCC seja amplamente utilizado tanto na prática clínica como acadêmica, as suas propriedades de medida não foram bem determinadas. Apesar disso, diferentes estudos que utilizam o TFCC reportam que o teste apresenta boas propriedades como validade de construto e confiabilidade (JULL e FALLA, 2016; JULL et al. 2009; FALLA et al. 2004). Essas propriedades foram avaliadas em estudos individuais (FALLA et al. 2003; JUUL et al., 2013; JORGENSEN et al. 2014). Porém, para que pesquisadores e clínicos tomem decisões adequadas a partir dos resultados observados nestes estudos, é fundamental que os estudos tenham sido desenhados adequadamente e apresentem baixo risco de viés. Este tipo de análise pode ser realizado através de revisões sistemáticas que sumarizem a literatura e realizem uma avaliação da qualidade metodológica dos estudos incluídos.

Em uma revisão sistemática publicada em 2008, a única propriedade de medida relatada para o TFCC foi a confiabilidade intraexaminador (DE KONING et al. 2008).

Essa revisão tem limitações, como número limitado de estudos incluídos e métodos desatualizados para avaliar o risco de viés e resumir a força das evidências (LOHR et al. 1996; BOT et al. 2004). Desde então, o número de estudos publicados avaliando as propriedades de medida do TFCC aumentou (JUUL et a. 2013; SOON et al. 2010; ARUMUGAN et al. 2011; JAMES et al. 2010; JORGENSEN et al. 1014; JORGENSEN et al. 2017; MARTINS et al. 2017). Além disso, o *Consensus-based Standards for the selection of health Measurement Instruments* (COSMIN) foi desenvolvido para avaliar o risco de viés de estudos individuais que exploram as propriedades de medida de diferentes testes e instrumentos (MOKKINK et al. 2010), e é a ferramenta mais indicada atualmente para este tipo de análise.

Além das limitações desta revisão sistemática (DE KONING et al. 2008), a avaliação de outras propriedades de medida além da confiabilidade intraexaminador, como por exemplo validade interexaminador, validade discriminativa, confiabilidade, erro de medida e responsividade do TFCC não foram ainda sumarizadas.

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2 JUSTIFICATIVA

Diante do atual contexto apresentado, foram encontradas algumas lacunas na literatura, a saber:

1) A ausência de informações adequadas sobre as características de *feedback* extrínseco reportada em estudos a respeito deste tema. Seria esta ausência um reflexo do desconhecimento dos fisioterapeutas sobre o assunto assim como o desconhecimento dos fisioterapeutas sobre quais são características de *feedback* extrínseco mais adequadas num contexto clínico de avaliação e reabilitação de desordens motoras?

2) A ausência de uma sumarização sobre as mais diferentes propriedades de medida do TFCC realizada a partir de uma análise adequada do risco de viés dos respectivos estudos conduzidos sobre o tema. É importante entender se o TFCC é realmente válido, confiável, capaz de discriminar pacientes e sujeitos saudáveis e capaz de identificar mudanças clinicamente importantes, para assim, futuramente, conseguir afirmar se o uso de determinadas características de *feedback* durante o exercício de flexão craniocervical promovem efeitos estatistica e clinicamente superiores a outros exercícios convencionais.

3 OBJETIVOS

3.1 OBJETIVO GERAL

- Identificar o conhecimento dos fisioterapeutas que atuam no Brasil sobre as diferentes caraterísticas de *feedback* extrínseco e verificar a qualidade das propriedades de medida do TFCC.

3.2 OBJETIVOS ESPECÍFICOS (Estudo I)

- Identificar o uso das diferentes caraterísticas de conteúdo de *feedback* extrínseco pelos fisioterapeutas que atuam no Brasil;
- Identificar o uso das diferentes caraterísticas de tempo de *feedback* extrínseco pelos fisioterapeutas que atuam no Brasil;
- Identificar se fisioterapeutas que atuam no Brasil costumam realizar um teste de retenção para verificar o aprendizado motor, após um treinamento com *feedback* extrínseco;
- Identificar eventuais barreiras e fatores que influenciam o uso das diferentes caraterísticas de *feedback* extrínseco pelos fisioterapeutas que atuam no Brasil;

3.3 OBJETIVOS ESPECÍFICOS (Estudos II e III)

- Revisar sistematicamente a literatura a respeito das propriedades de medida do TFCC;
- Verificar, a partir da avaliação com o COSMIN sobre o risco de viés dos respectivos estudos sobre o tema, a qualidade da evidência para cada propriedade de medida do TFCC.

4 DESENVOLVIMENTO

A seção de desenvolvimento será apresentada a seguir na forma de três manuscritos. O primeiro submetido para apreciação do corpo editorial do periódico *“Brazilian Journal of Physical Therapy”, o segundo* já publicado no periódico *“BMJ Open”*, e o terceiro aceito para publicação no periódico *“Physical Therapy Journal”.*

4.1 MANUSCRITO I

Knowledge and use of extrinsic feedback characteristics: A survey of current practice among Brazilian physical therapists

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Highlights

- Most Brazilian physical therapists are unclear about the definition of extrinsic feedback (EF);
- The most common types of feedback were verbal and visual; and mirror, photo or video were the most common resources used;
- Brazilian physical therapists use adequate content characteristics according to best practices;
- Brazilian physical therapists do not use the proper timing characteristics according to best practices;
- Clinicians do not perform retention test for assessing motor learning.

Knowledge and use of extrinsic feedback characteristics: A survey of current practice among Brazilian physical therapists

Abstract

Objectives: This study aimed to identify the knowledge about the different characteristics of and the use of extrinsic feedback (EF) by Brazilian physical therapists.

Methods: This cross-sectional study used an internet-based survey with questions about knowledge and application of extrinsic feedback in clinical practice. We analyzed the responses in relation to the best available evidence on motor control and learning. We recruited Brazilian registered physical therapists through the Regional Physical Therapy Registration Boards of different regions in Brazil. Participant demographics and survey responses were analyzed using descriptive statistics.

Results: Two hundred and forty-six Brazilian physical therapists participated in the study. Most participants affirmed not knowing the definition of EF (55.69%), use some form of EF in their clinical practice (86.59%), and use it in 50 to 90% of their patients (26.42%). Brazilian physical therapists mainly use summary feedback (69.10%) with external focus of attention (63.41%). Participants mainly use concurrent feedback (82.83%), and delivered it after every exercise repetition (63.82%). Most participants (43.09%) do not carry out any type of learning retention assessment.

Conclusions: The results of this survey indicate that Brazilian physical therapists do not have sufficient knowledge about the different characteristics of EF, consider EF useful and use it in most of their patients. Brazilian physical therapists adopt adequate content characteristics of EF. However, there are inconsistencies related to their knowledge and current evidence, especially regarding the timing characteristics of EF.

Keywords: Feedback; Exercise Therapy; Motor learning; Therapeutic Exercise; Survey.

Introduction

When performing a motor task, humans rely on afferent sensory information to adapt movement and successfully achieve the goal of that motor task.[1] Afferent sensory information is also referred to as intrinsic feedback system.[1,2] Intrinsic feedback refers to self-sensory perceptual information that is available as a result of movement being performed, while extrinsic feedback (EF) refers to additional information derived from an external source (e.g. the physical therapist or a biofeedback device).[3,4] Both are important for informing the motor system about how it is performing or correcting movements.[5]

Patients with different clinical conditions (e.g. stroke, neck pain, low back pain, lumbopelvic pain or urinary incontinence) may have impaired neuromuscular function.[3,6-8] In addition, in some clinical chronic musculoskeletal disorders (e.g. low back pain, neck pain or patellofemoral pain syndrome) motor cortex alterations have a crucial role in the pathophysiology of movement.[9] To target neuromuscular impairments, physical therapists commonly use some form of EF when managing patients with musculoskeletal,[4,10,11] neurological[3,12,13] or urogenital disorders[7] to assist those patients in (re)learning a task or movement. Clinicians may offer EF using different approaches (verbal, tactile or visual feedback) or different equipment (electromyographic biofeedback,[14] ultrasound,[15,16] virtual reality[13], mirror or pressure biofeedback).[17]

EF can be offered to patients in different ways, and these are mainly based on the content and timing characteristics of the EF. When treating patients, clinicians can offer the EF with the following characteristics: 1) the amount of feedback (constant or intermittent); 2) the time the information is provided (during practice, immediately the exercise is completed or delayed – i.e. few seconds after the exercise is completed); 3) the focus of attention (internal or external); and 4) the way this instruction reaches the patient (tactile, audible or visual).[1]

The largest amount of evidence on feedback characteristics comes from the field of motor control and performance, conducted mainly with healthy participants and little research has been done within physiotherapy and rehabilitation[3,8,11,12]. Some evidence suggests that these characteristics may both improve and even hinder performance and motor learning in healthy individuals.[4] For example, previous research showed that feedback provided with summarized results, with external focus of attention, intermittent, delayed and with reduced or self-controlled frequency led to better clinical outcomes.[3,4,8,18-21] Therefore, seems that characteristics of EF can also positively or negatively influence clinical outcomes when treating patients.

A recent systematic review reported the addition of EF to exercise therapy to be more effective than exercise therapy alone or control for pain when managing patients with neck pain.[10] This review and another one focusing on patients with low back pain reported that the included studies did not adequately report the characteristics of EF used.[10,18] Given the small number of studies exploring how different characteristics of EF impact on clinical outcomes, physical therapists possibly lack knowledge about the different characteristics and their influence in the outcomes.

Therapeutic exercise has been considered a cornerstone for the rehabilitation of several clinical conditions.[22] Proper use of EF can promote better clinical outcomes, such as reducing pain and improving balance and motor coordination than treatment without EF.[3,10,11] However, there is a gap in the current literature on the knowledge of physical therapists about the different characteristics of EF. Therefore, this study aims to identify the knowledge and use of Brazilian physical therapists about the different characteristics of EF.

Methods

Study Design

This is a cross-sectional observational design utilizing an Internet-based survey of Brazilian registered physical therapists. We followed the recommendation from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[23] This study was approved on May 10 2019, by the Ethics Committee of the Universidade Federal de Ciências da Saúde de Porto Alegre (CAE: 05024918.6.0000.5345). All participants read and accepted (electronically) the informed consent form before answering the questionnaire.

Participants

We included physical therapists, with valid certification by the Regional Physical Therapy Registration Board, regardless of area of expertise or clinical experience. According to data from the Federal Council of Physical Therapy and Occupational Therapy, in 2017 there were 224,368 registered physical therapists in Brazil.[24] Assuming 5% of margin error and a confidence level of 90%, a minimum sample of 271 of responders was estimated as representative of the registered physical therapy population in Brazil.

Survey Development

We could not find a valid and reliable survey that addressed the topic of this study. Therefore, we developed a new questionnaire following recommended best practices for developing questionnaires.[25-28] Prior to conducting the survey, we piloted the survey and conducted a “think aloud” interview and a test-retest reliability assessment, to ensure our survey had content validity and was reliable. The pilot version of the survey was answered and analyzed by a group of 20 physical therapists’ and post-graduate students. During the pilot, we used a “think-aloud” interview technique for gathering information from participants with regards to the clarity of the survey questions and response options.[25] We used data from this pilot to revise the survey (questions and response options). Both pilot and final versions of the survey were written in Portuguese.

The final survey consisted of 28 questions, with multiple-choice or Likert scales as response options. The questions covered the following domains: 1) consent form; 2) sociodemographic data; 3) current practice status; 4) knowledge and application of EF in clinical practice; 5) usefulness and factors that influence the use of EF. The first question about knowledge and application of EF in clinical practice asked whether participants were familiar with the definition of EF. Following that question, we presented a definition for EF to ensure participants contextualized the questions when completing the survey. As there is evidence that attention span of respondents may decline after 30 questions, we have chosen to not exceed 28 questions.[26]

We conducted the test-retest reliability by collecting data with a four-week interval. For the test-retest reliability, we collected data from a convenience sample of 18 physical therapists with different expertise areas.[29]

Survey Administration

The final survey was hosted on the Internet-based survey site, Google Docs, which enabled secure and anonymous survey participation, and was applied between May 2019 and January 2020.

We contacted the Regional Physical Therapy Registration Board of 17 regions of Brazil requesting support for the dissemination of the survey to all registered physical therapists in their respective regions. All invitations were sent by Regional Physical Therapy Registration Boards, without any participation of the researchers. This ensured the anonymity of potential participants as well as to avoid intentional targeting.

To maximize the response rate, the survey was written using colloquial language, and one reminder email was sent approximately two months after the initial email to all Regional Physical Therapy Registration Boards, requesting the Boards to resend invitations to physical therapists.[27] We used a snowballing technique,[26] as utilized by Potter et al. (2012),[16] which allowed recipients to forward the invitational e-mail to colleagues for whom they thought it would be appropriate. No financial incentive was offered, as previous research suggests that does not affect response rate.[28]

Data Analysis

We exported data from Google Docs and analyzed it using the Statistical Package for the Social Sciences software (SPSS 22.0, IBM Corp., Armonk, NY, USA). We performed descriptive analysis to define the characteristics of the participants, the absolute and relative frequency of responses. We presented data as frequencies and percentages based on the number of valid responses per question. The test-retest reliability was analyzed with unweighted Kappa, considering the responses of the sections on knowledge and application of EF on clinical practice. The following criteria was used for interpreting unweighted Kappa coefficients: <0.00 poor agreement; between 0.00 and 0,20 slight agreement; between 0.21 and 0,40 fair agreement; between 0.41 and 0,60 moderate agreement; between 0.61 and 0,80 substantial agreement; and between 0.81 and 1.00 almost perfect agreement.[30] All data were independently analyzed, with no interference from Regional Physical Therapy Registration Boards.

Results

Two hundred and forty-six Brazilian physical therapists participated in this study. The reliability between responses on each question of the analyzed sections (knowledge and application of EF in clinical practice and usefulness and factors that influence the use of EF) over a 4-week interval with our convenience pilot sample ranged between k=0.416 and k=1 (a moderate to almost perfect agreement).

Participants' characteristics

Information about participants' demographics and their clinical practice experience is presented in Table 1. The majority of participants: were women (65.85%); aged between 25 and 30 (25.20%) or 30 and 35 (27.24%) years old; graduated from a private university (80.49%), within the last five years (32.52%) or nine years (27.24%), and completed a master of coursework or residency program (41.87%). Most respondents (77.24%) worked in the south of Brazil, treating patients (87.40%) in a private company (44.31%), clinic (27.24%) or home care (21.95%) setting, with interest on musculoskeletal area (65.45%).

Insert Table 1 Around Here

Knowledge and application of extrinsic feedback in clinical practice

Findings regarding knowledge and application of EF in clinical practice are presented in Table 2. The majority of participants affirmed not knowing the definition of EF (55.69%), use some form of EF in their clinical practice (86.59%), in about 50 to 90% of their patients (26.42%). Most of respondents usually use verbal (87.40%), visual

(76.42%) or tactile (66.26%) EF. Mirror (72.36%) or films and photos (49.59%) showing the patients themselves are the most commonly used resources. The average importance score for using EF for the participants was 7.77 (SD = 3.16), based on a scale of 0 (no importance) to 10 (very important). Most participants reported not having any barriers that prevent them from using EF (52.03%). The remaining participants reported the following barriers: absence of adequate instruments (23.98%), lack off training for the use of EF (15.85%), and the high cost of purchasing equipment (13.01%).

Insert Table 2 Around Here

Content and Timing Characteristics of Extrinsic Feedback

The content and timing characteristics of EF most used are reported in Table 3. Regarding the content characteristics, physical therapists mainly use summary feedback (69.10%) with external focus of attention (63.41%). For the other characteristics of EF, 52% of respondents informed using knowledge of performance, and 47% of respondents informed using program feedback. Regarding the timing characteristics, physical therapists mainly use concurrent feedback, with 82% providing EF during exercise or after the execution of an exercise (82.83%), and 63% of respondents confirmed using constant feedback (instead of using reduced frequency or self-controlled feedback). Finally, most participants (43.09%) do not carry out any type of learning retention assessment following an intervention period.

Insert Table 3 Around Here

Usefulness and Factors that Influence the use of EF

Approximately 59% of clinicians consider the use of EF useful for rehabilitation, regardless of how it is offered to the patient. Approximately 40% consider that EF can be useful for rehabilitation, but it can also delay motor relearning depending on how it is offered to the patient (Table 4). In addition, the greatest influences on the choice of whether to use EF comes from clinical experience (83.33%), scientific papers (76.93%), and learning from courses (71.14%). Sixty-four percent of respondents considered information from websites and blogs to have little influence on the choice of EF (Table 5).

Insert Table 4 Around Here

Insert Table 5 Around Here

Discussion

Summary of main findings

This paper explored the knowledge and use of Brazilian physical therapists about the different characteristics of EF. We found that the majority of the Brazilian physical therapists use some form of EF in their clinical practice with most patients regardless of not knowing the definition of EF. Respondents are unaware that EF may hinder performance and motor learning during rehabilitation depending on the characteristics chosen. Verbal and visual feedback were the most used types of EF, whereas mirror, photo or filming were the resources most used. The main perceived barriers preventing the use of EF were financial or high costs of equipment (such as electromyography and ultrasound imaging), as well as, the lack of adequate training on EF. Participants generally use appropriate content characteristics, such as summary feedback with an external focus of attention. However, the timing characteristics used by respondents were not in line with findings from the literature. For example, constant feedback delivery during exercises is not recommended.[8,18,21] Few participants perform a retention test properly. Most participants consider important the update through scientific evidence, however, the factor that most influences the choice of EF characteristics for Brazilian physical therapists is the clinical experience.

Strengths and weaknesses of the study

This study was carefully designed following the recommendations from STROBE statement.[23] We verified the content validity of the survey in a pilot study, we conducted a test-retest reliability analysis, we avoid intentional targeting due to the non-participation of researchers in sending invitation e-mails, and we contact all

Regional Physical Therapy Registration Boards in Brazil. Nevertheless, our study also has some limitations. Despite our efforts to contact all Regional Physical Therapy Registration Boards, and strategies to maximize the response rate, the sample size was below the target sample size. The distribution of the sample was not homogeneous (the vast majority of participants are from the southern region and practiced within the musculoskeletal field). This may impact generalizability of our findings as our sample might not be representative of all Brazilian physical therapists. Despite our best efforts to engage with Registration Boards from all regions in Brazil, not all were supportive of this project. However, a small sample size or low response rate is often a limitation in survey studies[15,16,31-37].

Comparison with other studies

This study was the first to investigate Brazilian physical therapists use of EF, and that prevents direct comparison with other studies. Similarly to previous surveys amongst physical therapists,[15,16,38,39] most of participants were female, graduated from private university, completed a masters degree, worked treating patients, and practiced within the musculoskeletal field. Our sample size (n = 246) was very close to our target (n = 271), seems to reflect the professional characteristics observed in Brazil,[38,39] and are similar for those reported in other countries.[15,16,31,40]

In addition, similarly to previous surveys, clinicians reported practices that were not always consistent with the current best-evidence.[31,32,38,39] Our findings present some inconsistencies between the recommendations on the use of EF and the choices of the respondents (especially regarding the timing characteristics, the retention test, and the lack of knowledge that some characteristics can worsen motor learning). This is probably due to barriers faced by physical therapists when implementing evidence-based practice, as for example difficulty to obtain full-text papers, difficulty with the language of publication of scientific papers, lack of evidence-based practice training and difficulty to understand the statistics.[38,39,41]

Meaning of the study

Although current evidence supports that EF should be provided with summarized results, with external focus of attention, intermittent, delayed and with reduced or self-controlled frequency,[3,4,8,18-21] most physical therapists adopt a constantly and concurrently EF, which can worsen motor learning or cause a dependence on feedback for the exercise/task to be performed correctly.[3,21,42-44]

According to Ribeiro et al. (2011),[4] with any treatment intervention, the selection of appropriate EF should be based on careful stages of decision-making. For example, if the patient is not familiar with the exercise or incapable of performing it, program feedback should be provided.[4] Whereas, as the general motor task is mastered, improvement of specific characteristics of movement should be targeted with parameter feedback.[1] Brazilian physical therapists adopt both forms of feedback (i.e. program and parameter feedback). The absence of an adequate motor skill assessment, for example observed in the lack of retention testing, demonstrates that these stages do not seem to be well accomplished.

The types of feedback most commonly used by participants are verbal and visual. Verbal feedback can be an effective tool and inadequate verbal feedback can even override the patient self-correct visual feedback in some situations.[45] Provide verbal knowledge of results feedback may be redundant when knowledge of results is inherent in a task. Based on our survey, some clinicians offer excessive and redundant feedback provided to patients, and this form of EF can hinder motor learning.[42]

These findings suggest that most of our sample of Brazilian physical therapists do not have adequate knowledge about the different EF characteristics and the effects provided by the choice of these different characteristics. The process of assessing motor learning, planning and progressing treatment may not be adequate. This is due to most participants not performing retention test for assessing motor learning and deciding on EF use based on their own clinical experience, without little consideration about best evidence on the use of EF for motor control and learning.

Conclusion

The results of this survey indicate that our Brazilian physical therapists sample do not have adequate knowledge about the different characteristics of EF, consider EF useful and use it in most of their patients. Verbal and visual were the types, mirror and photo or filming were the resources of EF most used. Brazilian physical therapists adopt adequate content characteristics of EF. However, there are inconsistencies related to their knowledge and current evidence, especially regarding the timing characteristics of EF.

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Conflicts of interest

The authors declare no conflicts of interest.

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Table 1. Characteristics of respondents (n = 246)

Characteristics	**n (%)**
Gender	
Female	162 (65.85)
Age (years old)	
20 – 25	20 (8.13)
25 – 30	62 (25.20)
30 – 35	67 (27.24)
35 – 40	43 (17.48)
40 – 45	30 (12.20)
45 – 50	13 (5.28)
50 – 55	7 (2.85)
55 – 60	2 (0.81)
> 60	2 (0.81)
Type of university (during graduate course)	
Private	198 (80.49)
Public	48 (19.51)
Acting region	
South	190 (77.24)
Southeast	9 (3.66)
Midwest	11 (4.47)
Northeast	35 (14.23)
North	1 (0.41)
*Level of education**	
Bachelor degree	65 (26.42)
Master degree of coursework / residency program	103 (41.87)
Master degree of research	65 (26.42)
Doctorate degree	14 (5.65)
Post-Doctoral degree	4 (1.63)
Time from graduation (years)	
< 5	80 (32.52)
5 – 9	67 (27.24)
9 – 14	52 (21.14)
15 – 20	28 (11.38)
20 – 24	12 (4.88)
> 25	7 (2.85)
*Current practice**	
Treating patients	215 (87.40)
Teaching	51 (20.73)
Research	43 (17.48)
Management	20 (8.13)
Others	9 (3.66)

*Primary facility or setting type**	32 (13.01)
Hospital (public)	25 (10.16)
Hospital (private)	27 (10.98)
Outpatient rehabilitation center (public)	21 (8.54)
Outpatient rehabilitation center (private)	22 (8.94)
Basic health unit	43 (17.48)
Rehabilitation center (owner)	39 (15.85)
Rehabilitation center (employee)	10 (4.07)
Clinic	67 (27.24)
University clinic	2 (0.81)
Sports club	8 (3.25)
Private company (workplace physical therapy)	109 (44.31)
Home care	54 (21.95)
University	14 (5.69)
Research center	10 (4.07)
Others	

*Area of interest**	
Musculoskeletal or orthopedics	161 (65.45)
Gerontology	57 (23.17)
Neurology	54 (21.95)
Cardiorespiratory	45 (18.29)
Sports	40 (16.26)
Health promotion	34 (13.82)
Public health	21 (8.54)
Workplace health	18 (7.32)
Women's health	16 (6.50)
Dermatology	13 (5.28)
Oncology	12 (4.88)
Acupuncture	12 (4.88)
Others	41 (16.67)

Table 2. Knowledge, application and barriers of EF in clinical practice

Questions	**n (%)**
Have you heard about intrinsic and extrinsic feedback?	
Yes	157 (63.82)
No	89 (36.18)
Do you know the definitions of "intrinsic" and "extrinsic" feedback?	
Yes	109 (44.31)
No	137 (55.69)
Do you use any form of EF in the treatment of your patients?	
Yes	213 (86.59)
No	33 (13.41)
*What type of EF do you usually use?**	
Verbal	215 (87.40)
Visual	188 (76.42)
Tactile	163 (66.26)
With some additional resource/instrument	73 (29.67)
Other	2 (0.81)
*Which resource or instrument do you use EF with?**	
Pressure feedback	57 (23.17)
Electromyography	20 (8.13)
Ultrasound imaging	3 (1.22)
Virtual reality	20 (8.13)
Mirror	178 (72.36)
Filming or photos of the patient during some exercise	122 (49.59)
Other	25 (10.16)
What is the approximate percentage of patients that you use some form of EF in your clinical practice?	
All my patients	46 (18.70)
More than 90% of my patients	46 (18.70)
50 – 90% of my patients	65 (26.42)
10 – 50% of my patients	48 (19.51)
Less than 10% of my patients	17 (6.91)
I don't use it with my patients	24 (9.76)
What is the importance of using EF in your clinical practice? (0 = no importance, 10 = very important)	Mean (SD) 7.77 (3.16)

*What are the main barriers that prevent you from using EF in your clinical practice?**	
I don't know what EF is	7 (2.85)
I have no interest in using EF in my clinical practice	2 (0.81)
I was not trained to use EF	39 (15.85)
I don't feel confident using EF	8 (3.25)
There are no equipment/instruments for using EF at my workplace	59 (23.98)
The equipment I would like to use for EF are expensive	32 (13.01)
The use of EF is not appropriate for my patients	13 (5.28)
My patients fail to follow EF instructions	26 (10.57)
I don't have enough time during my treatment session to include EF	15 (6.10)
I do not believe in the possible clinical effect of EF on my clinical practice	1 (0.41)
There is insufficient scientific evidence for the effectiveness of EF in clinical practice	1 (0.41)
No barrier prevents me from using EF in my clinical practice	128 (52.03)
Others	4 (1.63)

Legend: EF, extrinsic feedback; *, in this question participants could choose more than one answer; SD, standard deviation.

Table 3. Content and Timing Characteristics of EF Most Used

Content Characteristics Questions	**n (%)**
<u>How</u> do you usually present feedback information to guide/correct the exercise/movement?	
I guide the patient to perform a certain task to achieve a goal (Knowledge of results)	101 (41.06)
I worry about the movement or the gesture itself, not the task (Knowledge of performance)	127 (51.63)
I do not use any of these forms of feedback	18 (7.32)
<u>Which way</u> do you usually provide feedback to guide/correct an exercise/task?	
Use Feedback to inform the patient about the most global pattern of movement being performed (Program feedback)	115 (46.75)
Use Feedback to inform the patient about specific components of the movement being performed (Parameter feedback)	108 (43.9)
I do not use any of these forms of feedback	23 (9.35)
<u>With what focus</u> do you usually guide/correct the patient to perform the exercise/movement?	
I advise the patient which muscles to contract and which joints to move (Internal focus)	67 (27.24)
I advise the patient about the effect that the movement should have in relation to an object or the external environment (External focus)	156 (63.41)
I do not use any of these forms of feedback	23 (9.35)
<u>Which way</u> do you usually <u>deliver</u> feedback to the patient?	
I provide an average score (based on error or performance score) calculated after a number of exercises/tests are performed (Average)	11 (4.47)
I provide qualitative feedback after several exercises / tests have been performed (Summary)	170 (69.10)
I adopt an acceptable amount of error for the moment the patient is in the rehabilitation process (Bandwidth)	56 (22.76)
I do not use any of these forms of feedback	9 (3.66)
Timing Characteristics Questions	**n (%)**
<u>When</u> do you usually present feedback to the patient?*	
While performing an exercise/task (Concurrent feedback)	204 (82.93)
Immediately at the end of the exercise / task (Terminal – immediate feedback)	36 (14.63)
After some period (seconds or minutes) that the patient performed the exercise/task (Terminal – delayed feedback)	17 (6.91)
I do not use any of these forms of feedback	11 (4.47)
<u>With which frequency</u> do you usually present feedback to the patient?	
After performing each of the tasks/exercises (Constant feedback)	38 (15.45)
At the end of some series of the exercise (Reduced feedback)	26 (10.57)
Only when the patient requests (Self-controlled feedback)	9 (3.66)
Constantly throughout the execution of the exercise (Concurrent feedback)	157 (63.82)
I do not use any of these forms of feedback	16 (6.51)

Retention Test Question	n (%)
Do you usually measure the patient's motor learning (<u>retention test</u>)?	
No, I just use feedback as a form of training	106 (43.09)
Yes, I repeat the same test/exercise without any feedback instrument at the end of the session to verify motor learning	50 (20.33)
Yes, I repeat the same test/exercise with the same feedback instrument at the end of the service to check motor learning	22 (8.94)
Yes, I repeat the same test/exercise without any feedback instrument on the patient's return (2 to 7 days after) to check motor learning	32 (13.01)
Yes, I repeat the same test/exercise with the same feedback instrument on the patient's return (2 to 7 days after) to check the motor learning	21 (8.54)
I don't use any of these forms of learning assessment	15 (6.10)

Legend: EF, extrinsic feedback; * In this question, participants could choose more than one answer.

Table 4. Perceived usefulness of EF (n = 246)

	EF is always useful for rehabilitation, regardless of how it is offered to the patient	EF can be useful for rehabilitation, but it can also delay motor re-learning depending on how it is offered to the patient	Feedback is a useless approach to the rehabilitation
Perceived usefulness n (%)	144 (58.54)	99 (40.24)	3 (1.22)

Legend: EF, Extrinsic feedback.

Table 5. Factors that influence the choice of type and characteristics of EF (n = 246)

Factors influencing use of EF n (%)	No influence	Little influence	Much influence
Scientific papers	14 (5.69)	43 (17.48)	189 (76.93)
Books	18 (7.32)	113 (45.93)	115 (46.75)
Website/Blogs	60 (24.39)	156 (63.41)	30 (12.20)
Learning from graduation	31 (12.60)	84 (34.15)	131 (53.25)
Learning from courses	17 (6.91)	54 (21.95)	175 (71.14)
Clinical experience	8 (3.25)	33 (13.41)	205 (83.33)
Information from networking	20 (8.13)	95 (38.62)	131 (53.25)
Patient's preference	38 (15.45)	96 (39.02)	112 (45.53)

Legend: EF, Extrinsic feedback.

4.2 MANUSCRITO II

Open Access Protocol

BMJ Open

Measurement properties of the craniocervical flexion test: a systematic review protocol

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ABSTRACT

Introduction Neck pain is the leading cause of years lived with disability worldwide and it accounts for high economic and societal burden. Altered activation of the neck muscles is a common musculoskeletal impairment presented by patients with neck pain. The craniocervical flexion test with pressure biofeedback unit has been widely used in clinical practice to assess function of deep neck flexor muscles. This systematic review will assess the measurement properties of the craniocervical flexion test for assessing deep cervical flexor muscles.

Methods and analysis This is a protocol for a systematic review that will follow the Preferred Reporting Items for Systematic Review and Meta-Analysis statement. MEDLINE (via PubMed), EMBASE, PEDro, Cochrane Central Register of Controlled Trials (CENTRAL), Scopus and Science Direct will be systematically searched from inception. Studies of any design that have investigated and reported at least one measurement property of the craniocervical flexion test for assessing the deep cervical flexor muscles will be included. All measurement properties will be considered as outcomes. Two reviewers will independently rate the risk of bias of individual studies using the updated COnsensus-based Standards for the selection of health Measurement Instruments risk of bias checklist. A structured narrative synthesis will be used for data analysis. Quantitative findings for each measurement property will be summarised. The overall rating for a measurement property will be classified as 'positive', 'indeterminate' or 'negative'. The overall rating will be accompanied with a level of evidence.

Ethics and dissemination Ethical approval and patient consent are not required since this is a systematic review based on published studies. Findings will be submitted to a peer-reviewed journal for publication.

PROSPERO registration number CRD42017062175.

Strengths and limitations of this study

- ► Comprehensive and exhaustive search for relevant studies from several databases.
- ► A new summary of the evidence on measurement properties of a widely used clinical test: the craniocervical flexion test with the pressure biofeedback unit for the assessment of deep cervical flexor muscles.
- ► This review used the internationally recognised, validated COnsensus-based Standards for the selection of health Measurement Instruments risk of bias checklist to assess the methodological quality of the included studies when assessing the quality of the craniocervical flexion test.
- ► The proposed systematic review will adhere to the Preferred Reporting Items for Systematic Review and Meta-Analysis guidelines, ensuring consistency and uniformity in reporting and the full systematic review.
- ► A limitation of the review is that it will only include papers published in English.

INTRODUCTION

Neck pain is the leading cause of years lived with disability worldwide, and it accounts for high economic and societal burden.[1 2] In the general population, 16.7%–75.1% of adults will develop an episode of neck pain in any given year.[3 4] Patients may present recurrent neck pain,[5 6] and the prognosis of recovery is poor.[5] Between 50% and 75% of people who experienced neck pain still present with symptoms 1–5 years after the onset of symptoms.[6]

Altered activation of the neck muscles is a common musculoskeletal impairment presented by patients with neck pain.[7] Compared with asymptomatic individuals, patients with neck pain exhibit increased activity of superficial neck flexors and reduced activity of the deep neck flexors,[8] poor muscle endurance,[9 10] altered kinematics of the cervical spine,[11] delayed feedforward activity[12] and impaired proprioception.[13–15] These impairments are likely to contribute to maintenance of symptoms in patients with chronic neck pain.[16]

As the clinical presentation of patients with neck pain are not homogeneous, clinical assessment of neck muscle function is important for identifying musculoskeletal impairments and tailoring treatment to patients' needs.[17] Several tests have been designed to evaluate different aspects of neck muscle performance.[18-23] Among those tests, the craniocervical flexion test with pressure biofeedback unit has been developed to evaluate the ability of an individual to selectively recruit the deep neck flexors (*longus capitis* and *longus colli*) while maintaining low activity levels of the superficial neck flexors (eg, *sternocleidomastoid, anterior scalene*) during an active craniocervical flexion in supine lying.[23] This test has been widely used in clinical practice to assess function of deep neck flexor muscles.[8 23 24]

To conduct the craniocervical flexion test with pressure biofeedback unit, the patient's head is positioned in neutral, with patient in supine crook lying. The test consists of an active head nodding movement. During this movement, the patient attempts to target five different pressure levels, from 22 to 30 mm Hg.[24] This test is performed with an extrinsic air-filled pressure biofeedback unit placed behind the neck. This device provides feedback and direction for the patient to perform the test and enables an objective and quantitative assessment of the patient performance.[23] The performance of the test is assessed through the following components: how well the patient performs the active head nodding and achieves that by contracting the deep cervical flexors without contraction of superficial flexors), muscle endurance (through isometric contraction) of deep cervical flexors at each test stages with appropriate craniocervical flexion contraction and quality and range of craniocervical movement in the sagittal plane (which is expected to increase as the patient progress through the five different pressure levels).[8 23]

Ideally, the measurement properties (eg, reliability, validity and responsiveness) of an instrument or test, for instance, the craniocervical flexion test with pressure biofeedback unit, should be assessed before its full implementation in clinical practice.[25] Selecting instruments with proper measurement properties is fundamental for well-conduced clinical trials.[26] Hence, systematic reviews of measurement properties are useful for identifying instruments and tools with the highest reliability, validity and responsiveness scores.[27]

A previous systematic review[28] evaluated the measurement properties of methods to measure muscle function in patients with non-specific neck pain. In this review, the intraobserver reliability was the only measurement property assessed.[28] This review was conducted over 10 years ago, included only four studies and used a checklist adapted from two previous studies.[29 30] Since then, the number of published studies evaluating measurement properties of craniocervical flexion test has increased. In addition, new tools have been developed for assessing methodological quality of individual studies exploring measurement properties of instruments (ie, Consensus-based Standards for the selection of health Measurement Instruments (COSMIN)).[25] It is likely that a new review evaluating the measurement properties of the craniocervical flexion test with pressure biofeedback unit will provide relevant insights on the state of research in this field. This systematic review will critically appraise and summarise the quality of the measurement properties of the craniocervical flexion test for assessing deep cervical flexor muscles.

METHODS

Protocol and registration

This is a protocol for a systematic review that was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P).[31] The systematic review has been registered with Prospective Register of Systematic Reviews (PROSPERO) (CRD42017062175).

Eligibility criteria

We will include studies if they meet the following criteria:

- Articles that have investigated and reported at least one measurement property (ie, validity, reliability or responsiveness) of the craniocervical flexion test for assessing the deep cervical flexor muscles.
- Articles published in English.
- Assessing participants older than 18 years.
- Articles available in full text.
- Studies with both asymptomatic and symptomatic individuals (including those with acute, subacute and chronic neck pain with or without nerve root compromise; neck-related shoulder pain, whiplash-associated disorders and neck disorders associated with headache).

Studies assessing only the effectiveness of interventions, but not reporting measurement property outcomes of pressure biofeedback unit for assessing motor control of deep cervical flexor muscles will be excluded.

Outcomes

All measurement properties will be considered as outcomes in this systematic review. We will adopt the COSMIN terminology and definitions of measurement properties.[32] Reliability is defined as the degree to which a measurement is free from measurement error; validity is the degree to which an outcome instrument measures the construct(s) it purports to measure and responsiveness is the ability of an outcome instrument to detect change over time in the construct to be measured.[32] Among these properties, reliability and validity are further subdivided. For example, reliability is further classified into reliability, internal consistency and measurement error; validity comprises content validity, construct validity and criterion validity.[32] For the purposes of this review, we will include all outcome measures used assessing psychometric properties that are reported by included studies.

Search strategy

The search strategy was designed through consultation with a health sciences faculty librarian. Our search will include the following databases: MEDLINE (via PubMed), EMBASE, PEDro, Cochrane Central Register of Controlled Trials (CENTRAL), Scopus and Science

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Table 1 Search strategy in MEDLINE (via Pubmed)

1#	((((((patient outcome assessment (Mesh)) OR ((outcome and process assessment (Mesh)))) OR treatment outcome (Mesh) OR instrumentation (sh) OR methods (sh) OR 'Validation Studies' (pt) OR 'Comparative Study' (pt) OR 'psychometrics' (MeSH) OR psychometr* (tiab) OR clinimetr* (tw) OR clinometr*(tw) OR 'outcome assessment (healthcare)' (MeSH) OR 'outcome assessment' (tiab) OR 'outcome measure*'(tw) OR 'observer variation' (MeSH) OR 'observer variation' (tiab) OR 'Health Status Indicators' (Mesh) OR 'reproducibility of results' (MeSH) OR reproducib* (tiab) OR 'discriminant analysis' (MeSH) OR reliab*(tiab) OR unreliab* (tiab) OR valid* (tiab) OR 'coefficient of variation'(tiab) OR coefficient (tiab) OR homogeneity (tiab) OR homogeneous(tiab) OR 'internal consistency' (tiab) OR (cronbach* (tiab) AND (alpha (tiab) OR alphas (tiab))) OR (item (tiab) AND (correlation* (tiab) OR selection* (tiab) OR reduction* (tiab))) OR agreement (tw) OR precision (tw) OR imprecision (tw) OR 'precise values' (tw) OR test-retest(tiab) OR (test (tiab) AND retest (tiab)) OR (reliab* (tiab) AND (test(tiab) OR retest(tiab))) OR stability (tiab) OR interrater (tiab) OR inter-rater (tiab) OR intrarater (tiab) OR intra-rater (tiab) OR intertester (tiab) OR inter-tester (tiab) OR intratester (tiab) OR intra-tester (tiab) OR interobserver (tiab) OR inter-observer (tiab) OR intraobserver (tiab) OR intra-observer (tiab) OR intertechnician (tiab) OR inter-technician (tiab) OR intratechnician (tiab) OR intra-technician (tiab) OR interexaminer (tiab) OR inter-examiner (tiab) OR intraexaminer (tiab) OR intra-examiner (tiab) OR interassay (tiab) OR inter-assay (tiab) OR intraassay (tiab) OR intra-assay (tiab) OR interindividual (tiab) OR inter-individual (tiab) OR intraindividual (tiab) OR intra-individual (tiab) OR interparticipant (tiab) OR inter-participant (tiab) OR intraparticipant (tiab) OR intra-participant (tiab) OR kappa (tiab) OR kappa's (tiab) OR kappas (tiab) OR repeatab*(tw) OR ((replicab* (tw) OR repeated (tw)) AND (measure (tw) OR measures (tw) OR findings (tw) OR result (tw) OR results (tw) OR test (tw) OR tests (tw))) OR generaliza* (tiab) OR generalisa* (tiab) OR concordance (tiab) OR (intraclass (tiab) AND correlation* (tiab)) OR discriminative (tiab) OR 'known group' (tiab) OR 'factor analysis' (tiab) OR 'factor analyses' (tiab) OR 'factor structure' (tiab) OR 'factor structures' (tiab) OR dimension* (tiab) OR subscale* (tiab) OR (multitrait (tiab) AND scaling (tiab) AND (analysis(tiab) OR analyses(tiab))) OR 'item discriminant' (tiab) OR 'interscale correlation*' (tiab) OR error(tiab) OR errors(tiab) OR 'individual variability' (tiab) OR 'interval variability' (tiab) OR 'rate variability' (tiab) OR (variability (tiab) AND (analysis (tiab) OR values (tiab))) OR (uncertainty (tiab) AND (measurement (tiab) OR measuring (tiab))) OR 'SE of measurement' (tiab) OR sensitiv* (tiab) OR responsive* (tiab) OR (limit (tiab) AND detection (tiab)) OR 'minimal detectable concentration'(tiab) OR interpretab*(tiab) OR ((minimal (tiab) OR minimally (tiab) OR clinical (tiab) OR clinically (tiab)) AND (important (tiab) OR significant (tiab) OR detectable (tiab)) AND (change (tiab) OR difference (tiab))) OR (small* (tiab) AND (real (tiab) OR detectable (tiab)) AND (change (tiab) OR difference (tiab))) OR 'meaningful change' (tiab) OR 'ceiling effect' (tiab) OR 'floor effect' (tiab) OR 'Item response model' (tiab) OR IRT (tiab) OR Rasch (tiab) OR 'Differential item functioning'(tiab) OR DIF(tiab) OR 'computer adaptive testing' (tiab) OR 'item bank' (tiab) OR 'cross-cultural equivalence' (tiab))))))
2#	(((((pressure biofeedback unit (Title/Abstract) OR pressure biofeedback units (Title/Abstract) OR unit, pressure biofeedback (Title/Abstract) OR units, pressure biofeedback (Title/Abstract) OR stabilizer (Title/Abstract) OR (Title/Abstract) OR stabiliser (Title/Abstract) OR stabilizers (Title/Abstract) OR biofeedback (Title/Abstract) OR biofeedbacks (Title/Abstract) OR craniocervical flexion test (Title/Abstract) OR cranio-cervical flexion test (Title/Abstract) OR cranio cervical flexion test (Title/Abstract) OR cranio cervical flexion (Title/Abstract)))))
3#	((((((Muscle, Neck (Title/Abstract) OR Muscles, Neck (Title/Abstract) OR Neck muscle (Title/Abstract)))) OR Neck muscles (MeSH Terms))) OR ((neck (MeSH Terms)) OR Necks (Title/Abstract) OR deep cervical flexor* (Title/Abstract) OR rectus capit* (Title/Abstract) OR longus colli (Title/Abstract) OR longus capiti (Title/Abstract)))
4#	1# AND 2# AND 3#

Direct. All databases will be searched from their inception to present time using a published search filter for finding studies on measurement properties.[33] MEDLINE full-search strategy is described in table 1.

Data extraction

Two reviewers (FXA and MSS) will independently screen titles and abstracts for eligibility. A third reviewer (MPC) will resolve any disagreement. The full text of potentially eligible articles will be screened independently by two reviewers (FXA and MSS). Data from included studies will be extracted independently by the two reviewers, using a piloted data collection form. Data will then be compared for accuracy, and disagreements will be resolved by consensus. The following information will be extracted from the included studies: study design, sample characteristics, measurement properties (eg, validity, reliability or responsiveness) assessed by included studies, craniocervical flexion test procedures and results of the measurements properties.

Risk of bias within included studies

Two reviewers (FXA and GEF) will independently rate the risk of bias of individual studies using the updated COSMIN risk of bias checklist.[34] The COSMIN risk of bias checklist is a validated critical appraisal tool designed for the systematic evaluation of the methodological quality of studies on the measurement properties.[27] For each study, only applicable domains to the study being assessed will be used for assessing the quality of the study. Disagreements between reviewers will be resolved by a third reviewer (MPC).

Synthesis of results

A structured narrative synthesis will be used for data analysis. Quantitative findings for each measurement

Table 2 Quality criteria for measurement properties

Property	Rating	Quality criteria
Reliability		
Internal consistency	+	Cronbach's alpha(s) ≥0.70
	?	Cronbach's alpha not determined or unidimensionality unknown
	–	Cronbach's alpha(s) <0.70
Reliability	+	ICC/weighted Kappa ≥0.70 OR Pearson's r ≥0.80
	?	Neither ICC/weighted Kappa, nor Pearson's r determined
	–	ICC/weighted Kappa <0.70 OR Pearson's r <0.80
Measurement error	+	MIC>SDC OR MIC outside the LoA
	?	MIC not defined
	–	MIC≤SDC OR MIC equals or inside LoA
Validity		
Content validity	+	All items are considered to be relevant for the construct to be measured, for the target population and for the purpose of the measurement AND the questionnaire is considered to be comprehensive
	?	Not enough information available
	–	Not all items are considered to be relevant for the construct to be measured, for the target population and for the purpose of the measurement OR the questionnaire is considered not to be comprehensive
Construct validity Structural validity	+	Factors should explain at least 50% of the variance
	?	Explained variance not mentioned
	–	Factors explain <50% of the variance
Hypothesis testing	+	Correlations with instruments measuring the same construct≥0.50 OR at least 75% of the results are in accordance with the hypotheses AND correlations with related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	–	Correlations with instruments measuring the same construct<0.50 OR <75% of the results are in accordance with the hypotheses OR correlations with related constructs are lower than with unrelated constructs
Cross-cultural validity	+	No differences in factor structure OR no important DIF between language versions
	?	Multiple group factor analysis not applied AND DIF not assessed
	–	Differences in factor structure OR important DIF between language versions
Criterion validity	+	Convincing arguments that gold standard is 'gold' AND correlation with gold standard≥0.70
	?	No convincing arguments that gold standard is 'gold'
	–	Correlation with gold standard<0.70
Responsiveness		
Responsiveness	+	Correlation with changes on instruments measuring the same construct≥0.50 OR at least 75% of the results are in accordance with the hypotheses OR AUC≥0.70 AND correlations with changes in related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	–	Correlations with changes on instruments measuring the same construct<0.50 OR <75% of the results are in accordance with the hypotheses OR AUC<0.70 OR correlations with changes in related constructs are lower than with unrelated constructs

+, positive rating; –, negative rating; ?, indeterminate rating; AUC, area under the curve; DIF, differential item functioning; ICC, intraclass correlation coefficient; LoA, limits of agreement; MIC, minimal important change; SDC, smallest detectable change.

property will be summarised. The overall rating for a measurement property will be classified as 'positive', 'indeterminate' or 'negative'. The overall rating will be accompanied with a level of evidence (strong, moderate, limited, conflicting, unknown—table 2) as proposed by Terwee *et al*.[35] The criteria used to assign levels of evidence for the quality of each measurement property (table 3) will follow the framework proposed by the Cochrane Back and Neck Review Group.[36]

Table 3 Levels of evidence for the quality of the measurement property

Level	Rating	Criteria
Strong	+++ or −−−	Consistent findings in multiple studies of good methodological quality OR in one study of excellent methodological quality
Moderate	++ or −−	Consistent findings in multiple studies of fair methodological quality OR in one study of good methodological quality
Limited	+ or −	One study of fair methodological quality
Conflicting	+/−	Conflicting findings
Unknown	?	Only studies of poor methodological quality

−, negative rating; ?, indeterminate rating; +, positive rating.

We will conduct a narrative synthesis of subgroups, if applicable, based on the sample characteristics (ie, asymptomatic or symptomatic) and type of disorder (eg, acute, subacute and chronic non-specific neck pain; acute, subacute and chronic neck pain with nerve root compromise; neck-related shoulder pain; whiplash-associated disorders and neck disorder associated with headache).

Ethics and dissemination

Ethical approval and patient consent are not required since this is a systematic review based on published studies. This protocol has been registered on the international PROSPERO and the systematic review will be conducted according to the PRISMA statement. The results of this systematic review will be submitted to a peer-reviewed journal for publication and will be presented at national and international conferences.

Contributors FXdeA is a PhD student and the leading researcher, responsible for conceiving the study and designing the protocol. FXdeA and MSS were involved in the screening of title, abstracts and full text for eligibility. MSS and GEF extracted data, provided the statistical analysis plan of the study and conducted the data analysis. FXdeA and GEF rated the methodological quality of individual studies. MPdeC resolved any disagreement between reviewers. FXdeA, MSS and GEF wrote the first version of the paper. MPdeC, DCR and MFS provided the critical revision of the paper. All authors read and provided final approval of this protocol to be published. All authors have contributed to the conception and design of the study protocol, development of the search strategy, the establishment of the inclusion and exclusion criteria, data extraction criteria, analyses and interpretation.

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Competing interests None declared.

Patient consent Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement This is a protocol and all data is available on the protocol reporting.

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Measurement properties of the craniocervical flexion test: a systematic review protocol

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4.3 MANUSCRITO III

Measurement properties of the craniocervical flexion test: a systematic review

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Measurement properties of the craniocervical flexion test: a systematic review

Francisco Xavier de Araujo, Giovanni Esteves Ferreira, Maurício Scholl Schell, Marcelo Peduzzi de Castro, Marcelo Faria Silva, Daniel Cury Ribeiro

ABSTRACT:

Background: Patients with neck pain commonly present altered activity of the neck muscles. The craniocervical flexion test (CCFT) is used to assess function of deep neck flexor muscles in patients with musculoskeletal neck disorders. Systematic reviews summarizing the measurement properties of the CCFT are outdated.

Purpose: To systematically review the measurement properties of the CCFT for assessing deep neck flexor muscles.

Data Sources: MEDLINE, EMBASE, PEDro, Cochrane Central Register of Controlled Trials, Scopus and Science Direct were searched in April 2019.

Study Selection: We included studies of any design that reported at least one measurement property of the CCFT for assessing the deep neck flexor muscles.

Data Extraction: Two reviewers independently extracted data and rated the risk of bias of individual studies using the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) risk of bias checklist. The overall rating for each measurement property was classified as "positive", "indeterminate", or "negative". The overall rating was accompanied with a level of evidence.

Data Synthesis: Fourteen studies were included. There is a positive and moderate level of evidence for inter and intra-rater reliability and convergent validity. There is conflicting rating and level of evidence for discriminative validity. Measurement error is indeterminate, with unknown level of evidence. Responsiveness is negative with limited level of evidence.

Limitations: Only papers published in English included.

Conclusions: The CCFT is a valid and reliable test that can be used in clinical practice as an assessment test. Due to the conflicting and low-quality evidence, currently caution is advised when using the CCFT as a discriminative test and as an outcome measure. Future well-designed studies are warranted.

Word count: 4128 words

INTRODUCTION:

Neck pain is one of the most common musculoskeletal causes of years lived with disability worldwide.[1] It accounts for a high economic and societal burden.[1,2] The point prevalence of neck pain is estimated to be 4,9%, being higher in women and in high income countries.[2] The prognosis of recovery is poor, and recurrent symptoms are common.[3-5] Between 50% and 75% of people who experienced an episode of neck pain will still have symptoms in the following one to five years.[3]

Although neck pain is multifactorial, patients with neck pain commonly present several neck muscle impairment.[4] The impairments include: decreased strength,[5] decreased endurance,[6,7] delayed onset of neck muscles activation,[8] and changes in the coordination between muscles (e.g. increased activity of superficial neck flexors concurrently with reduced activity of deep neck flexors).[9] Structural changes, such as fatty infiltrate and atrophy, may also occur on cervical muscle morphology in patients with cervical pain.[10] These impairments may contribute to the perpetuation of symptoms in patients with chronic neck pain.[11] Clinicians often aim at targeting these impairments with exercises tailored to the patient's impairments.[9,12,13]

To assess the presence of muscle imbalance between superficial and deep neck flexors, physical therapists often perform the craniocervical flexion test (CCFT) with a pressure biofeedback unit. This test was developed to evaluate the ability of an individual to selectively recruit the deep neck flexors muscles (*longus capitis* and *longus colli*) while maintaining low activity levels of the superficial neck flexors muscles (e.g. *sternocleidomastoid*, *anterior scalene*) during an active craniocervical flexion in supine lying.[14] To conduct the craniocervical flexion test with pressure biofeedback unit, the patient is in supine crook lying with the head in neutral position.[14] The patient then performs a gentle active head nodding movement. During this movement, the patient attempts to target five different pressure levels, from 22 to 30 mm Hg, avoiding compensation strategies.[14] This test is mainly used in clinical practice to assess the function of deep neck flexor muscles,[9,14,15] but the same test procedures can also be used as a form of exercise to train motor control to improve the coordination between the deep and superficial neck flexors and then the low-level endurance capacity of the deep neck flexor muscles in patients with neck pain.[12] In addition, the pressure biofeedback unit can also be used as an extrinsic feedback tool to facilitate motor control training in these patients.[16]

In clinical and research settings, patient's performance focuses simultaneously on: (1) the patient's ability to perform the correct craniocervical flexion action without compensation strategies, (2) the excessive activity of the superficial neck flexors in association with reduced activity in the deep neck flexors, (3) the pressure level achieved with the correct craniocervical flexion movement, without excessive activity of the superficial flexors. In a research setting, it is possible to measure activity levels of both superficial and deep cervical flexor muscles at each stage of the test.[13] To measure activity of deep flexor muscles, invasive methods are required.[17] There is an inverse relationship between superficial and deep neck flexors electromyographic activity.[9] For that reason, most studies assess activity levels of superficial flexor muscles only.[18–22]

In a clinical setting, patient's performance during the CCFT is assessed by the clinician's judgement of which of the five pressure levels the patient can sustain for a period of time while performing the craniocervical flexion without using compensation strategies (e.g. excessive use of the sternocleidomastoid or anterior scalene muscles).[17] Originally the patient's performance during the CCFT was evaluated with different parameters, such as the activation score and the performance index.[23] The activation score is defined as the maximum pressure level achieved and held in a steady manner for 10 seconds above the baseline pressure, without any compensation strategies. The performance index is calculated by multiplying the activation score by the number of successful repetitions.[23] There have been modifications to the CCFT test protocol from its original description, and the test is now evaluated in two stages.[14] In stage 1, performance is assessed by observing which pressure level the patient can achieve and hold it for 2 to 3 seconds with the correct craniocervical flexion action, without palpable activity of the superficial flexors. The performance of stage 2 is assessed by quantifying the pressure level that the patient can hold steady for repeated 10-second holds, with minimal superficial muscle activity and in the absence of any other substitution strategies.[14]

Ideally, the measurement properties (e.g. reliability, validity, and responsiveness) of a test, for instance the CCFT with pressure biofeedback unit, should be determined before its full implementation in clinical practice.[24] Selecting instruments with good measurement properties is fundamental for an evidence-based clinical practice and for conducting well-designed clinical trials.[25] Hence, there is a growing interest on systematic reviews of measurement properties,[26–33] as such studies are useful for identifying instruments and tests with the highest reliability, validity and responsiveness scores.[34]

In a previous systematic review[35] published in 2008, the only measurement property reported for the CCFT was the intra-observer reliability. This review has limitations, such as limited number of included studies and the outdated methods to evaluate risk of bias and to summarize the strength of evidence.[36,37] Since then, the number of published studies evaluating measurement properties of CCFT has increased.[15,19,38–42] In addition, the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) was developed for assessing risk of bias of individual studies exploring measurement properties of instruments.[24] Therefore, the purpose of this systematic review was to critically appraise and summarize the quality of the measurement properties of the CCFT for assessing deep cervical flexor muscles.

METHODS

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations[43] and was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) (registration number: CRD42017062175). The protocol of this systematic review with complete description of methods was previously published.[44]

Data Sources and Searches

We searched MEDLINE (via PubMed), EMBASE, PEDro, Cochrane Central Register of Controlled Trials (CENTRAL), Scopus and Science Direct from their inception to April 2019. A librarian assisted in the development of the search strategy for each database. We used a previously published search filter for finding studies on measurement properties.[45] A detailed description of the search strategy is presented in Appendix 1.

Study Selection

We included studies if they met the following criteria: (1) studies of any design that have investigated and reported at least one measurement property (i.e, reliability, validity or responsiveness) of the CCFT, regardless of CCFT outcome measure (e.g. activation score, performance index or electromyography activity); (2)

studies conducted in adults over 18 years old; (3) studies that included either asymptomatic or with neck pain with or without nerve root compromise, neck-related shoulder pain, whiplash-associated disorders and neck disorders associated with headache; (4) studies published in English and with full-text available were included. Studies that assessed the effects of craniocervical flexion exercises (e.g. muscle activation or endurance) using the pressure biofeedback unit but did not report any measurement property of the CCFT were excluded. Two reviewers (FXA and MSS) independently screened titles and abstracts for eligibility, and later, independently screened full-text of potentially eligible studies. We also conducted hand-searching of the reference list of included studies.

Measurement Properties

All measurement properties were considered as outcomes. We used the COSMIN definitions of measurement properties to identify which outcomes had been assessed in a study, regardless of the terminology used in the included studies (Appendix 2).[31,46] The COSMIN checklist is a validated critical appraisal tool designed for the systematic evaluation of the methodological quality of studies on the measurement properties. It contains standards referring to design requirements and preferred statistical methods of studies on measurement properties.[47] The COSMIN checklist was originally designed to evaluate health-related patient-reported outcomes,[34] but it can also be used for other types of instruments, such as clinician- reported outcome measures or performance- based outcome measures.[48] Examples of performance-based outcome measures include the six minute walk test[32,34] lower extremities functional tests,[29] and physical capacity tasks designed to assess functioning in patients with low back pain.[33]

The COSMIN risk of bias checklist has 10 domains, each one representing a measurement property included in the COSMIN taxonomy: (1) patient-reported outcome measure (PROM) development; (2) content validity; (3) structural validity; (4) internal consistency; (5) cross-cultural validity; (6) reliability; (7) measurement error; (8) criterion validity; (9) hypotheses testing for construct validity; (10) responsiveness.[47] Because the CCFT is a performance-based test, some of these domains are not applicable, as for example: (1) patient-reported outcome measure (PROM) development; (2) content validity; (3) structural validity; (4) internal consistency; (5) cross-cultural validity.

Hence, for the purpose of this review, the following domains were used: reliability (box 6), measurement error (box 7), hypotheses testing for construct validity (box 9), and responsiveness (box 10). Reliability is defined as the degree to which a test is free from measurement error.[46] The measurement properties within this domain are assessed by repeated measurements in a defined period when there has been no change in the patient's condition.[49] For example, when repeating the CCFT over time (test-retest), measuring an outcome by different examiners on the same occasion (inter-rater) or measuring an outcome by the same examiner on different occasions (intra-rater). Measurement error is defined as the systematic and random error of a patient's score that is not attributed to true changes in the construct to be measured. For example, whether the observed changes in CCFT performance are really attributable to improved patient performance or an inherent test error. Validity is the degree to which a test measures what it purports to measure.[46] According to COSMIN, hypothesis testing for construct validity is a domain divided into two categories: convergent validity and discriminative validity.[46] Example of convergent validity is whether the CCFT is able to assess the recruitment level of deep cervical flexor muscles when compared with another valid instrument such as electromyography. Discriminative validity refers to whether the CCFT is able to discriminate different groups (e.g. patients *versus* asymptomatic) (discriminative validity). Responsiveness (box 10) is the ability of a test to detect change over time.[46] For example, whether the CCFT is able to identify changes (improvement or worsening) in clinical (e.g. pain and disability) or biomechanical (e.g. deep neck flexors activation levels) outcomes. Responsiveness should be assessed against another valid instrument. A more detailed description of the definitions of each measurement property contained in the COSMIN checklist are presented in Appendix 2.

Data Extraction and Quality Assessment

A data collection form was developed and piloted in five studies prior to data extraction. After that, two reviewers independently extracted data from included studies. Data were then compared for accuracy, and disagreements were resolved by consensus. We extracted the following information from the included studies:

study design, sample characteristics, measurement properties assessed by included studies, duration of symptoms and measurement property findings reported by studies.

Two reviewers (FXA and GEF) independently rated the risk of bias of each single study on a measurement property using the COSMIN risk of bias checklist.[47] Each measurement property was evaluated separately, considering several items that can be scored on a 4-point rating scale (i.e., ‘very good’, ‘adequate’, ‘doubtful’ or ‘inadequate’).[48]

For each study, a risk of bias score per domain is obtained by taking the lowest rating of any item in a domain (i.e. “the worst score counts” principle), that is, if one question in one domain is scored inadequate, the overall methodological quality of the assessment for that measurement property is determined to be inadequate.[34] Disagreements between reviewers were resolved by a third reviewer (MPC).

Data Synthesis and Analysis

A structured narrative synthesis was used for data analysis. We used the COSMIN updated criteria for good measurement properties to determine the result of each single study on a measurement property.[50] Every domain presents specific criteria. Based on these criteria, the quality of each measurement property was rated as (1) positive, (2) indeterminate or (3) negative.[50] The definition for each measurement property, as well as, the criteria for good measurement properties is described in Appendix 2.

In addition, we determined the level of evidence (strong, moderate, limited, conflicting and unknown) for each measurement property using the framework proposed by the Cochrane Back and Neck Review Group. This framework was included in our protocol,[44] and used in recent systematic reviews in this area.[27,31,49,51] The level of evidence is based on consistency of findings, number of studies reaching the same conclusion and risk of bias of included studies.[52]

For each measurement property, we summarized the *quality* (i.e. positive, indeterminate and negative) and the *level of evidence* (i.e. strong, moderate, limited, conflicting and unknown).

RESULTS

The database research identified 702 records. We identified a further 6 records after checking included articles' references. After removing duplicates, 593 articles were screened and 62 full-texts were screened. Fourteen studies involving 588 participants were included. The PRISMA flowchart (Figure 1) illustrates the flow of studies in this review.

INSERT FIGURE 1 AROUND HERE

Seven studies included only asymptomatic participants,[17,19,38,39,53,54] one study included only patients with chronic neck pain,[41] five studies included either asymptomatic participants and patients with neck pain,[15,40,42,55,56] one study included either asymptomatic participants and patients with cervicogenic headache,[23] and one study included either asymptomatic participants and patients with whiplash associated disorders.[18] Eleven studies evaluated inter-rater reliability,[16,31,33,35,36,47–52] five studies evaluated intra-rater reliability,[15,39,40,54,55] seven studies evaluated measurement error,[15,17,19,39,40,42,54] three studies evaluated convergent validity,[17,18,56] seven studies evaluated discriminative validity[15,18,23,40,42,55,56] and only one study evaluated responsiveness[41] (Table 1).

The specific results on reliability and measurement error are presented in Table 2, the specific results on validity and responsiveness are presented table 3, and the summary of the quality of the measurement property followed by the level of evidence for each measurement property are presented in Table 4.

INSERT TABLE 1 AROUND HERE

Reliability

For inter-rater reliability, the methodological quality of two studies was rated as inadequate,[38,53] four studies were rated as doubtful,[17–19,55] four studies were rated as adequate,[23,40,42,54] and one study was rated as very good.[15] This measurement property was rated as positive for seven studies,[15,19,23,38,40,42,54] negative for two studies,[18,55] and indeterminate for two studies[17,57] (Table 2). We therefore classified the overall rating of inter-rater reliability of CCFT for measuring deep cervical flexors as positive, and the level of evidence as moderate (Table 4).

For intra-rater reliability, the methodological quality of one study was rated as doubtful,[55] two studies as adequate,[40,54] and two studies as very good.[15,39] This measurement property was rated as positive for four studies,[39,40,54,55] and negative for one study[15] (Table 2). We therefore classified the overall rating of intra-rater reliability of CCFT for measuring deep cervical flexors as positive, and the level of evidence of intra-rater reliability as moderate (Table 4).

Measurement Error

Seven studies assessed measurement error.[15,17,19,39,40,42,54] The methodological quality of three studies were classified as doubtful,[17,19,40,42] one study was rated as adequate[42] and three study were rated as very good.[15,39,54] This measurement property was rated as indeterminate for all seven studies (Table 2). We therefore classified the overall rating of measurement error of CCFT for measuring deep cervical flexors as indeterminate, and the level of evidence of measurement error as unknown (Table 4).

INSERT TABLE 2 AROUND HERE

Hypotheses Testing for Construct Validity

Three studies assessed convergent validity by correlating the stages in the CCFT with electromyographic activity.[17,18,56] The methodological quality of these studies was rated as inadequate[18] or doubtful[17,56] (Table 3). This measurement property was rated as positive for all three studies. We therefore classified the overall rating of convergent validity of CCFT for measuring deep cervical flexors as positive, and the level of evidence of convergent validity as moderate (Table 4).

Seven studies assessed the discriminative validity of CCFT by comparing the CCFT results between patients and asymptomatic participants.[15,18,23,40,42,55,56] The methodological quality of these studies was rated as doubtful[18,23,55,56] or very good[15,40,42] (Table 3). This measurement property was rated as positive for five studies,[15,18,23,40,56] and negative for two studies.[42,55] We therefore classified the overall rating of discriminative validity of CCFT for measuring deep cervical flexors as conflicting, and the level of evidence of discriminative validity as conflicting (Table 4).

Responsiveness

Only one study[41] assessed the responsiveness of the CCFT (Table 3). Its methodological quality was rated as doubtful, and the measurement property was rated as negative. We therefore classified the overall rating of responsiveness of CCFT for measuring deep cervical flexors as negative, and the level of evidence of responsiveness as limited (Table 4).

INSERT TABLE 3 AROUND HERE

INSERT TABLE 4 AROUND HERE

DISCUSSION

This review assessed the measurement properties of CCFT for assessing deep cervical flexor muscles. Most studies (n=11) have assessed intra or inter-rater reliability[16,31,33,35,36,47–52], discriminative validity (n=7),[15,17,18,23,40,42,56] or measurement error (n=7).[15,17,19,39,40,58,59] Only a very limited number of studies have evaluated convergent validity (n=3),[17,18,56] and only one study[41] evaluated responsiveness. Our results showed conflicting results for hypotheses testing and discriminative validity, limited evidence for responsiveness, and unknown evidence for measurement error. We demonstrated positive Inter and intra-rater reliability and convergent validity. No measurement property was classified with strong level of evidence (Table 4). We rated most studies as having inadequate or doubtful methodological quality for assessing different measurement properties.

This was the first systematic review on measurement properties of CCFT using the COSMIN risk of bias checklist,[47] which is a validated and accepted tool for systematically evaluating the methodological quality of studies assessing and reporting measurement properties. Another strength of this review is the use of a validated, highly sensitive search strategy to identify relevant studies.[45] We included studies that reported measure property of the test even if they were not specifically designed for it. That approach allowed us to identify a broad range of studies. We conducted this review according (PRISMA) recommendations,[43] ensuring consistency and uniformity in reporting the systematic review, and we registered this review on PROSPERO, and published the protocol previously.[44]

This review updates and adds to a previous review.[35] Our review included 14 studies, including 8 published since 2008, and summarized results for measurement properties other than intra-rater reliability. In addition, our study also presents a level of evidence for each measurement property. The study conducted by Koning et al.[35] included only 4 studies and interpreted their data from included studies based on criteria drawn from two separate questionnaires. To be considered as positive the reliability in that previous review,[35] the included study should present adequate methodology and ICC > 0.85. Based on these criteria, that previous review classified reliability as negative. For the purposes of our review, and following the COSMIN, reliability was considered positive if the ICC is ≥ 0.70. In addition, COSMIN has better defined criteria for assessing the risk of bias within each study. Our review classified the overall rating for intra-rater reliability as positive, as well as, the level of evidence for intra-rater reliability as moderate. In addition, our review also scored the overall rating for inter-rater reliability as positive and with moderate level of evidence.

Methodological quality of the included studies evaluated by the COSMIN checklist was generally inadequate to adequate, with fewer studies rating as very good. This could be explained due to the conservative nature of the COSMIN checklist[47] since the methodological quality of each study is performed by taking the lowest rating of any item in a box (‘‘worst score counts’’). The main methodological limitations of the included studies were limited sample size, lack of clarity in reporting sample characteristics (i.e. whether participants remained stable in the evaluation period), or failures in statistical methods. In studies of measurement properties of assessment tools, it is recommended that samples should include at least 50 individuals, or a pilot study should be performed prior to the sample size calculation.[50] In addition, among the fourteen included studies, six[17–19,23,53,56] presented results on some measure property, but the evaluation of measurement property was not the main objective of the study (Table 1). This may have influenced the design and reporting of the study negatively impacting on the risk of bias score.

It is important to note that most studies included either asymptomatic participants only,[17,19,38,39,53,58] or mixed samples of asymptomatic participants and patients with neck pain.[15,17,18,23,40,42,56] Because of the limited number of studies conducted with patients with musculoskeletal conditions, such as neck pain or cervicogenic headache, we were not able to assess whether differences exist on some measurement properties across different subgroups of patients and asymptomatic participants. It is unlikely, however, that measurement properties such as reliability and convergent validity, characteristics of the sample would bias psychometric properties of the test. In contrast, responsiveness, which is defined as the ability to detect changes over time, would not be generalizable to patient populations in studies including asymptomatic participants only. The only study in our review that evaluated responsiveness[41] was conducted with a sample of patients with chronic neck pain.

Among the included studies, seven[15,17,18,23,40,42,56] performed a comparison of subgroups (discriminative validity) (i.e. a group of patients and a group of healthy participants). When taking the methodological quality of these studies into account, we concluded that there were conflicting findings and conflicting level of evidence. Considering the conflicting evidence for discriminative validity, the use of CCFT to distinguish pain-free from symptomatic populations should be done with caution. Future well-designed studies are likely to change the strength of evidence for the CCFT discriminative validity.

The CCFT is widely used in clinical practice and research, regardless of the quality of its measurement properties.[9,14,15] Our findings suggest that the CCFT reflects the activity of the deep neck flexor muscles, as it presented consistent results of positive convergent validity with moderate level of evidence. Furthermore, different clinicians and the same clinician at different points in time are likely to reach similar conclusions when using this test, since intra and inter-rater reliability scores were positive with moderate level of evidence. In addition, most studies (n = 10) analyzed the performance of CCFT in a clinical setting,[23,38–42,53,55,58,60] with parameters that can be easily implemented by clinicians during their clinical practice. That reinforces the external validity of our findings. Together, these findings support its use in clinical practice as an assessment tool.

However, other measurement properties of the test suggest caution when using the test in clinical practice, given the quality and the level of evidence for other measurement property domains (e.g. measurement error, discriminative validity, and responsiveness). Based on limited evidence from one study,[41] we recommend caution when using the CCFT as an outcome measure in clinical trials or in clinical practice to monitor responses to treatment due to its low responsiveness. In addition, the studies addressing measurement error presented a moderate level of evidence.[15,17,19,39,40,42,54] The smallest detectable change ranged from 2.94[33] to 5.11mmHg.[16] Thus, changes in performance inferior to these values are likely to be related to natural variability and measurement error and then should not be considered as change in the health state of the patient or a response of treatment. None of the included studies reported the minimal important change for the CCFT. Based on our findings, it is not possible to determine whether the smallest detectable change of the CCFT is acceptable (i.e. inferior to the minimal important change) and then was classified as unknown. We suggest that future studies should be conducted following the COSMIN criteria of high methodological quality, assessing the smallest important change to more accurately define CCFT measurement error, as well as to more accurately assess CCFT discriminative validity and responsiveness.

Study Limitations

The COSMIN checklist was originally developed to evaluate the methodological quality of studies on measurement properties of patient-reported questionnaires. As, CCFT is a performance-based test, that might impact on our interpretation. Nevertheless, in the absence of a specific measure specifically designed to evaluate clinimetric studies, the COSMIN can also be used for other types of measurement instruments (like clinician- reported outcome measures or performance- based outcome measures), or other applications (e.g. diagnostic or predictive applications).[48] In addition, the items of the checklist are phrased in a general manner and draw upon the researchers' knowledge of the test, such as the appropriate time interval between the first and second administrations in a reliability study, which makes COSMIN applicable to other types of tests and minimizes this limitation.[33] Another limitation of this review is that it only included papers published in English. Finally, it is important to observe that the findings of the present review were based in most studies rated as poor methodological quality.

Conclusions

The CCFT is a valid and reliable test that can be used in clinical practice as an assessment tool for the deep neck flexor muscles. Due to the conflicting and low-quality evidence, caution is advised when using the CCFT to differentiate patient subgroups, as well as symptomatic from asymptomatic populations. The CCFT should be used with caution in clinical practice and in research settings as an outcome measure. Future well-designed studies may impact on conclusions regarding the use of CCFT as an outcome measure.

Authors' contributions: FXA is the leading researcher, responsible for conceiving the study, and designing the protocol. All authors have contributed to the conception and design of the study protocol, development of the search strategy, the establishment of the inclusion and exclusion criteria, data extraction criteria, analyses and interpretation. FXA and MSS screened title, abstracts and full text for eligibility. MSS and GEF extracted data. FXA and GEF rated the methodological quality of individual studies. MPC resolved any disagreement between reviewers. FXA, GEF, MSS and MPC conducted the data analysis. FXA, MSS, GEF wrote the first version of the paper. MPC, DCR and MFS provided critical revision of the paper. All authors provided final approval of this paper to be published.

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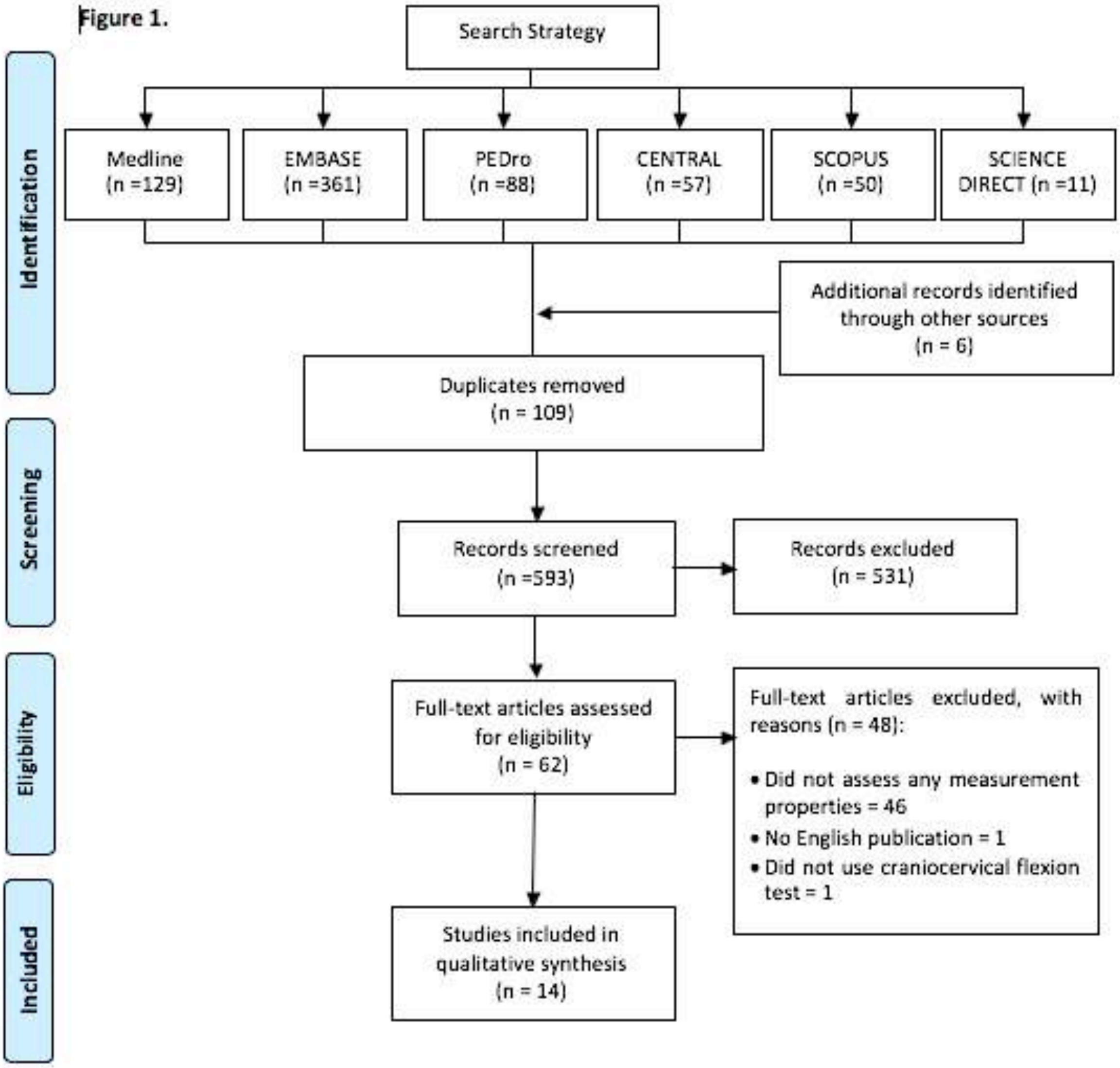
Figure 1.



Legend: Flowchart of results of search strategy and selection of articles.

Table 1. Characteristics of included studies

Study (Year)	Study design	Description of the sample	COSMIN BOX/Domain evaluated	Was the study's primary aim to evaluate a measurement property?	Study Aims	Outcome Measures
Arumugam (2011)	Cross-sectional	30 asymptomatic participants Age, mean (SD): 33.7 (8.55) Women, n (%): 15 (50)	Box 6. Reliability	Yes	Investigate the inter-rater reliability between a novice and an experienced rater concurrently judging the performance of the CCFT in asymptomatic individuals	CCFT AS
Chiu (2005)	Cross-sectional	10 asymptomatic participants Age, mean [Range]: 37.7 [26-60] Woman, n (%): 5 (50)	Box 6. Reliability	No	Compare the low-load action of the deep cervical flexors in subjects with and without neck pain by using the CCFT	CCFT AS
Falla (2003)	Cross-sectional	10 asymptomatic participants Age, mean (SD): 30.7 (10.3) Women, n (%): 6 (60%)	Box 6. Reliability; Box 7. Measurement Error; Box 9. Hypotheses testing (9a)	No	Evaluate a new EMG technique for the examination of the DCF muscles	EMG activity o DCF and superficial cervical flexor muscles

Falla (2004)	Cross-sectional	10 neck pain participants Age, mean (SD): 32.2 (9.1) Women, n (%): 6 (60%) 10 asymptomatic Age, mean (SD): 26.4 (5.8) Women, n (%): 7 (70%)	Box 9. Hypotheses testing (9a e 9b)	No	Compare deep and superficial cervical flexor muscle activity and craniocervical flexion range of motion across the five stages of the CCFT between patients with chronic neck pain and asymptomatic controls	EMG activity o DCF and superficial cervical flexor muscles CCFT ROM
Hudswell (2005)	Reliability study	40 participants for the inter-rater reliability study Age, mean [range]: 24.7 [18-40] Women, n (%): 22 (55%) 15 participants for the intra-rater reliability study Age, mean [range]: 23.6 [18-30] Women, n (%): 9 (60%)†	Box 6. Reliability; Hypotheses testing (9b)	Yes	Analyze the reliability and discriminative validity of CCFT	CCFT AS CCFT PI
James (2010)	Reliability study	19 asymptomatic participants Age, mean [range]: 24.9 [22-36] Women, n (%): 7 (42%)	Box 6. Reliability; Box 7. Measurement Error	Yes	Evaluate the intra-rater reliability of the CCFT in asymptomatic subjects	CCFT CPI

Jorgensen (2014)	The study was a reproducibility study of six clinical tests with two examiners, and a test-retest study of two physical performance tests, conducted by a third examiner.	21 (13 neck pain and 8 WAD) participants aged, mean (SD): 46.1(15.6) Woman, n (%): Not clear 21 asymptomatic participants aged, mean (SD): 44.7(14.8) Woman, n (%): Not Clear	Box 6. Reliability; Box 7. Measurement Error; Box 9. Hypotheses testing (9a e 9b)	Yes	Investigate intra- and inter-rater reliability of six cervical clinical tests in patients with and without chronic neck pain	CCFT AS*
Jorgensen (2017)	Secondary analysis of a randomized trial. The study aim was to verify the "responsiveness" of the CCFT and other clinical tests used in patients with neck pain.	118 non-radicular neck pain participants with NDI >20% age, mean (SD): 45.1 (11.7) Woman, n (%): 128 (77%)	Box 10. Responsiveness	Yes	Examine the responsiveness of four clinical tests with continuous variables for people with chronic neck pain	CCFT AS*
Jull (1999)	Cross-sectional (not described in the paper)	50 asymptomatic participants (for the reliability study) aged, mean (SD): Not clear Woman, n (%): Not clear 15 asymptomatic participants (for the	Box 6. Reliability; Hypotheses testing (9b)	No	Evaluate the CCFT performance between patients with headache and asymptomatic subjects	CCFT AS CCFT PI Responses to passive stretch

		discriminative validity study) aged, mean (SD): Not clear 15 participants with cervicogenic headache (for the discriminative validity study) aged, mean (SD): Not clear Woman, n (%): Not clear				
Jull (2000)	Cross-sectional (not described in the paper)	12 WAD participants aged, mean (SD): 37.8 (11.6) Woman, n (%): not clear 12 asymptomatic aged, mean (SD): Not clear Woman, n (%): Not clear	Box 3. Structural Validity; Box 6. Reliability; Box 9. Hypotheses testing (9a e 9b)	No	Measure the deep neck flexor muscle function in patients with whiplash associated disorders and in asymptomatic subjects	EMG activity o superficial cervical flexor muscles
Juul (2013)	An intra-rater (between-day) and inter-rater (within-day) design was applied.	33 neck pain participants Age, mean (SD): 54. (15.1) Women, n (%): 25 (76%) 30 asymptomatic	Box 6. Reliability; Box 7. Measurement Error; Hypotheses testing (9b)	Yes	Determine the clinical reliability of five muscle performance tests in patients with and without neck pain	CCFT AS*

		Age, mean (SD): 34. (14.1) Women, n (%): 17(57%)				
Kotwani (2018)	An intra-rater (between-day) and inter-rater (within-day) design was applied	60 asymptomatic participants aged, mean (SD): Not clear Woman, n (%): Not clear	Box 6. Reliability; Box 7. Measurement Error	Yes	Investigate the intra and inter-rater reliabilities of the CCFT in asymptomatic subjects	CCFT CPI
Martins (2017)	Reliability and validity study	<u>Within-session reliability</u> 33 neck pain participants Age, mean (SD): 36.8 (2.4) Women, n (%): 28 (84.9%) 33 asymptomatic participants Age, mean (SD): 36.2 (2.3) Women, n (%): 28 (84.9%) <u>Between-session reliability and Validity</u> 31 neck pain participants	Box 6. Reliability; Box 7. Measurement Error; Box 9. Hypotheses testing (9a e 9b).	Yes	To compare reliability indexes, construct validity and ability to discriminate between individuals with and without neck pain of four muscle tests	CCFT 1 CCFT 2

		26 asymptomatic participants				
Soon (2010)	Double-blind, controlled, within-subjects crossover design, in which each subject experienced all 3 interventions in a randomized order	6 asymptomatic participants Age, mean (SD): Not clear Women, n (%): 3 (50%)	Box 6. Reliability; Box 7. Measurement Error.	No	Determine if passive cervical mobilization improve motor function in situations where motor performance was not impaired by the presence of pain in pain-free individuals	EMG activity o superficial cervical flexor muscles PPT

Legend: CCFT, Craniocervical Flexion Test; NDI, Neck Disability Index; SD, Standard Deviation; WDA, Whiplash Associated Disorders; †Asymptomatic, neck pain and WAD (Grade 1 and Grade 2) participants, although symptoms distribution was unclear; CCFT AS, CCFT Activation Score defined as the maximum pressure (in millimeters of mercury) achieved and held in a steady manner for 10 seconds above the baseline pressure (20 mm Hg) without any substitution strategies; CCFT PI, CCFT performance index defined as the activation score multiplied by the number of successful repetitions; CCFT CPI, CCFT cumulative performance index calculated adding a preceding score to performance index depending on the level achieved; CCFT1, is the activation score but each level was maintained for 3 seconds instead of 10 seconds of the former; CCFT2, is the activation score with 3 repetitions on each level; EMG, electromyography; DCF, deep cervical flexor; PPT, pressure pain threshold; ROM, range of motion; * this was the outcome related to CCFT as other clinical tests were evaluated in this study.

Table 2. Reliability and Measurement Error of CCFT

Author (Year)	Study Population		Reliability (Intra-rater)			Reliability (Inter-rater)			Measurement Error	
		N	Cosmin Risk of Bias Score	Cosmin Quality Rating	N	Cosmin Risk of Bias Score	Cosmin Quality Rating	N	Cosmin Risk of Bias Score	Cosmin Quality Rating
Arumugan et al. (2011)	Asymptomatic	NA	NA	NA	30	Inadequate[1]	+	NA	NA	NA
Chiu et al. (2005)	Asymptomatic	NA	NA	NA	10	Inadequate[2]	?	NA	NA	NA
Falla et al. (2003)	Asymptomatic	NA	NA	NA	10	Doubtful[3]	?	10	Doubtful[3]	?
Hudswell et al. (2005)	Asymptomatic/ Patients with neck pain / Patients with whiplash associated disorders	15	Doubtful[4]	**+**	40	Doubtful[4]	**-**	NA	NA	NA
James et al. (2010)	Asymptomatic	19	Very Good	+	19	NA	NA	NA	Very Good	?
Jorgensen et al. (2014)	Asymptomatic/ Patients with neck pain / Patients with whiplash associated disorders	42	Adequate[5]	+	42	Adequate[5]	+	42	Doubtful[6]	**?**
Jull et al.	Patients with	NA	NA	NA	50	Adequate[5]	+	NA	NA	NA

(1999)	cervicogenic headache									
Jull et al. (2000)	Asymptomatic/ Patients with whiplash associated disorders	NA	NA	NA	24	Doubtful[4,6]	-	NA	NA	NA
Juul et al. (2013)	Asymptomatic/ Patients with neck pain	63	Very Good	**-**	63	Very Good	**+**	63	Very Good	?
Kotwani et al. (2018)	Asymptomatic	60	Adequate[5]	+	60	Adequate[5]	+	60	Very Good	?
Martins et al. (2017)	Asymptomatic/ Patients with neck pain	NA	NA	NA	66 (first day) 57 (second day)	Adequate[7]	**+**	66 (first day) 57 (second day)	Adequate[7]	?
Soon et al. (2010)	Asymptomatic	NA	NA	NA	6	Doubtful[3,6]	+	6	Doubtful[3,6]	?

Legend: CCFT, Cranio Cervical Flexion Test; ICC, intraclass correlation coefficient; NA, Not applicable; CI, Confidence interval; SEM, standard error of measurement; SDC, smallest detectable change; LoA, limits of agreement, MIC, minimal important change.

ICC +, ICC ≥ 0.70 OR Pearson's r ≥ 0.80.
ICC ?, Neither ICC nor Pearson's r determined.
ICC –, ICC < 0.70 OR Pearson's r < 0.80.
Measurement error +, MIC > SDC OR MIC outside the LoA.
Measurement error ?, MIC not defined.
Measurement error -, MIC ≤ SDC OR MIC equals or inside LoA.

[1], Time interval NOT appropriate.
[2], No ICC or Pearson or Spearman correlations calculated.
[3], Other minor methodological flaws (small sample of participants included).
[4], Other minor methodological flaws (unclear reporting of characteristics of the sample and if participants were stable in the interim period).
[5], ICC calculated but model or formula of the ICC not described or not optimal.
[6], Doubtful whether time interval was appropriate or time interval was not stated.
[7], Assumable that patients were stable

Table 3. Validity and Responsiveness of CCFT

Author (Year)	Study Population		Structural Validity			Hypoteses testing for Construct Validity			Responsiveness	
		N	Cosmin Risk of Bias Score	Cosmin Quality Rating	N	Cosmin Risk of Bias Score	Cosmin Quality Rating	N	Cosmin Risk of Bias Score	Cosmin Quality Rating
Falla et al. (2003)	Asymptomatic	10	Inadequate[1]	?	10	Doubtful[2]	+	NA	NA	NA
Jull et al. (2000)	Asymptomatic/ Patients with whiplash associated disorders	24	Inadequate[1]	?	24	Inadequate[3]	+	NA	NA	NA
Soon et al. (2010)	Asymptomatic	6	Inadequate[1]	?	NA	NA	NA	NA	NA	NA
Jorgensen et al. (2014)	Asymptomatic/ Patients with neck pain / Patients with whiplash associated disorders	NA	NA	NA	42	Very Good	+	NA	NA	NA
Martins et al. (2017)	Asymptomatic/ Patients with neck pain	NA	NA	NA	66 (first day)	Very Good	-	NA	NA	NA
Jorgensen et al. (2017)	Patients with neck pain	NA	NA	NA	NA	NA	NA	164	Doubtful[2]	-

Legend: CCFT, Cranio Cervical Flexion Test; NA, Not applicable.

Structural validity +, Factors should explain at least 50% of the variance.
Structural validity ?, Explained variance not mentioned.
Structural validity –, Factors explain < 50% of the variance.
Hypothesis testing for construct validity +, Correlations with instruments measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses AND correlations with related constructs are higher than with unrelated constructs.
Hypothesis testing for construct validity?, Solely correlations determined with unrelated constructs.
Hypothesis testing for construct validity -, Correlations with instruments measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR correlations with related constructs are lower than with unrelated constructs.
Responsiveness +, Correlation with changes on instruments measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses OR AUC ≥ 0.70 AND correlations with changes in related constructs are higher than with unrelated constructs.
Responsiveness ?, Solely correlations determined with unrelated constructs.
Responsiveness -, Correlations with changes on instruments measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR AUC < 0.70 OR correlations with changes in related constructs are lower than with unrelated constructs.

[1], Inadequate sample size included in the analysis.
[2], Other minor methodological flaws (small sample of participants included).
[3], Statistical method applied NOT optimal.

Table 4. Best Evidence Synthesis of Measurement Properties of the CCFT

Measurement Properties	Overall Rating	Level of Evidence
Reliability (Intra-rater)	++	Moderate
Reliability (Inter-rater)	++	Moderate
Measurement error	?	Unknown
Convergent Validity	++	Moderate
Discriminative Validity	+/-	Conflicting
Responsiveness	-	Limited

Legend: CCFT, Cranio Cervical Flexion Test; +++ or −−− Consistent findings in multiple studies of good methodological quality OR in one study of excellent methodological quality; ++ or −− Consistent findings in multiple studies of fair methodological quality OR in one study of good methodological quality; + or − One study of fair methodological quality; +/– conflicting findings, ? unknown due to only studies of poor methodological quality or no studies on that measurement property.

Appendix 1.

Search Strategy in MEDLINE

1#	(((((((patient outcome assessment [Mesh]) OR ((outcome and process assessment [Mesh]))) OR treatment outcome [Mesh] OR instrumentation[sh] OR methods[sh] OR "Validation Studies"[pt] OR "Comparative Study"[pt] OR "psychometrics"[MeSH] OR psychometr*[tiab] OR clinimetr*[tw] OR clinometr*[tw] OR "outcome assessment (health care)"[MeSH] OR "outcome assessment"[tiab] OR "outcome measure*"[tw] OR "observer variation"[MeSH] OR "observer variation"[tiab] OR "Health Status Indicators"[Mesh] OR "reproducibility of results"[MeSH] OR reproducib*[tiab] OR "discriminant analysis"[MeSH] OR reliab*[tiab] OR unreliab*[tiab] OR valid*[tiab] OR "coefficient of variation"[tiab] OR coefficient[tiab] OR homogeneity[tiab] OR homogeneous[tiab] OR "internal consistency"[tiab] OR (cronbach*[tiab] AND (alpha[tiab] OR alphas[tiab])) OR (item[tiab] AND (correlation*[tiab] OR selection*[tiab] OR reduction*[tiab])) OR agreement[tw] OR precision[tw] OR imprecision[tw] OR "precise values"[tw] OR test-retest[tiab] OR (test[tiab] AND retest[tiab]) OR (reliab*[tiab] AND (test[tiab] OR retest[tiab])) OR stability[tiab] OR interrater[tiab] OR inter-rater[tiab] OR intrarater[tiab] OR intra-rater[tiab] OR intertester[tiab] OR inter-tester[tiab] OR intratester[tiab] OR intra-tester[tiab] OR interobserver[tiab] OR inter-observer[tiab] OR intraobserver[tiab] OR intra-observer[tiab] OR intertechnician[tiab] OR inter-technician[tiab] OR intratechnician[tiab] OR intra-technician[tiab] OR interexaminer[tiab] OR inter-examiner[tiab] OR intraexaminer[tiab] OR intra-examiner[tiab] OR interassay[tiab] OR inter-assay[tiab] OR intraassay[tiab] OR intra-assay[tiab] OR interindividual[tiab] OR inter-individual[tiab] OR intraindividual[tiab] OR intra-individual[tiab] OR interparticipant[tiab] OR inter-participant[tiab] OR intraparticipant[tiab] OR intra-participant[tiab] OR kappa[tiab] OR kappa's[tiab] OR kappas[tiab] OR repeatab*[tw] OR ((replicab*[tw] OR repeated[tw]) AND (measure[tw] OR measures[tw] OR findings[tw] OR result[tw] OR results[tw] OR test[tw] OR tests[tw])) OR generaliza*[tiab] OR generalisa*[tiab] OR concordance[tiab] OR (intraclass[tiab] AND correlation*[tiab]) OR discriminative[tiab] OR "known group"[tiab] OR "factor analysis"[tiab] OR "factor analyses"[tiab] OR "factor structure"[tiab] OR "factor structures"[tiab] OR dimension*[tiab] OR subscale*[tiab] OR (multitrait[tiab] AND scaling[tiab] AND (analysis[tiab] OR analyses[tiab])) OR "item discriminant"[tiab] OR "interscale correlation*"[tiab] OR error[tiab] OR errors[tiab] OR "individual variability"[tiab] OR "interval variability"[tiab] OR "rate variability"[tiab] OR (variability[tiab] AND (analysis[tiab] OR values[tiab])) OR (uncertainty[tiab] AND (measurement[tiab] OR measuring[tiab])) OR "standard error of measurement"[tiab] OR sensitiv*[tiab] OR responsive*[tiab] OR (limit[tiab] AND detection[tiab]) OR "minimal detectable concentration"[tiab] OR interpretab*[tiab] OR ((minimal[tiab] OR minimally[tiab] OR clinical[tiab] OR clinically[tiab]) AND (important[tiab] OR significant[tiab] OR detectable[tiab]) AND (change[tiab] OR difference[tiab])) OR (small*[tiab] AND (real[tiab] OR detectable[tiab]) AND (change[tiab] OR difference[tiab])) OR "meaningful change"[tiab] OR "ceiling effect"[tiab] OR "floor effect"[tiab] OR "Item response model"[tiab] OR IRT[tiab] OR Rasch[tiab] OR "Differential item functioning"[tiab] OR DIF[tiab] OR "computer adaptive testing"[tiab] OR "item bank"[tiab] OR "cross-cultural equivalence"[tiab])))))
2#	(((((pressure biofeedback unit[Title/Abstract] OR pressure biofeedback units[Title/Abstract] OR unit, pressure biofeedback[Title/Abstract] OR units, pressure biofeedback[Title/Abstract] OR stabilizer[Title/Abstract] OR stabilizers[Title/Abstract] OR stabiliser[Title/Abstract] OR stabilisers[Title/Abstract] OR biofeedback[Title/Abstract] OR biofeedbacks[Title/Abstract] OR craniocervical flexion test[Title/Abstract] OR cranio-cervical flexion test[Title/Abstract] OR cranio cervical flexion test[Title/Abstract] OR cranio cervical flexion[Title/Abstract)))))
3#	((((((Muscle, Neck[Title/Abstract] OR Muscles, Neck[Title/Abstract] OR Neck muscle[Title/Abstract])))) OR Neck muscles[MeSH Terms])) OR ((neck[MeSH Terms]) OR Necks[Title/Abstract] OR deep cervical flexor*[Title/Abstract] OR rectus capit*[Title/Abstract] OR longus colli[Title/Abstract] OR longus capiti [Title/Abstract]))
4#	1# AND 2# AND 3#

Search strategy in EMBASE

1#	construct validity/ or criterion related validity/ or validity/ or cocnurrent validity/ or convergent validity/ or conctent validity/ or discriminant validity
2#	psychometry/ or psychometr* .mp.

3#	reliability / or retest reliabilityt/ or test-retest.mp. or reproducibility/
4#	interrater reliability/ or intrarater.mp. or rating scale/ or scoring
5#	intrarater reliability/ or intrarater.mp.
6#	biofeedback.mp. or feedback system/
7#	exercise/ or pressure biofeedback.mp.
8#	stabilizer.mp.
9#	estabiliz*.mp.
10#	neck/ or electromyography/ or craniocervical flexion tests.mp. or flexor muscle/ or neck muscle/ or cervical spine/ or neck pain/ or whiplash injury/
11#	1 or 2 or 3 or 4 or 5
12#	6 or 7 or 8 or 9
13#	10 and 11 and 12

Search strategy in PEDro

Abstract & Title:	pressure biofeedback unit OR pressure biofeedback units OR pressure biofeedback OR stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR craniocervical flexion test OR cranio-cervical flexion test OR cranio cervical flexion test OR cranio cervical flexion cranio-cervical flexion
Body part	head or neck
Subdiscipline	musculoskeletal
Method	Clinical Trial

Search strategy in CENTRAL

1#	MeSH descriptor: [Patient Outcome Assessment] explode all trees
2#	MeSH descriptor: [Outcome and Process Assessment (Health Care)] explode all trees
3#	MeSH descriptor: [Treatment Outcome] explode all trees
4#	MeSH descriptor: [Psychometrics] explode all trees
5#	psychometr*:ti,ab,kw (Word variations have been searched)
6#	clinimetr* (Word variations have been searched)
7#	clinometr* (Word variations have been searched)
8#	MeSH descriptor: [Outcome Assessment (Health Care)] explode all trees
9#	outcome assessment:ti,ab,kw (Word variations have been searched)
10#	outcome measure* (Word variations have been searched)
11#	MeSH descriptor: [Observer Variation] explode all trees
12#	observer variation:ti,ab,kw (Word variations have been searched)
13#	MeSH descriptor: [Health Status Indicators] explode all trees
14#	reproducib*:ti,ab,kw (Word variations have been searched)
15#	MeSH descriptor: [Discriminant Analysis] explode all trees
16#	reliab*:ti,ab,kw (Word variations have been searched)
17#	unreliab*:ti,ab,kw (Word variations have been searched)
18#	valid*:ti,ab,kw (Word variations have been searched)
19#	"coefficient of variation":ti,ab,kw (Word variations have been searched)
20#	coefficient:ti,ab,kw (Word variations have been searched)
21#	homogeneity:ti,ab,kw (Word variations have been searched)
22#	homogeneous:ti,ab,kw (Word variations have been searched)
23#	"internal consistency":ti,ab,kw (Word variations have been searched)
24#	cronbach* and (alpha or alphas):ti,ab,kw (Word variations have been searched)
25#	(item and (correlation* or selection* or reduction*)):ti,ab,kw (Word variations have been searched)
26#	agreement (Word variations have been searched)
27#	precision:ti,ab,kw (Word variations have been searched)
28#	imprecision:ti,ab,kw (Word variations have been searched)
29#	"precise values":ti,ab,kw (Word variations have been searched)
30#	test-retest:ti,ab,kw or (test and retest):ti,ab,kw or (reliab* and (test or retest)):ti,ab,kw or stability:ti,ab,kw or interrater:ti,ab,kw (Word variations have been searched)
31#	inter-rater:ti,ab,kw or intrarater:ti,ab,kw or intra-rater:ti,ab,kw or intertester:ti,ab,kw or intratester:ti,ab,kw (Word variations have been searched)
32#	intra-tester:ti,ab,kw or interobserver:ti,ab,kw or inter-observer:ti,ab,kw or intraobserver:ti,ab,kw

	or intra-observer:ti,ab,kw (Word variations have been searched)
33#	intertechnician or inter-technician or intratechnician or intra-technician or interexaminer or inter-examiner or intraexaminer or intra-examiner or interassay or inter-assay or intraassay or intra-assay or interindividual or inter-individual or intraindividual or intra-individual or interparticipant or inter-participant or intraparticipant or intra-participant or kappa or kappa's or kappas:ti,ab,kw (Word variations have been searched)
34#	repeatab* (Word variations have been searched)
35#	((replicab* or repeated) and (measure or measures or findings or result or results or test or tests)) (Word variations have been searched)
36#	generaliza* or generalisa* or concordance or (intraclass and correlation*) or discriminative or "known group" or "factor analysis" or "factor analyses" or "factor structure" or "factor structures" or dimension* or subscale* or (multitrait and scaling and (analysis or analyses)) or "item discriminant" or "interscale correlation*" or error or errors or "individual variability" or "interval variability" or "rate variability" or (variability and (analysis or values)) or (uncertainty and (measurement or measuring)) or "standard error of measurement" or sensitiv* or responsive* or (limit and detection) or "minimal detectable concentration" or interpretab* or ((minimal or minimally or clinical or clinically) and (important or significant or detectable) and (change or difference)) or (small* and (real or detectable) and (change or difference)) or "meaningful change" or "ceiling effect" or "floor effect" or "Item response model" or IRT or Rasch or "Differential item functioning" or DIF or "computer adaptive testing" or "item bank" or "cross-cultural equivalence":ti,ab,kw (Word variations have been searched)
37#	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36
38#	pressure biofeedback unit or pressure biofeedback units or unit, pressure biofeedback or units, pressure biofeedback or stabilizer or stabilizers or stabiliser or stabilisers or biofeedback or biofeedbacks or craniocervical flexion test or cranio-cervical flexion test or cranio cervical flexion test or cranio cervical flexion:ti,ab,kw (Word variations have been searched)
39#	Muscle, Neck or Muscles, Neck or Neck muscle:ti,ab,kw (Word variations have been searched)
40#	MeSH descriptor: [Neck Muscles] explode all trees
41#	Necks or deep cervical flexor* or rectus capit* or longus colli or longus capiti:ti,ab,kw (Word variations have been searched)
42#	#39 or #40 or #41
43#	#37 and #38 and #42

Search strategy in SCOPUS

1#	TITLE-ABS-KEY(psychometr* OR clinimetr* OR clinometr* OR "outcome assessment" OR "outcome measure*" OR "observer variation" OR reproducib* OR reliab* OR unreliab* OR valid* OR "coefficient of variation" OR coefficient OR homogeneity OR homogeneous OR "internal consistency" OR (cronbach* AND (alph OR alphas)) OR (item AND (correlation* OR selection* OR reduction*)) OR agreement OR precision OR imprecision OR "precise values" OR test-retest OR (test AND retest) OR (reliab* AND (test OR retest)) OR stability OR interrater OR inter-rater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR intratechnician OR inter-technician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra-examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa's OR kappas OR repeatab* OR ((replicab* OR repeated) AND (measure OR measures OR findings OR result OR results OR test OR tests)) OR generaliza* OR generalisa* OR concordance OR (intraclass AND correlation*) OR discriminative OR "known group" OR "factor analysis" OR "factor analyses" OR "factor structure" OR "factor structures" OR dimension* OR subscale* OR (multitrait AND scaling AND (analysis OR analyses)) OR "item discriminant" OR "interscale correlation*" OR error OR errors OR "individual variability" OR "interval variability" OR "rate variability" OR (variability AND (analysis OR values)) OR (uncertainty AND (measurement OR measuring)) OR "standard error of measurement" OR sensitiv* OR responsive* OR (limit AND detection) OR "minimal detectable concentration" OR interpretab* OR ((minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable) AND (change OR difference)) OR (small* AND (real OR detectable) AND (change OR difference)) OR "meaningful change" OR "ceiling effect" OR "floor effect" OR "Item response model" OR IRT OR

	Rasch OR "Differential item functioning" OR DIF OR "computer adaptive testing" OR "item bank" OR "cross-cultural equivalence")
2#	TITLE-ABS-KEY("pressure biofeedback unit" OR "pressure biofeedback units" OR "pressure biofeedback" OR stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR "craniocervical flexion test" OR "cranio-cervical flexion test" OR "cranio cervical flexion test" OR "cranio cervical flexion" OR "cranio-cervical flexion")
3#	TITLE-ABS-KEY("Neck Muscle" OR "Neck Muscles" OR Necks OR Neck* OR "deep cervical flexor*" OR "rectus capit*" OR "longus colli" OR "longus capiti") AND NOT INDEX(medline)
4	1# and 2# and 3#

Search strategy in SCIENCE DIRECT

1	TITLE-ABSTR-KEY("coefficient of variation" OR coefficient OR homogeneity OR homogeneous OR "internal consistency" OR (cronbach* AND (alpha OR alphas)) OR (item AND (correlation* OR selection* OR reduction*)) OR agreement OR precision OR imprecision)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
2	TITLE-ABSTR-KEY("outcome assessment" OR "outcome measures" OR "observer variation" OR "observer variation" OR "Health Status Indicators" OR "reproducibility of results" OR reproducib* OR "discriminant analysis" OR reliab* OR unreliab* OR valid*)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
3	TITLE-ABSTR-KEY("precise values" OR test-retest OR (test AND retest) OR (reliab* AND (test OR retest)) OR interrater OR inter-rater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver) or TITLE-ABSTR-KEY(inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra-examiner OR interassay OR inter-assay)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
4	TITLE-ABSTR-KEY(intraassay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant) or TITLE-ABSTR-KEY(kappa OR kappa's OR kappas OR repeatab* OR ((replicab* OR repeated) AND (measure OR measures OR findings OR result OR results OR test OR tests)) OR generaliza*)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
5	TITLE-ABSTR-KEY(generalisa* OR concordance OR (intraclass AND correlation*) OR discriminative OR "known group" OR "factor analysis" OR error) or TITLE-ABSTR-KEY("factor analyses" OR "factor structure" OR dimension* OR subscale* OR (multitrait AND scaling AND (analysis OR analyses)))[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
6	TITLE-ABSTR-KEY("item discriminant" OR "interscale correlation*" OR "individual variability" OR "interval variability" OR "rate variability") or TITLE-ABSTR-KEY((variability AND (analysis OR values)) OR (uncertainty AND (measurement OR measuring)) OR "standard error of measurement")[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports*

	and Recreation)]
7	TITLE-ABSTR-KEY(sensitiv* OR responsive* OR (limit AND detection) OR "minimal detectable concentration" OR interpretab*) or TITLE-ABSTR-KEY(((minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable) AND (change OR difference)))[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
8	TITLE-ABSTR-KEY((small* AND (real OR detectable) AND (change OR difference)) OR "meaningful change" OR "ceiling effect") or TITLE-ABSTR-KEY("floor effect" OR "Item response model" OR IRT OR Rasch OR "Differential item functioning" OR DIF)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
9	TITLE-ABSTR-KEY("computer adaptive testing" OR "item bank" OR "cross-cultural equivalence")[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
10	(TITLE-ABSTR-KEY((small* AND (real OR detectable) AND (change OR difference)) OR "meaningful change" OR "ceiling effect") or TITLE-ABSTR-KEY("floor effect" OR "Item response model" OR IRT OR Rasch OR "Differential item functioning" OR DIF)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) OR (TITLE-ABSTR-KEY("computer adaptive testing" OR "item bank" OR "cross-cultural equivalence")[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
11	TITLE-ABSTR-KEY(pressure biofeedback unit OR pressure biofeedback units OR unit, pressure biofeedback OR units, pressure biofeedback) or (stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR craniocervical flexion test)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
12	TITLE-ABSTR-KEY(cranio-cervical flexion test OR cranio cervical flexion test OR cranio cervical flexion)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
13	(TITLE-ABSTR-KEY(pressure biofeedback unit OR pressure biofeedback units OR unit, pressure biofeedback OR units, pressure biofeedback) or (stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR craniocervical flexion test)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) OR (TITLE-ABSTR-KEY(cranio-cervical flexion test OR cranio cervical flexion test OR cranio cervical flexion)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
14	TITLE-ABSTR-KEY(Neck muscle OR Necks OR "deep cervical flexor*" OR "rectus capit*" OR Longus colli OR longus capiti)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
15	((TITLE-ABSTR-KEY(pressure biofeedback unit OR pressure biofeedback units OR unit, pressure biofeedback OR units, pressure biofeedback) or (stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR craniocervical flexion test)) OR (TITLE-ABSTR-KEY(cranio-cervical flexion test OR cranio cervical flexion test OR cranio cervical flexion))[All Sources(Medicine and Dentistry,Neuroscience,Nursing and

	Health Professions,Sports and Recreation)]) AND (TITLE-ABSTR-KEY(Neck muscle OR Necks OR "deep cervical flexor*" OR "rectus capit*" OR Longus colli OR longus capiti)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
16	(TITLE-ABSTR-KEY(sensitiv* OR responsive* OR (limit AND detection) OR "minimal detectable concentration" OR interpretab*) or TITLE-ABSTR-KEY(((minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable) AND (change OR difference)))[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) AND (((TITLE-ABSTR-KEY(pressure biofeedback unit OR pressure biofeedback units OR unit, pressure biofeedback OR units, pressure biofeedback) or (stabilizer OR stabilizers OR stabiliser OR stabilisers OR biofeedback OR biofeedbacks OR craniocervical flexion test)) OR (TITLE-ABSTR-KEY(cranio-cervical flexion test OR cranio cervical flexion test OR cranio cervical flexion))) AND (TITLE-ABSTR-KEY(Neck muscle OR Necks OR "deep cervical flexor*" OR "rectus capit*" OR Longus colli OR longus capiti))[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
17	TITLE-ABSTR-KEY(Neck muscle OR Necks OR deep cervical flexor* OR "deep cervical flexor*" OR "rectus capit*" OR Longus colli OR longus capiti)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
18	TITLE-ABSTR-KEY(craniocervical flexion test OR cranio-cervical flexion test OR cranio-cervical flexion OR cranio-cervical flexion test OR biofeedback OR stabilizer OR feedback)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
19	TITLE-ABSTR-KEY(outcome assessment OR outcome measure* OR psychometr* OR reproducib* OR reliab* OR valid* OR agreement OR interrater OR intrarater)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)] *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*
20	(TITLE-ABSTR-KEY(craniocervical flexion test OR cranio-cervical flexion test OR cranio-cervical flexion OR cranio-cervical flexion test OR biofeedback OR stabilizer OR feedback)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) AND (TITLE-ABSTR-KEY(outcome assessment OR outcome measure* OR psychometr* OR reproducib* OR reliab* OR valid* OR agreement OR interrater OR intrarater)[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]) *[All Sources(Medicine and Dentistry,Neuroscience,Nursing and Health Professions,Sports and Recreation)]*

APPENDIX 2. Definition and quality criteria for measurement properties.

Property / Definition	Rating	Quality criteria
Reliability		
Internal consistency / The degree of the interrelatedness among the items	+	Cronbach's alpha(s) ≥ 0.70
	?	Cronbach's alpha not determined or unidimensionality unknown
	-	Cronbach's alpha(s) < 0.70
Reliability / The degree to which the measurement is free from measurement error	+	ICC / weighted Kappa ≥ 0.70 OR Pearson's r ≥ 0.80
	?	Neither ICC / weighted Kappa, nor Pearson's r determined
	-	ICC / weighted Kappa < 0.70 OR Pearson's r < 0.80
Measurement error / The systematic and random error of a patient's score that is not attributed to true changes in the construct to be measured	+	MIC > SDC OR MIC outside the LoA
	?	MIC not defined
	-	MIC ≤ SDC OR MIC equals or inside LoA
Validity		
Content validity / The degree to which the content of a PROM is an adequate reflection of the construct to be measured	+	All items are considered to be relevant for the construct to be measured, for the target population, and for the purpose of the measurement AND the questionnaire is considered to be comprehensive
	?	Not enough information available
	-	Not all items are considered to be relevant for the construct to be measured, for the target population, and for the purpose of the measurement OR the questionnaire is considered not to be comprehensive
Structural validity - The degree to which the scores of a PROM are an adequate reflection of the dimensionality of the	+	Factors should explain at least 50% of the variance
	?	Explained variance not mentioned
	-	Factors explain < 50% of the variance

construct to be measured		
Construct validity / Hypothesis testing - The degree to which the scores of a PROM are consistent with hypotheses based on the assumption that the PROM validly measures the construct to be measured	+	Correlations with instruments measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses AND correlations with related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	-	Correlations with instruments measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR correlations with related constructs are lower than with unrelated constructs
- **Cross-cultural validity** / The degree to which the performance of the items on a translated or culturally adapted PROM are an adequate reflection of the performance of the items of the original version of the PROM	+	No differences in factor structure OR no important DIF between language versions
	?	Multiple group factor analysis not applied AND DIF not assessed
	-	Differences in factor structure OR important DIF between language versions
- **Criterion validity** / The degree to which the scores of a PROM are an adequate reflection of a 'gold standard'	+	Convincing arguments that gold standard is "gold" AND correlation with gold standard ≥ 0.70
	?	No convincing arguments that gold standard is "gold"
	-	Correlation with gold standard < 0.70
Responsiveness		
Responsiveness / The ability of a PROM to detect change over time in the construct to be measured	+	Correlation with changes on instruments measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses OR AUC ≥ 0.70 AND correlations with changes in related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs

	-	Correlations with changes on instruments measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR AUC < 0.70 OR correlations with changes in related constructs are lower than with unrelated constructs

Legend: PROM, patient-reported outcome measures; MIC, minimal important change; SDC, smallest detectable change; LoA, limits of agreement; ICC, intraclass correlation coefficient; DIF, differential item functioning; AUC, area under the curve; +, sufficient; –, insufficient; ?, indeterminate.

5 CONCLUSÃO

A partir dos achados provenientes dos diferentes manuscritos realizados neste projeto, é possível concluir que os fisioterapeutas que atuam no Brasil não possuem conhecimento suficiente sobre as caraterísticas de *feedback* extrínseco embora o considerem útil e o utilizem na reabilitação da maioria dos seus pacientes. Os fisioterapeutas que atuam no Brasil, utilizam principalmente *feedback* verbal e visual, e com recursos como espelho, foto ou filmagem dos pacientes. A escolha das características de conteúdo está alinhada com as recomendações da literatura atual, enquanto que as características de tempo estão em desacordo com estas recomendações. A maioria dos fisioterapeutas brasileiros não realiza nenhum tipo de teste de retenção para avaliar o aprendizado motor, após o treinamento com *feedback* extrínseco. Ademais, as principais barreiras sinalizadas pelos participantes foram o alto custo e/ou falta de equipamentos adequados para este tipo de abordagem, além da falta de treinamento adequado. Os fatores considerados mais influentes para a escolha destas características foram a experiência clínica e a leitura de artigos científicos.

Além disso, é possível concluir que o TFCC é um teste válido e confiável que pode ser usado na prática clínica como uma ferramenta de avaliação para os músculos flexores profundos cervicais. Nenhuma propriedade de medida do TFCC foi classificada com alto nível de evidência. Devido às evidências conflitantes e de baixa qualidade, recomenda-se cautela ao usar o TFCC para diferenciar subgrupos de pacientes, bem como populações sintomáticas e assintomáticas. O TFCC deve ser usada com cautela na prática clínica e em ambientes de pesquisa como uma medida de desfecho. Futuros estudos bem delineados podem impactar nas conclusões sobre o uso do TFCC como uma medida de desfecho.

Por fim, recomendamos que estudos futuros investiguem se o uso de características adequadas de *feedback* extrínseco, que já se demonstraram superiores para a aprendizagem motora em diferentes condições de treinamento e reabilitação, são superiores a um exercício convencional também na reabilitação de pacientes com dor cervical que apresentem algum tipo de desequilíbrio neuromuscular.

6 APÊNDICES

6.1 PUBLICAÇÃO REFERENTE À ESTA TEMÁTICA

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Original article

Effectiveness of Physiotherapy interventions plus Extrinsic Feedback for neck disorders: A systematic review with meta-analysis

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ABSTRACT

Purpose: To systematically review the effectiveness of Physiotherapy interventions combined with extrinsic feedback (EF) compared to Physiotherapy interventions alone or control for the management of neck pain and disability.

Methods: Randomized clinical trials were searched and retrieved from six databases, from inception through August 2016. Risk of bias of included studies was assessed using the PEDro scale. When possible data were pooled and Meta-analyses were conducted. The quality and strength of evidence for each outcome was assessed using the GRADE approach.

Results: Eight studies ($n = 677$) were included in the review. The pooled estimates suggested Physiotherapy intervention + EF was not superior to Physiotherapy intervention alone for disability ($MD = -0.38$; $95\%CI = -0.91$ to 0.18; $I^2 = 82\%$), but was superior for pain ($MD = -0.37$; $95\%CI = -0.73$ to -0.01; $I^2 = 68\%$). Physiotherapy intervention + EF was not superior than control for disability scores ($SMD = -3.94$; $95\%CI = -12.06$ to 4.18; $I^2 = 92\%$). Physiotherapy intervention + EF intervention was more effective than control for pain scores at short-term ($SMD = -1.44$; $95\%CI = -2.25$ to-0.63; $I^2 = 50\%$). Most studies did not specify nor use the ideal characteristics of EF.

Conclusion: There is very low quality of evidence that Physiotherapy intervention + EF is more effective than Physiotherapy intervention alone or control for short-term pain, but not for disability. Physiotherapy intervention plus EF was more effective than Physiotherapy alone for acute neck pain, but not for chronic pain or disability. There was high risk of bias within included studies. Future studies are likely to change the estimates of the effects of Physiotherapy intervention plus EF on neck rehabilitation.

1. Introduction

Neck pain is a common musculoskeletal disorder seen by general practitioner (Carroll et al., 2009), and is the fourth cause of years lived with disability (Vos et al., 2015). The one-year prevalence of neck pain ranges from 16.7% to 75.1% (Fejer et al., 2006). The mean lifetime prevalence is 48.5% (Fejer et al., 2006) and the economic costs associated with this disorder are high (Martin et al., 2008). Patients with neck pain present poor self-reported health status, and are more likely to suffer from depression (Fernández-De-Las-Peñas et al., 2011).

Numerous neuromuscular impairments are associated with neck pain, including altered muscle recruitment pattern, muscle weakness, poor muscle endurance and proprioception (Falla and Farina, 2008). Cervical spine rehabilitation often comprises of specific neuromuscular training (Gross et al., 2016), with the use of extrinsic feedback (EF) (Jull et al., 2009) as part of the treatment. Examples of EF include pressure feedback units (Jull et al., 2009) ultrasound (Jesus et al., 2008), and electromyography (Vollenbroek-Hutten et al., 2006). The rationale for rehabilitation exercises with biofeedback is to augment patient's somatosensory system, and restore optimal motor control of the cervical spine muscles (Hodges, 2011; Huang et al., 2006; Schmidt and Wrisberg, 2009).

The characteristics of EF may facilitate or hinder recovery (Ribeiro et al., 2011b). According to the motor control and learning literature, the use of feedback will optimize motor control if provided to user with the following features: (1) content

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2468-7812/

characteristics: program, summary results and external focus of attention; (2) timing characteristics: reduced frequency or self-selected feedback (Magill, 2007; Ribeiro et al., 2011b; Schmidt and Wrisberg, 2009). The literature also suggests that non-ideal forms of EF can hinder motor learning (Magill, 2007; Schmidt and Wrisberg, 2009), potentially impacting on recovery (Ribeiro et al., 2011b). A critical literature review suggested that most research exploring the use of EF on the management of low back pain has not considered the ideal forms of EF provision (Ribeiro et al., 2011a).

There is conflicting evidence in the literature for including EF as part of neck rehabilitation programme, and that may be explained by the different forms of the EF is being used (Falla et al., 2007; Jull et al., 2002). Therefore, the research questions of this review were: (1) in patients with neck pain, do physiotherapy interventions combined with EF reduce pain and improve disability compared to: a control condition (of either no treatment or a placebo/sham) or Physiotherapy intervention alone? (2) Are studies assessing the effectiveness of EF on the management of neck pain adopting the ideal characteristics of feedback provision?

2. Methods

This systematic review followed the Preferred Reporting Item for Systematic Reviews and Meta-Analyses (PRISMA) recommendations (Liberati et al., 2009) and was prospectively registered at the International Prospective Register of Systematic Reviews (PROSPERO) (registration number: CRD42015020555).

2.1. Identification and selection of studies

A health sciences faculty librarian helped with the electronic search strategy. Searches were conducted on Cinahl, Embase, Medline, Psycinfo, Scopus and Web of Science databases, from their inception to August 2016. A description of the search strategies, with key-words and Boolean terms used is presented in Appendix 1. We also screened reference lists from included studies. Studies being reported on languages other than English, Portuguese, Italian, or Spanish were excluded.

Studies were included if they were randomized clinical trial (RCT) and met the other inclusion criteria summarised in Fig. 1. Studies were excluded if they used any other study design than RCT; included healthy participants; or the feedback intervention focused on ergonomic training, or behavioural feedback. Studies were also excluded if the feedback intervention did not focus on motor training. Conference abstracts were also excluded.

Studies identified through the electronic search were stored in Endnote software (X7.5, Thomson Reuters). One reviewer (MSS) identified and removed duplicate results. Two reviewers (FXA and MSS) independently screened all titles as well as reference lists, and at the second stage of study selection, screened abstract and full-text articles according to the inclusion and exclusion criteria. Reviewers were not blinded for journal titles, authors and institutions, as research has shown that blinding does not affect the inclusion and data extraction of studies when conducting a systematic review (Berlin, 1997). In case of multiple reporting, one study was included in the review, and all others were referenced.

Data were extracted independently by one reviewer (MSS) to a standardized data extraction form, and double-checked by a second reviewer (FXA). In case of disagreement, a third reviewer was consulted (DCR). Information about author, publication year, sample size, study design, study purpose, interventions, feedback characteristics, number of subjects in each condition, follow-up time-points (if applicable), frequency of the interventions (if applicable), outcomes measures, comparators and results were extracted from each study. The extrinsic feedback characteristics extracted from studies included: timing (e.g. concurrent, terminal and frequency), content (e.g. program, parameter, summary, average, bandwidth and focus of attention) characteristics, and the nature of feedback (e.g., knowledge of results or knowledge of performance) (Ribeiro et al., 2011a). For the purpose of this study, a short-term follow-up was defined as 0 to 12 weeks, mid-term follow-up defined as 13 to 26 weeks and long-term follow-up defined as more or equal to 27 weeks.

2.2. Risk of bias within included studies

Risk of bias of included studies was assessed using the PEDro scale (Maher et al., 2003). Two reviewers (FXA and MSS) independently assessed the risk of bias of included studies, and a third reviewer (DCR) was consulted if no consensus was achieved. Trials scoring greater than six were considered to be lower risk of bias, while trials scoring 6 or less were considered as having high risk of bias (Armijo-Olivo et al., 2015). This instrument has shown good levels of validity and reliability (de Morton, 2009; Macedo et al., 2010; Maher et al., 2003).

2.3. Participants

Trials involving people with non-specific neck pain, with or without radicular symptoms, or neck pain with associated headache, aged between 18 and 65 years old were considered for inclusion. There was no restriction related to the source of participants.

2.4. Interventions

The experimental condition was Physiotherapy interventions which include the use of an EF (e.g. pressure biofeedback, electromyography feedback). Studies were eligible if comparing EF with physiotherapy alone or with a control group.

2.5. Outcome measures

The primary outcome measures were neck pain (measured throughout visual analogue scale, or any other instrument such as algometer), and functional disability (e.g., neck disability index or other scale). The second outcome measure, when reported, was motor performance (e.g., the ability to recruit deep cervical muscles).

2.6. Data analysis and quality of evidence

Meta-analyses were conducted using Review Manager software (Version 5.3., Copenhagen, The Nordic Cochrane Centre) using the random effects model (Review Manager, 2014). The mean difference (MD) or standard mean difference (SMD) was calculated using the pre-intervention and post-intervention means and standard deviations, and statistical heterogeneity was quantified with the I^2. The pooled data for each outcome were reported as SMD or MD with a 95% CI. When all studies in a homogenous meta-analysis group reported an outcome using the same scale, then MD was calculated, while SMD was calculated for outcomes using a different scale. Statistical significance was set at a level of 0.05.

We compared pain and disability at short, mid and long-term between: Physiotherapy intervention plus EF and Physiotherapy intervention alone; and Physiotherapy intervention plus EF and control. For the purpose of this review, we considered as control any inactive intervention, as for example either no intervention or an intervention that is unlikely to lead to any therapeutic effect (Higgins and Green, 2009). We conducted a subgroup analysis for

Design
- Randomised controlled trial.

Participants
- Patients presenting with non-specific neck pain with or without radicular symptoms, or patients with neck disorders associated with cervicogenic headache.

Intervention
- Physiotherapy interventions including a form of extrinsic feedback (e.g. pressure bio-feedback, electromyography feedback) as part of the treatment of neck pain.

Outcome measures
- Neck pain (measured throughout visual analogue scale, or any other instrument such as algometer). Functional disability (measured throughout neck disability index or other scale).

Comparisons
- Effect of Physiotherapy plus extrinsic feedback versus Physiotherapy alone.
- Effect of Physiotherapy plus extrinsic feedback versus control.

Fig. 1. Inclusion criteria.

studies comparing: "Physiotherapy intervention plus EF versus that same physiotherapy intervention without EF"; and a subgroup analysis for patients with acute and chronic pain. When only one trial compared interventions at these time-points, meta-analyses was not conducted, and the between-group mean difference, 95% confidence interval (CI) and p-value was reported.

We performed an overall comparison between interventions, including patients with different subtypes of neck disorders (e.g. non-specific neck pain, with or without radicular symptoms, or cervicogenic headache). We opted for that approach, as the principles for using extrinsic feedback is the same (i.e. to restore optimal control of the cervical muscles). A recent Cochrane review (Gross et al., 2016) has used a similar approach for assessing the effect of exercises on neck disorders. When appropriate, we conducted sub-analysis to compare the effectiveness of interventions on pain and disability in patients with a specific subtype of neck disorder (e.g. chronic neck pain, or headache).

The quality and strength of evidence for each outcome was assessed using the GRADE approach, as suggested by the Cochrane Collaboration (Guyatt et al., 2011). Strength and quality of evidence was categorized as follow: (1) High-quality: consistent findings among at least 75% of the participants from low risk of bias studies; consistent, direct and precise data; and no known or suspected publication biases. Further research is unlikely to change either the estimate or confidence in the results; (2) Moderate-quality: one of the domains was not met. Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate; (3) Low-quality: two of the domains were not met. Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate; (4) Very low-quality: Three of the domains were not met and the results are very uncertain.

3. Results

3.1. *Flow of studies through the review*

The PRISMA flowchart describing selection, screening and inclusion process is illustrated in Fig. 2.

3.2. *Risk of bias within included studies*

A very high inter-rater agreement was found for the PEDro scores ($k = 0.904$; 95% $CI = 0.812$ to 0.996). The PEDro score ranged from two to seven (Table 1). Seven out of eight trials scored less than six or less on the PEDro scale, and were considered as having high risk of bias (Cüzdan et al., 2013; Iqbal et al., 2013; Nezamuddin et al., 2013).

3.3. *Grade*

Both summary of findings and evidence profile are presented in Table 2. The overall grade of the evidence obtained for Physiotherapy intervention plus EF ranged from 'low' to 'very low' grades.

3.4. *Characteristics of included trials*

3.4.1. *Participants*

A summary of the characteristics of included studies is presented in Table 3. Most studies included patients with neck pain ($n = 387$) (Chiu et al., 2005; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2009; Nezamuddin et al., 2013). Two studies (Iqbal et al., 2013; Nezamuddin et al., 2013) assessed patients with acute neck pain ($n = 80$), while three studies (Falla et al., 2007; Jull et al., 2007, 2009) assessed patients with chronic neck pain ($n = 162$). One study (Jull et al., 2002) included 200 patients with neck pain with associated headache, and one study included 90 participants with trigger points in the upper trapezius muscle (Cüzdan et al., 2013).

3.4.2. *Interventions*

There were two different sources of EF in the included articles: pressure biofeedback stabilizer (Chiu et al., 2005; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009; Nezamuddin et al., 2013), wearable audio-biofeedback device (Cüzdan et al., 2013). The type of feedback was visual/tactile (Chiu et al., 2005; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009), visual/tactile/verbal (Nezamuddin et al., 2013), and auditory (Cüzdan et al., 2013). Two studies compared Physiotherapy intervention plus EF versus control (Chiu et al., 2005; Jull et al., 2002). The control interventions comprised of infrared irradiation (Chiu et al., 2005) and no physiotherapy intervention (Jull et al., 2002). The nature of EF used by the studies is presented in Table 3, and EF timing and content characteristics adopted by studies are reported in Table 4.

3.4.3. *Outcomes and time-points*

Seven studies measured both pain and disability outcomes (Chiu et al., 2005; Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009), whereas only one study reported only pain as outcome (Nezamuddin et al., 2013). All included studies

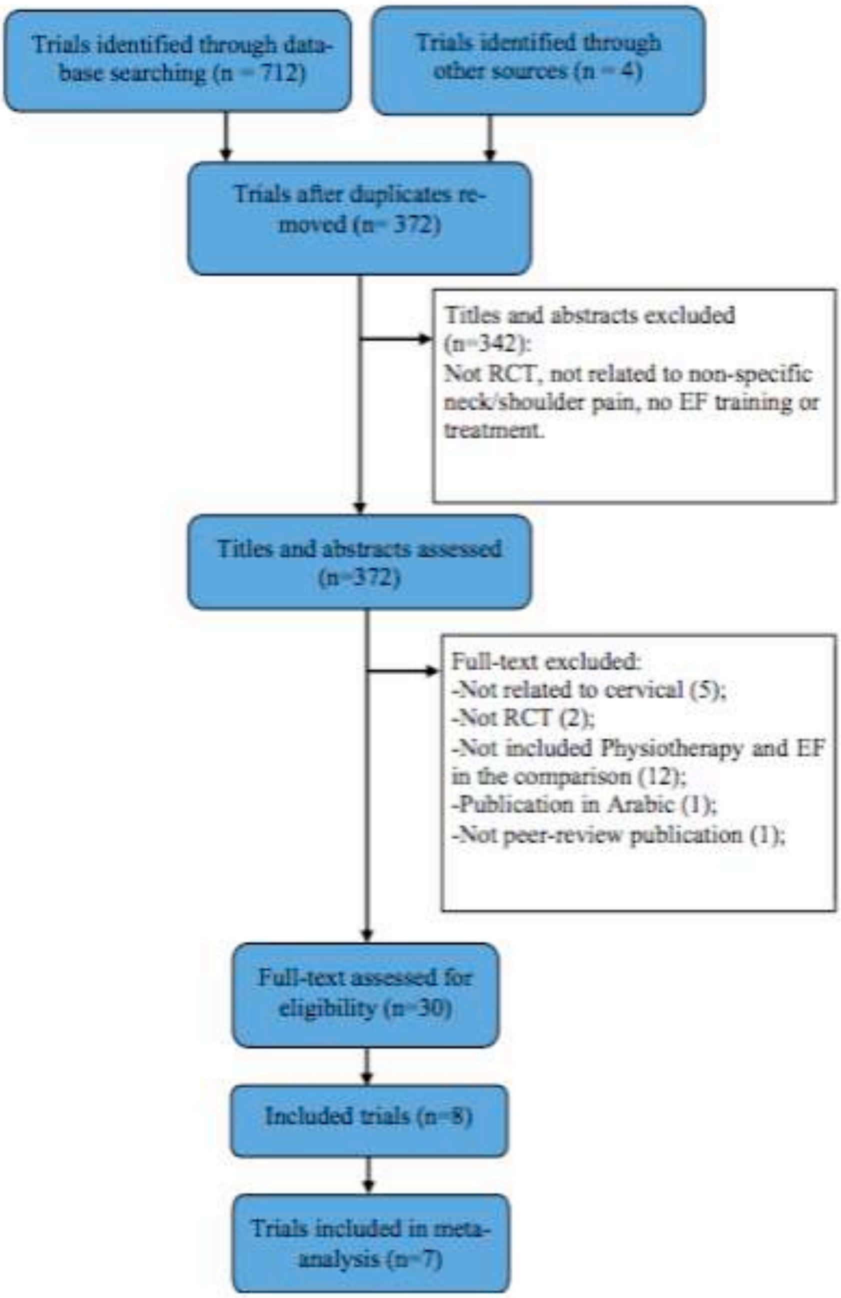

Fig. 2. PRISMA Flowchart diagram.

reported short-term follow-up (Chiu et al., 2005; Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009; Nezamuddin et al., 2013), with one study (Chiu et al., 2005) reporting mid-term, and another (Jull et al., 2002), long-term follow-up.

3.5. *Effects of intervention*

3.5.1. *Effect of Physiotherapy intervention plus EF versus Physiotherapy intervention alone*

The pooled estimate from five trials (Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009)

Table 1
PEDro scores of included trials (n = 8).

First Author (Year)	Random allocation	Concealed allocation	Baseline comparability	Participant blinding	Therapist blinding	Assessor blinding	Adequate follow-up	Intention- to-treat analysis	Between-group comparisons	Point estimates and variability	Total Score
Chiu et al. (2005)	Y	Y	Y	N	N	N	N	Y	Y	Y	6
Cüzdan et al. (2013)	Y	N	Y	N	N	N	N	N	Y	Y	4
Falla et al. (2007)	Y	Y	Y	N	N	N	Y	N	Y	Y	6
Iqbal et al. (2013)	Y	N	Y	N	N	N	Y	N	Y	Y	5
Jull et al. (2002)	Y	Y	Y	N	N	N	Y	Y	Y	Y	7
Jull et al. (2007)	Y	N	Y	N	N	N	Y	N	Y	Y	5
Jull et al. (2009)	Y	Y	Y	N	N	N	Y	N	Y	Y	6
Nezamuddin et al. (2013)	Y	N	Y	N	N	N	Y	N	Y	Y	5

Y = Yes; N = No.

indicated no significant differences between Physiotherapy intervention plus EF and Physiotherapy intervention alone for short-term disability (Fig. 3). There is very low-quality (GRADE) that Physiotherapy intervention plus EF did not promote better results for disability than Physiotherapy intervention alone at short-term follow-up (Table 2).

We also compared Physiotherapy intervention plus EF versus Physiotherapy intervention alone on short-term pain from six trials involving 312 participants (Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007, 2002, 2009; Nezamuddin et al., 2013). Pooled estimates suggest statistically significant differences in favour of Physiotherapy intervention plus EF for pain (Fig. 3). There is very low-quality evidence (GRADE) that Physiotherapy intervention plus EF reduces pain at short-term follow-up compared to Physiotherapy intervention alone (Table 2).

A single study (Jull et al., 2002) involving 100 patients, measured the effect of Physiotherapy intervention plus EF versus Physiotherapy intervention alone on disability and pain at long-term. Findings from this study suggest no statistically significant differences between Physiotherapy intervention plus EF compared to Physiotherapy intervention alone on disability (MD = −3.0, 95% CI = −8.12 to 2.12, $p = 0.25$), as well as on pain (MD = −0.42, 95% CI = -1.39 to 0.55, $p = 0.40$). There is low-quality evidence (GRADE) suggesting that Physiotherapy intervention plus EF leads to better outcomes than Physiotherapy intervention alone (i.e., disability and pain) at long-term follow-up compared to Physiotherapy intervention alone (Table 2).

3.5.2. *Effect of Physiotherapy intervention plus EF versus control*

The short-term effects of Physiotherapy intervention plus EF versus control on disability and pain were examined by pooling post-intervention data from two trials (Chiu et al., 2005; Jull et al., 2002), with a total of 242 patients. The pooled estimate indicated no statistically significant differences between Physiotherapy intervention plus EF and control for disability scores (Fig. 4). Statistically significant differences were found for pain scores, favouring Physiotherapy intervention plus EF intervention (Fig. 4). At short-term follow-up, there is very low-quality evidence (GRADE) that Physiotherapy intervention plus EF is not superior than control for improving disability as well as very low-quality evidence (GRADE) that Physiotherapy intervention plus EF is superior than control for improving pain (Table 2).

One trial (Chiu et al., 2005) with 145 participants, assessed the effect of Physiotherapy intervention plus EF versus control on disability and pain at mid-term follow-up. That study reported no statistically significant differences between Physiotherapy intervention plus EF and control on disability scores (MD = 0.2, 95% CI = 0.0 to 0.4, $p = 0.08$). There is low-quality evidence (GRADE) that Physiotherapy intervention plus EF is not better than control for improving disability at mid-term follow-up. With regards to pain scores, Physiotherapy intervention plus EF presented superior effect than control (MD = 1.2, 95%CI = 0.4 to 2.0, $p < 0.05$). There is low-quality evidence (GRADE) that, at mid-term follow-up, Physiotherapy intervention plus EF improves pain outcomes compared to control. Another trial (Jull et al., 2002), with 97 participants, assessed the long-term effects of Physiotherapy intervention plus EF versus control on disability and pain. Physiotherapy intervention plus EF was statistically significant superior to control in reducing disability (MD = −7.77, 95%CI = −12.62 to −2.91, $p = 0.0023$) and pain (MD = −1.37, 95%CI = −2.31 to −0.42, $p = 0.0054$). There is low-quality evidence (GRADE) that Physiotherapy intervention plus EF leads to better outcomes (i.e., disability and pain) at long-term follow-up if compared to control (Table 2).

3.5.3. *Effect of Physiotherapy intervention plus EF versus that same physiotherapy intervention without EF*

Only two studies (Cüzdan et al., 2013; Iqbal et al., 2013) compared "Physiotherapy intervention plus EF versus that same physiotherapy intervention without EF" with a total of 90 participants. Due to heterogeneity regarding the type of EF (e.g. pressure biofeedback stabilizer (Iqbal et al., 2013) and wearable audio-biofeedback device (Cüzdan et al., 2013), we did not conduct meta. One study (Iqbal et al., 2013) used pressure biofeedback stabilizer as the EF tool, and reported statistically significant differences between Physiotherapy intervention plus EF versus the same physiotherapy intervention on: disability (SD = 3.39, 95% CI = −3.87 to −1.77, $p = 0.000$), and pain (SD = 1.06, 95%CI = −2.12 to −0.52, $p = 0.0009$) at short-term. Another trial [32] used wearable audio-biofeedback device as the EF tool. That trial (Cüzdan et al., 2013) reported no statistically significant differences between Physiotherapy intervention plus EF versus the same physiotherapy intervention on disability (SD = 11.91, 95%CI = −0.52 to 0.50, $p = 0.0962$) and pain (SD = 1.45, 95%CI = −0.26 to 0.75, $p = 0.3423$) at short-term.

3.5.4. *Effect of Physiotherapy plus EF on patients with acute neck pain*

Two studies (Iqbal et al., 2013; Nezamuddin et al., 2013) compared "Physiotherapy Intervention plus EF vs Physiotherapy intervention" for patients with acute neck pain (n = 80 participants), and findings suggest better outcomes for Physiotherapy Intervention plus EF for pain at short-term (Fig. 5). For that comparison, we found low heterogeneity for effect estimates (as expressed by the I2 equal to zero); and there was low heterogeneity for participants, interventions and outcomes from these studies, with the exception of the control intervention. Iqbal et al. (2013)

Table 2
GRADE evidence profile (EP) and summary of findings (SoF).

	Number of participants & number of studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall Quality of Evidence	Summary of Findings Anticipated absolute effects Risk difference with intervention (95%)
Physiotherapy Intervention + EF versus Physiotherapy Intervention alone.								
Disability								
Short-term (0–12 weeks)	340 Six studies (Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007; Jull et al., 2002; Jull et al., 2009)	Very serious [a]	Very Serious [b]	Not serious	Not serious	Undetected	Very low	The mean disability in the intervention group was 0.38 lower (0.91 lower to 0.15 higher)
Long-term (52 - > weeks)	100 One study (Jull et al., 2002)	Serious [c]	Not Serious	Not serious	Serious	Undetected	Low	The mean disability in the intervention group was 3.0 lower (8.12 lower to 2.12 higher)
Pain								
Short-term (0–12 weeks)	402 Seven studies (Cüzdan et al., 2013; Falla et al., 2007; Iqbal et al., 2013; Jull et al., 2007; Jull et al., 2002; Jull et al., 2009; Nezamuddin et al., 2013)	Very Serious [e]	Very Serious [b]	Not serious	Not Serious	Undetected	Very low	The mean pain in the intervention group was 0.37 lower (0.73–0.01 lower)
Long-term (52 - > weeks)	100 One study (Jull et al., 2002)	Serious [c]	Not serious	Not serious	Serious [d]	Undetected	Low	The mean pain in the intervention group was 0.42 lower (1.39 lower to 0.55 higher)
Physiotherapy Intervention + EF versus control								
Disability								
Short-term (0–12 weeks)	242 Two studies (Chiu et al., 2005; Jull et al., 2002)	Very Serious [f]	Very serious [b]	Not serious	Not serious	Undetected	Very Low	The mean disability in the intervention group was 3.94 lower (12.06 lower to 4.18 higher)
Mid-term (13–26 weeks)	145 One study (Chiu et al., 2005)	Serious [c]	Not serious	Not serious	Serious [d]	Undetected	Low	The mean disability in the intervention group was 0.2 higher (0.00–0.4 higher)
Long-term (52 - > weeks)	97 One study (Jull et al., 2002)	Serious [c]	Not serious	Not serious	Serious [d]	Undetected	Low	The mean disability in the intervention group was 7.77 lower (12.62–2.91 lower)
Pain								
Short-term (0–12 weeks)	242 Two studies (Chiu et al., 2005; Jull et al., 2002)	Very Serious [f]	Serious [g]	Not serious	Not serious	Undetected	Very Low	The mean pain in the intervention group was 1.44 lower (2.25–0.63 lower)
Mid-term (13–26 weeks)	145 One study (Chiu et al., 2005)	Serious [c]	Not serious	Not serious	Serious [d]	Undetected	Low	The mean pain in the intervention group was 1.2 higher (0.4–2.0 higher)
Long-term (52 - > weeks)	97 One study (Jull et al., 2002)	Serious [c]	Not serious	Not serious	Serious [d]	Undetected	Low	The mean pain in the intervention group was 1.37 lower (2.31–0.42 lower)

[a] Most studies (50%) did not grant allocation concealment; 100% studies did not blinded assessors; Most studies (85%) did not provided intention-to-treat analysis.
[b] Considerable heterogeneity (I2 > 65%) p < 0.05; The confidence interval of one outlier study did not overlap with those of most included studies.
[c] One single study without blinded assessor.
[d] Low magnitude of the median sample size; small number of included studies.
[e] Most studies (57%) did not grant allocation concealment; 100% studies did not blinded assessors; Most studies (85%) did not provided intention-to-treat analysis.
[f] One study (50%) without adequate follow-up; 100% studies without blinded assessor.
[g] May represent Considerable heterogeneity (I2 = 51%) p < 0.05.

Table 3
Characteristics of the included studies.

First Author (Year)	Population	Intervention	Nature of EF (KP KR)	Type of EF	Instrument	Outcomes	Time-points
Chiu et al. (2005)	145 Chronic neck pain patients	6-weeks training (12 session) G1: Dynamic Strengthening of the neck muscles, DFC activation and Infrared Irradiation; G2: Infrared Irradiation	KR $	Visual and Tactile	Pressure Stabilizer Biofeedback	Pain: NPRS Disability: NPNPQ	Short + T Mid + T
Ciuδan et al. (2013)	90 Myofascial Pain Syndrome patients	4-weeks training G1: Wearable audio-biofeedback + home based exercises G2: Home based exercise	KP $	Auditory	Wearable audio-biofeedback	Pain: VAS Disability: NPDS	Short + T
Falla et al. (2007)	58 Females with chronic neck pain	6-weeks (6 sessions) G1: CCF Training G2: Endurance Strength training	KR $	Visual and Tactile	Pressure stabilizer Biofeedback	Pain: NPRS Disability: NDI	Short + T
Iqbal et al. (2013)	30 Teachers with neck pain (NPRS>5, NDI – mild-moderate)	4-weeks training (16 sessions) G1: DCF training with pressure biofeedback + conventional exercises; G2: Conventional exercises only with DCF without biofeedback	Unable to determine	Visual and Tactile	Pressure Stabilizer Biofeedback	Pain: NPRS Disability: NDI	Short + T
Jull et al. (2002)	200 (193 completed the trial) Patients with neck pain associated with headache	6 weeks (8–12 session) G1: CCF Training with biofeedback + Low Load endurance exercise; G2: Cervical Mobilization and Manipulation; G3: Therapeutic Exercise Intervention + Manual Therapy; G4: No physiotherapy interventions	KR $	Visual and Tactile	Pressure Stabilizer Biofeedback	Pain: VAS Disability: NPNPQ	Short + T Long + T
Jull et al. (2007)	58 (30 CCF) Chronic neck pain patients	6-Week (1x/week with therapist + home based everyday) G1: CCF Training G2: Proprioception Exercises (Head relocation practice, gaze stability, eye-follow and eye/head coordination exercises)	KR $	Visual and Tactile	Pressure Stabilizer Biofeedback	Pain: NPRS Disability: NDI	Short + T
Jull et al. (2009)	46 Female chronic neck pain patients	6-Week (1x/week with therapist + home based everyday) G1: Low Load strength training (CCF) G2: High Load strength training	KR $	Visual and Tactile	Pressure Stabilizer Biofeedback	Pain: NPRS Disability: NDI	Short + T
Nezamuddin et al. (2013)	50 neck pain patients	6 weeks (5 days/week) G1: CCF training with feedback G2: Stretching and strengthening	Unable to determine	Visual, Verbal and Tactile	Pressure Stabilizer Biofeedback	Pain: VAS	Short T

EF – Extrinsic feedback; KP – Knowledge of Performance; KR – Knowledge of Results; DCF – Deep Cervical Flexor muscles; NPRS – Numeric Pain Rating Scale; NPNPQ – Northwick Park Neck Pain Questionnaire; VAS – Visual Analogue Scale; NPDS – Neck Pain Disability Scale; CCF – Craniocervical Flexion; NDI – Neck Disability Index; Short – Short-term follow-up; Mid – Mid-term follow-up; Long – Long-term follow-up; $ – interpreted by the reviewers; + – Disability; T – Pain.

Table 4
Extrinsic feedback content and timing characteristics.

First Author (Year)	Content Characteristics						Timing Characteristics					
	Program	Parameter	Summary	Average	Bandwidth	Focus of attention	Concurrent	Terminal Immediate	Delayed	Frequency Constant	Reduced frequency	Self-controlled
Chiu et al. (2005)	YES	NO	NO	NO	NO	Internal	YES	NO	NO	YES	NO	NO
Cizdan et al. (2013)	YES	NO	NO	NO	NO	Internal	YES	NO	NO	YES	NO	NO
Falla et al. (2007)	YES	NO	NO	NO	NO	External	YES	NO	NO	YES	NO	NO
Iqbal et al. (2013)	YES	NO	NO	NO	NO	Internal	UD	UD	UD	UD	UD	UD
Jull et al. (2002)	YES	NO	NO	NO	NO	Internal and external	YES	NO	NO	UD	UD	UD
Jull et al. (2007)	YES	NO	NO	NO	NO	Internal and external	UD	UD	UD	UD	UD	UD
Jull et al. (2009)	YES	NO	NO	NO	NO	Internal and external	YES	NO	NO	YES	NO	NO
Nezamuddin et al. (2013)	YES	NO	NO	NO	NO	Internal	YES	NO	NO	YES	NO	NO

UD – Unable to determine; Internal – Internal focus of attention; External – External focus of attention; Int. and Ext. – Internal and external focus of attention.

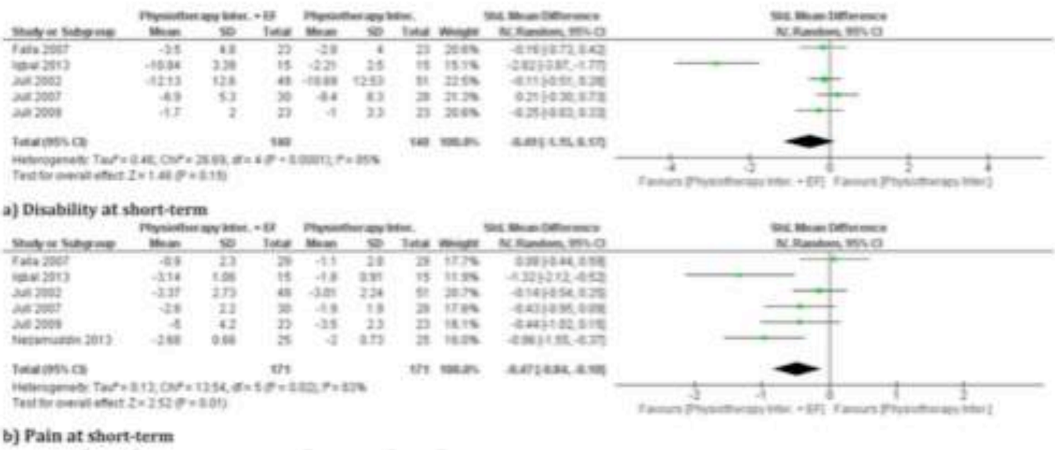

Fig. 3. Physiotherapy Intervention plus EF vs. Physiotherapy intervention.

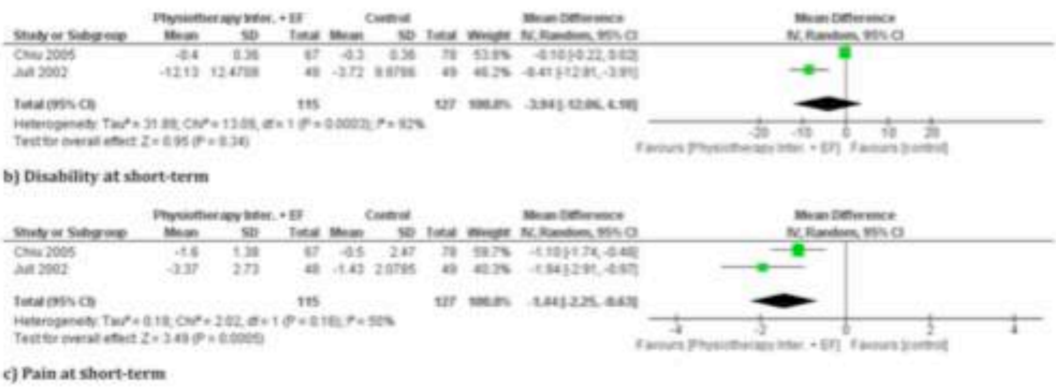

Fig. 4. Physiotherapy Intervention plus EF vs. Control.

used as control intervention exercise therapy focusing on cervical deep flexors (without the use of extrinsic feedback), while Nezamuddin et al. (2013) used stretching and strengthening exercises that also included exercise therapy focusing on cervical deep flexors (without the use of extrinsic feedback).

3.5.5. Effect of Physiotherapy plus EF on patients with chronic neck pain

Three studies (Falla et al., 2007; Jull et al., 2007, 2009) compared pain and disability outcomes between "Physiotherapy Intervention plus EF" and "Physiotherapy intervention" in patients with chronic neck pain (n = 162 participants) at short-term follow-up (Fig. 6). There were no differences between interventions for both disability and pain (Fig. 6).

4. Discussion

This review assessed the effectiveness of EF on pain and disability outcomes for the treatment of patients with neck pain disorders and reviewed the characteristics of EF used for neck rehabilitation. There is very low-grade evidence suggesting that Physiotherapy intervention plus EF is more effective than Physiotherapy intervention alone for neck-related pain at short-term. We found very low evidence suggesting no difference between Physiotherapy intervention plus EF and Physiotherapy intervention alone for neck-related disability. Based on meta-analysis findings, there is very low evidence indicating that Physiotherapy intervention plus EF is not superior than control for disability at short-term follow-up; and very low-grade evidence suggesting that Physiotherapy intervention plus EF is superior than control for pain outcomes. Based on findings from single studies, there is low evidence suggesting no difference between Physiotherapy intervention plus EF and EF alone for disability and pain, at short- and long-term follow-up. There is also low quality evidence supporting that Physiotherapy intervention plus EF is no different to control for disability, but is superior for pain, at mid-term follow-up. At long-term, there is low evidence suggesting no differences between Physiotherapy intervention plus EF and Physiotherapy intervention alone for both neck-related disability and pain. However, Physiotherapy intervention plus EF is more effective than control for improving disability and pain.

It is reasonable to assume that motor control training will have a larger effect on patients who present with motor control impairments. Five studies (Chiu et al., 2005; Cüzdan et al., 2013; Iqbal et al., 2013; Jull et al., 2002; Nezamuddin et al., 2013) did not explicitly state whether patients presented with impaired control of cervical muscles; while the other three included patients who presented poor performance in the cranio cervical flexion test (Falla et al., 2007; Jull et al., 2009) or reduced joint position sense (Jull et al., 2007). The absence of impaired control of cervical muscles at baseline may have impacted on effect estimates of these five studies. On the other hand, it has been repeatedly reported in the literature that patients with neck disorders have altered motor control of cervical muscles (Jull and Falla, 2016; Lindstrom et al., 2011). Based on that, there is a small chance that the effect estimates reported by studies included in our review are biased.

Overall, the EF characteristics were not adequately described. None of the included studies reported parameter, summary, average or bandwidth content characteristics. Such characteristics are crucial for motor learning, and might have influenced clinical outcomes (Herbert et al., 2008). The effectiveness Physiotherapy intervention plus EF may have been hindered by the non-ideal forms of EF provision. A rationale for EF has been proposed for low back pain rehabilitation (Herbert et al., 2008), and that could also be used as a guide for neck rehabilitation. Future studies assessing the effectiveness of EF in neck rehabilitation should carefully plan how EF is provided to patients.

Previous reviews assessed the effect of exercise on neck disorders (Gross et al., 2016), and EF on low back pain (Ribeiro et al., 2011a). Moderate to low quality evidence that exercises interventions are effective for improving pain and function in patients with chronic, mechanical neck pain and cervicogenic headache (associated with neck pain) at short- and long-term (Gross et al., 2016). Ribeiro et al. (2011a) presented important insights about the role of different EF characteristics, and recommended the provision of certain characteristics for feedback provision. These authors also mentioned that studies did not adequately report the characteristics of EF. Similar to findings from Ribeiro et al. (2011a) the conflicting evidence for inclusion of EF as part of the rehabilitation programme (for neck disorders) may be due to non-ideal forms of EF provision.

Musculoskeletal physiotherapists should consider the impact of feedback characteristics on motor control and learning. There is strong evidence from the literature on motor control and learning that non-ideal forms of feedback provision hinder motor learning (Magill, 2007). Musculoskeletal physiotherapy research exploring the impact of different forms of feedback provision on motor learning is scarce (Herbert et al., 2008). Further research is warranted to confirm which are the ideal forms of feedback provision for patients with neck pain. In the meantime, we suggest clinicians to explore the proposed ideal forms of feedback provision that are based on motor control and learning research.

Subgroup analysis based on neck disorder suggested Physiotherapy Intervention plus EF are more effective than Physiotherapy Intervention alone for patients with acute neck pain at short-term. This effect estimate is based in only two trials, and there was some intervention heterogeneity for the control intervention between the two studies. One study (Iqbal et al., 2013) compared the deep cervical flexor training with and without EF, the other study (Nezamuddin et al., 2013) compared motor control training for craniocervical flexor muscle plus EF with general strength and stretching exercises. The heterogeneity for control intervention may have impacted on pooled estimated effects. It has been suggested that some heterogeneity between studies is inevitable (Higgins et al., 2011). While the "control" intervention was not exactly the same, we considered these as similar enough to allow for meta-analysis. Based on that, it is difficult to drawn any conclusion regarding the additional value of the EF to the rehabilitation programme.

Based on our findings, the use of EF was not as effective for patients with chronic neck pain, as it was for pain patients with acute neck pain. Chronic neck pain patients present with neuromuscular impairments such as increased superficial cervical flexor activity, and, simultaneously, inhibition of deep cervical flexor muscles (Jull and Falla, 2016), but also present with a number of beliefs and fears around movement and their musculoskeletal disorder. These findings suggest the need of multi-modal interventions, including exercise therapy, education and behavioral therapy (Sutton et al., 2016; Taimela et al., 2000).

Pain Short-term

Fig. 5. Physiotherapy Intervention plus EF vs. Physiotherapy intervention (acute pain).

Fig. 6. Physiotherapy intervention plus EF vs. Physiotherapy intervention (chronic pain).

Our systematic review has strengths and limitations. This review reports novel findings regarding the inclusion of EF as part of the rehabilitation programme for neck disorders (as previous review focused on exercises intervention only). Studies with low risk of bias and with the ideal forms of EF provision are likely to change the evidence for EF on neck rehabilitation. The limitations of this review include the high statistical heterogeneity (greater than 90%) found in included studies. Most of the included studies had small sample size (less than 50 patients) and seven studies presented high risk of bias (PEDro score less than 6/10). In addition, half of the included studies were conducted by the same research group, which may impact on the external validity of the findings. Finally, we included only studies published in English, and this may increase the chances of publication bias.

Our review has identified research gaps in this field. Future studies could: explore different forms of EF provision and the impact of that on clinical outcomes; compare the effectiveness of different types of feedback on clinical outcomes in patients with neck disorders; which patients (i.e. acute, subacute or chronic) are more likely to benefit from EF; and assess the addition of EF with optimal timing and content characteristics lead to better clinical outcomes compared to physiotherapy alone. In addition, future studies should provide a detailed description of feedback characteristics, explicitly presenting the content and timing characteristics of feedback used in the study. This will ensure we can clarify the role of extrinsic feedback in the management of neck disorders.

In conclusion, this systematic review presents very low to low quality of evidence that Physiotherapy intervention plus EF is more effective than Physiotherapy intervention alone or control for short-term pain, but not for disability. In addition, Physiotherapy intervention plus EF was more effective than Physiotherapy alone for acute neck pain, but was not superior for pain and disability in chronic patients at short-term follow-up. Due to high risk of bias within included studies, and the low strength and quality of evidence, future studies with low risk of bias are likely to change the estimates of the effects of Physiotherapy intervention plus EF on neck rehabilitation. In addition, researchers and clinicians are encouraged to carefully consider the characteristics of EF provision as these may hinder or enhance recovery.

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Appendix 1. Search strategy

The search of **CINAHL, EMBASE, MEDLINE, PSYCINFO, SCOPUS** and **WEB OF SCIENCE** databases was optimised by using the related terms used in previous research for participants (neck pain), intervention (external feedback) and outcomes (pain, disability).

Cinahl
1) Neck pain
2) Feedback
3) Biofeedback
4) Extrinsic Feedback
5) 2 OR 3 OR 4
6) 1 AND 5

Embase
1. Neck pain
2. Neck ache
3. 1 OR 2
4. Feedback system
5. 3 AND 4

Medline
1. Neck Pain
2. Biofeedback, Psychology
3. Feedback, Sensory
4. Feedback
5. 2 OR 3 OR 4
6. 1 AND 5

Psycinfo
1. Neck Pain
2. Biofeedback Training
3. Biofeedback
4. Feedback
5. 2 OR 3 OR 4
6. 1 AND 5

Scopus
1. Extrinsic feedback
2. Biofeedback
3. Feedback
4. 1 OR 2 OR 3
5. Neck ache
6. Neck Pain
7. 5 OR 6
8. 4 AND 7

Web of Science
1. Extrinsic feedback

2. Biofeedback
3. Feedback
4. 1 OR 2 OR 3
5. Neck ache
6. Neck Pain
7. 5 OR 6
8. 4 AND 7

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7. ANEXOS

7.1 APROVAÇÃO NO COMITÊ DE ÉTICA E PESQUISA DA UFCSPA

UNIVERSIDADE FEDERAL DE
CIÊNCIAS DA SAÚDE DE
PORTO ALEGRE

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: CONHECIMENTO DE FISIOTERAPEUTAS DO SUL DO BRASIL SOBRE CARACTERÍSTICAS DE FEEDBACK EXTRÍNSECO

Pesquisador: Marcelo Faria Silva

Área Temática:

Versão: 3

CAAE: 05024918.6.0000.5345

Instituição Proponente: Universidade Federal de Ciências da Saúde de Porto Alegre

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.319.076

Apresentação do Projeto:

Introdução: Para o aprendizado de uma nova tarefa motora o corpo humano vale-se de informações sensoriais aferentes que podem ser provenientes de um sistema de feedback intrínseco ou extrínseco. Pacientes com diferentes condições clínicas podem apresentar uma perda de funções neuromusculares, levando ao comprometimento do uso das informações intrínsecas. Nesses casos o uso feedback extrínseco (ou aumentado) como ferramenta para melhora do desempenho é prática corriqueira dos profissionais que lidam com movimento. Algumas evidências sugerem que algumas características de feedback extrínseco podem tanto melhorar como inclusive prejudicar a performance e o aprendizado motor. Além disso, uma revisão sistemática apontou um efeito significativo a favor do uso do feedback extrínseco adicional à outras abordagens fisioterapêuticas. Esta revisão, porém, constatou que os estudos não reportam adequadamente as características utilizadas. Uma possível explicação é o desconhecimento pelos fisioterapeutas das diferentes características e da relevância das mesmas nas variáveis de desfechos analisadas. Objetivo: Identificar o conhecimento dos fisioterapeutas que atuam no sul do Brasil sobre as diferentes caraterísticas de feedback extrínseco. Metodologia: Este é um estudo observacional descritivo transversal quantitativo. Nós desenvolveremos um formulário de preenchimento on-line para ser respondido pelos fisioterapeutas atuantes no sul do Brasil. Um total de 1233 fisioterapeutas serão convidados a responder a pesquisa.

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através do envio de e-mails pelo CREFITO-5. Após a assinatura do Termo de Consentimento Livre e Esclarecido, uma série de 24 questões de múltipla escolha englobarão dados demográficos, características da área de atuação e do tipo de serviço de saúde em que o profissional atua, conhecimentos sobre características de feedback extrínseco assim como barreiras encontradas na utilização desta abordagem. Para verificar a associação entre as variáveis sera utilizado o teste Qui-Quadrado. O nível de significância adotado para o
estudo será de 5% (= 0,05).

Objetivo da Pesquisa:

Objetivo geral: Identificar o conhecimento dos fisioterapeutas que atuam no sul do Brasil sobre as diferentes caraterísticas de feedback extrínseco.

Objetivos específicos:

-Identificar a frequência de utilização de feedback extrínseco pelos fisioterapeutas que atuam no sul Brasil.

-Identificar os fatores que contribuem para escolha das diferentes características de feedback extrínseco pelos fisioterapeutas que atuam no sul Brasil.

-Identificar o perfil dos fisioterapeutas do sul do brasil que utilizam feedback extrínseco.

-Identificar as principais barreiras que impedem a utilização de feedback extrínseco pelos fisioterapeutas que atuam no sul do Brasil.

Avaliação dos Riscos e Benefícios:

Riscos: A participação no presente estudo não confere qualquer risco a sua saúde. Poderá haver risco de constrangimento do participante ao responder as perguntas. A decisão em participar deste estudo é voluntária. O participante pode decidir não participar do estudo. Uma vez que o participante decidiu participar do estudo, o mesmo poderá retirar seu consentimento e participação a qualquer momento. Se o participante decidir não continuar no estudo e retirar sua participação, não haverá nenhum tipo de prejuízo.

Benefícios: Como fisioterapeutas, os voluntários que participarem do estudo irão contribuir para o conhecimento científico sobre um tema relevante. O benefício não será individual, mas para a classe profissional. Os achados do presente estudo poderão contribuir para futuros projetos de pesquisa assim como para um melhor tratamento oferecido os pacientes.

Comentários e Considerações sobre a Pesquisa:

A pesquisa possui relevância acadêmica e busca conhecimentos de interesse da classe de profissionais da fisioterapia e afins.

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos apresentados e ajustados de acordo com recomendações CEP UFCSPA.

Recomendações:

Nenhuma.

Conclusões ou Pendências e Lista de Inadequações:

Nenhuma.

Considerações Finais a critério do CEP:

De acordo com o parecer do Relator.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1253159.pdf	09/04/2019 17:40:17		Aceito
Outros	Carta_Resposta_CEP.docx	09/04/2019 17:39:40	Francisco Xavier de Araujo	Aceito
Parecer Anterior	PB_PARECER_CONSUBSTANCIADO_CEP_3223535.pdf	09/04/2019 17:38:36	Francisco Xavier de Araujo	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Revisado_CEP.docx	09/04/2019 17:37:34	Francisco Xavier de Araujo	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Survey_Feedback_Revisado_CEP.docx	09/04/2019 17:37:10	Francisco Xavier de Araujo	Aceito
Outros	Convite.docx	04/02/2019 17:11:54	Francisco Xavier de Araujo	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	Anuencia.pdf	04/02/2019 17:11:32	Francisco Xavier de Araujo	Aceito
Outros	Termo.pdf	07/12/2018 18:10:38	Francisco Xavier de Araujo	Aceito
Folha de Rosto	FolhadeRosto_CEP.pdf	12/11/2018 14:48:49	Francisco Xavier de Araujo	Aceito

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Continuação do Parecer: 3.319.076

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

PORTO ALEGRE, 10 de Maio de 2019

Assinado por:
Fernanda Bordignon Nunes
(Coordenador(a))

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Bairro: Sarmento **CEP:** 90.050-170
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PARECER CONSUBSTANCIADO DO CEP

DADOS DA EMENDA

Título da Pesquisa: CONHECIMENTO DE FISIOTERAPEUTAS DO BRASIL SOBRE CARACTERÍSTICAS DE FEEDBACK EXTRÍNSECO

Pesquisador: Marcelo Faria Silva

Área Temática:

Versão: 4

CAAE: 05024918.6.0000.5345

Instituição Proponente: Universidade Federal de Ciências da Saúde de Porto Alegre

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.594.833

Apresentação do Projeto:

Trata-se de Emenda para alteração de alguns itens do projeto já aprovado previamente. Anteriormente a pesquisa seria aplicada apenas aos fisioterapeutas que
atuassem no estado do Rio Grande do Sul e nessa emenda está sendo solicitado expansão do estudo para aplicação do mesmo questionário para os fisioterapeutas de
todos os estados do Brasil.

Introdução: Para o aprendizado de uma nova tarefa motora o corpo humano vale-se de informações sensoriais aferentes que podem ser provenientes de um sistema de feedback intrínseco ou extrínseco. Pacientes com diferentes condições clínicas podem apresentar uma perda de funções neuromusculares, levando ao comprometimento do uso das informações intrínsecas. Nesses casos o uso feedback extrínseco (ou aumentado) como ferramenta para melhora do desempenho é prática corriqueira dos profissionais que lidam com movimento. Algumas evidências sugerem que algumas características de feedback extrínseco podem tanto melhorar como inclusive prejudicar a performance e o aprendizado motor. Além disso, uma revisão sistemática apontou um efeito significativo a favor do uso do feedback extrínseco adicional à outras abordagens fisioterapêuticas. Esta revisão, porém, constatou q ue os estudos não reportam adequadamente as características utilizadas. Uma possível explicação é o desconhecimento pelos fisioterapeutas das diferentes características e da relevância das mesmas nas variáveis de desfechos analisadas. Objetivo: Identificar o conhecimento dos fisioterapeutas que atuam no Brasil sobre as diferentes caraterísticas de feedback extrínseco. Metodologia: Este é um estudo observacional descritivo transversal quantitativo. Nós desenvolveremos um formulário de preenchimento on-line para ser respondido pelos fisioterapeutas atuantes no Brasil, inscritos nos conselhos regionais de Fisioterapia das suas respectivas regiões. Os fisioterapeutas serão convidados a responder a pesquisa através de envio de e-mails pelo CREFITO-5 e pela Associação Brasileira de Fisioterapia Traumato-Ortopédica. Após a assinatura do Termo de Consentimento Livre e Esclarecido, uma série de 24 questões de múltipla escolha englobarão dados demográficos, características da área de atuação e do tipo de serviço de saúde em que o profissional atua, conhecimentos sobre características de feedback extrínseco assim como barreiras encontradas na utilização desta abordagem. Para verificar a associação entre as variáveis sera utilizado o teste Qui-Quadrado. O nível de significância adotado para o estudo será de 5% (= 0,05).

Objetivo da Pesquisa:

2.1. Objetivo geral

Identificar o conhecimento dos fisioterapeutas que atuam no Brasil sobre as diferentes caraterísticas de feedback extrínseco.

2.2. Objetivos específicos

Identificar a frequência de utilização de feedback extrínseco pelos fisioterapeutas que atuam no Brasil.

Identificar os fatores que contribuem para escolha das diferentes características de feedback extrínseco pelos fisioterapeutas que atuam no Brasil.

Identificar o perfil dos fisioterapeutas do brasil que utilizam feedback extrínseco.

Identificar as principais barreiras que impedem a utilização de feedback extrínseco pelos fisioterapeutas que atuam no Brasil.

Avaliação dos Riscos e Benefícios:

Riscos:

Poderá haver risco de constrangimento do participante ao responder as perguntas, ou eventual quebra do sigilo da identidade, uma vez que o participante deve fornecer o seu número do registro no conselho profissional. Sua decisão em participar deste estudo é voluntária. Você pode decidir não participar do estudo. Uma vez que você decidiu participar do estudo, você pode retirar seu consentimento e participação a qualquer momento,assim como suspender o preenchimento do questionario e / ou nao submeter o envio das respostas. Se você decidir não continuar no estudo e retirar sua participação, não haverá nenhum tipo de prejuízo.

Benefícios:
Como fisioterapeutas, os voluntários que participarem do estudo irão contribuir para o conhecimento científico sobre um tema relevante. O benefício não será individual, mas para a classe profissional. Os achados do presente estudo poderão contribuir para futuros projetos de pesquisa assim como para um melhor tratamento oferecido os pacientes.

Comentários e Considerações sobre a Pesquisa:
A pesquisa possui relevância acadêmica e busca conhecimentos de interesse da classe de profissionais da fisioterapia e afins.

Considerações sobre os Termos de apresentação obrigatória:
Todos os termos de apresentação obrigatória foram apresentados.

Conclusões ou Pendências e Lista de Inadequações:
Trata-se de Emenda para alteração de alguns itens do projeto já aprovado previamente. Anteriormente a pesquisa seria aplicada apenas aos fisioterapeutas que atuassem no estado do Rio Grande do Sul e nessa emenda está sendo solicitado expansão do estudo para aplicação do mesmo questionário para os fisioterapeutas de todos os estados do Brasil.

Considerações Finais a critério do CEP:
De acordo com o parecer do Relator.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_1401102_E1.pdf	02/08/2019 16:21:34		Aceito
Outros	Termo_Anuencia_Abrafito.pdf	02/08/2019 16:14:33	Francisco Xavier de Araujo	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Revisado_CEP.docx	02/08/2019 16:13:51	Francisco Xavier de Araujo	Aceito
Outros	Convite.docx	02/08/2019 16:13:39	Francisco Xavier de Araujo	Aceito

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Projeto Detalhado / Brochura Investigador	Projeto_Survey_Feedback_Revisado_CEP_Expansao_Brasil.docx	02/08/2019 16:13:18	Francisco Xavier de Araujo	Aceito
Outros	Carta_Resposta_CEP.docx	09/04/2019 17:39:40	Francisco Xavier de Araujo	Aceito
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TCLE / Termos de Assentimento / Justificativa de Ausência	Anuencia.pdf	04/02/2019 17:11:32	Francisco Xavier de Araujo	Aceito
Outros	Termo.pdf	07/12/2018 18:10:38	Francisco Xavier de Araujo	Aceito
Folha de Rosto	FolhadeRosto_CEP.pdf	12/11/2018 14:48:49	Francisco Xavier de Araujo	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

PORTO ALEGRE, 24 de Setembro de 2019

Assinado por:
Luciane Dalcanale Moussalle
(Coordenador(a))

7.2 NORMAS DE SUBMISSÃO DO BRAZILIAN JOURNAL OF PHYSICAL THERAPY

BRAZILIAN JOURNAL OF PHYSICAL THERAPY

AUTHOR INFORMATION PACK

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ISSN: 1413-3555

DESCRIPTION

The *Brazilian Journal of Physical Therapy* (BJPT) is the official publication of the Brazilian Society of Physical Therapy Research and Graduate Studies (ABRAPG-Ft). It publishes original research articles on topics related to the areas of physical therapy and rehabilitation sciences, including clinical, basic or applied studies on the assessment, prevention, and treatment of movement disorders.

IMPACT FACTOR

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ABSTRACTING AND INDEXING

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INTRODUCTION

Types of article

The **Brazilian Journal of Physical Therapy (BJPT)** publishes original research articles, reviews, and brief communications on topics related to physical therapy and rehabilitation, including clinical, basic or applied studies on the assessment, prevention and treatment of movement disorders. Our Editorial Board is committed to disseminate high-quality research in the field of physical therapy. The BJPT follows the principle of publication ethics included in the code of conduct of the Committee on Publication Ethics (COPE).The BJPT accepts the submission of manuscripts with up to 3,500 words (excluding title page, abstract, references, tables, figures and legends). Information contained in appendices will be included in the total number of words allowed. A total of five (5) combined tables and figures is allowed.

The following types of study can be considered for publication, if directly related to the journals scope:
a) Intervention studies (clinical trials): studies that investigate the effect(s) of one or more interventions on outcomes directly related to the BJPTs scope. The World Health Organization defines a clinical trial as any research study that prospectively allocates human participants or groups of humans to one or more health-related interventions to evaluate the effect(s) on health outcome(s). Clinical trials include single-case experimental studies, case series, non-randomized controlled trials, and randomized controlled trials. Randomized controlled trials (RCTs) must follow the CONSORT (Consolidated Standards of Reporting Trials) recommendations, which are available at: http://www.consort-statement.org/consort-statement/overview0/. The CONSORT checklist and Statement Flow Diagram, available at http://www.consort-statement.org/consort-statement/flow-diagram, must be completed and submitted with the manuscript. Clinical trials must provide registration that satisfies the requirements of the International Committee of Medical Journal Editors (ICMJE), e.g. http://clinicaltrials.gov/ and/or http://www.anzctr.org.au. The complete list of all clinical trial registries can be found at: http://www.who.int/ictrp/network/primary/en/index.html. We suggest that all authors register clinical trials prospectively via the website http://www.clinicaltrials.gov.
Note: We do not accept single case studies and series of cases (i.e. clinical trials without a comparison group).

b) Observational studies: studies that investigate the relationship(s) between variables of interest related to the BJPTs scope. Observational studies include cross-sectional studies, cohort studies, and case-control studies. All observational studies must be reported following the recommendation from the STROBE statement (http://strobe-statement.org/index.php?id=strobe-home).

c) Qualitative studies: studies that focus on understanding needs, motivations, and human behavior. The object of a qualitative study is guided by in-depth analysis of a topic, including opinions, attitudes, motivations, and behavioral patterns without quantification. Qualitative studies include documentary and ethnographic analysis.

d) Systematic reviews: studies that analyze and/or synthesize the literature on a topic related to the scope of the BJPT. Systematic reviews that include meta-analysis will have priority over other systematic reviews. Those that have an insufficient number of articles or articles with low quality in the Methods section and do not include an assertive and valid conclusion about the topic will not be considered for peer-review analysis.
The authors must follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist to format their systematic reviews. The checklist is available at http://www.prisma-statement.org/PRISMAStatement/Default.aspx and must be filled in and submitted with the manuscript.
Potential authors are encouraged to read the following tutorial, which contains the minimum requirements for publication of systematic reviews in the BJPT: Mancini MC, Cardoso JR, Sampaio RF, Costa LCM, Cabral CMN, Costa LOP. Tutorial for writing systematic reviews for the Brazilian Journal of Physical Therapy (BJPT). Braz J Phys Ther. 2014 Nov-Dec; 18(6):471-480.

e) Studies on the translation and cross-cultural adaptation of questionnaires or assessment tools: studies that aim to translate and/or cross-culturally adapt foreign questionnaires to a language other than that of the original version of existing assessment instruments. The authors must use the checklist (Appendix) to format this type of paper and adhere to the other recommendations of the BJPT. The answers to the checklist must be submitted with the manuscript. At the time of submission, the authors must also include written permission from the authors of the original instrument that was translated and/or cross-culturally adapted.

f) Methodological studies: studies centered on the development and/or evaluation of clinimetric properties and characteristics of assessment instruments. The authors are encouraged to use the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) to format methodological papers, in addition to following BJPT instructions. Important: Studies that report electromyographic results must follow the Standards for Reporting EMG Data recommended by ISEK (International Society of Electrophysiology and Kinesiology), available at http://www.isek.org/wp-content/uploads/2015/05/Standards-for-Reporting-EMG-Data.pdf.

g) Clinical trial protocols: The BJPT welcomes the publication of clinical trial protocols. We only accept trial protocols that are substantially funded, have ethics approval, have been prospectively registered and of very high quality. We expect that clinical trial protocols must be novel and with a large sample size. Finally, authors have to provide that the clinical trial is on its first stages of recruitment. Authors should use the SPIRIT statement while formatting the manuscript (http://www.spirit-statement.org). Funding solely based upon scholarships or fellowships are not considered as substantially funded.

h) Short communications: the BJPT will publish one short communication per issue (up to six a year) in a format similar to that of the original articles, containing 1200 words and up to two figures, one table, and ten references.

i) Masterclass articles: This type of article presents the state of art of any topic that is important to the field of physical therapy. All masterclass articles are invited manuscripts and the authors must be recognized experts in the field. However, authors can send e-mails to the editor in chief with an expression of interest to submit a masterclass article to the BJPT.

Submission checklist

You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address

All necessary files have been uploaded:
Manuscript:
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• All figures (include relevant captions)
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• Ensure all figure and table citations in the text match the files provided
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• Manuscript has been 'spell checked' and 'grammar checked'
• All references mentioned in the Reference List are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Internet)
• A competing interests statement is provided, even if the authors have no competing interests to declare
• Journal policies detailed in this guide have been reviewed
• Referee suggestions and contact details provided, based on journal requirements

For further information, visit our Support Center.

BEFORE YOU BEGIN

Ethics in publishing

Please see our information pages on Ethics in publishing and Ethical guidelines for journal publication.

Studies in humans and animals

If the work involves the use of human subjects, the author should ensure that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The manuscript should be in line with the Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals and aim for the inclusion of representative human populations (sex, age and ethnicity) as per those recommendations. The terms sex and gender should be used correctly.

Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

All animal experiments should comply with the ARRIVE guidelines and should be carried out in accordance with the U.K. Animals (Scientific Procedures) Act, 1986 and associated guidelines, EU Directive 2010/63/EU for animal experiments, or the National Institutes of Health guide for the care and use of Laboratory animals (NIH Publications No. 8023, revised 1978) and the authors should clearly indicate in the manuscript that such guidelines have been followed. The sex of animals must be indicated, and where appropriate, the influence (or association) of sex on the results of the study.

Declaration of interest

All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential competing interests include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. Authors must disclose any interests in two places: 1. A summary declaration of interest statement in the title page file (if double-blind) or the manuscript file (if single-blind). If there are no interests to declare then please state this: 'Declarations of interest: none'. This summary statement will be ultimately published if the article is accepted. 2. Detailed disclosures as part of a separate Declaration of Interest form, which forms part of the journal's official records. It is important for potential interests to be declared in both places and that the information matches. More information.

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Submission of an article implies that the work described has not been published previously (except in the form of an abstract, a published lecture or academic thesis, see 'Multiple, redundant or concurrent publication' for more information), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify originality, your article may be checked by the originality detection service Crossref Similarity Check.

Use of inclusive language

Inclusive language acknowledges diversity, conveys respect to all people, is sensitive to differences, and promotes equal opportunities. Articles should make no assumptions about the beliefs or commitments of any reader, should contain nothing which might imply that one individual is superior to another on the grounds of race, sex, culture or any other characteristic, and should use inclusive language throughout. Authors should ensure that writing is free from bias, for instance by using 'he or she', 'his/her' instead of 'he' or 'his', and by making use of job titles that are free of stereotyping (e.g. 'chairperson' instead of 'chairman' and 'flight attendant' instead of 'stewardess').

Authorship

All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Changes to authorship

Authors are expected to consider carefully the list and order of authors **before** submitting their manuscript and provide the definitive list of authors at the time of the original submission. Any addition, deletion or rearrangement of author names in the authorship list should be made only **before** the manuscript has been accepted and only if approved by the journal Editor. To request such a change, the Editor must receive the following from the **corresponding author**: (a) the reason for the change in author list and (b) written confirmation (e-mail, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed.
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In line with the position of the International Committee of Medical Journal Editors, the journal will not consider results posted in the same clinical trials registry in which primary registration resides to be prior publication if the results posted are presented in the form of a brief structured (less than 500 words) abstract or table. However, divulging results in other circumstances (e.g., investors' meetings) is discouraged and may jeopardise consideration of the manuscript. Authors should fully disclose all posting in registries of results of the same or closely related work.

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Randomized controlled trials should be presented according to the CONSORT guidelines. At manuscript submission, authors must provide the CONSORT checklist accompanied by a flow diagram that illustrates the progress of patients through the trial, including recruitment, enrollment, randomization, withdrawal and completion, and a detailed description of the randomization procedure. The CONSORT checklist and template flow diagram are available online.

Registration of clinical trials

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