EVALUATION OF MUSCLE STRENGTH IN MEDULLAR INJURY: A LITERATURE REVIEW

AVALIAÇÃO DA FORÇA MUSCULAR NA LESÃO MEDULAR: UMA REVISÃO DA LITERATURA

EVALUACIÓN DE LA FUERZA MUSCULAR EN LA LESIÓN MEDULAR: UNA REVISIÓN DE LA LITERATURA

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ABSTRACT

Objective: To identify the tools used to evaluate muscle strength in subjects with spinal cord injury in both clinical practice and scientific research. Methods: Initially, the literature review was carried out to identify the tools used in scientific research. The search was conducted in the following databases: Virtual Health Library (VHL), Pedro, and PubMed. Studies published between 1990 and 2016 were considered and selected, depicting an evaluation of muscle strength as an endpoint or for characterization of the sample. Next, a survey was carried out with physiotherapists to identify the instruments used for evaluation in clinical practice, and the degree of satisfaction of professionals with respect to them. Results: 495 studies were found; 93 were included for qualitative evaluation. In the studies, we verified the use of manual muscle test with different graduation systems, isokinetic dynamometer, hand-held dynamometer, and manual dynamometer. In clinical practice, the manual muscle test using the motor score recommended by the American Spinal Cord Injury Association was the most used method, despite the limitations highlighted by the physiotherapists interviewed. Conclusion: In scientific research, there is great variation in the methods and tools used to evaluate muscle strength in individuals with spinal cord injury, differently from clinical practice. The tools available and currently used have important limitations, which were highlighted by the professionals interviewed. No instrument depicts direct relationship of muscle strength and functionality of the subject. There is no consensus as to the best method for assessing muscle strength in spinal cord injury, and new instruments are needed that are specific for use in this population.

Keywords: Muscle strength; Physical examination; Spinal cord.

RESUMO

Objetivo: Identificar quais são os instrumentos utilizados para avaliação de força muscular em sujeitos com lesão medular tanto na prática clínica, quanto em pesquisas científicas. Métodos: Inicialmente, realizou-se a revisão da literatura para identificação dos instrumentos utilizados em pesquisas científicas. A busca foi feita nas bases Biblioteca Virtual em Saúde (BVS), PEdro e PubMed. Foram considerados estudos publicados entre 1990 e 2016 e selecionados os que apresentaram a avaliação da força muscular como desfecho ou para caracterização da amostra. A seguir, foi realizado um levantamento junto a fisioterapeutas para identificar quais são os instrumentos utilizados para avaliação na prática clínica, e qual o grau de satisfação dos profissionais com relação a eles. Resultados: Foram encontrados 495 artigos; 93 foram incluídos para avaliação qualitativa. Nos estudos, verificou-se o uso do teste muscular manual com diferentes sistemas de graduação, do dinamômetro isocinético, do dinamômetro portátil e do dinamômetro manual. Na prática clínica, o teste muscular manual com uso do escore motor recomendado pela American Spinal Cord Injury Association foi o método mais utilizado, apesar das limitações destacadas pelos fisioterapeutas entrevistados. Conclusão: Nas pesquisas cientificas, é grande a variação de métodos e instrumentos utilizados para avaliação da força muscular em sujeitos com lesão medular, diferentemente da prática clínica. Os instrumentos disponíveis e utilizados atualmente apresentam importantes limitações, que foram destacadas pelos profissionais entrevistados. Nenhum instrumento apresenta a relação direta da força muscular com a funcionalidade do sujeito. Não há consenso sobre qual o melhor método para avaliação da força muscular na lesão medular, e são necessários novos instrumentos que sejam específicos para uso nessa população.

Descritores: Força muscular; Exame físico; Medula espinhal.

RESUMEN

Objetivo: Identificar cuáles son los instrumentos utilizados para evaluar la fuerza muscular en sujetos con lesión medular tanto en la práctica clínica, como en investigaciones científicas. Métodos: Inicialmente, se realizó la revisión de la literatura para identificar los instrumentos utilizados en investigaciones científicas. La búsqueda fue hecha en las bases de Biblioteca Virtual en Salud (BVS), PEdro y PubMed. Se consideraron estudios publicados entre 1990 y 2016 y se seleccionaron los que presentaron la evaluación de la fuerza muscular como resultado o para caracterización de la muestra. A continuación, se realizó un levantamiento junto a fisioterapeutas para identificar cuáles son los instrumentos utilizados para evaluación en la práctica clínica y cuál es el grado de satisfacción de los profesionales con relación a ellos. Resultados: Se han encontrado 495 artículos; 93 se incluyeron para la evaluación cualitativa. En los estudios se verificó el uso del test muscular manual con diferentes sistemas de graduación, del dinamómetro isocinético, del dinamómetro portátil y del dinamómetro manual. En la práctica clínica,

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la prueba muscular manual con uso de la puntuación motora recomendada por la American Spinal Cord Injury Association fue el método más utilizado, a pesar de las limitaciones destacadas por los fisioterapeutas entrevistados. Conclusión: En las investigaciones científicas, es grande la variación de los métodos e instrumentos utilizados para evaluar la fuerza muscular en sujetos con lesión medular, diferentemente de la práctica clínica. Los instrumentos disponibles y utilizados actualmente presentan importantes limitaciones, que fueron destacadas por los profesionales entrevistados. Ningún instrumento presenta la relación directa de la fuerza muscular con la funcionalidad del sujeto. No hay consenso sobre cuál es el mejor método para evaluar la fuerza muscular en la lesión medular, y son necesarios nuevos instrumentos que sean específicos para su uso en esa población.

Descriptores: Fuerza muscular; Examen físico; Médula espinal.

INTRODUCTION

Spinal cord injury is a devastating condition that affects thousands of people each year.[1] In patients with spinal cord injury, muscle atrophy, and loss of strength contribute to the development of disability. Muscle weakness and paralysis limit the performance of functional activities, with decrease in the quality of life.[2,3]

In this context, muscle strength relates to functionality and its evaluation is fundamental in the process of rehabilitation as the first step in defining realistic objectives.[3,4] The assessment tools used for the patient with spinal cord lesion are mostly similar to those used in other areas of rehabilitation. Few are exclusive.[4] The cost, the time available for evaluation, and the tolerance of the patients evaluated should be considered in the choosing the technique to be used. Additionally, the choice of the test should take the nervous system to be assessed (autonomic or sensory) into account. In terms of muscle strength, there are different methods that can be both objective, using specific equipment, and subjective.[5,6]

Despite the importance of evaluation in the rehabilitation process and the recommendations of the American Spinal Injury Association (ASIA), there is no international consensus around which tools should be used in the evaluation of strength in patients with spinal cord injury.[7] Thus, the objective of this study was to identify the main tools used to evaluate muscle strength through a bibliographical review of studies conducted on spinal cord lesion. We also conducted a survey to characterize the evaluation of muscle strength by physical therapists in clinical practice for subsequent identification of their satisfaction with the tools available in the scientific literature.

METHODS

This study was approved by the Institutional Review Board of the Universidade Federal de Ciências da Saúde de Porto Alegre as approval number 934.809 (UFCSPA). A search of the PubMed, PEDro, and Virtual Health Library databases was conducted from August 2015 to December 2016. It was performed by two independent investigators, in addition to a third, responsible for reviewing cases of disagreement. The following descriptors were used: spinal cord injury and muscle strength.

Articles published between 1990 and 2016, written in English, Portuguese, and Spanish and conducted with humans that used the endpoints muscle strength of the trunk, lower and/or upper limbs, or manual grip strength to classify the sample, were included. Repeated articles, dissertations, theses, review and validation articles, and those that did not present the complete available text or did not detail the evaluation method used were excluded.

Survey of the data

The data related to clinical practice for the identification of the satisfaction of professionals who worked with patients suffering from spinal cord injury on a daily basis were collected using a questionnaire with 26 mixed questions prepared by the investigators. The participants were chosen by intentional sampling, The questionnaire was sent by e-mail to 44 physical therapists in the South region of Brazil with experience in neurofunctional physical therapy. They were asked about their academic background and professional experience, their knowledge about muscle strength evaluation tools, their clinical routines, and their opinions about the quality of the muscle strength evaluation tools available. The results were considered using descriptive analysis. We excluded those with inconsistent answers or whose professional information did not report experience in spinal cord injury rehabilitation.

RESULTS

We found 495 articles, 94 of which were eligible for qualitative analysis. (Figure 1) The following data were extracted: year of publication, authors, tools used, and description of the technique.

Among the studies reviewed (Table 1), forty-two used manual muscle tests, thirty used isokinetic dynamometers, fourteen used portable dynamometers, and two used manual dynamometers. The use of customized tools with load cells or other alternative forms of objective muscle strength evaluation was confirmed in 16 studies. The maximum repetition test was used by three authors. Several authors used a combination of more than one technique.

In the studies that used manual muscle testing (MMT), 11 different tools and scales were identified: ASIA, Kendall, Daniels and Worthinghan, Medical Research Council and its modification, modified Brunnstron and Dennen, OXFORD, and Graded Redefined Assessment of Strength, Sensibility, and Prehension (GRASSP), in addition to unspecified scales.

The MMT tool, recommended by ASIA in the International Classification Standards, with its upper and lower limb motor score was the most frequently cited, found in nineteen studies. (Table 1) The motor scores from this tool evaluate 10 key muscle groups, five of the upper limbs and five of the lower limbs, using a six-point scale in addition to a non-testable (NT) category.[4]

The use of the MMT methodology proposed by Kendall was observed in five works.[49,67,75,80,86] This method uses a grading system with the introduction of numbers and symbols. The muscles are evaluated individually, with specific positioning for each of them. The choice of which muscles need to be evaluated is made by the examiner.[102]

The Daniels and Worthinghan methodology was used in three studies.[12,84,87] It also uses a six-point scale for MMT grading, but instead of isolated muscles, it evaluates muscle groups, which should also be determined by the examiner.[103]

Another scale applied to MMT grading is that elaborated by the Medical Research Council,[23, 50, 79,86] as well as its variation,[83 96,99]

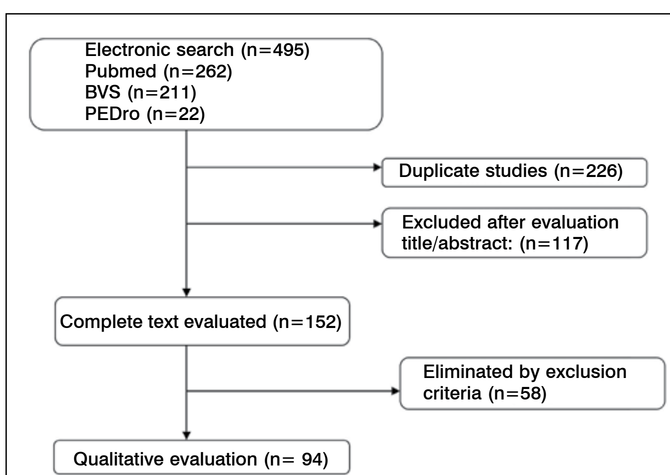

Figure 1. Flowchart of review process.

Table 1. Instruments used to evaluate muscle strength in scientific research.

Author	Instruments	Method
Carrasco-Lopez et al (2016)[8]	MMT	UEMS
Bouton et al. (2016)[9]	MMT	GRASSP
Stevens et al. (2015)[10]	Portable dynamometer	Maximum isometric force; one series with a minimum of three repetitions with 3 to 5s of contraction
Kim et al. (2015)[11]	Portable dynamometer	Break-test
Senthilvelkumar et al. (2015)[12]	MMT	Daniels and Worthinghan
Gomes-Osman; Field-Fote (2015)[13]	Manual dynamometer	Average of three repetitions
Mulroy et al. (2015)[14]	Isokinetic dynamometer	one series of two repetitions of 5s of contraction, with 15 seconds of rest between them
Dipiro et al (2015)[15]	MMT	LEMS
	Isokinetic dynamometer	Maximum isometric contraction: three repetitions with 5s duration and 60s of rest between them
Duffell; Brown; Mirbagheri (2015)[16]	Isokinetic dynamometer	Two repetitions of maximum isometric contraction
Bravo-Esteban et al. (2014)[17]	Isokinetic dynamometer	Isometric contractions with duration of 5s, five cycles of isotonic contraction; 10 cycles of isokinetic contraction
Chu; Hornby; Schmit (2014)[18]	Isokinetic dynamometer	Isometric contractions: eight repetitions with duration of 5s and rest of 25s between them
Jarocha et al. (2015)[19]	MMT	Lovett Scale
Esclarín-Ruz et al. (2014)[20]	MMT	LEMS
Backus et al. (2014)[21]	AMES device	six voluntary maximum contractions (three for extension and three for flexion). Average peak torque calculated
Fleerkotte et al (2014)[22]	MMT	LEMS
Guiraud et al. (2014)[23]	MMT	MRC
	Isokinetic dynamometer	Maximum isometric contraction
Kalsi-Ryan et al. (2014)[24]	MMT	GRASSP
Gabison et al. (2014)[25]	Portable dynamometer	one series of three repetitions of 5s, with rest of 30s between them
Van Straaten et al. (2014)[26]	Adapted load cells	one series of two and three voluntary maximum isometric contractions with duration of 3 to 5s each
Froelich-Grobe et al. (2014)[27]	1 RM	Maximum voluntary contraction
Rosety-Rodriguez et al. (2014)[28]	Manual dynamometer	Maximum grip strength measured in one series of three repetitions with an interval of 90s between them
Dost et al. (2014)[29]	Isokinetic dynamometer	five maximum voluntary contractions
Triolo et al. (2013)[30]	Isokinetic dynamometer	Isometric contractions: eight repetitions with duration of 5s and rest of 25s between them
Labruyere; Zimmerli; Van Hedel (2013)[31]	MMT	LEMS
Fornusek; Davis; Russold (2013)[32]	Isokinetic dynamometer	one series of three isometric contractions with duration of 7s, with interval of 10s between them
Yeoun-Seung Kang et al. (2013)[33]	MMT,	UEMS
	Dynamometer customized with force transducer	Maximum voluntary contraction, average of 3 repetitions
Thompson; Hornby (2013)[34]	MMT	LEMS
Jayaraman et al. (2013)[35]	MMT	LEMS
	Isokinetic dynamometer	Maximum voluntary isometric contraction: three repetitions
Cortes et al. (2013)[36]	MMT	UEMS
Sadowsky et al. (2013)[37]	Isokinetic dynamometer	Maximum voluntary contraction: five repetitions
Lindberg et al. (2012)[38]	Piezoelectric force sensor coupled to customized ergometer	Peak strength in the last 60 seconds of the maximum and submaximum test
Triolo Etal.(2012)[39]	Isokinetic dynamometer	Average peak torque of 12 repetitions with 15s interval between them
Nooijen et al. (2012)[40]	Portable dynamometer	Break-test
Wu et al. (2012)[41]	MMT	LEMS
	Isokinetic dynamometer	Average maximum voluntary torque, without methodology details
Trumbower et al. (2012)[42]	Isokinetic dynamometer	three maximum voluntary contractions, with 3 to 6s of duration, and 1 minute of rest between them
Sledziewski; Schaaf; Mount (2012)[43]	MMT	UEMS
Alcobendas-Maestro et al. (2012)[44]	MMT	LEMS
Zijdewind et al. (2012)[45]	Customized dynamometer with force transducer	Maximum contraction, maintained for 5s. Combined contractions 5s, with 1 minute of rest between them
Serra-Añó et al. (2012)[46]	Isokinetic dynamometer	six series of three repetitions with duration of 5s, and 30s of interval between them
Serra-Añó et al. (2012)[47]	Isokinetic dynamometer	one series of three isometric contractions of 5s; 30s of rest between them. 3 minutes of rest, 5 repetitions of concentric contractions at different velocities
Boland et al. (2011)[48]	MMT	LEMS; UEMS + thumb abductor
Johnston et al. (2011)[49]	Isokinetic dynamometer	three repetitions; 2 minutes of rest between them
Yang et al. (2011)[50]	MMT	Kendall
Lundell et al.(2011)[51]	MMT	MRC
Harvey et al. (2011)[52]	MMT	GRASSP – strength subtest
Saraf et al.(2010)[53]	MMT	LEMS
	Isokinetic dynamometer	Maximum voluntary contraction maintained for 2 to 5s
Larson et al. (2010)[54]	Portable dynamometer	Maximum voluntary contraction from one series of three repetitions, with interval of 15s between them

Harvey et al. (2010)[55]	Isokinetic dynamometer	Best of sis attempts at one RM, with 1 minute of rest between them
Valent et al. (2009)[56]	Portable dynamometer	break-test
Glinsky et al. (2009)[57]	Load cell with visual feedback	Maximum isometric contraction, measured in 1 series of 8 contractions of 4s, with 1 minute of rest between them. Average of the three best measurements
Bowden; Stokic (2009)[58]	MMT	LEMS, UEMS
Rudhe; Van Hedel (2009)[59]	MMT	UEMS, GRASSP
Jacobs (2009)[60]	1 RM	Mayhew regression equation
Beekhuizen; Field-Fote (2008)[61]	Portable dynamometer	One average of five repetitions
Glinsky et al. (2008)[62]	Load cells	Measurement of maximum voluntary isometric torque. one series of eight contractions with duration of 4s, and 1 minute of interval between them
Haisma et al. (2008)[63]	Portable dynamometer	Break- test
Kern et al. (2008)[64]	Customized force transducers	Measurement of maximum voluntary isometric contraction
Johnston et al (2008)[65]	Isokinetic dynamometer	three repetitions with 2 minutes between them
Wirth; Van Hedel; Já; Curt (2008)[66]	Customized force transducers	Maximum voluntary contraction. Peak torque was measured when the subjects were able to maintain the contraction for 2 seconds
Wirth; Van Hedel; Já; Curt (2008)[67]	Customized force transducer	Maximum voluntary contraction. Peak torque was measured when the subjects were able to maintain the contraction for 2 seconds
De Groot et al. (2008)[68]	MMT	Kendall
	Portable dynamometer	Break test
Jayaraman et al. (2008)[69]	Isokinetic dynamometer	Maximum isometric contraction, measured in one series of three repetitions, with interval of 5s between them
Gregory et al. (2007)[70]	Isokinetic dynamometer	Maximum voluntary contraction measured in three repetitions, with 60s of rest between them
Liu et al. (2007)[71]	Isokinetic dynamometer	Average of five maximum voluntary isometric contractions
Widman et al. (2007)[72]	Isokinetic dynamometer	Maximum voluntary contraction: repetitions
Haisma et al. (2007)[73]	Portable dynamometer	Break- test
Amanda Liussuwan et al. (2007)[74]	Isokinetic dynamometer	Maximum voluntary contraction: three repetitions
Van Drogelen et al. (2006)[75]	MMT	Kendall
Wirz et al. (2006)[76]	MMT	LEMS
Javiere et al. (2006)[77]	Weights and pulleys	Time to complete 20 repetitions with 70% 1 RM
Rittweger et al. (2006)[78]	Customized dynamometer	Measurement of maximum voluntary contraction
Norton; Gorassini (2006)[79]	MMT	MRC
Haisma et al. (2006)[80]	MMT	Kendall
	Portable dynamometer	Break test
Jayaraman et al. (2006)[81]	Isokinetic dynamometer	Maximum isometric contraction, measured in one series of three repetitions
Bjerkefors; Jansson, Thorstensson (2006)[82]	Isokinetic dynamometer	4 maximum contractions, with rest of 4s between them. 2 minutes of rest between each series
Warms et al.(2004)[83]	Portable dynamometer	Noreau and Vachon modified MRC
Mulcahey et al. (2004)[84]	MMT	Daniels and Worthinghan
Kim; Whittaker (2004)[85]	MMT	Modified Brunnstron and Denenn; LEMS
Bryden Et A L(2004)[86]	MMT	Kendall; MRC
Beninato; O'kane; Sullivan (2004)[87]	MMT	Daniels and Worthinghan
Hicks et al. (2003)[88]	1 RM	Test of one repetition with maximum load
Diego et al. (2002)[89]	MMT	Scale from 0 to 5
Smith; Mulcahey; Betz (2001)[90]	MMT	Scale from 0 to 5
Jacobs; Nash; Rusinowski (2001)[91]	Isokinetic dynamometer	Concentric and eccentric contractions: average of three repetitions
Harvey et al. (2001)[92]	Pinch strength with modified transducer Grip strength with various objects	Average of three repetitions; Cylinders of different sizes and weights
Belanger et al. (2000)[93]	Isokinetic dynamometer	Maximum voluntary isometric contraction; duration of 2s, measured every 5s in an interval of 4 minutes
Kuz; Van Heest; House (1999)[94]	MMT	Scale from 0 to 5
Thomas et al. (1998)[95]	MMT	UEMS
	Customized force transducer	Maximum voluntary contraction
Noreau; Vachon (1998)[96]	MMT Portable dynamometer Isokinetic dynamometer	Modified MRC Maximum voluntary contraction, one series of three repetitions; 10 seconds of rest between them. Maximum voluntary contraction: one series of three repetitions; 10 seconds of rest between them
Herbison et al. (1996)[97]	MMT	Modified Brunnstron and Denenn.
	Portable dynamometer	one series of three repetitions with duration of 1 to 2s of maximum voluntary contraction
Signorile et al. (1995)[98]	Customized force transducer	Measurement of maximum voluntary contraction
Kornsgold et al. (1994)[99]	MMT	Modified MRC, UEMS
Granat et al.(1993)[100]	MMT	Oxford Scale
	Customized dynamometer	Maximum voluntary contraction: best of three repetitions
Crozier et al. (1992)[101]	MMT	Brunnstron e Dennen

which grades strength on a scale of 0 to 5. It does not define the resistance that must be applied by the examiner at the time of the test, nor does it consider the range of motion developed.[104] In its modified version, the scale was increased by 1.2 points between the degrees of strength.

Application of the motor subtest of the GRASSP tool was confirmed in four studies.[9,24,51,58] It evaluates the upper limbs through MMT on a scale of six points.[26]

The modified Brunstron and Dennem grading scale was applied in three studies.[85,97,101] This method evaluates, through MMT, not only isolated muscles, but also active movement.[102] It also uses a six-point scale, with half point between the grades in the modified version.[85,97,101]

The OXFORD scale for the assessment of muscle strength was identified in one study.[100] Unspecified scales with scoring from 0 to 5 were used in three studies.[89,90,94] These scales use six-point grading with the force of gravity as a reference of resistance to movement.[100]

As regards the survey about strength assessment in clinical practice, 42 of the 44 questionnaires sent were returned. Of these, two were excluded for inconsistency in the responses. In relation to academic background, 22.5% had masters or doctoral degrees and 32.5% had specialization in neurofunctional physical therapy. As for professional experience, 52.5% had worked with neurological patients for more than five years and 42.5% had more than five years of experience in rehabilitation of spinal cord injury.

In terms of their professional knowledge about the assessment of muscle strength, the physical therapists reported knowing various different methods. The manual muscle test was the most popular and known by all, followed by the manual dynamometer known by 75%, and the isokinetic dynamometer and maximum repetition test by 67.5%. The least remembered was the portable dynamometer, with only 3%. As regards the techniques and muscle strength grading scales used in spinal cord lesions, the ASIA motor score was the best known, followed by the Kendall methodology, identified by 65% of the professionals.

In clinical practice, 95% evaluated muscle strength in patients with spinal cord injury during routine sessions. Moreover, for 100% of the participating physical therapists, the principal objective of strength assessment in these cases was planning the intervention. The most used method was the manual muscle test, used by all those who evaluate muscle strength. The tool used varied, but the motor score recommended by ASIA was the most frequently used (75%).

Although MMT was used by most of them for clinical evaluation, when questioned about the quality of the MMT tools and scales available, 65% answered that they did not meet the needs for assessment of patients with spinal cord injury. Among the limitations are the lack of sensitivity in the grading of the scales (30%), the recommended positioning (25%), the muscle groups tested (10%), and the lack of practicality for their application (10.17%).

DISCUSSION

In order to choose the best method for assessing muscle strength, the context and the goal of the evaluation, as well as the modality available to the patient, need to be considered.[2,5,6] In patients with neurological impairment, it is important that the muscle strength evaluation be made in comparison to the best expected outcome, given the motor deficit of the patient, and not by comparing the outcome with the pattern of movement expected in patients without injury.[2]

This study revealed that MMT is the most commonly used muscle strength evaluation method in spinal cord injuries, both in clinical practice and in scientific research. MMT is an inexpensive examination method that provides information not only about muscle strength, but also about the extent of the nerve injury and the pattern of movement that it generates. In the muscle function test, not only a test of the strength of a muscle or group of muscles is conducted, but also an assessment of the pattern of movement developed by the patient,[105] which is important for the evaluation of the neurological patient. However, the survey showed the interviewees' dissatisfaction with the limitations of the MMT tools available in clinical practice. The lack of specific scales for spinal cord injury results makes standardization of the evaluations impossible. Moreover, the available scales do not show a direct relationship between the results and the functionality of the patient. Thus, the limitations of the currently available tools for MMT evaluation need to be resolved.

We identified a large variety of tools and scales in scientific studies using MMT in the evaluation of patients with spinal cord injury. Although most of the studies used the methodology recommended by ASIA, some studies used scales modified for evaluation using manual muscle testing that are not specific and not recommended for assessing spinal cord injury, such as the MRC or modified MRC scale with ½ point between each level.[104]

In clinical practice, it has already been confirmed that most physical therapists follow ASIA's recommendation of the use of MMT, in spite of their dissatisfaction with the significant limitations of the tool, such as, for example, the muscle groups evaluated and the suggested positioning. The assessment of motor function through this score only considers five muscle groups for upper limbs and five for lower limbs, representing the C5 to T1 and L1 to S1 myotomes. The trunk muscles are not mandatorily evaluated, though an abdominal function test is suggested.[6] Thus, any recovery of motor function below T1 is not recorded, causing a "ceiling" effect on the resulting score that mostly impacts the assessment of cervical injuries.[82] Another limitation cited in the literature is that this motor evaluation would not be related to patient functionality.[8] As for psychometric properties, some authors showed strong intra- and inter-examiner reliability with the tool indicated by ASIA for motor evaluation,[105] while others noted that the motor score presents convergent and divergent construct validity, but suggest that more studies be conducted for the psychometric evaluation of this tool.[105]

The main difference between using manual muscle testing and the other techniques identified, like that proposed by Kendall or the motor score defined by ASIA, is the limitation of the muscles evaluated and the position for the test. In the other techniques used for manual muscle testing, the position for evaluation of each muscle group varies between supine, prone, and lateral. Each muscle is evaluated individually. The muscles are evaluated with the patient always in the supine position. In this position, gravity is eliminated in the evaluation of muscle strength grade 1/5 in the upper limbs, but not in grade 1/5 in the lower limbs.[106]

Another frequently used MMT method identified here was that developed by the Medical Research Council (MRC). Its scale does not define how much resistance must be applied by the examiner at the time of the test, an aspect principally relevant to distinguishing between grades 4 and 5. The division offered between these two grades (moderate, low, and high resistance) is descriptive and its real meaning is not clear, remaining at the discretion of the examiner.[102] The range of motion in which the assessment should be conducted is not considered in the MRC scale.

MMT was originally developed by a physician and professor in the Orthopedic Surgery Department of Harvard Medical School, Dr. Lovett, and described by Dr. Wilhelmina Wright in 1912. Lovett created a graduated scale for muscle strength considering gravity as resistance.[103] Several other grading systems were developed based on this. Nevertheless, while its variations are being constantly revised and perfected by various authors, the factors of weight and movement established by Lovett continue to be the basis for most current tests and scales.[102]

When first developed, MMT was designed for the assessment of victims of poliomyelitis, but currently it is used in different populations, such as patients with spinal cord injury, with greatly differing characteristics. In the literature, there are results published from strength tests based on specific populations, such as athletes or the elderly, and some scales are focused on defined pathologies, such as Duchenne muscular dystrophy. The great variation in the particular characteristics of different populations makes modifications to the systems that grade the results obtained in manual muscle testing necessary.[101]

Objective measurements, like the dynamometer, are needed for their precision. Studies have found that, while manual muscle testing results reach a plateau, in evaluations with the portable dynamometer strength values continue to increase.[5] Many studies have confirmed the use of equipment like the isokinetic dynamometer and the portable dynamometer, especially more recently. However, their use is not easy to apply. They are not always available due to the high cost, which decreases their frequency of use and can be a justification for opting for customized objective assessment tools.

The isokinetic dynamometer also presents limitations when used to evaluate very weak musculatures, which are common in spinal cord lesions.[2] In addition, even though the portable dynamometer is easy to manipulate and can be used in various environments, the isometric strength measured by it may be influenced by the resistance applied by the evaluator and their ability to keep the device in a stable position, perpendicular to the segment being tested. The correct usage of the portable dynamometer requires more time for positioning than manual muscle testing.[5] For this reason, muscle strength is most often evaluated without the use of special equipment and inferred through manual muscle testing.[6]

Thus, there is still a lack of global consensus around evaluation methods and the use of standardized scales to assess muscle strength. New tools should try to resolve the restrictions of use identified by professionals, seeking to approximate the theory of clinical practice, and associating the evaluation results with patient functionality. After identifying the limitations and restrictions in the current tools, this study should go on to create a new tool for manual evaluation of muscle strength in patients with spinal cord injury for clinical practice.

Limitations of this review include the exclusion of articles not indexed in the databases consulted and the lack of a critical evaluation of the studies reviewed.

CONCLUSIONS

There are different ways of evaluating muscle strength in patients with spinal cord injury. None of the methods identified by this review demonstrated a relationship between assessed muscle strength and patient functionality, an important finding both in research and in clinical practice.

Given this, this study showed the need for new studies focused on the development of specific methodologies for the standardized evaluation of these patients.

Todos os autores declaram não haver nenhum potencial conflito de interesses referente a este artigo.

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