Annals of Physical and Rehabilitation Medicine xxx (2018) xxx–xxx

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Review

Review of pelvic and perineal neuromuscular fatigue: Evaluation and impact on therapeutic strategies

Maëlys Teng [a,b,*], Florian Kervinio [a,b], Mirella Moutounaïck [a,b], Gabriel Miget [a,b], Audrey Charlanes [a,b], Camille Chesnel [a,b], Frédérique Le Breton [a,b], Gérard Amarenco [a,b]

[a] GRC 01, GREEN - groupe de recherche clinique en neuro-urologie, hôpital Tenon, Sorbonne université, AP–HP, 75020 Paris, France
[b] Service de neuro-urologie, hôpital Tenon, AP–HP, 4, rue de la Chine, 75020 Paris, France

ARTICLE INFO

Article history:
Received 27 February 2018
Accepted 16 June 2018

Keywords:
Pelvic floor muscle
Perineal fatigue
Evaluation
Stress urinary incontinence
Pelvic organ prolapse
Pelvic floor fatigue rehabilitation

ABSTRACT

Background: Pelvic floor fatigue is known by its clinical consequences (fecal incontinence, stress urinary incontinence, pelvic organ prolapse), but there are still few studies on the subject.
Objective: This article presents an overview of the current knowledge of pelvic and perineal fatigue, focusing on its assessment and consequences in terms of evaluation and therapeutic strategies, to propose an evaluation that could be routinely performed.
Methods: We performed a systematic review of the literature in MEDLINE via PubMed and Cochrane Library databases by using the keywords pelvic floor, muscular fatigue, physiopathology, stress urinary incontinence, pelvic organ prolapse, fecal incontinence, physical activity, and pelvic rehabilitation. We included reports of systematic reviews and retrospective and prospective studies on adult humans and animals in English or French published up to April 2018 with no restriction on start date.
Results: We selected 59 articles by keyword search, 18 by hand-search and 3 specific guidelines (including the 2009 International Continence Society recommendations); finally 45 articles were included; 14 are described in the Results section (2 reviews of 6 and 20 studies, and 12 prospective observational or cross-over studies of 5 to 317 patients including 1 of animals). Perineal fatigue can be assessed by direct assessment, electromyography and spectral analysis and during urodynamics. Because pelvic floor fatigue assessments are not evaluated routinely, this fatigability is not always identified and is often falsely considered an exclusive pelvic floor weakness, as suggested by some rehabilitation methods that also weaken the pelvic floor instead of enhancing it.
Conclusion: Pelvic floor fatigue is not evaluated enough on a routine basis and the assessment is heterogeneous. A better knowledge of pelvic floor fatigue by standardized routine evaluation could lead to targeted therapeutic strategies.

1. Introduction

The human body is composed of 3 different types of muscles: skeletal, cardiac and smooth. Skeletal muscles are striated and under voluntary control. Pelvic floor striated muscles (PFMs), like all skeletal muscles, consist of slow and fast twitches. The combination of slow (type I) and fast (type IIa or IIb) twitches defines the importance of skeletal muscular fatigue because a high proportion of slow twitches promotes better and higher endurance. [1] Muscular fatigue can be understood under a physiological, instrumental, sensory-perception or psychological definition but is commonly defined as any exercise-induced reduction in the maximal capacity to generate force or power output [1] or in other words, the fall of force in response to contractile activity [2,3].

There are several mechanisms explaining this skeletal fatigue: from central factors influencing the activation of motor neurons (motivational factors, integration of sensory information), to peripheral factors due to mechanical properties, electrolyte shifts or energy turnover (e.g., inhibition of actomyosin interactions) leading to excitation–contraction coupling failure or contractile failure. Fatigue can result from fatigue-induced exercise of maximal voluntary contraction or by tetanic electrical stimulation. The assessment can be by direct evaluation of the maximal voluntary contraction or by electromyography (EMG) activity study. For example, the origin of central fatigue can be differentiated as a

* Corresponding author. GRC 01, GREEN - groupe de recherche clinique en neuro-urologie, hôpital Tenon, Sorbonne université, AP–HP, 75020 Paris, France.
E-mail address: maelys.teng@aphp.fr (M. Teng).

https://doi.org/10.1016/j.rehab.2018.06.006
1877-0657/© 2018 Published by Elsevier Masson SAS.

peripheral fatigue mechanism by a loss of strength in maximal voluntary contraction force but not by tetanic peripheral stimulation [1].

Indeed, even if PFMs, and the external urethral sphincter in particular, contain a high proportion of slow twitches [4], fatigue exists in these muscles, as revealed by clinical consequences.

First, PFM fatigue has been demonstrated in several studies, particularly in women with stress urinary incontinence (SUI), which suggests its involvement in the pathophysiology of SUI [5,6]. Indeed, many women report more frequent and greater SUI episodes at the end of the day or just after a pelvic rehabilitation session. Ree et al., in a cross-over study, investigated whether strenuous physical activity could produce pelvic floor fatigue in nulliparous women. The authors assessed vaginal contraction by measuring vaginal pressure after maximal voluntary contraction after a 90-min resting period or 90 min of strenuous physical activity. In young nulliparous women with mild SUI, strenuous physical exercise promoted lower maximal voluntary vaginal-contraction pressure, thereby indicating pelvic floor muscle fatigue [7]. Moreover, urinary incontinence during exercise is common, especially in high-impact sports. Even young nulliparous women frequently report incontinence during exercise and the prevalence is greater in activities that involve jumping and bouncing and thus repetitive and strong efforts. Also, women are more likely to report anal incontinence when participating in high intensity activity than are less active women. In middle-aged women, lifetime physical activity increases the risk of SUI [8].

Second, heavy occupational work can be associated with pelvic organ prolapse (POP) [9]. Larsen and Yavorek described that women who attended paratrooper training were significantly more likely to have stage II prolapse at the end of the summer training session than those without the training, which suggests an increase in POP after strenuous activities [10]. Concerning lifetime physical activity, middle-aged women showed no increased risk of anatomic POP [11] or risk of SUI [8]. However, strenuous activity during teenage years may confer higher risk of POP [11]. Hence, increasing POP or SUI after intense physical activity suggests a muscular mechanism that can be due to a lack of muscle or at worse no muscle at all. From this statement, we can presume that perineal fatigue may also explain these clinical symptoms. Indeed, Ali-Ross et al. assessed symptoms and the Pelvic Organ Prolapse Quantification (POP-Q) score right after a period of prescribed activity (walking 45 min, 5 standing from sitting, 10 bending down and jogging/stamping briskly on the spot for 1 min), then re-examined the next day after an overnight bed rest. POP-Q stage increased with physical activity ($P < 0.001$) [12].

Third, fecal incontinence can be associated with a reduced fatigue index rate (a calculated measure of time necessary for the external sphincter to become completely fatigued) as compared with continence [13,14]. Thus, endurance of the external anal sphincter could be an important factor in maintaining fecal continence.

Fourth, incontinence after prostatectomy is multifactorial but mainly due to intrinsic sphincter deficiency because of injury of the rhabdosphincter during apical dissection and denervation to neurovascular bundles during the surgery [15]. It generates a weakness of the pelvic floor, which will then be more susceptible to fatigue and is corroborated by a greater number of leaks at the end of the day.

The prevalence of these clinical examples (all causes, perineal fatigue included) is high. Indeed, SUI concerns 10% of middle-aged women with daily or severe incontinence and one-third with weekly leakage [16]. In French women, the prevalence of SUI ranges from 17 to 41% [17]. The prevalence of POP ranges from 2.9 to 49.4% depending on the definition, 3 to 6% by symptoms and up to 50% by vaginal examination [18,19]. For fecal incontinence, the median prevalence is 7.7% (range 2.0 to 20.7%) [20]. All these epidemiologic results suggest the condition's ubiquity and the high impact on daily life, which justifies the need to improve knowledge of perineal fatigue and propose new routine evaluations in this field.

In a previous systematic review, Deffieux et al. described only the different ways to assess muscular fatigue and particularly perineal fatigue [5]. The aim of this systematic review was to present an overview of the current knowledge of pelvic and perineal fatigue, focusing on its assessment and therapeutic consequences, to propose an evaluation that could be performed on a routine basis.

2. Methods

This systematic review followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for reporting systematic review (Appendix).

2.1. Data collection

Articles were searched by using multiple and specific keywords in MEDLINE via PubMed and the Cochrane Library database, checking references, and searching for publishing recommendations and grey literature on specific websites found on Google Scholar.

2.2. Search strategy

Articles in English or French published up to April 2018 with no restriction on start date were searched in MEDLINE via PubMed and the Cochrane Library with the keywords "perineal muscular fatigue", "stress urinary incontinence AND fatigue", "fecal incontinence AND fatigue", "pelvic organ prolapse AND fatigue", "pelvic organ prolapse AND physical activity", "stress urinary incontinence AND physical activity", "prostatectomy AND stress urinary incontinence", "skeletal muscular fatigue AND assessment AND physiopathology" and "physical activity AND pelvic floor muscle", "pelvic organ prolapse quantification", "pelvic floor rehabilitation", "reliability AND pelvic muscle strength". We also searched reference lists of reviews dealing with muscular fatigue and particularly perineal fatigue. We included systematic reviews and retrospective and prospective studies of adult humans and animals related to the pathophysiology, assessment and consequences of perineal fatigue, and therapeutic strategies.

2.3. Study selection

Articles were initially selected on the title and the abstract. After reading the full text, we retained only articles that best answered:

- what is muscular fatigue?
- What is perineal fatigue and how is it assessed?
- What are the clinical consequences and the current therapeutic strategies and consequences?

3. Results

We selected 59 articles on the basis of their title, 18 articles by searching references, and 3 specific guidelines (PRISMA guidelines, 2009 International Continence Society [ICS] Recommendations and Pelvic Organ Prolapse Quantification–ICS). After reading the

Please cite this article in press as: Teng M, et al. Review of pelvic and perineal neuromuscular fatigue: Evaluation and impact on therapeutic strategies. Ann Phys Rehabil Med (2018), https://doi.org/10.1016/j.rehab.2018.06.006