



SIAMOC Best Clinical Paper 2018

Impact of instrumental analysis of stiff knee gait on treatment appropriateness and associated costs in stroke patients

Andrea Merlo*, Isabella Campanini

LAM-Motion Analysis Laboratory, San Sebastiano Hospital, Correggio, Neuromotor and Rehabilitation Department, Azienda USL-IRCCS di Reggio Emilia, Reggio Emilia, Italy



ARTICLE INFO

Keywords:

Stiff knee gait
Gait analysis
Spasticity
Botulinum toxin
Treatment appropriateness

ABSTRACT

Background: Stiff Knee Gait (SKG) in stroke patients is typically treated by the inhibition of the rectus femoris (RF) with botulinum toxin (BoNT) after clinical evaluation, obtaining an average pooled recovery in knee flexion (KF) of 7 degrees.

Purpose: Our hypothesis is that this limited recovery after BoNT could depend on the inadequacy in the selection of patients to be treated. The aim of this study was to assess the percentage of inappropriate treatments (PIT) that can be avoided when instrumental gait analysis (GA) is used, and to estimate the associated cost savings.

Methods: We retrospectively analyzed GA data from chronic stroke patients with SKG and clinically assessed knee extensors spasticity referred to our laboratory over a five-year period. Gait kinematics and dynamic electromyography data were used. Patients were considered unsuitable for RF inhibition when: their SKG was determined by inadequate ankle push-off (APO) rather than by a brake from knee extensors, based on a previously published algorithm using gait kinematics (PIT_{KIN}); when RF was not active during KF (PIT_{EMG}); and when a proximal braking mechanism was found, if this was not due to RF activity (PIT_{GA}).

Results: 160 patients, age 20–87 years, gait speed 9–77%height/s, KF peak -4–44 degrees, were included. Of these, in 119 cases poor APO was the main cause of SKG, thus leading to PIT_{KIN} = 74%. In 48 out of 107 non-obese subjects, RF spasticity was not involved in SKG, resulting in PIT_{EMG} = 45%. Finally, patients with a braking activity as the main cause and concurrent RF activity were 20/107 = 19%, resulting in PIT_{GA} = 81%.

Significance: When treating SKG, proper use of GA can reduce the percentage of inappropriate treatments by BoNT at the RF up to 81%. Savings are in the order of €100k/year when considering centers treating 100 or more patients/year.

1. Introduction

Stiff-knee gait (SKG) is a prominent feature in post-stroke walking, characterized by limited knee flexion (KF) during the swing period of gait [1,2]. This reduces gait speed, may cause toe dragging, increases the risk of falls, and compromises the stability of gait, greatly interfering with everyday activities.

SKG can either be caused by an insufficient or absent push-off at the ankle [2–4], or by an insufficient pull-off at the hip due to hip flexor weakness [5,6] and also by the presence of an abnormal braking activity of the thigh muscles, which is typically triggered by a quick knee flexion at toe-off when the push-off is maintained [3,7–9]. Since KF is a passive result of shank and thigh quick angular accelerations [5], SKG can arise independently from RF interference [10] when these

mechanisms are missing.

In medical literature, overactivity of the rectus femoris (RF) muscle is often indicated as the primary cause of SKG [11,12], and historically it has typically been uniquely attributed to spastic quadriceps activity [13]. Consequently, treatments to relieve SKG focus on reducing RF interference with botulinum toxin (BoNT) injection, which is considered the gold standard procedure [14,15]. RF inhibition is chosen based on clinical assessment and in the presence of spasticity. This is assessed at the bedside by means of several scoring systems that trigger the abnormal stretch-reflex of knee extensor muscles by provoking a quick KF, such as the Modified Ashworth Scale (MAS), the Tardieu scale and the Wartenberg's pendulum test. However, during gait, spasticity may not be triggered when KF takes place slowly, as in the case of an impaired foot-ankle complex, resulting in an inadequate ankle push-off

* Corresponding author at: LAM-Motion Analysis Laboratory, San Sebastiano Hospital, Correggio, Neuromotor and Rehabilitation Department, Azienda USL-IRCCS di Reggio Emilia, Reggio Emilia, Italy.

E-mail address: andrea.merlo@ausl.re.it (A. Merlo).

<https://doi.org/10.1016/j.gaitpost.2019.06.009>

Accepted 10 June 2019

0966-6362/ © 2019 Elsevier B.V. All rights reserved.