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# ORIGINAL STUDIES

# Rehabilitation treatment of post-stroke spastic and non-spastic genu recurvatum

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**Abstract**

*Background.* Stroke is a leading cause of long-term disability. Gait impairment post-stroke has a major implication for health and it is an essential predictor for functional independence. A common gait impairment is the presence of genu recurvatum in post-stroke patients, whether spastic or non-spastic.

*Aims.* To evaluate the efficacy of the rehabilitation program and botulinum toxin upon gait spatial and temporal parameters, muscle spasticity, functionality of lower limb and risk of fall in post-stroke patients with spastic and non-spastic genu recurvatum.

*Methods.* We conducted a two-year prospective study (April 2018 – April 2020) of forty hemiparetic patients with spastic (20) and non-spastic (20) genu recurvatum who underwent a rehabilitation program for three weeks and ultrasound guided botulinum toxin injection for the spastic group.

*Results.* In the non-spastic group, statistically significant differences were observed post-treatment (after 3 weeks) in the case of gait speed from 0.457 meters/sec (T0) to 0.6265 m/sec (T1), TUG from 16.3 (T0) to 14.15 (T1) and LEFS from 32.45 (T0) to 34.7 (T1). In the spastic group, gait speed also had significant differences, from 0.467 (T0) to 0.7145 (T1). LEFS had an increase from 32.45 (T1) to 34.75 (T2). MAS had a decrease from 2.65 (T0) to 1.55 at (T1).

*Conclusions.* Following a 3-week rehabilitation program and using ultrasound guided botulinum toxin injections, in the case of spasticity, improves gait spatiotemporal asymmetry and ameliorates functionality, lowering the risk of fall in hemiparetic patients with post-stroke genu recurvatum whether spastic or non-spastic.

**Keywords:** stroke, genu recurvatum, spasticity, botulinum toxin, ultrasound guided.

## Introduction

Stroke is a leading cause of long-term disability. Of individuals who survive, more than 80% have gait impairment that recovers to some extent in the first 2 months after stroke. Yet, community ambulation often remains compromised in most survivors. Gait impairment has major implications for health; it is an essential predictor of functional independence and long-term survival after stroke. Unsurprisingly, regaining gait ability is one of the most common goals of stroke survivors (Cristea, 2020).

Genu recurvatum affects between 40 and 68% of hemiparetic stroke patients. From a biomechanical point of view, genu recurvatum occurs during the stance phase. It is characterized by a ground reaction force vector that passes well in front of the knee (Bleyenheuft et al., 2010).

Different methods, whether conservative or surgical procedures, for the treatment of genu recurvatum were used depending on etiology, such as intramuscular injection of Botulinum Toxin Type A in the presence of gastrocnemius-soleus spasticity (Klotz et al., 2013), ankle-foot orthoses (Ohsawa et al., 1992), knee-ankle-foot orthoses (Boudarham et al., 2013), and electrogoniometric feedback (Bleyenheuft et al., 2010), functional electrical stimulation (Chantraine et al., 2016), aponeurotic calf muscle lengthening (Bleyenheuft et al., 2010). Also, other devices that approached post-stroke gait rehabilitation using body-weight support systems (Berteanu et al., 2014) showed improvements of gait parameters, but in post-stroke patients without the presence of genu recurvatum.

Early studies that discuss genu recurvatum had some methodological limitations and did not specify the period from the onset of stroke to the initiation of treatment. Also, their approach was not focused on the etiology of genu recurvatum, whether caused only by a neurological issue or a mixed one (orthopedic and neurologic) (Bleyenheuft et al., 2010). Although some studies demonstrated the efficacy of functional electrical stimulation (FES)

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upon ankle kinematics, spatiotemporal parameters, gait symmetry, and balance control in post-stroke hemiparetic patients, the potential benefits of FES on the mechanics of post-stroke non-spastic genu recurvatum still remain unclear (Chantraine, et al., 2016).

## Objectives

To evaluate the efficacy of the rehabilitation program associated with neuromuscular electrical stimulation or botulinum toxin upon gait spatial and temporal parameters, muscle spasticity, functionality of lower limb and risk of fall in post-stroke patients with spastic and non-spastic genu recurvatum.

## Hypothesis

Many patients with post-stroke gait disability have some similarities regarding spatiotemporal parameters. In post-stroke patients associating genu recurvatum with or without the presence of spasticity of the lower limb, these spatiotemporal parameters tend to differ between them. The question remains which mechanisms are involved in the appearance of post-stroke spastic or non-spastic genu recurvatum.

## Material and methods

**Research protocol**

*a) Period and place of the research*

We conducted a two-year prospective study (April 2018 - April 2020) at the Neurological Rehabilitation Unit of Elias Emergency University Hospital.

*b) Subjects and groups*

Forty hemiparetic patients with spastic (20) and non-spastic (20) genu recurvatum who underwent a rehabilitation program for three weeks associated with neuromuscular electrical stimulation for the non-spastic group and ultrasound guided botulinum toxin injections for the spastic group.

The exclusion criteria were: less than 6 months after stroke, ability to walk without a walking aid for a distance of 10 meters, lower extremity musculoskeletal condition other than stroke that could restrict ambulation, severe cardiopulmonary disease affecting gait ability, severe cognitive impairment, unstable medical conditions and peripheral neuropathy.

The two groups followed a complex rehabilitation program, and in the spastic group ultrasound guided botulinum toxin injections in spastic muscles were performed. Patients that met the study criteria were included in the study. All patients signed an informed consent, and the study protocol was approved by the research ethics committee of the hospital.

Each of the groups included 20 patients (eleven men and nine women in the spastic group and thirteen men and seven women in the non-spastic group), the mean age was 61.6 years (range 41 - 80 years) for the non-spastic group and 62 years (range 44 - 75 years) for the spastic group. The average period after stroke was 15.8 months for the non-spastic group and 14.1 for the spastic group.

In the non-spastic group, 14 patients had right hemiplegia and 6 had left hemiplegia, and in the spastic group, 9 patients had right hemiplegia and 11 left hemiplegia.

*c) Applied tests*

Evaluation was made on the first and last day of the rehabilitation program and at one month for the non-spastic group and at 2 months for the spastic group. The evaluation consisted of gait analysis, Lower Extremity Functional Scale (LEFS), Modified Ashworth Scale (MAS) and Timed Up and Go Test. Gait analysis was performed with G-WALK from BTS which is a wearable system for the functional analysis of movement that offers a quantitative analysis for the performance of gait (spatial-temporal parameters, general kinematic parameters, symmetry index, propulsion index and pelvis kinematics).

Each patient who joined the study was evaluated before the rehabilitation program and botulinum toxin injection (baseline, T0), at 3 weeks on the day of discharge (T1), and after discharge at 4 weeks (T2) for those in the non-spastic group and at 8 weeks (T2) for those in the spastic group.

To obtain a better qualitative gait measurement, gait analysis was made using BTS G-Walk inertial sensor and 3 successful trials were recorded with the patients at their self-selected speed (without a walking aid) on a 10-meter-long walkway. For each patient, the outcome measures were calculated and averaged for the trial session. Therefore, the average value would not be modified by minor deviations in the time of occurrence of peaks and valleys in the stance and swing phases data.

To evaluate the degree of spasticity and to determine the botulinum toxin dosage, the Modified Ashworth Scale (MAS) was used. To establish the impact of treatment on the functionality of the lower limb, the Lower Extremity Functional Scale (LEFS) was used, and to assess the risk of fall, the Timed Up and Go Test was chosen.

The complex rehabilitation program followed by the two groups spanned 3 weeks, 4 hours daily, 5 days/week, and consisted of Bobath therapy, neuromuscular electrical stimulation (NMES), gait training, and in the spastic group the same rehabilitation program, 3 hours daily 5 days/week, without NMES and ultrasound guided abobotulinumtoxinA (aboBoNT-A, Dysport [Ipsen]) injection.

The stimulation frequency used in the case of NMES is set between 12 and 50 Hz, and the strength of muscle contraction is modulated by changing either the pulse amplitude (typically 0 to 100 mA) or pulse width (typically 0 to 300 μsec). NMES was applied to the quadriceps muscle and dorsiflexors of the foot for 30 minutes daily.

The dosage of abobotulinumtoxinA used which totaled 800 IU was divided as follows: 100 IU for each head of the quadriceps muscle, 100 IU for each gastrocnemius muscle, and 200 IU for the soleus muscle. The remaining 200 IU were injected in the upper limb spastic muscles. The injection was performed using the ultrasound guided approach, targeting the belly of the muscle.

*d) Statistical processing*

Data analysis was performed in the R programming language, version 3.6.2, and some tables and graphs in the Excel application of the Microsoft 365 for Enterprise package.

For the evaluation of the type of distribution, i.e., whether the data in a batch were normally distributed or not, the Shapiro-Wilk test was used, with a significance threshold of 0.05.

To compare the pairs-batches (from one moment to another), we used the paired t-test when data were normally distributed and the Wilcoxon signed rank sum test when data were not normally distributed.

To compare independent groups (from one muscle group to another or from non-spastic to spastic ones), we used two independent sample t-tests when data were normally distributed and Wilcoxon-Mann Whitney test when data were not normally distributed. Pearson's (r being the associated correlation indicator) was used to perform the correlations since we had to deal with continuous data.

Before starting to compare the time periods between them, for each variable and for each muscle group by spasticity, the normality of the distribution should be evaluated.

## Results

In Table I we can see the comparison tests between times T0 and T1 in the non-spastic group. Below we see the difference of the means, plus the classic p-value and the related statistics. In the non-spastic group, statistically significant differences were observed post-treatment (after 3 weeks) in the case of cadence from a mean of 46.15 steps/minute (T0) to 57.5 (T1), gait speed from 0.457 meters/sec (T0) to 0.6265 m/sec (T1) and 0.5965 m/sec (T2), stance phase duration from 69.43% (T0) to 65.44% (T1, $p < 0.05$) with almost 4% on average. Swing phase duration from 33.91 (T0) to 34.57 (T1, $p < 0.05$), Timed Up and Go from 16.3 (T0) to 14.15 (T1) and LEFS from 32.45 (T0) to 34.7 (T1). No differences were observed in the case of double support duration from 19.94 (T0) to 18.65 (T1) and single support duration from 29.76 (T0) to 31.1 (T1).

**Table I**
Results of comparison tests between times T0 and T1 for non-spastic patients.

| Parameter | Test | Average difference (T0-T1) | Result (p-value) |
|---|---|---|---|
| Cadence | Wilcoxon signed rank sum test | -11.35 | < **0.0001** |
| Gait speed | Wilcoxon signed rank sum test | -0.0925 | < **0.0001** |
| Stride length | Paired t-test | 0.154 | **0.0382** |
| Stance phase duration | Wilcoxon signed rank sum test | 3.99 | **0.0020** |
| Swing phase duration | Wilcoxon signed rank sum test | -0.66 | 0.1615 |
| Double support duration | Paired t-test | 1.29 | 0.1203 |
| Single support duration | Wilcoxon signed rank sum test | -1.34 | 0.0701 |
| TUG test | Wilcoxon signed rank sum test | 2.15 | **0.0001** |
| LEFS | Paired t-test | -2.25 | < **0.0001** |

Legend: TUG: Timed Up and Go test, LEFS: Lower Extremity Functional Scale

The comparison between T0 and T2 (at one month post-discharge) in the non-spastic group can be seen in Table II, and this time the variables that registered significant differences from T0 to T2 were slightly different:

Cadence showed significant differences from (T0) 46.15 to (T2) 49.7, with an average increase of 3.55 units of measurement at T2 compared to T0 (when the T0-T2 difference was negative, it means that it increased at T2); gait speed also had significant differences, with an increase at (T2) 0.5165 of 0.025 units of measurement from a baseline value of 0.4915; on the other hand, stride length did not register any statistical differences, from (T0) 1.16 to (T2) 1.19.

The stance phase duration of the affected leg registered significant differences, with a decrease of 2.78 units of measurement from (T0) 69.43 to (T2) 66.65, and the swing phase duration of the affected leg also showed significant differences, from 33.91 (T0) to 33.34 (T2).

In the case of double support duration, p-value was very close to the significance threshold; in any case, in absolute value it decreased by 0.865 units of measurement, having a value of 19.94 at baseline and 19.08 at T2, while the single support duration, with a value of 29.76 at T0 and 30.58 at T2, also had a p-value quite close to the 0.05 threshold, but higher. In absolute value, there was an increase of 0.81 percentage points.

Timed Up & Go registered significant differences from (T0) 15.5 to (T2) 16.3, but LEFS did not record significant differences from one moment to another, (T0) 32.45 and (T2) 32.75; in absolute value, there was an increase of 0.3 units of measurement.

**Table II**
Results of comparison tests between times T0 and T2 for non-spastic patients.

| Parameter | Test | Average difference (T0-T2) | Result (p-value) |
|---|---|---|---|
| Cadence | Wilcoxon signed rank sum test | -3.55 | **0.0003** |
| Gait speed | Wilcoxon signed rank sum test | -0.025 | **0.0034** |
| Stride length | Paired t-test | 0.065 | 0.236 |
| Stance phase duration | Wilcoxon signed rank sum test | 2.78 | **0.0019** |
| Swing phase duration | Wilcoxon signed rank sum test | 0.565 | 0.2707 |
| Double support duration | Paired t-test | 0.865 | 0.0571 |
| Single support duration | Wilcoxon signed rank sum test | -0.81 | 0.0761 |
| TUG test | Wilcoxon signed rank sum test | 0.8 | **0.0017** |
| LEFS | Wilcoxon signed rank sum test | -0.3 | 0.1145 |

Legend: TUG: Timed Up and Go test, LEFS: Lower Extremity Functional Scale

Regarding the results in the spastic group, from baseline to T1, first, as usual, we observe the type of distribution (whether it is normal or not) of the data for each of the variables. In Table III we can see that most of the variables at most times were normally distributed.

Cadence showed statistical differences from baseline compared to 3 weeks later. In absolute terms, it meant an increase of 23.9 units of measurement, from 38.85 (T0) to 62.75 (T1). Gait speed also had significant differences from one time to another, i.e., an increase of 0.2475 units of measurement on average, from 0.467 (T0) to 0.7145 (T1). Instead, stride length had an increase of 0.30 units

of measurement, without this difference being statistically significant, from 0.60 (T0) to 0.92 (T1). The stance phase duration had an average increase of 14,855 units of measurement, from 41.34 (T0) to 56.2 (T1). The swing phase duration, on the other hand, decreased significantly, from 58.8 (T0) to 43.35 (T1). The double support duration phase registered a decrease of 4.52 units of measurement, a statistically significant difference, from 22.26 (T0) to 17.74 (T1). The single support duration phase had an increase of 4,785 units of measurement, also significant, from 25.88 (T0) to 30.66 (T1).

Timed Up & Go registered a significant difference from baseline, 17.5, with a value of 14.1 (T2). LEFS had a statistically significant increase of 2.3 units of measurement, with a value of 32.45 at T1 and 34.75 at T2. MAS also showed a statistically significant decrease of 2.3 units, from 2.65 (T0) to 1.55 at (T1).

**Table III**
Results of comparison tests between times T0 and T1 for the group of spastic patients.

| Parameter | Test | Average difference (T0-T1) | Result (p-value) |
|---|---|---|---|
| Cadence | Paired t-test | -23.9 | **< 0.0001** |
| Gait speed | Wilcoxon signed rank sum test | -0.2475 | **< 0.0001** |
| Stride length | Wilcoxon signed rank sum test | 0.30 | 0.5754 |
| Stance phase duration | Paired t-test | -14.855 | **< 0.0001** |
| Swing phase duration | Paired t-test | 14.855 | **< 0.0001** |
| Double support duration | Paired t-test | 4.52 | **< 0.0001** |
| Single support duration | Paired t-test | -4.785 | **< 0.0001** |
| TUG test | Wilcoxon signed rank sum test | 3.4 | **< 0.0001** |
| LEFS | Paired t-test | -2.3 | **< 0.0001** |
| MAS | Wilcoxon signed rank sum test | -2.3 | **< 0.0001** |

Legend: TUG: Timed Up and Go test, LEFS: Lower Extremity Functional Scale, MAS: Modified Ashworth Scale

The results presented in Table IV at the third evaluation (T2) at 2 months post-discharge in the spastic group revealed that some of the effects obtained at discharge were maintained.

Cadence had significant differences, with an average increase of 20 units at T2, 58.85, compared to 38.85 (T0). Gait speed registered a significant average increase of 0.1655 units, from 0.467 (T0) to 0.6325 (T2). Stride length had a significant increase of 0.21 units on average at T2, but with a much higher p-value than in the previous cases (much closer to the threshold of 0.05), from 0.60 at T0 to 0.81 (T2).

Stance phase duration showed a significant increase of 8,085 units at T2 from 41.34 (T0) to 49.42 (T2). Swing phase duration (also in the affected leg) had a statistically significant decrease of 8.97 units, from 58.66 (T0) to 49.69 (T2). Double support duration had a significant decrease of 2,405 units from 22.26 (T0) to 19.86 (T2). Single support duration registered a significant increase of 2.53 units from 25.88 (T0) to 28.4 (T2). T had a decrease of 1.6 units (significant) from 17.5 (T0) to 15.9 (T2). LEFS showed an increase of 0.65 units (significant) from 32.45 (T0) to 33.1 (T2). MAS had a decrease of 0.525 (significant), from 2.65 (T0) to 2.125 (T2).

**Table IV**
Results of comparison tests between times T0 and T2 for the group of spastic patients.

| Parameter | Test | Average difference (T0-T2) | Result (p-value) |
|---|---|---|---|
| Cadence | Paired t-test | -20 | **0.0008** |
| Gait speed | Wilcoxon signed rank sum test | -0.1655 | **< 0.0001** |
| Stride length | Wilcoxon signed rank sum test | 0.21 | **0.0289** |
| Stance phase duration | Paired t-test | -8.085 | **< 0.0001** |
| Swing phase duration | Paired t-test | 8.97 | **< 0.0000** |
| Double support duration | Paired t-test | 2.405 | **< 0.0000** |
| Single support duration | Paired t-test | -2.53 | **< 0.0001** |
| TUG test | Wilcoxon signed rank sum test | 1.6 | **0.0001** |
| LEFS | Paired t-test | -0.65 | **0.0009** |
| MAS | Wilcoxon signed rank sum test | 0.525 | **< 0.0000** |

Legend: TUG: Timed Up and Go test, LEFS: Lower Extremity Functional Scale, MAS: Modified Ashworth Scale

## Discussions

The aims of this study were to analyze the differences between post-stroke spastic and non-spastic patients with genu recurvatum gait asymmetries and to determine the efficacy of a complex 3-week rehabilitation program associated with neuromuscular electrical stimulation (in the non-spastic group) and alongside botulinum toxin injection (in the spastic group).

Regarding the selected evaluation periods, in the case of patients in the non-spastic group, the evaluation at 1 month post-treatment was chosen in accordance with other studies that demonstrated the effects of neuromuscular electrostimulation as having a post-treatment duration of approximately 2 to 4 weeks (Hong et al., 2018). In the case of patients in the spastic group, the evaluation was performed 2 months after treatment, based on the finding that the beneficial effect usually occurs at 7-10 days post-injection and the maximum response can be reached in approximately 4-6 weeks and could last for an average of 12 weeks. Also, ultrasound guided botulinum toxin injections are usually repeated every 3-4 months (Ozcakir & Sivrioglu, 2007).

In the initial evaluation, we can observe a couple of differences and similarities between the spastic and non-spastic groups regarding gait spatiotemporal parameters and patterns.

The similarities present in both groups, either spastic or non-spastic, were represented in the first case by spatiotemporal parameters such as cadence, gait speed, both single and double support duration, stride length,

and in the second case by functional parameters such as the Timed Up and Go Test and the Lower Extremity Functional Scale.

The differences between the two groups, either spastic or non-spastic, were only present in the spatiotemporal parameters, the non-spastic group having a longer duration of the stance phase and a shorter duration of the swing phase.

We believe that these differences are due to the presence of spasticity of the quadriceps and gastrocnemius-soleus complex muscles in the spastic group and the weakness of quadriceps, gluteal and dorsiflexor muscles in the non-spastic group. From a biomechanical point of view, patients with non-spastic genu recurvatum are trying to keep their knee in a hyperextension position, keeping their ground reaction force in front of the knee, thus preventing a probable fall (Bleyenheuft et al., 2010). Also, it is important for patients with non-spastic genu recurvatum to maintain their posture during gait, allowing them a normal step with minimal risks of fall, and maintaining the load line in front of the knee (Bleyenheuft et al., 2010).

In the case of spastic genu recurvatum patients, the concomitant presence of spasticity in the quadriceps muscle which leads to a "stiff-knee gait", in which genu recurvatum is present during the stance phase and the gastrocnemius-soleus complex that forms the plantar flexion-knee extension couple which also has an influence upon extension of the knee during the stance phase (Perry et al., 2010; Klotz et al., 2013), could explain the shorter stance phase duration and a longer swing phase in comparison with the non-spastic genu recurvatum.

From a functional view, both post-stroke non-spastic and spastic genu recurvatum had similar implications regarding the functionality of the lower limb, evaluated on the lower extremity functional scale (LEFS), which is a well-known and validated patient-rated outcome measure (PROM) that can be used to measure lower extremity function (Dingemans et al., 2017).

Regarding the efficacy of the 3-week rehabilitation program associated with neuromuscular electrical stimulation on gait spatiotemporal parameters in patients with post-stroke non-spastic genu recurvatum, we can observe an increase of gait speed, cadence and stride length, slightly lowering the risk of fall and the functionality of the lower limb, changes that were maintained at one month after discharge. In the literature, few studies have been conducted on the efficacy of botulinum toxin on the spatiotemporal parameters of patients with spastic hemiparesis after stroke associated with genu recurvatum. However, a recent study has shown the effectiveness of botulinum toxin on lower limb muscle spasticity and spatiotemporal parameters of post-stroke gait (Esquenazi et al., 2021). In the presence of quadriceps muscle spasticity, the administration of botulinum toxin improved the degree of knee flexion in the stance and swing phases, and caused a decrease in energy consumption, but not a reduction of genu recurvatum (Caty et al., 2008).

The presence of spasticity in the gastrocnemius-soleus complex muscle also plays an important role in the occurrence of the genu recurvatum, with only one study demonstrating the effectiveness of botulinum toxin injected into the gastrocnemius-soleus complex muscle in reducing recurvatum in pediatric cerebral palsy patients (Klotz et al., 2013). So far, no studies have been conducted regarding the effectiveness of ultrasound guided botulinum toxin injection in association with a rehabilitation program in post-stroke spastic genu recurvatum. A recent multicenter, prospective, double-blind, randomized, placebo-controlled, adult lower limb study has shown that a dosage of aboBoNT-A 1500 U significantly reduced gastrocnemius-soleus complex spasticity at week 4 and 12 post-injection (Santamato et al., 2019).

Using the ultrasound guided approach increases the injection accuracy considering that the gastrocnemius are thin muscles and are easy to miss; and being biarticular muscles, they have a role in knee extension in the stance phase in closed kinetic chain, thus promoting the occurrence of genu recurvatum when spasticity is present. We can observe that associating ultrasound guided injection of botulinum toxin in the spastic muscles (quadriceps and gastrocnemius-soleus complex muscle) with a 3-week rehabilitation program improved the gait spatiotemporal parameters, functionality of the spastic lower limb, lowering the risk of fall and reducing the degree of spasticity in post-stroke spastic genu recurvatum. In the post-discharge evaluation, the remaining effects were mainly due to the botulinum toxin maintenance effect.

During the course of our study, patients that followed oral antiplatelet or anticoagulant therapy showed no adverse effects regarding muscle hematomas or other post-injection complications, an evolution that concurs with other studies (Popescu et al., 2018).

## Conclusions

1. Our findings suggest that following a 3-week rehabilitation program and using ultrasound guided botulinum toxin injections, in the case of spasticity, improves gait spatiotemporal asymmetry and ameliorates functionality, lowering the risk of fall in patients with post-stroke genu recurvatum, whether spastic or non-spastic.

2. The gait pattern of stroke genu recurvatum patients has some differences regarding the stance phase duration, which is longer in the case of non-spastic patients and shorter in spastic ones.

3. Besides the implications of quadriceps and dorsiflexor muscles in post-stroke non-spastic genu recurvatum, gluteal muscles could be another cause, and further studies are needed to determine their implication.

4. In the case of post-stroke spastic genu recurvatum, both muscle groups, the quadriceps and the gastrocnemius-soleus complex are involved, but the gastrocnemius-soleus complex seems to have a greater involvement. Further studies need to establish the percentage of involvement of each muscle group.

5. Botulinum toxin injections are an effective method of treating focal lower limb spasticity in post-stroke hemiparetic patients with genu recurvatum, especially when the ultrasound guided approach is used.

6. Post-stroke genu recurvatum, whether spastic or non-spastic, increases the risk of fall, having a negative influence on lower limb function.

**Conflict of interests**
Nothing to declare.

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