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ORIGINAL ARTICLE

Dry needling of the flexor digitorum brevis muscle reduces postural control in standing: A pre-post stabilometric study

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Abstract

There are studies that show the better balance after dry needling in lumbar pain. However, the postural control effects after foot dry needling are unknown. Our objective was to check if dry needling reduces postural control. Eighteen subjects with flexor digitorum brevis (FDB) muscle Myofascial trigger point were evaluated pre- and post-deep dry needling. We measured stabilometric variables in a pre-post study. We have found significant differences in three stabilometric variables: surface with eyes closed (29.36–53.21 mm^2) ($p = 0.000$), medium speed of the laterolateral displacement with eyes closed (1.42–1.64 mm/s) ($p = 0.004$), and medium speed of the anteroposterior displacement with eyes closed (1.30–1.53 mm/s) ($p = 0.025$). Dry needling therapy application in FDB muscle reduces standing postural control with eyes closed.

KEYWORDS
motor control, myofascial trigger point, physical therapy modalities, postural balance, stabilometry

1 | INTRODUCTION

Adequate postural control is necessary to carry out our daily activities, which is achieved thanks to the integration and selection of visual, vestibular, and proprioceptive sensory information by the central nervous system (Carver et al., 2006). The central nervous system can select different signals from different body zones in different situations or contexts, as has been

demonstrated in healthy people and low back pain (Brumagne et al., 2004).

Pain in the musculoskeletal system is often the first symptom of myofascial pain syndrome (MPS; Hidalgo-Lozano et al., 2010). The cause of myofascial pain is a trigger point, a hyperirritable structure in skeletal muscle fibers; the trigger point generates hypersensitivity, which is exacerbated by the clinical examination maneuvers: compression of the trigger point, stretching, and contraction of the involved muscle (Bron & Dommerholt, 2012; Sanz et al., 2016; Travell & Simons, 2004). Nociception in MPS is local and referred (Travell & Simons, 2004). The characteristic pain of MPS is a type of referred pain. It is a pain that produces sensitization at the central nervous system level and that at the same time is maintained over time due to this sensitization (Rubin et al., 2009). Sensitization affects sensitive nociceptive and non-nociceptive fibers. The nociceptive hypersensitivity of the MTrP or hyperalgesia and the non-nociceptive hypersensitivity, called allodynia, occur in the MTrP. Therefore, it shows the alteration of both fibers (Li et al., 2009). Also, the sensory fibers of proprioception information are involved. Proprioceptive fiber compression of MTrP, but not in other areas, has been shown to increase the pain threshold to pressure and referred pain, confirming its involvement in the pathophysiology of pain and involvement of proprioceptive fibers in this peripheral sensitization (Wang et al., 2010). Trigger points (MTrP) in the muscles of the neck have been associated with alteration in static postural control (Talebian et al., 2012), and subjects with fibromyalgia also show a deficit in balance (Viseux et al., 2020). Research investigating the effects of dry needling therapy has shown the ability to reverse the central sensitization process due to MTrP (Freeman et al., 2009; Giamberardino, 2003) In addition to being an effective therapy in treating pain, it is considered a safe technique (Fogelman & Kent, 2015; Kietrys et al., 2013).

Plantar Heel pain has a high incidence within the musculoskeletal pathologies of the foot. Approximately 10% of the population will suffer from MPS in their lifetime (Klingler et al., 2014). One of the causes of heel pain is referred pain produced by MPS of the flexor digitorum brevis (FDB; Travell & Simons, 2004). There are two types of trigger points: active and latent. Both generate clinical symptoms of decreased joint range and increased fatigability, but only the latent trigger point does not present pain unless it is mechanically stimulated (Ge et al., 2012). Treatment of FDB trigger points with dry needling therapy proves effective in research (Cotchett et al., 2014).

Among the effects of the dry needling technique, the effect of pain reduction is demonstrated in numerous quality studies (Cotchett et al., 2014; Dommerholt & Fernández de las Peñas, 2019; Haser et al., 2017). However, regarding postural control, there is only one study in patients with sub-chronic low back pain that has shown less pain and better functional balance after dry needling in lumbar muscles (Loizidis et al., 2020).

The foot is an important captor within the vestibular system and in both static and dynamic balance (Magnusson et al., 1990; Patel et al., 2011; Viseux et al., 2019), and static postural balance measured with the platform while standing is a reliable study variable (Winter, 1995). The neuromuscular control of center of pressure (COP) in a standing position is done (Lima et al., 2014) by the combined control of neuromuscular regulation of both left and right dorsiflexor—plantarllexors (from the anteroposterior COP direction) and eversor—inversors (from the mediolateral direction) and also with the contribution of intrinsic muscles, which has recently been proven to be related to static posture maintenance (Behm et al., 2004; Chatzopoulos et al., 2014; Costa et al., 2009; E. Martínez-Jiménez et al., 2019; Morrin & Redding, 2013; Scharfbillig & Scutter, 2014).

Although there are many studies on the effectiveness of dry needling against pain, there are no studies on the effects on the postural balance after applying the therapy to the foot, such as the FDB muscle. So, we hypothesize that after the dry puncture on the foot, the balance worsens. This study aims to test the acute side effects of balance to improve the warnings, advice, and care when applying dry needling.

TABLE 1 Characteristics of the subjects. Sociodemographic variables.

	Women Mean ± SD 95% CI ($n = 10$)	Men Mean ± SD 95% CI ($n = 8$)	Total Mean ± SD 95% CI ($n = 18$)	p
Age (years)	29.60 ± 7.22 (27.96–31.23)	34.37 ± 7.24 (32.73–36.01)	31.72 ± 7.43 (30.03–33.40)	0.090
Weight (Kg)	58.60 ± 7.60 (56.87–60.32)	67.50 ± 8.88 (65.48–69.51)	62.55 ± 9.15 (60.48–64.62)	0.020
Height (m)	1.6100 ± 0.0764 (1.5926–1.6273)	1.7187 ± 0.0135 (1.7156–1.7218)	1.658 ± 8.26 (1.639–1.677)	0.006
BMI (Kg/m^2)	22.78 ± 3.42 (22.00–23.55)	22.73 ± 2.95 (22.06–23.40)	22.73 ± 2.84 (22.09–23.38)	0.450
Size of shoe	38.00 ± 1.56 (37.64–38.35)	40.87 ± 1.36 (40.56–41.18)	39.27 ± 2.05 (38.81–39.74)	0.002

Abbreviations: BMI, body mass index; CI, confidence interval; SD, standard deviation.

2 | METHODS

2.1 | Subjects

We selected 18 subjects with bilateral active or latent myofascial trigger points in FDB muscle, 10 females and 8 males. The study sample had similar sociodemographic characteristics, see Table 1.

Inclusion criteria: (1) Subjects whose reason for consultation was bilateral heel pain caused by MTrP in FDB muscle active or latent; (2) no other MTrP was found in the foot or lower limbs; (3) all subjects were normal weight (Winter, 1995); and (4) and had an age range of 27.96–36.04 (95% confidence interval [CI]) (Lima et al., 2014).

Exclusion criteria: (1) Any musculoskeletal pathology associated with the foot or lower limb, such as plantar fasciitis, tendinopathy, bursitis, sprains (Behm et al., 2004); (2) surgery on the lower limb (Costa et al., 2009); (3) Having received previous or treatment (Magnusson et al., 1990); (4) diabetes mellitus (Morrin & Redding, 2013); (5) digital deformities such as hallux valgus (Chatzopoulos et al., 2014); (6) the subjects refrained from vigorous exercise and alcohol consumption for 24 h and stimulant (e.g., caffeine) use for 6 h before testing (Dudek et al., 2014); (7) had no previous surgery on the lower extremities; no history of injury with residual symptoms in the lower extremities within the last year; no evidence of a leg-length discrepancy (difference in distance from the anterior superior iliac spine to the superior surface of the most prominent aspect of the medial malleolus) of more than 1 cm; had at least 15° of ankle dorsiflexion (Behm et al., 2004); and (8) no evidence of balance deficits (determined by oral questioning regarding falls) (Shim et al., 2015), using the Balance Evaluation Systems test (BESTest) (Horak et al., 2009). The Ethics Committee of the Rey Juan Carlos University gave its consent to carry out the study with number 2706201911419. The research has been carried out following the ethical guidelines of the Declaration of Helsinki. A prospective registration with the number NTC04222946 was made on the Clinicaltrial.gov platform.

2.2 | Number of test subjects

The GPower® 3.1 program was used to calculate the sample size. We are based on a pre-test–post-test study that evaluated the consequences in stabilometry of performing intermittent stretching in a pre-post study (E. Martínez-Jiménez et al., 2019). These authors found that the Surface with eyes open variable decreased after stretching from 13.56±9.43 to 6.15±4.10 ($p = 0.000$) (Dudek et al., 2014). To achieve this, we use a two-tailed calculation, since the variables could improve or worsen with the intervention. For statistical confidence of 95%, a study power of 80% (error $\alpha = 0.05$, $\beta = 20\%$) was chosen, as it is considered the ideal power for any study (Shim et al., 2015); the result obtained was 18 participants.

2.3 | Procedures

First, latent MTrPs were identified by the same clinician who carried out the outcome measurements before and after the intervention. Latent MTrP was defined as the most hyperalgesic nodule in a taut band generating local or referred pain under the same pressure of mechanical stimulation by manual palpation (Calvo-Lobo et al., 2017).

The procedures performed followed the present order: (1) Once the MTrP of the FDB muscle was diagnosed, compliance with the criteria of inclusion and exclusion to enroll in the study was evaluated; (2) collection of data on the platform of pressures before intervention (Dudek et al., 2014), (3) application of deep dry needling therapy in both FDB muscles (Figure 1)—subjects positioned in the prone position received the therapy, at least one local spasm response was observed as proof of arrival at the trigger point with the needle (Behm et al., 2004), the multiple deep dry needling insertions procedure used (Imani et al., 2021) and all subjects confirmed the characteristic referred pain pattern of FDB muscle during dry needling (4) immediate post-treatment evaluation.

Data collected before and after the intervention: the subjects received the instructions to position themselves on the pressure platform with the support of both bare feet (Shim et al., 2015), the feet were positioned at the same distance to the midline 39 and at angulation to the midline of 30 degrees (Behm et al., 2004; Costa et al., 2009), the upper limbs remained relaxed on both sides of the body (Landis & Koch, 1977). The subjects were instructed to stand as still as possible, with their eyes open, while concentrating on a point about 2-m away, at eye level. We took two trials of each condition: eyes open (EO) and eyes closed (EC), each trial was 30 s duration (Dudek et al., 2014; Magnusson et al., 1990; E. Martínez-Jiménez et al., 2019; E.M. Martínez-Jiménez et al., 2020; Shim et al., 2015), and the order of the conditions was randomized (Öztuna et al., 2006).

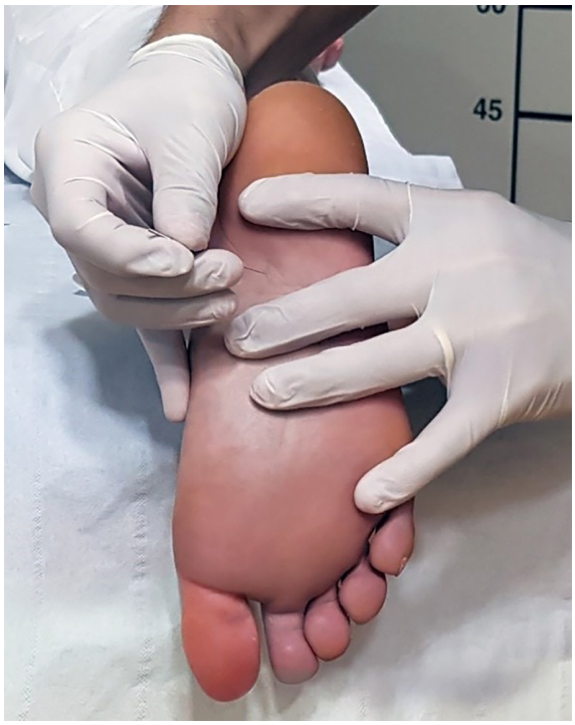

FIGURE 1 Dry needling therapy of the flexor digitorum brevis muscle.

2.4 | Variables

The stabilometric variables were X displacement eyes open (mm), Y displacement eyes open (mm), surface eyes open (mm^2), and medium speed of the laterolateral displacement. Eyes open (mm/s), medium speed of the anteroposterior displacement eyes open (mm/s), X displacement eyes closed (mm), Y displacement eyes closed (mm), surface eyes closed (mm^2), medium speed of the laterolateral displacement eyes closed (mm/s), and medium speed of the anteroposterior displacement Eyes closed (mm/s). All variables were recorded and digitized with Podoprint (Medicapteurs; Balma, Francia). This platform has 2304 sensors in 400×400 mm and 200 Hz acquisition frequency and allows an autocalibrated system at any use, and technical characteristics are shown in Table 1.

2.5 | Statistical analysis

Knowing that the sample size was less than 30 subjects, the indication to define the normality of the distribution of the data of the variables is carried out with the Shapiro–Wilk test, as we did in this study (Leblebici et al., 2017), and data were considered normally distributed if $p > 0.05$. Descriptive statistical analysis was performed using mean ± standard deviation (SD) and a 95% CI. For each intrasession trial, the intraclass correlation coefficient (ICC) was used to evaluate the reliability of each parameter. To interpret ICC values, we used benchmarks as proposed by Landis and Koch (Landis & Koch, 1977): 0.20 or less, slight agreement; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; and 0.81 or greater, almost perfect.

Standard errors of the mean (SEM) were calculated to measure the range of error of each gait parameter. The SEM was calculated between sessions from the ICCs and SDs. SEM = $s\_x.\sqrt{(1 - r\_xx)}$ where s_x is the SD of the observed set of test scores, and r_xx is the reliability coefficient for these data, which, in this case, is considered using the ICC.

Indeed, the minimum detectable change (MDC) at a confidence level of 95%, which reflect the magnitude of change necessary to provide confidence that a change is not the result of random variation or measurement error, was calculated from the SEM values by the following formula $\text{MDC} = \sqrt{2} \times 1.96 \times \text{SEM}$. Both SEM and MDC were analyzed according to Bland and Altman (Bland & Altman, 2010).

Also, the mean value of the two measurements of each variable was used. The Wilcoxon signed-rank test was performed to test for any differences in no parametric variables, and the paired *t*-test was used for parametric variables.

To objectify gender differences, we have separated the results by sex; these results can be seen in Tables 4 and 5. For this, we have used the related samples test for non-normal distribution variables Wilcoxon Test.

While a *p* value can tell us whether or not there is a statistically significant difference between two groups, an effect size can tell us how large this difference actually is. We calculated the effect size Cohen's *d*, which is interpreted as a value of 0.2 represents a small effect size; 0.5 represents a medium effect size; and a value of 0.8 represents a large effect size (Sim & Wright, 2005).

Finally, values of normality (VN) of the sample for all variables obtained with the ultrasound and cadaveric dissection were defined. These were obtained from the formula VN = (Mean ± 1.96) × SD. From the result of each variable, VN was used to calculate the interval of confidence at 95%. A *p* value <0.05 with a CI of 95% was considered statistically significant for all tests (SPSS for Windows, version 20.0; SPSS, Inc.).

Table 2 analyses the intrasession reliability of the studied variables and VN in the total population.

TABLE 2 Technical specifications of the pressure platform.

Specification	Description
Size (length × width × height)	530 × 600 × 45 mm
Thickness	4 mm
Active surface	400 × 400 mm
Weight	6.8 kg
Sensors	Calibrated resistive
Sensor	8 × 8 mm
Sensor thickness	0.15 mm
No. of sensors	2304 (48 × 48)
Permissible temperature	−40 to 85°C
Sensor pressure (minimum/maximum)	0.4 N/m^2 (0.0004 kPa)/100 N/m^2 (0.1 kPa)
Type of PC interface/platform	USB
Supply	USB cable
Data acquisition frequency	200 images/s
Vertical force recording	60 Hz
Operating system required	Windows XP, Vista, or 7

3 | RESULTS

A total of 18 participants were recruited. The participants had similar sociodemographic characteristics due to age and BMI did not show a significant difference ($p > 0.05$) as shown in Table 2.

Analysis of intrasession reliability of the variables and VN in the total population is detailed in Table 2. It is the aim that all the variables should obtain an ICC value of 0.848 or greater, which is considered almost perfect reliability (Leblebici et al., 2017). SEM values provide an acceptable error for each measurement.

The variables surface eyes open, medium speed of the laterolateral displacement with eyes open, and medium speed of the anteroposterior displacement eyes open showed no normal distribution (Table 3).

We have found significant differences in three stabilometric variables in the before and after dry needling study: Surface with

TABLE 3 Analysis of intrasession reliability of the variables studied and values of normality in total population.

Variable	Pre-test (n = 18)				Post-test (n = 18)				
	ICC (95% CI)	SEM	MDC	Values of normality 95% CI	ICC (95% CI)	SEM	MDC	Values of normality 95% CI
X displacement eyes open (mm)	0.870 (0.650–0.952)	1.88	5.22	38.33–58.83	0.742 (0.320–0.903)	2.80	7.77	32.12–53.76
Y displacement eyes open (mm)	0.824 (0.406–0.940)	3.62	10.03	207.81–231.28	0.974 (0.925–0.990)	2.45	6.79	461.16–520.75
Surface eyes open (mm^2)	0.854 (0.617–0.945)	6.72	18.63	278.80–347.75	0.614 (−0.68–0.858)	13.80	38.26	506.61–593.71
Medium speed of the laterolateral displacement. Eyes open (mm/s)	0.006 (−0.470–0.455)	1.75	4.86	−0.61–6.28	0.835 (0.567–0.938)	0.17	0.48	−0.31–1.37
Medium speed of the anteroposterior displacement. Eyes open (mm/s)	0.914 (0.745–0.969)	0.14	0.39	−0.47–1.44	0.909 (0.757.966)	0.15	0.41	−0.46–1.5
X displacement eyes closed (mm)	0.901 (0.741–0.963)	2.05	5.69	48.64–74.24	0.986 (0.964–0.995)	0.78	2.18	54.61–80.71
Y displacement eyes closed (mm)	0.958 (0.889–0.984)	2.29	6.35	304.59–348.45	0.952 (0.872–0.982)	3.34	9.26	455.05–514.87
Surface eyes closed (mm^2)	0.958 (0.889–0.984)	3.65	10.14	817.89–934.90	0.709 (0.152–0.895)	22.75	63.08	2162.23–2327.62
Medium speed of the laterolateral displacement. Eyes closed (mm/s)	0.735 (0.272–0.902)	0.22	0.62	−0.23–1.48	0.967 (0.913–0.988)	0.10	0.29	−0.18–2.08
Medium speed of the anteroposterior displacement. Eyes closed (mm/s)	0.712 (0.207–0.893)	0.27	0.77	−0.34–1.69	0.930 (0.812–0.974)	0.19	0.54	−0.31–2.58

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient; MDC, minimum detectable change; SD, standard deviation; SEM, standard error of measurement.

eyes closed, medium speed of the laterolateral displacement with eyes closed, and medium speed of the anteroposterior displacement with eyes closed (Table 3).

Table 4 shows the comparison of the variables before and after dry needling in the total sample.

Table 5 shows the variables before and after dry needling in women. Table 6 shows the variables before and after dry needling in men.

We have selected an image from the stabilometry provided by the platform software to visualise the plantar pressures of the study subjects, and we show it in Figure 2.

4 | DISCUSSION

This study aimed to analyse changes in balance variables immediately after FDB muscle dry needling. We found that after dry needling surface with eyes closed, medium speed of the laterolateral displacement with eyes closed, and medium speed of the anteroposterior displacement with eyes closed increase their values with significant differences.

We have performed the calculation of the MDC and the calculation of the Cohen effect size to be able to observe not only the significant differences but also the size of the findings. After the results, we observe that the results of our research must be considered, but surely the change in the balance that occurs is small in this study population and that it can be magnified with other associated factors such as comorbid diseases or age. Body mass index (BMI) is a person's weight in kilograms divided by the square of height in meters. BMI is a cheap and easy screening method to determine weight categories: underweight, healthy weight, overweight and obese, and it is important that both groups have no differences in BMI and sex in this study while maintaining homogeneity.

We found sex differences in relation to the effect of loss of balance after dry needling. We believe that soreness can inhibit the FDB muscle contraction, which, as for other intrinsic muscles of the foot, has an important stability function in gait and running in healthy people and the flat-footed (Farris et al., 2019). This inhibition is likely to have a greater effect among women, who generally have a greater ligament laxity than men (Quatman et al., 2008). Also, women have greater post-puncture pain according to the latest studies; in the opinion of the authors (Martín-Pintado-Zugasti et al., 2016), this fact may be the cause of the greater loss of balance control after the puncture, although further studies are needed.

Pain is associated with loss of static balance in older adults (Viseux et al., 2020) and is associated with MPS (Loizidis et al., 2020). However, while in patients with low back pain, the dry needling in painful areas and penetrating all the muscle groups show to have an improvement of pain and an increase in static postural control immediately (Brumagne et al., 2008), the effects of the FDB muscle dry needling, looking at our study results, in the foot differ in relation to the balance.

However, it has been reported that pain is associated with worse performance in balance in multiple structures, such as the neck (Talebian et al., 2012), lower back pain (Loizidis et al., 2020; Nies Byl

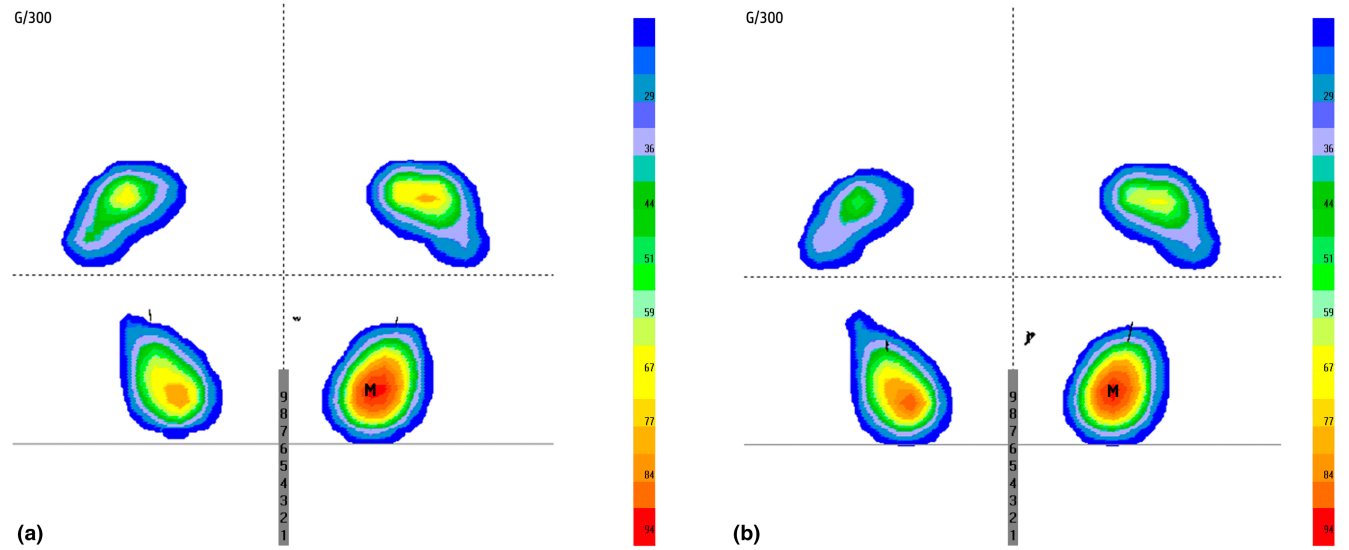

FIGURE 2 Stabilometry pattern before with eyes closed (a) and after with eyes closed (b) dry needling. The scale at the bottom indicates pressure (g/cm2). The central black line of each image represents the body's pressure center movement. The center black line of each foot represents the calculated pressure center displacement within each foot.

& Sinnott, 1973), and in different diseases with different areas of MTrP as fibromyalgia (Viseux et al., 2020). In this sense, it is logical that the reduction in local and referred pain that occurs after dry needling generates better balance processing by the central nervous system. Also, the peripheral sensitization suffered by the nerve fibers in MPS affects the proprioceptive fibers (Tao et al., 2010), a sensitization that recovers after dry needling (Freeman et al., 2009).

On the other hand, recent studies in chronic nociceptive and neuropathic foot pain relate the reduction in pain after the use of foot insoles for 6 weeks and improvement in postural control (Myburgh et al., 2012). In the current study, we found that the dry needling of FDB muscle worsens the balance with eyes closed. Our study also indicates the relationship between the variables of foot pain and postural alteration The authors believe that the soreness that occurs after dry needling might be one of the causes of the loss of balance since the sole of the foot where the puncture is performed is in contact with the ground and can add a passing algal stimulus. Soreness onset rates of 30%–50% after deep dry needling have been referenced (Han et al., 2016), but the support of the sole of the foot may increase the incidence of appearance. Therefore, the authors recommend avoiding insoles with a high internal arch or heels that may increase compression in the puncture area to avoid pain and the associated loss of postural control.

The variation of any variable in the stabilometry study of postural balance, provided it is statistically significant, is considered in the research by different authors as a sample of changes in postural control. However, they are only evident in one variable (Lima et al., 2014; E.M. Martínez-Jiménez et al., 2020).

Furthermore, within the study of proprioception and balance, we know that the diagnostic test's mere repetition supposes a proprioceptive improvement. For this reason, we believe that the changes produced after dry needling clinically imply a significant worsening of postural control (Ledoux et al., 2013; van Netten et al., 2016). In this sense, patients should be advised not to do sports, dance, or activities that require balance, especially those with closed eyes, which were associated with the worst values. Clinicians should also indicate stable footwear without a high heel and with good support, preferably boots (van Netten et al., 2016). The methodology that we have carried out control circumstances that authors such as Knapp explain as important in pre-test–post-test studies (Knapp, 2016) The authors recommend taking precautions in the application of this technique in clinical practice. These recommendations are especially important for those with loss of balance or neuropathy, such as diabetics (Katoulis et al., 1996; Ledoux et al., 2013; van Netten et al., 2016).

4.1 | Clinical implications and future lines

After dry needling, patients should be advised not to do sports, dance, or activities that require balance, especially those with closed eyes, which are the ones that show the worst values after. Indicate stable footwear without a high heel and with good support. Boots preferably. These recommendations are especially important for those with loss of balance or neuropathy such as diabetics. More studies must be carried out to compare different interventions after dry needling to verify which of them allows to recover the balance before.

5 | STUDY LIMITATIONS

One of the limitations of the study is that the long-term effect of dry needling has not been assessed. Also, this study was

TABLE 4 Stabilometric variables before and after dry needling in all samples.

Variable	Pre-test ($n = 18$)		Post-test ($n = 18$)		
	Mean ± SD (95% CI)	Median (RI)	Mean ± SD (95% CI)	Median (RI)	p
X displacement eyes open (mm)	9.29 ± 5.23 (8.10–10.47)	9.05 (8.16)	7.78 ± 5.52 (6.53–9.03)	6.52 (6.35)	0.124**
Y displacement eyes open (mm)	26.04 ± 8.63 (24.08–27.99)	30.42 (11.25)	32.30 ± 15.20 (28.85–35.74)	30.62 (15.27)	0.068**
Surface eyes open (mm^2)	17.81 ± 17.59 (13.83–21.79)	19.72 (23.86)	24.76 ± 22.22 (19.73–29.80)	17.65 (24.69)	0.149*
Medium speed of the laterolateral displacement eyes open (mm/s)	1.61 ± 1.76 (1.21–2.01)	1.2 (0.33)	1.23 ± 0.43 (1.14–1.33)	1.65 (0.86)	0.831*
Medium speed of the anteroposterior displacement eyes open(mm/s)	0.99 ± 0.49 (0.87–1.10)	0.82 (0.40)	1.04 ± 0.50 (0.92–1.16)	0.87 (0.49)	0.114*
X displacement eyes closed (mm)	9.41 ± 6.53 (7.94–10.89)	9.05 (8.16)	10.16 ± 6.66 (8.65–11.67)	10.42 (10.32)	0.619**
Y displacement eyes closed (mm)	29.18 ± 11.19 (26.65–31.72)	30.42 (11.25)	31.78 ± 15.26 (28.32–35.23)	33.27 (12.85)	0.148**
Surface eyes closed (mm^2)	29.36 ± 29.85 (22.60–36.12)	19.72 (23.86)	53.21 ± 42.19 (43.66–62.77)	37.55 (71.92)	0.000*
Medium speed of the laterolateral displacement eyes closed (mm/s)	1.42 ± 0.44 (1.32–1.52)	1.4 (0.52)	1.64 ± 0.58 (1.51–1.78)	1.65 (0.86)	0.004*
Medium speed of the anteroposterior displacement eyes closed(mm/s)	1.30 ± 0.52 (1.18–1.42)	1.17 (0.54)	1.53 ± 0.74 (1.36–1.70)	1.40 (0.76)	0.043*

Abbreviations: CI, confidence interval; RI, range interquartile; SD, standard deviation.

*p Value from Wilcoxon signed-rank test; **p value from paired t-test; a p value <0.05 with a confidence interval of 95% was considered statistically significant.

TABLE 5 Stabilometric variables before and after dry needling in female subjects.

Variable	Female		Female			Effect size
	Pre-test ($n = 18$)		Post-test ($n = 18$)			
	Mean ± SD (95% CI)	Median (RI)	Mean ± SD (95% CI)	Median (RI)	p	Cohen d
X displacement eyes open (mm)	8.28 ± 3.74 (5.60–10.95)	8.62 (5.58)	6.76 ± 5.05 (3.14–10.37)	9.32 (9.21)	0.386*	0.866
Y displacement eyes open (mm)	29.41 ± 6.38 (24.84–33.97)	28.37 (10.83)	40.78 ± 12.12 (32.11–49.45)	22.80 (16.46)	0.037*	−2.090
Surface eyes open (mm^2)	19.07 ± 22.24 (3.15–34.98)	11.70 (19.48)	28.57 ± 24.87 (10.77–46.36)	17.60 (17.41)	0.005*	−2.805
Medium speed of the laterolateral displacement eyes open (mm/s)	2.10 ± 2.29 (0.45–3.74)	1.32 (0.72)	1.41 ± 0.47 (1.06–1.75)	1.05 (0.32)	0.878*	−0.154
Medium speed of the anteroposterior displacement eyes open (mm/s)	1.07 ± 0.49 (0.71–1.42)	0.90 (0.31)	1.18 ± 0.58 (0.76–1.59)	0.70 (0.52)	0.005*	−2.812
X displacement eyes closed (mm)	7.38 ± 5.67 (3.32–11.43)	7.62 (9.35)	9.26 ± 6.00 (4.97–13.55)	10.65 (5.80)	0.386*	0.866
Y displacement eyes closed (mm)	35.82 ± 7.36 (30.55–41.08)	30.40 (13.16)	39.90 ± 11.24 (31.85–47.94)	23.15 (16.12)	0.173*	−1.362
Surface eyes closed (mm^2)	36.82 ± 36.61 (10.41–63.22)	19.72 (75.71)	69.34 ± 48.21 (34.84–103.83)	18.27 (18.01)	0.005*	−2.805
Medium speed of the laterolateral displacement eyes closed (mm/s)	1.52 ± 0.47 (1.17–1.86)	1.47 (0.38)	1.79 ± 0.61 (1.35–2.23)	1.22 (0.77)	0.010*	−2.565
Medium speed of the anteroposterior displacement eyes closed(mm/s)	1.43 ± 0.62 (0.98–1.88)	1.17 (0.78)	1.76 ± 0.89 (1.20–1.39)	1.07 (0.53)	0.182*	−1.334

Abbreviations: CI, confidence interval; RI, range interquartile; SD, standard deviation.

*p Value from Wilcoxon signed-rank test; a p value <0.05 with a confidence interval of 95% was considered statistically significant.

TABLE 6 Stabilometric variables before and after in male subjects.

Variable	Male		MALE			Effect size
	Pre-test ($n = 18$)		Post-test ($n = 18$)			
	Mean ± SD (95% CI)	Median (RI)	Mean ± SD (95% CI)	Median (RI)	p	Cohen d
X displacement eyes open (mm)	10.56 ± 6.72 (4.94–16.18)	9.32 (9.21)	9.05 ± 6.15 (3.91–14.19)	8.35 (4.33)	0.236*	−1.185
Y displacement eyes open (mm)	21.83 ± 9.81 (13.79–29.86)	22.80 (16.46)	21.70 ± 11.89 (11.75–31.64)	24.25 (21.72)	1.000*	0.000
Surface eyes open (mm^2)	16.24 ± 10.49 (7.46–25.01)	17.60 (17.41)	20.01 ± 18.90 (4.21–35.82)	17.65 (23.08)	0.866*	−0.169
Medium speed of the laterolateral displacement eyes open (mm/s)	1.00 ± 0.26 (0.78–1.23)	1.05 (0.32)	1.25 ± 0.60 (0.80–1.24)	0.95 (0.42)	0.666	−0.431
Medium speed of the anteroposterior displacement eyes open(mm/s)	0.89 ± 0.51 (0.46–1.32)	0.70 (0.52)	0.88 ± 0.34 (0.58–1.17)	0.77 (0.53)	0.715*	−0.365
X displacement eyes closed (mm)	11.96 ± 6.99 (6.12–17.81)	10.65 (5.80)	11.28 ± 7.68 (4.86–17.70)	11.10 (8.21)	0.735*	−0.338
Y displacement eyes closed (mm)	20.90 ± 9.66 (12.81–28.98)	23.15 (16.12)	21.63 ± 13.82 (10.06–33.19)	26.17 (27.22)	0.866*	−0.169
Surface eyes closed (mm^2)	20.04 ± 15.32 (7.23–32.85)	18.27 (18.01)	33.06 ± 22.36 (14.36–51.76)	29.35 (28.26)	0.018*	−2.371
Medium speed of the laterolateral displacement eyes closed (mm/s)	1.31 ± 0.40 (0.97–1.64)	1.22 (0.77)	1.46 ± 0.52 (1.02–1.90)	1.47 (1.11)	0.175*	−1.357
Medium speed of the anteroposterior displacement eyes closed(mm/s)	1.14 ± 0.33 (0.86–1.40)	1.07 (0.53)	1.25 ± 0.37 (0.93–1.56)	1.22 (0.68)	0.175*	−1.355

Abbreviations: CI, confidence interval; SD, standard deviation; RI, range interquartile.

*p Value from Wilcoxon signed-rank test; a p value <0.05 with a confidence interval of 95% was considered statistically significant.

performed on subjects where dry needling was performed on both feet to eliminate the disturbance due to asymmetric intervention, but the authors are aware that isolated dry needling is common and the balance disturbance in these cases may be different. Future comparative studies with different population groups and with different foot interventions will be necessary to frame the findings.

6 | CONCLUSION

After the application of dry needling therapy in the FDB muscle, standing postural control is reduced in the conditions: Surface with eyes closed, medium speed of the laterolateral displacement with eyes closed, and medium speed of the anteroposterior displacement with eyes closed.

AUTHOR CONTRIBUTIONS

All authors have contributed at all stages of the research development.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data will be shared upon motivated request to evamam03@ucm.es.

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