Pain Medicine, 00(0), 2021, 1–4
doi: 10.1093/pm/pnab274
Advance Access Publication Date: 14 September 2021
Technical Note

Safety of Dry Needling of the Pronator Teres Muscle in Cadavers: A Potential Treatment for Pronator Syndrome

César Fernández-de-las-Peñas, PT, PhD,[*,†] Carlos López-de-Celis, PT, PhD,[‡,§] Jacobo Rodríguez-Sanz, PT, PhD,[‡,§] César Hidalgo-García, PT, PhD,[¶] Joseph M. Donelly, PT, DHSc,[‖] Simón A. Cedeño-Bermúdez, PT,[‡,§] and Albert Pérez-Bellmunt PT, PhD[‡,§]

*Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation, Universidad Rey Juan Carlos (URJC), Alcorcón, Madrid, Spain; [†]Cátedra Institucional en Docencia, Clínica e Investigación en Fisioterapia: Terapia Manual, Punción Seca y Ejercicio Terapéutico, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain; [‡]Faculty of Medicine and Health Sciences, Universitat Internacional de Catalunya (UIC-Barcelona), C/Josep Trueta s/n. Sant Cugat del Vallès, Barcelona, Spain; [§]ACTIUM Functional Anatomy Group, Barcelona, Spain; [¶]Unidad de Investigación en Fisioterapia, Universidad de Zaragoza, Zaragoza, Spain; and [‖]Department of Physical Therapy, University of Saint Augustine for Health Sciences—Miami Campus, Coral Gables, Florida, USA

Correspondence to: César Fernández de las Peñas, PT, PhD, Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n 28922 Alcorcón, Madrid, Spain. Tel: + 34 91 488 88 84; Fax: +34 91 488 89 57; E-mail: cesarfdlp@yahoo.es/cesar.fernandez@urjc.es.

Funding source: No funds were received for this study.

Conflicts of interest: There are no conflicts of interest to report.

Carlos López-de-Celis and Albert Pérez-Bellmunt contributed equally.

Received on 23 June 2021; revised on 27 August 2021; Accepted on 2 September 2021

Abstract

Background. Entrapment of the median nerve at the pronator teres muscle can contribute to symptoms in the forearm and wrist. The pronator teres is also involved in patterns of spasticity observed in people who had suffered a stroke. Research on treatment efficacy with dry needling is scarce. **Objective.** To determine if a solid filiform needle safely penetrates the pronator teres muscle during the clinical application of dry needling. **Design.** A cadaveric descriptive study. **Methods.** Needle insertion of the pronator teres was conducted in ten cryopreserved forearms with a 30 ×0.32 mm filiform needle. With the forearm supinated, the needle was inserted 3 cm distal to the mid-point between the biceps tendon insertion and the medial epicondyle. The needle was advanced in a cranial and medial direction to a depth clinically judged to be in the pronator teres muscle. Safety was assessed by measuring the distance from the needle to the surrounding neurovascular bundles. **Results.** Accurate needle penetration of the pronator teres was observed in 100% of the specimens (mean needle penetration: 16.7 ± 4.3 mm, 95% confidence interval [CI] 13.6 to 19.7 mm). No neurovascular bundles were pierced in any of the specimen's forearms. The distances from the tip of the needle to the surrounding neurovascular bundles were 16.4 ± 3.9 mm (95% CI 13.6 to 19.2 mm) to the ulnar nerve (A), 9.0 ± 2.2 mm (95% CI 7.3 to 19.5 mm) to the median nerve (B), and 12.8 ± 4.0 mm (95% CI 10.0 to 15.7 mm) to brachial artery (C). **Conclusions.** The results from this cadaveric study support the assumption that needling of the pronator teres using described anatomical landmarks can be accurately and safely conducted by an experienced clinician.

Key Words: Pronator Teres; Dry Needling; Cadaver; Safety; Median Nerve; Brachial Artery

Introduction

Symptoms associated with the entrapment of the median nerve are usually diagnosed as carpal tunnel syndrome; however, preliminary evidence suggests that muscle referred pain can also mimic symptoms compatible with this syndrome [1]. The median nerve can be entrapped at different anatomical locations throughout its course [2].

An important, and sometimes underreported, potential entrapment zone of the median nerve is between the pronator teres humeral (superficial) and ulnar (deep) heads [2]. The compression of the median nerve at this location is called "pronator syndrome" [3]. Pronator syndrome is associated with sensory changes on the palmar side of the first three fingers (similar to carpal tunnel syndrome) and motor deficits in the muscles innervated by the anterior interosseus and the palmar nerve branches [3].

There is a paucity in the literature regarding treatment interventions for pronator syndrome. Some authors proposed manual therapy interventions applied to the pronator teres for the management of carpal tunnel syndrome [4], whereas others proposed the application of dry needling [5]. The pronator teres could contribute to forearm and wrist symptoms in two different ways. First, the pain referral pattern from the pronator teres muscle spreads to the volar radial region of the forearm/wrist which could mimic sensory impairments compatible with nerve entrapment [5]. Second, an increased tension and shortening of the pronator teres due to overuse or the presence of muscle taut bands could contribute to entrapment syndromes of the median nerve mimicking a pronator syndrome [5]. Pronator teres referred pain can also be involved in the symptomatology experienced by people with medial epicondylalgia [5]. Additionally, since the pronator teres is also involved in flexor pattern of the upper extremity, dry needling has been shown to be effective for treating spasticity of the upper extremity in people who had suffered a stroke [6].

Due to the anatomical relationship between the median nerve and the pronator teres, dry needling could present a potential risk of piercing or injuring the neurovascular bundle. Although most adverse events experienced with dry needling are described as minor (e.g., mild bleeding, bruising, pain), major events (e.g., neuropraxia) can also occur [7].

Ultrasound-guided approaches are proposed for median nerve stimulation at the pronator teres; however, ultrasound imaging is not readily available for daily clinical practice of dry needling. Anatomical landmarks represent the most common clinical method for applying dry needling. Park et al described that the safest needle electromyographic insertional site for evaluating the pronator teres muscle is 2–3.5 cm distal to the mid-point between the biceps tendon insertion and the medial epicondyle of the humerus with the needle inserted cranially and medial [8]. No anatomical study has investigated if a solid filiform needle, as used clinically with dry needling, accurately and safely penetrate the pronator teres. Therefore, the aim of this study was to determine the safety of dry needling the pronator teres by measuring the distance between the needle and surrounding neurovascular bundles in a cadaver model.

Methods

Cadaveric Sample

Ten cryopreserved forearm cadaver specimens donated to the institutional university anatomy laboratory of Barcelona University (Spain) were used. The forearm specimens were visually inspected for evidence of surgery, trauma, or any anatomical abnormalities that could influence the study. The frozen specimens were stored at −20°C and were thawed to room temperature 24 hours prior to the experiment. This study was approved by the Local Ethics Committee of the Barcelona University (CBA-2020-2A).

Needling Procedure

Dry needling technique was conducted by a clinician with more than ten years of experience utilizing sterile stainless-steel filiform needles with a plastic cylindrical guide, 30 mm in length and 0.32 mm caliber which are typically used in clinical practice. With the forearm supinated, the needle was inserted 3 cm distal to the midpoint between the biceps tendon insertion and the medial epicondyle, and advanced in a cranial and medial direction to a depth clinically judged to reach the pronator teres (Figure 1).

Anatomical Procedure

Cross-sectional anatomical dissections at the needle insertion point were conducted for the anatomical study. The filiform needle was left in situ during the cross-sectional anatomical dissection for proper visualization of the tip of the needle. Once the cross-sectional anatomical dissection was conducted, blue latex was injected with a hypodermic beveled, cutting edge needle to depict where the tip of the filiform needle was located to determine the accuracy of the insertion into the pronator teres. Finally, cross-sectional anatomical dissections at the needle insertion point were photographed and analyzed by photometry for measuring the distances in relation to the neurovascular bundles (Figure 2):

1. Needle tip to ulnar nerve (A): The distance (mm) between the tip of the needle and the ulnar nerve.

2. Needle tip to median nerve (B): The distance (mm) between the tip of the needle and the median nerve.

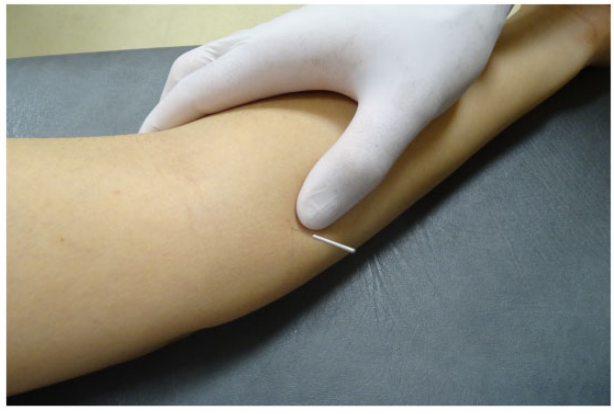

Figure 1. Illustration of needling insertion of the pronator teres muscle in a living individual.

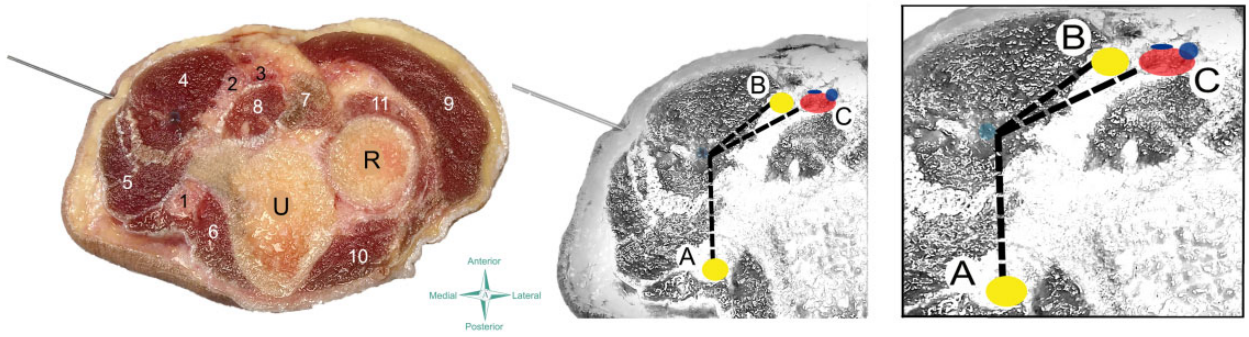

Figure 2. Scheme of the needling procedure of the pronator teres on a cadaver (left) and anatomical draws (center and right). U: ulnar R: radio; 1: ulnar nerve; 2: median nerve; 3: brachial artery; 4: pronator teres humeral head; 5; flexor digitorum superficialis; 6: flexor carpi ulnaris; 7: biceps brachii muscle; 8: brachial muscle; 9: lateral wrist extensor muscles; 10: posterior wrist extensor muscles; 11: supinator muscle. (**A**) distance from needle tip to ulnar nerve; (**B**) distance from needle tip to median nerve; (**C**) distance from needle tip to brachial artery.

3. Needle tip to brachial artery (C): The distance (mm) between the tip of the needle and the brachial artery bundle.

The needle penetration (the length of the needle inserted) for targeting the pronator teres was also measured.

Results

Needling of the pronator teres was conducted on ten cryopreserved forearms (40% females; mean age: 71, SD: 9 years, 40% left). The dissection analysis revealed that the tip of the needle pierced the pronator teres belly in all forearms (accuracy 100%). The needle was inserted a mean depth of 16.7 ± 4.3 mm (95% confidence interval [CI] 13.6 to 19.7 mm) to reach the pronator teres (Figure 2 **left image**).

The neurovascular bundles were not pierced during needling trials in any specimen forearms. The distances from the tip of the needle to the surrounding neurovascular bundles were 16.4 ± 3.9 mm (95%CI 13.6 to 19.2 mm) to the ulnar nerve (A), 9.0 ± 2.2 mm (95%CI 7.3 to 19.5 mm) to the median nerve (B), and 12.8 ± 4.0 mm (95% CI 10 to 15.7 mm) to brachial artery (C).

A preliminary analysis by gender revealed that the needle was inserted a mean depth of 15.5 ± 4mm and of 17.5 ± 4.5 mm to reach the pronator teres in female and male cadavers, respectively. The distances from the tip of the needle to the surrounding neurovascular bundles were also similar between female (16.2 ± 1.5 mm to the ulnar nerve -A-, 7.5 ± 1.3 mm to the median nerve -B-, and 12.5 ± 4.0 mm to brachial artery -C-) and male (16.5 ± 5.1 mm to the ulnar nerve -A-, 9.8 ± 2.3 mm to the median nerve -B-, and 13.0 ± 4.4 mm to brachial artery -C-) forearms specimens.

Discussion

The results of this cadaveric study found that clinical application of dry needling penetrated the pronator teres with an accuracy of 100% using the anatomical landmarks described for the needling procedure. The results also demonstrate that the procedure is safe with no penetration of the anatomically related neurovascular bundles related to needling this muscle. We found that dry needling of the pronator teres using this approach provided enough space to avoid penetration of the median (9 mm) and ulnar (15 mm) nerves supporting the potential safety of the procedure. These distances were similar between male and female forearm cadavers, although this assumption must be considered with caution at this stage due to the small number of specimens used in the study. Hence, considering that a solid filiform needle has a gauze of 0.32 mm, these distances can be considered safe.

In this study, the needle was inserted to a depth of 16.7 ± 4.3 mm to penetrate the pronator teres. Based on current data, no more than 20 mm of the needle should be inserted during clinical application of dry needling of the pronator teres. Our results agree with a prediction model for the selection of needle length where needles ranging from 13 mm to 25 mm exhibited predictive values of 92% and 100% respectively based on the forearm circumference [9]. A cut-off value of 27.5 cm of forearm circumference was calculated to determine the needle length for preventing median nerve piercing (damage) during dry needling of the pronator teres [9]. Current and previous findings support the safety of dry needling of the pronator teres in relation to the median nerve using anatomical landmarks described in the current study. However, clinicians should also consider the presence of anatomical variations, which would require different depths of needle insertion.

This study supports an accurate and safe placement of a solid filiform needle in the pronator teres which has implications for clinical application of this dry needling technique. First, dry needling of the pronator teres could be safely administered in patients with pronator syndrome or carpal tunnel syndrome. Dry needling could be effective for treating the referred pain elicited from the pronator teres or for decreasing muscle tension associated with the

presence of trigger point taut bands in the muscle. A potential decrease of muscle tension in the "pronator teres" interface could improve the neurodynamics of the median nerve at this point. Second, dry needling of the pronator teres has been shown to be effective for treating spasticity of the upper extremity in people who had suffered a stroke [6]. The results of this study should be considered by clinicians preforming dry needling of the pronator teres in patients with these conditions to avoid injury to the median or ulnar nerve during their approaches. In addition, individuals with other elbow/wrist pain syndrome associated with trigger points in the pronator teres (e.g., medial epicondylalgia) may also benefit from the dry needling approach utilized in this study.

Some limitations of this investigation should also be recognized. First, dissections were conducted in a small sample size (10 forearm specimens). Due to the small sample size, gender analyses in needle placement should be considered with caution. Furthermore, an investigation of wrist anthropometric data [9] should be conducted to see the influence of the observed distances to the surrounding neurovascular bundles. Second, manual identification of anatomical landmarks is a requisite for a successful needle insertion into the targeted muscle. We used a standardized anatomical landmark for targeting the pronator teres, however, clinicians should consider that myofascial trigger points tend to be present at the neuromuscular junction and their location in the pronator teres muscle may differ from the anatomical landmarks used in this study. Third, all needling insertions were conducted once by an experienced clinician on cadaver specimens. We do not currently know the safety and accuracy of dry needling approaches when applied to viable tissues or by unexperienced clinicians.

Conclusion

The results of this cadaveric study support the hypothesis that dry needling of the pronator teres is an accurate and safe procedure when conducted with a solid filiform needle of 30 mm in length utilizing described anatomical landmarks when applied by an experienced clinician.

References

1. Qerama E, Kasch H, Fuglsang-Frederiksen A. Occurrence of myofascial pain in patients with possible carpal tunnel syndrome: A single-blinded study. Eur J Pain 2009;13(6):588–91.
2. Soubeyrand M, Melhem R, Protais M, Artuso M, Crézé M. Anatomy of the median nerve and its clinical applications. Hand Surg Rehabil 2020;39(1):2–18.
3. Adler JA, Wolf JM. Proximal median nerve compression: Pronator syndrome. J Hand Surg Am 2020;45(12):1157–65.
4. Hains G, Descarreaux M, Lamy AM, Hains F. A randomized controlled (intervention) trial of ischemic compression therapy for chronic carpal tunnel syndrome. J Can Chiropr Assoc 2010;54 :155–63.
5. Donnelly J, ed. Travell, Simons & Simons' Myofascial Pain and Dysfunction: The Trigger Point Manual, 3rd edition. Philadelphia: Wolters Kluwer; 2019.
6. Ansari N, Naghdi S, Fakhari Z, Radinmehr H, Hasson S. Dry needling for the treatment of poststroke muscle spasticity: A prospective case report. NeuroRehabilitation 2015;36(1):61–5.
7. Boyce D, Wempe H, Campbell C, et al. Adverse events associated with therapeutic dry needling. Int J Sports Phys Ther 2020;15 (1):103–13.
8. Park MK, Cheong IY, Kim KH, Park BK, Kim DH. Anatomical basis of pronator teres for electromyography needle placement using ultrasonography. Ann Rehabil Med 2015;39(1):39–46.
9. Ferrer-Peña R, Calvo-Lobo C, Gómez M, Muñoz-García D. Prediction model for choosing needle length to minimize risk of median nerve puncture with dry needling of the pronator teres. J Manipulative Physiol Ther 2019;42(5):366–37.